

Evaluation of Waste Management System in the School Environment as an Environmental Education Effort

Baharuddin^{1*}, Juardin²

¹Program Studi Hukum Bisnis, Fakultas Agama, UIN Mataram

²Program Studi Ilmu Hukum, Sosial Politik, Universitas Mataram

aldisajianpantarman00@gmail.com, ardanjuardin11@gmail.com



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Abstract : *The problem of waste is one of the environmental issues that is receiving increasing attention in the context of sustainable development, including in the educational environment. Schools as educational institutions not only play a role in transferring knowledge, but also shaping students' awareness and behavior towards the environment. One of the efforts that can be made is through the implementation of a good waste management system in the school environment. This study aims to evaluate the waste management system in the school environment as part of environmental education efforts for school residents. The research method used is a qualitative descriptive approach with data collection techniques through observation, documentation, and literature studies. The results of the study show that the waste management system in schools includes waste sorting activities, the provision of sorted waste bins, organic waste processing through composting, and environmental education activities for students. However, the implementation of the waste management system still faces several obstacles, such as limited facilities, lack of awareness among some school residents, and the lack of optimal integration of environmental education programs in learning activities. Therefore, it is necessary to strengthen school policies, increase the participation of school residents, and integrate environmental education in the curriculum to increase the effectiveness of waste management. This research is expected to contribute to the development of sustainable waste management practices in the school environment and support the formation of environmental care character in students.*

Keywords: *waste management, environmental education, schools, environmental awareness, sustainability.*

INTRODUCTION

Environmental problems are one of the global issues that have received increasing attention in recent decades. Population growth, urbanization, increased consumption, and intensification of economic activities have increased the amount of waste produced by the community. Waste that is not managed properly can cause soil, water, and air pollution. Waste accumulation can also trigger the appearance of bad odors, the development of disease vectors, clogged drainage channels, and a decrease in the quality of environmental health. In the long term, these conditions can disrupt the balance of ecosystems and increase the risk of health problems for the communities living around them (Ferronato & Torretta, 2019; Nanda & Berruti, 2021).

The waste problem is not only related to the amount of waste produced, but also related to human behavior in using, disposing, sorting, and processing residual materials. Waste mixed with organic materials, plastics, paper, metals, and hazardous materials will be more difficult to manage and have the potential to increase negative impacts on the environment. Therefore, waste management needs to be carried out thoroughly from the source. These approaches include reducing the use of single-use items, waste sorting, reusing of viable goods, processing of organic waste, and reusing recyclable materials. Sustainable waste management requires consistent support of systems, facilities, policies, and changes in community behavior.

One important approach to building responsible waste management behaviors is through environmental education. Environmental education not only aims to provide information about environmental conditions, but also builds knowledge, attitudes, skills, awareness, and individual responsibility for the environment. Through environmental education, students can understand the relationship between human activities and the emergence of pollution problems, climate change, degradation of natural resources, and increased waste volumes. Environmental education also encourages learners to make more responsible decisions in their daily lives (Ardoin *et al.*, 2020; Stevenson *et al.*, 2013).

Schools have a strategic position in the implementation of environmental education because schools are a social space where students build knowledge, habits, values, and behavior patterns. The educational process in schools does not only take place through formal learning in the classroom, but also through daily experiences, social interactions, school culture, and the physical environment conditions of the school. In this context, schools can be an effective place to instill environmental care behaviors through real activities. Students can learn to maintain cleanliness, reduce the use of plastics, dispose of waste in its place, sort waste, reuse used items, and participate in environmental management activities.

The school environment also produces various types of waste from the routine activities of school residents. The waste comes from learning activities, the use of stationery, food and beverage consumption, canteen activities, administrative activities, garden maintenance, and the implementation of other school activities. The type of waste produced can be food scraps, dried leaves, paper, cardboard, plastic bottles, food packaging, cans, and certain hazardous material waste. If the waste is not managed properly, the school environment can become dirty, unhealthy, and uncomfortable for school residents. This condition can also reduce the effectiveness of the learning process because students learn in a less supportive environment.

