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Examining Middle School Students' Attitudes Toward Resource Recovery in Terms of Selected Variables

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ABSTRACT

The purpose of this study was to determine middle school students' attitudes toward resource recovery and examine these attitudes in terms of gender, grade level, and household waste separation level. The study was designed as a descriptive survey within the framework of quantitative research. The sample consisted of 249 students enrolled in Grades 5-8 at a public middle school located in Istanbul, Türkiye. Data were collected using a "Personal Information Form" and the "Attitude Scale Toward Resource Recovery for Middle School Students"[1]. Students' attitudes toward resource recovery were determined based on the total scores obtained from the attitude scale, whereas a Household Waste Separation Level Index was constructed using the items related to waste separation practices at home. Descriptive statistics were used to summarize the data. Group differences were examined through an independent samples t-test and analysis of variance, while relationships between the variables were investigated using correlation and linear regression analyses. The findings showed that students' attitudes toward resource recovery were generally high. A significant difference in resource recovery attitudes was found according to gender, in favor of girls. No significant difference in resource recovery attitudes was found according to grade level. A positive and significant relationship was found between household waste separation level and attitudes toward resource recovery. Moreover, household waste separation level significantly predicted students' attitudes toward resource recovery. These findings indicate that supporting school-based environmental education through family involvement and household waste

separation practices is important for fostering middle school students' attitudes toward resource recovery.

Keywords
Environmental Education
Middle School Students
Recycling Attitude
Resource Recovery

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Introduction

Sustainability has become a critical issue not only in environmental policy but also in education. Waste and the depletion of natural resources have become more prominent and unavoidable problems in day-to-day life. For this reason, recycling, reuse, and waste separation have become indispensable practices to reduce, recover, and manage waste. In this respect, resource recovery goes beyond technical issues related to waste management; it has become an educational priority to raise students' awareness, attitudes, values, and responsible practices related to sustainability. In this regard, school education plays a critical role in not only teaching students about environmental issues but also in fostering their attitudes toward recycling, reuse, waste separation, and resource recovery. Studies on children's pro-environmental behaviors emphasize the importance of developing environmentally sensitive orientations through school-based education as well as family and social interactions [2].

Science education is of particular importance in this respect since it provides students with the opportunity to interpret natural events, matter, and energy and to develop responsible behaviors toward the environment. Topics related to waste generation, recycling, use of natural resources, ecosystems, energy, and pollution are included in science education as integral components of sustainable living and have significant implications for students' daily lives. The recent science curriculum for middle school students covers the topic of recycling and sustainable living in an integrated manner throughout the curriculum. In particular, students are expected to be able to differentiate between recyclable and non-recyclable waste materials at home and to make inferences about the importance of recycling and care about waste management [3]. According to the previous science curriculum, students are also expected to develop environmental awareness, attitudes, and responsible behaviors related to recycling and the sustainable use of natural resources [4]. These expectations highlight the importance of fostering students' attitudes toward recycling and resource recovery.

The affective aspects of resource recovery are of particular importance since knowledge and awareness are not sufficient for the development of responsible behaviors. In

other words, students' knowledge about recycling and resource recovery may not be compatible with their attitudes, values, and behaviors related to waste management. Attitudes are considered to be a critical variable in this respect and have been the subject of considerable research in environmental education. The Theory of Planned Behavior highlights the significance of attitudes in the theory-planned relationship between attitudes and behaviors [5]. Attitude toward behavior, subjective norms, and perceived control over behavior are regarded as predictors of behavioral intention, which, in turn, determines behavior. With regard to the topic of the study, the focus of this study is students' attitudes toward resource recovery as an affective reaction to education on recycling and sustainable living. It is not the objective of this study to test the proposed model but rely on the theory to investigate the role of attitudes.

The analysis of the role of attitudes in influencing pro-environmental behavior is timely as recent studies stress the importance of assessing attitudes in combination with knowledge, awareness, and behavior. Pan and Liu [6], for instance, applied an extended theory of planned behavior to the analysis of adult and children's waste separation behavior. The authors found that for children, attitude, knowledge, and awareness were significant predictors of waste separation behavior. This finding has important implications for science education as it suggests the need for taking students' attitudes into account when designing educational interventions on recycling and waste management. In other words, when analyzing students' behavioral responses to environmental education, researchers should recognize the mediating role of attitudes, awareness, and knowledge in influencing behavior. In this respect, the current analysis contributes to science education research by providing insight into students' attitudes toward resource recovery.

Students' attitudes toward resource recovery might also be shaped by their attitudes and behaviors in the home environment and school. In the context of environmental education, school-age children's recycling attitudes and behaviors are determined by their parents' recycling attitudes and behaviors [7]. Šorytė and Pakalniškienė [8] similarly found that parental recycling behavior predicted children's recycling attitudes, whereas school attendance predicted recycling awareness. In turn, Deng et al. [9] demonstrated that children could shape their families' recycling attitudes and behaviors. De Iaco and Maggio [10] suggest that young people's attitudes toward separate waste collection should be interpreted within the contexts of school, home, and leisure time. Accordingly, the role of the family in shaping school-age children's recycling attitudes and behaviors should be taken into account in science education research and practice. Specifically, students' recycling attitudes and behaviors should be investigated within the context of the family and home recycling practices. In this

respect, the present study aims to investigate the influence of students' home waste separation practices on their attitudes toward resource recovery.

This home context is particularly important since children are exposed to and learn recycling practices from their families. Whether families separate waste at home and whether they have a separate bag or bin for recyclable materials can be considered as important indicators of their recycling attitudes and practices. In other words, home waste separation practices provide students with opportunities to engage in recycling activities. When students' families engage in recycling practices, such as waste separation, they can become more aware of and involved in recycling and resource recovery efforts. In this respect, investigating home waste separation practices can provide important insights into students' attitudes toward resource recovery. In this study, home waste separation practices were considered as a set of practices, including waste separation at home, separate bag/bin for recyclable materials at home, and the frequency of waste separation practices at home. These practices were combined to form a composite index of home waste separation level.

Studies on recycling emphasize the importance of investigating gender differences. In particular, girls are expected to display more pro-environmental attitudes and behaviors than their male counterparts. However, findings on gender differences are not always consistent, and the influence of gender seems to vary depending on the context and the variables under investigation. Konstantinidou et al. [11], in their systematic review on attitudes and practices related to waste reduction, separation, and recycling, reported that gender was one of the variables that were frequently investigated. Similarly, grade level is a frequently investigated variable, but findings are mixed as well. Students' attitudes toward resource recovery were expected to differ according to their grade levels since they were exposed to different science curricula and topics related to recycling and sustainable living. In particular, students in 5th, 6th, 7th, and 8th grades were exposed to different science curricula and topics related to sustainability, ecosystems, energy, and matter. However, it is important to note that the curriculum for middle school students was implemented within the framework of different grade levels. In other words, the differences between the 5th, 6th, 7th, and 8th grades were considered as differences within the same curriculum. Thus, grade level was considered as a variable, whereas the differences related to the curriculum were considered as contextual factors. In this study, the aim was not to investigate the influence of the curriculum on students' attitudes toward resource recovery but to examine whether these attitudes differed according to students' grade levels. In this respect, the focus was on gender differences and grade level as independent variables as well as students' attitudes toward resource recovery as a dependent variable. The influence of home waste separation practices was also investigated.

Studies on waste and recycling have made significant contributions to science education by emphasizing the importance of teaching recycling and sustainable living. In particular, Taşan [12] reported that students' knowledge and awareness of waste and recycling were generally insufficient, but projects and activities facilitated positive changes in students' knowledge, attitudes, and behaviors. Mustafaoğlu and Alkan [13], in their quantitative study on middle school students' recycling behaviors, reported that students' recycling behaviors could be predicted by several environmental and cognitive variables. These studies highlight the importance of investigating recycling-related variables, including attitudes, in middle school students. However, most studies focus on students' knowledge, attitudes, and behaviors related to recycling and sustainable living. Attitudes toward resource recovery, in particular, are a critical construct in this respect since they reflect students' affective responses to learning about recycling, reuse, and sustainable living. In addition, most studies investigate recycling practices within the school context but do not consider home practices. In particular, home waste separation practices are considered an important contextual factor but are not always investigated as an independent variable. Thus, investigating students' attitudes toward resource recovery in conjunction with gender, grade level, and home waste separation practices can contribute to science education by providing quantitative evidence on students' affective responses to learning about recycling and sustainable living.