Waste management in schools cannot be understood only as a technical activity in the form of waste collection and disposal. Waste management needs to be positioned as part of the educational process that shapes the habits and character of students. Waste sorting practices, for example, can teach learners to recognize the difference between organic, inorganic, and residual waste. Composting activities can help students understand the process of decomposing organic matter and its use for plants. Meanwhile, recycling activities can foster creativity, responsibility, and awareness that many used materials still have use value.

Environmental education will be more effective if students not only receive information theoretically, but also directly engage in environmental activities. Direct experience can strengthen students' understanding of the impact of human behavior on the environment. Waste management activities that are carried out regularly can form new habits, such as bringing your own food containers, reducing the use of single-use packaging, sorting waste before disposal, and maintaining the cleanliness of classrooms and school yards. Experiential education can also increase students' connection with the environment and encourage the emergence of more consistent pro-environmental behaviors (Otto & Pensini, 2017; Zhao *et al.*, 2024).

However, environmental knowledge does not always automatically result in environmentally friendly behavior. One can understand the negative impact of waste, but not necessarily have the habit of sorting waste or reducing plastic use. Pro-environmental behavior is influenced by various factors, such as knowledge, attitudes, values, social norms, availability of facilities, environmental support, motivation, and opportunities to participate. Therefore, schools need to create a system that supports environmental care behaviors that can be carried out easily, consistently, and become part of the school culture (Bamberg & Möser, 2007; Vicente-Molina et al., 2013).

The waste management system in schools needs to be supported by adequate facilities and infrastructure. Schools need to provide sorted waste bins, waste collection areas, composting facilities, storage places for recyclables, and information media regarding waste management. In addition, schools need to have clear rules regarding plastic use reduction, environmental cleanliness, picket schedules, waste sorting, and the responsibilities of each school citizen. The availability of the right facilities will make it easier for students, teachers, education staff, and other school residents to implement waste management behaviors consistently.

In addition to the facility aspect, the success of school waste management is also influenced by the active participation of all school residents. Teachers have a role in integrating environmental issues into learning. School principals play a role in formulating policies and providing institutional support. Students play the role of the main implementers of daily activities, while education staff and canteen managers play a role in maintaining the implementation of the waste management system on a regular basis. The involvement of all parties is important so that waste management is not only the responsibility of a certain group, but also a shared culture in the school environment.

Environmentally friendly school programs, including the Adiwiyata Program, can be a means to strengthen waste management as part of environmental education. The program emphasizes the integration of school policies, environment-based curriculum, participatory activities, and the management of environmentally friendly supporting facilities. In its implementation, schools are encouraged to build a clean, healthy, safe, and sustainable learning environment. Waste management is one of the important indicators because it is directly related to school cleanliness, resource use, student involvement, and the formation of environmental care behaviors (Siswanto et al., 2019; Saadah et al., 2023).

Several studies in Indonesia show that waste management activities can increase student participation in school environment programs. Activities such as waste sorting, waste banks, composting, recycling, and reducing single-use plastics can be a learning medium that is close to students' daily lives. These activities can also build a sense of shared responsibility for the cleanliness of the school environment. However, the level of student participation can vary depending on the type of activity, the availability of facilities, teacher assistance, and the consistency of program implementation (Ardianti et al., 2024; Hazam et al., 2020).

In practice, there are still schools that have not implemented an optimal waste management system. Obstacles that arise can be in the form of limited sorted waste bins, the unavailability of organic waste treatment facilities, lack of supervision, low awareness among some school residents, and the lack of integration of waste management into learning activities. In some schools, waste management activities are still carried out incidentally, for example only during community service, environmental day commemorations, or cleanliness competitions. These conditions show that waste management needs to be developed as a planned, structured, and sustainable program.