The aim of this study was to determine middle school students' attitudes toward resource recovery and to examine whether these attitudes differed according to gender, grade level, and home waste separation practices. The study was conducted with students in grades 5 through 8 in order to include all middle school students. In this respect, the study aimed to investigate whether students' attitudes toward resource recovery differed according to their grade levels. In addition, the study aimed to examine whether students' attitudes toward resource recovery differed according to their gender. Finally, the study aimed to investigate whether home waste separation practices were associated with students' attitudes toward resource recovery. In addition, students' home waste separation practices were investigated in terms of waste types and delivery points. In line with these aims, the following research questions were investigated:

1. What is the level of students' attitudes toward resource recovery?
2. Do students' attitudes toward resource recovery differ significantly according to gender?
3. Do students' attitudes toward resource recovery differ significantly according to grade level?
4. Is household waste separation level significantly associated with middle school students' attitudes toward resource recovery?

5. What household waste separation practices do students report in terms of waste types and delivery points?

Material and Methods

A. Research Model

This study was designed as a descriptive survey within the scope of quantitative research. Descriptive survey research is used to describe the characteristics of a population or sample at a particular point in time [14]. In this respect, this study was designed as a descriptive survey to describe middle school students' attitudes toward resource recovery, to examine whether these attitudes differed according to gender and grade level, and to investigate their relationship with household waste separation practices.

B. Sample

The sample consisted of 249 students in Grades 5–8 attending a public middle school located in the Sultangazi district of Istanbul, Türkiye. Convenience sampling was used, and participation was voluntary. The distribution of the sample by gender and grade level is presented in Table 1.

Table 1. Distribution of students by gender and grade level

Variable	Category	f	%
Gender	Female	122	49.0
	Male	127	51.0
Grade level	5th grade	92	36.9
	6th grade	51	20.5
	7th grade	51	20.5
	8th grade	55	22.1
	Total	249	100.0

As shown in Table 1, the sample was almost balanced in terms of gender, with 122 girls and 127 boys. Regarding grade level, the sample included students from all middle school grade levels: 92 students from 5th grade, 51 from 6th grade, 51 from 7th grade, and 55 from 8th grade. Participation in the study was voluntary. Only students whose parents provided consent and who agreed to participate were included in the study. No directly identifying personal information, such as students' names, was included in the data set.

C. Data Collection Tools

Research data was collected by the Personal Information Form and the Attitude Scale Toward Resource Recovery for Middle School Students. The Personal Information Form was developed by the researchers to collect information about students' gender, grade level, and household waste separation practices. On the form, students responded to questions about whether waste was separated at home and whether a separate bag/bin was used for recyclable materials (yes/no). Another question concerned how often waste was separated at home (always/often/sometimes/rarely/never). The mentioned three questions were used to

calculate the Household Waste Separation Level Index. The first two items were scored dichotomously: "Yes" responses were coded as 1 and "No" responses were coded as 0. For the frequency item, responses were scored from 4 ("Always") to 0 ("Never"). Thus, the possible scores ranged from 0 to 6 as the three items were combined into an index; higher scores indicated higher levels of household waste separation. The responses "Not sure" were coded as missing as they did not provide clear information about whether the students' families engaged in waste separation. The form included additional questions for students to report on the types of waste separated at home and where the separated waste was brought. These questions were analyzed descriptively and were not used to calculate the index.

The Attitude Scale Toward Resource Recovery for Middle School Students developed by Gökçe et al. [1] was used to measure students' attitudes toward resource recovery. The scale consisted of 14 items related to waste reduction, reuse, recycling, protection of natural resources, and resource recovery practices. Students rated their attitudes using a Likert-type three-point response scale that included the following options: Agree, No idea, and Disagree. In the analysis, the responses were scored as 3, 2, and 1, respectively. The total score was calculated by summing the scores on all items. Thus, the scale score ranged from 14 to 42, with higher scores indicating more positive attitudes toward resource recovery. According to the results of the original study, the scale had a one-dimensional structure with an explained variance of 44.55 and a Cronbach's alpha of .90 [1]. For the current study, Cronbach's alpha was calculated to assess the internal consistency of the scale.

D. Data Collection and Analysis

Data were collected after obtaining the necessary permissions and ethical approval. The application of the measures to the participants was organized in accordance with the schedule provided by the school administration. In particular, the Personal Information Form and Attitude Scale Toward Resource Recovery for Middle School Students were implemented in classes during one session that lasted 20-25 minutes.

After data collection, the forms were reviewed and the data were prepared for analysis. The data set was checked for missing responses, response errors, and out-of-range values. The Resource Recovery Attitude Total Score was calculated by summing the scores on the items of the Attitude Scale Toward Resource Recovery for Middle School Students. Scores ranged from 14 to 42, with higher scores indicating more positive attitudes toward resource recovery. The Household Waste Separation Level Index was computed using responses to three questions included in the Personal Information Form. The index was calculated only for students who provided valid responses to all three items. Responses indicating uncertainty were treated as missing values because they did not clearly indicate the presence or absence of household waste separation practices. Consequently, analyses involving the index were based on 152

valid cases. Descriptive statistics were then calculated to summarize the sample and the variables of interest. Frequencies and percentages were reported for categorical variables, including gender and grade level. For the Resource Recovery Attitude Total Score and the Household Waste Separation Level Index, means, standard deviations, minimum values, and maximum values were reported. Cronbach's alpha was calculated to assess the internal consistency of the Attitude Scale Toward Resource Recovery for Middle School Students.

Before inferential analyses, the assumptions for parametric tests were examined. Skewness and kurtosis values were used to evaluate normality, and Levene's test was used to assess the homogeneity of variances. An independent samples t-test was conducted to examine whether students' attitudes toward resource recovery differed significantly according to gender. One-way analysis of variance was used to examine differences according to grade level. When the homogeneity of variance assumption was violated, Welch ANOVA was used.

The relationship between household waste separation level and attitudes toward resource recovery was examined using Pearson correlation analysis. In addition, multiple linear regression analysis was conducted to determine whether household waste separation level significantly predicted students' attitudes toward resource recovery when gender and grade level were included in the model. The items related to the types of waste separated at home and where separated waste was delivered were analyzed descriptively using frequencies and percentages. An alpha level of .05 was used to determine statistical significance in all inferential analyses.

Results

In this section, the results are presented in line with the research questions of the study. First, descriptive statistics for the Resource Recovery Attitude Total Score and the Household Waste Separation Level Index are reported. Then, the findings related to gender, grade level, and household waste separation level are presented respectively.

A. Resource Recovery Attitudes and Household Waste Separation Level

Descriptive statistics for the Resource Recovery Attitude Total Score and the Household Waste Separation Level Index are presented in Table 2.

Table 2. Descriptive statistics for resource recovery attitude and household waste separation level

Variable	N	Min	Max	$\bar{X}$	SD	Cronbach's α
Resource Recovery Attitude Total Score	249	16	42	37.49	3.89	.75
Household Waste Separation Level Index	152	0	6	2.77	1.84	—

As shown in Table 2, the mean Resource Recovery Attitude Total Score was 37.49 out of a possible maximum score of 42. The Cronbach's alpha coefficient calculated for the Attitude Scale Toward Resource Recovery for Middle School Students in the present sample was .75.

The Household Waste Separation Level Index was calculated for 152 valid cases, and the mean score was 2.77 on a scale ranging from 0 to 6.

B. Resource Recovery Attitudes by Gender

An independent samples t-test was conducted to determine whether students' attitudes toward resource recovery differed significantly according to gender. The results are presented in Table 3.

Table 3. Independent-samples t-test results for resource recovery attitude scores by gender

Gender	N	$\bar{X}$	SD	t	df	p	Cohen's d
Female	122	37.99	3.71	2.02	247	.044	.26
Male	127	37.00	4.01				

The independent samples t-test showed a statistically significant difference in Resource Recovery Attitude Total Scores according to gender, $t(247) = 2.02$, $p = .044$. The mean score of girls was higher than that of boys. The effect size was small, Cohen's $d = .26$.

C. Resource Recovery Attitudes by Grade Level

Welch ANOVA was used to examine whether students' attitudes toward resource recovery differed significantly according to grade level, because the homogeneity of variance assumption was not met. Descriptive statistics for resource recovery attitude scores by grade level are presented in Table 4.

Table 4. Descriptive statistics for resource recovery attitude scores by grade level

Grade level	N	$\bar{X}$	SD
5th grade	92	38.29	2.89
6th grade	51	36.92	4.20
7th grade	51	37.51	2.71
8th grade	55	36.64	5.50
Total	249	37.49	3.89

Note. Levene's test indicated that the assumption of homogeneity of variances was violated, $F(3, 245) = 4.42$, $p = .005$; therefore, Welch ANOVA was used.

The analysis indicated that resource recovery attitude scores did not differ significantly according to grade level, Welch's $F(3, 115.15) = 2.60$, $p = .055$. Accordingly, no post hoc comparisons were conducted.

D. Relationship Between Household Waste Separation Level and Resource Recovery Attitudes

Pearson correlation analysis was conducted to examine the relationship between the Household Waste Separation Level Index and Resource Recovery Attitude Total Score. The results showed a positive and statistically significant relationship between the two variables, $r = .31$, $p < .001$. Multiple linear regression analysis was then conducted to determine whether

household waste separation level predicted students' attitudes toward resource recovery when gender and grade level were included in the model. The results are presented in Table 5.

Table 5. Multiple regression analysis predicting resource recovery attitude

Predictor	Unstandardized B	SE	t	p
Constant	36.51	0.81	44.81	<.001
Gender	-0.84	0.63	-1.33	.185
6th grade	-0.79	0.91	-0.87	.384
7th grade	0.04	0.91	0.04	.969
8th grade	-0.90	0.81	-1.12	.265
Household Waste Separation Level Index	.67	.17	3.82	<.001

Note. The analysis was based on 152 valid cases. Reference categories were girls for gender and Grade 5 for grade level.

The regression model was statistically significant, $F(5, 146) = 4.00$, $p = .002$, and explained 12.1% of the variance in Resource Recovery Attitude Total Scores, $R^2 = .121$. Household Waste Separation Level Index was a statistically significant predictor of Resource Recovery Attitude Total Score, $B = 0.67$, $SE = 0.17$, $t = 3.82$, $p < .001$.

E. Household Waste Separation Practices

To provide further information about the household context of waste separation, students' responses regarding the types of waste separated at home and the places where separated waste was usually delivered are presented in Table 6.

Table 6. Students' household waste separation practices by waste type and delivery point

Variable	Category	f	%
Types of waste separated at home	Paper/Cardboard	153	62.4
	Plastic	120	49.0
	Glass	79	32.2
	Metal	42	17.1
	Battery/Electronic waste	105	42.9
	Waste oil	101	41.2
Place where separated waste is delivered	Municipal recycling bin	107	43.0
	School/Institution bin	22	8.8
	Stored and delivered later	20	8.0
	Separated but eventually mixed with general waste	72	28.9
	Not sure	28	11.2

Note. For the types of waste separated at home, more than one response could be selected.

As shown in Table 6, 153 students reported separating paper/cardboard waste at home (62.4%), followed by plastic waste (f = 120, 49.0%), battery/electronic waste (f = 105, 42.9%), and waste oil (f = 101, 41.2%). Glass waste was reported by 79 students (32.2%), while metal waste was reported by 42 students (17.1%). Regarding where separated waste was usually delivered, 107 students (43.0%) reported municipal recycling bins, whereas 72 students (28.9%) stated that the waste was separated but eventually mixed with general waste.

Discussion

The results of the study revealed that middle school students' attitudes toward resource recovery were generally positive. Girls demonstrated significantly more positive attitudes toward resource recovery than boys, whereas no significant difference was found according to grade level. In addition, household waste separation level was positively and significantly associated with students' attitudes toward resource recovery and significantly predicted these attitudes when gender and grade level were included in the model.

The finding that students' attitudes toward resource recovery were generally high indicates that middle school students in the sample tended to report positive orientations toward waste reduction, reuse, recycling, and the protection of natural resources. This result may be considered consistent with the increasing emphasis placed on sustainability, recycling, and responsible waste management in science education curricula. The 2018 and the 2024 Science curricula include learning outcomes related to sustainable living, recycling, waste management, and environmental responsibility [4], [3]. In addition, Gökçe et al. [1] emphasized that resource recovery attitudes among middle school students are related to waste reduction, reuse, recycling, and the protection of natural resources. This interpretation is also supported by broader evidence showing that environmental education can positively influence environmental knowledge, attitudes, intentions, and behaviors among children and adolescents [15]. A recent systematic review similarly identified environmental attitudes and values as important internal factors, while environmental education represents one of the most frequently examined external influences on children's pro-environmental behavior [16]. Therefore, the high attitude scores obtained in the present study may suggest that resource recovery is reflected not only as a curricular topic but also as a positive affective orientation among students.

The gender-based comparison showed that girls had significantly higher resource recovery attitude scores than boys. However, the effect size was small, indicating that the magnitude of this difference was limited and should be interpreted cautiously. Previous studies and reviews have frequently examined gender in relation to environmental attitudes, recycling, waste separation, and sustainability-related practices, but the findings vary across contexts, samples, and measurement tools [11]. A systematic review of adolescents' pro-sustainable behavior identified gender as one of several demographic factors potentially associated with environmental behavior, while also emphasizing that pro-environmental behavior is shaped simultaneously by internal and external factors [17]. In a study of environmentally oriented schools, Wibowo et al. [18] also examined gender differences in students' environmental care attitudes, illustrating that gender-related patterns need to be understood within particular educational and sociocultural settings. Therefore, the gender

difference observed in the present study should not be interpreted as a universal pattern. Rather, it represents a statistically significant but small difference within the specific sample of this study. Future studies conducted in different schools, regions, and socioeconomic contexts may provide further evidence regarding gender differences in attitudes toward resource recovery.

Within the current study, the differences between grades were not statistically significant. Students in Grade 5 had the highest mean score, whereas students in Grade 8 had the lowest mean score. Thus, no consistent tendencies were found in terms of students' attitudes by grade level. During the period in which the study was conducted, some grade levels followed the 2018 Science Curriculum, whereas others were included in the 2024 Science Curriculum [4], [3]. Although both curricula include learning outcomes related to sustainability, recycling, and environmental responsibility, differences in the sequencing and implementation of these outcomes may have influenced students' attitudes toward resource recovery. The absence of a clear grade-level pattern is also plausible in light of meta-analytic evidence showing substantial heterogeneity in environmental education outcomes and finding that participant age did not consistently account for variation in program effects [15]. Future studies may examine whether resource recovery attitudes vary across grade levels under different curriculum implementations.

Another important finding of the study was that students' attitudes toward resource recovery were positively related to their reported household waste separation level. This statistically significant relationship indicated that students who reported higher levels of household waste separation tended to report more positive attitudes toward resource recovery. Moreover, as the results of multiple regression analysis indicate, the relationship between students' attitudes and their families' waste separation level remained significant after controlling for students' gender and grade level. This finding underscores the importance of considering both family and school contexts when studying student attitudes toward resource recovery and pro-environmental behavior in general. Hosany et al. [2] emphasized the importance of family, school, and social experience in shaping children's sustainable behavior. Specifically, Altikolatsi et al. [7] found that the recycling attitudes and behaviors of students' parents predicted their children's recycling attitudes and behaviors. Šorytė and Pakalniškienė [8] similarly found that parental recycling attitudes and behaviors predicted children's recycling attitudes. Furthermore, Deng et al. [9] found that children could influence their families' recycling attitudes and behaviors. More recent evidence supports this bidirectional perspective. Kong and Jia [19] found interdependent relationships between parents' and children's environmental knowledge and pro-environmental behavior, including evidence that children's environmental knowledge may contribute to parents' pro-

environmental behavior. Wang and Li [20] likewise demonstrated that adolescents can influence parental pro-environmental behavior through adolescents' own environmental behavior and knowledge transfer. A cross-national parent–child study in Japan and China further identified bidirectional within-family associations in environmental attitudes and pro-environmental behaviors [21]. This suggests that children and families influence each other, which should be taken into account when analyzing the relationship between children's pro-environmental attitudes and behaviors and those of families. Students may learn from household routines, but they may also contribute to shaping those routines. De Iaco and Maggio [10] also emphasized that young people's attitudes toward separate waste collection should be evaluated within multiple life contexts, including school, family, and everyday life. In this sense, the present finding highlights the importance of household waste separation as a contextual factor associated with students' attitudes toward resource recovery. More importantly, it suggests that environmental attitudes should be examined not only within school settings but also in relation to everyday practices taking place in the home environment.

This result can also be interpreted through the Theory of Planned Behavior. Although the present study did not test the full theoretical model, the positive association between household waste separation level and resource recovery attitudes suggests that attitudes may be connected with the practical and social contexts in which waste-related behaviors occur. According to Ajzen [5], attitudes are among the factors that shape behavioral intention. Pan and Liu [6] also reported that children's waste separation behavior was associated with attitude, knowledge, and awareness. Recent studies provide further support for extending this interpretation beyond attitude alone. Zhou et al. [22] showed that waste separation behavior reflects the combined influence of subjective internal factors and external situational conditions, particularly the convenience of recycling and sorting facilities and education about waste separation. Similarly, Tanjung et al. [23], using an extended TPB approach, found that environmental education, perceived behavioral control, and environmental knowledge were important factors associated with waste separation and recycling intentions. A recent meta-analysis of household waste separation studies further confirmed that intention, attitude, perceived behavioral control, and contextual conditions such as infrastructure and education operate jointly in explaining waste separation behavior [24]. Taken together, these findings support the view that attitudes toward resource recovery are connected with practical experiences and everyday environmental practices rather than being related solely to formal instruction.

The descriptive findings provide additional insight into students' household waste separation practices. Paper/cardboard and plastic were the most frequently separated waste types reported by students. Battery/electronic waste and waste oil were also separated by a

considerable proportion of participants. However, a substantial number of students reported that separated waste was eventually mixed with general waste. This finding suggests that household waste separation practices may not always be maintained throughout the entire waste management process. This distinction between positive attitudes or intentions and consistent waste separation practices is important because situational conditions can facilitate or constrain whether environmentally favorable orientations are translated into behavior [22]–[24]. In particular, accessible sorting and recycling facilities, environmental education, and knowledge about appropriate separation procedures have been identified as important contextual components of effective waste separation systems [22], [23]. Therefore, positive attitudes toward resource recovery should be supported by accessible recycling facilities and effective cooperation among schools, families, municipalities, and other stakeholders involved in waste management. Such cooperation may help translate positive attitudes into more consistent environmental practices at school and in everyday life.

Conclusion

To conclude, this study revealed that middle school students generally held positive attitudes toward resource recovery. While girls demonstrated significantly more positive attitudes than boys, no significant differences were identified across grade levels. Household waste separation level was positively associated with resource recovery attitudes and remained a significant predictor even when gender and grade level were taken into account. These findings highlight the importance of considering resource recovery not only as a topic addressed within science education but also as a practice embedded in students' everyday lives. The study further emphasizes the role of household experiences in shaping students' attitudes toward resource recovery and suggests that effective environmental education should be supported through collaboration among schools, families, and local communities.

Limitation and Suggestions

Based on the findings of this study, several suggestions can be offered. Since middle school students generally demonstrated positive attitudes toward resource recovery, science teachers should continue to integrate recycling, waste reduction, reuse, and sustainable resource use into classroom activities and out-of-school learning experiences. Because girls obtained significantly higher resource recovery attitude scores than boys, future educational practices may place greater emphasis on increasing boys' participation in recycling and resource recovery activities and on examining the possible reasons for this difference. Although no significant difference was found according to grade level, resource recovery education should be maintained systematically throughout all middle school grades in order to preserve and strengthen students' positive attitudes.

The positive relationship between household waste separation level and resource recovery attitudes indicates that school-based environmental education should be supported by family involvement. Schools may develop home-based waste separation activities, parent information sessions, and family participation practices that encourage students and their families to separate recyclable materials together. Since household waste separation level significantly predicted students' resource recovery attitudes, environmental education should not be limited to classroom instruction but should also be connected with household practices. In addition, the finding that a considerable proportion of students reported that separated waste was eventually mixed with general waste points to the need for stronger cooperation among schools, municipalities, and waste management services. Students should be able to observe that their waste separation efforts lead to visible and meaningful environmental outcomes. Recycling bins, battery collection boxes, waste oil collection points, and similar facilities should therefore be made more accessible, and their use should be clearly explained to students.

Future studies should be conducted with larger and more diverse samples from different schools, districts, and regions in order to improve the generalizability of the findings. Since the present study used a cross-sectional survey design, longitudinal studies may provide a clearer understanding of how students' resource recovery attitudes change over time. Intervention-based studies may also examine whether school–family waste separation activities improve students' attitudes and behaviors. Finally, future research may combine quantitative and qualitative methods to explore in greater depth the reasons underlying students' attitudes toward resource recovery and their household waste separation practices.

Conflict of Interest

The authors declare no conflict of interest.

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