Evaluation of the waste management system in the school environment is important to determine the level of effectiveness of the program that has been implemented. Evaluation can be carried out by looking at several aspects, such as school policies, availability of facilities, sorting mechanisms, collection, processing, involvement of school residents, integration in learning, and supervision and follow-up activities. Evaluation also needs to assess the results obtained, such as changes in school cleanliness conditions, reduced waste volume, increased participation of school residents, and development of attitudes and behaviors caring for the environment in students.

Through systematic evaluation, schools can identify supporting and inhibiting factors in the implementation of waste management. The results of the evaluation can be used as a basis for improving facilities, strengthening policies, increasing school citizen involvement, and developing more effective environment-based learning strategies. Evaluations can also help schools ensure that waste management is not only oriented towards physical hygiene, but also contributes to the formation of environmentally caring character and sustainable behaviour in students.

Based on this description, this study aims to evaluate the waste management system in the school environment as an environmental education effort. This research is expected to provide an overview of the implementation of waste management in schools, identify supporting factors and obstacles faced, and formulate relevant improvement recommendations. In addition, this research is expected to contribute to the development of more effective, participatory, and sustainable waste management practices in order to increase the awareness and concern of school residents for environmental sustainability.

RESEARCH METHODS

This study uses a qualitative descriptive approach to analyze waste management systems in the school environment as part of environmental education efforts. This approach was chosen because the research focuses on a deep understanding of the real conditions, implementation processes, forms of participation of school residents, and various factors that support and hinder waste management in the school environment. The qualitative descriptive approach allows researchers to describe phenomena based on field data contextually without manipulating the observed conditions. With this approach, the research not only identifies the availability of waste management facilities and implementation, but also examines the meaning, experience, and response of school residents to the environmental management programs implemented.

The research was conducted at [school name] located in [address or research area]. The research location was chosen purposively with consideration that the school has or is carrying out activities related to environmental cleanliness, waste management, Adiwiyata programs, or other forms of environmental education activities. The research was carried out from [month and year of research] to [month and year of research]. The timing of the research is adjusted to the conditions and schedule of school activities so that researchers can observe waste management activities directly in situations that occur naturally.

The focus of the research is directed at the waste management system in the school environment. The system includes the availability of school policies, facilities and infrastructure, the process of sorting, collecting, transporting, storing, processing, reuse, and waste disposal. The research also examined the involvement of school principals, teachers, education staff, students, cleaners, canteen managers, and other parties related to the implementation of waste management. In addition, the study paid attention to the relationship between waste management activities and learning, habituation of environmental care behavior, and environmental education programs run by schools.

The data sources in this study consist of primary data and secondary data. Primary data were obtained directly from field conditions and research informants. Primary data was collected through observation, interviews, and documentation of activities related to waste management in schools. Observations were carried out to obtain a factual picture of the condition of the school environment, the type of waste produced, the availability of sorted waste bins, environmental cleanliness, waste collection systems, sorting activities, organic waste processing, inorganic waste utilization, and waste disposal mechanisms implemented by schools.

Observation is carried out directly with the position of the researcher as an observer. During the observation activities, the researcher recorded the physical condition of the school environment, the activities of school residents, the use of waste management facilities, and the form of behavior that shows concern or indifference to environmental cleanliness. The results of observations are recorded in field notes to help researchers document events, conditions, and activities relevant to the research focus. Observations were made in several important areas, such as classrooms, school yards, canteens, parks, teachers' rooms, garbage bin areas, waste treatment facilities, and waste storage locations before being transported or further processed.

Primary data was also obtained through semi-structured interviews with purposively selected informants. The selection of informants is carried out based on their involvement, knowledge, and responsibility in the implementation of waste management in schools. Informants can include school principals, environmental program coordinators or *Adiwiyata*, teachers, education staff, cleaners, canteen managers, and students involved in environmental activities. Interviews were conducted to obtain information about school policies, waste management procedures, the level of school community participation, the form of environmental education activities, obstacles to program implementation, and efforts made to maintain the sustainability of waste management.

Interviews use open-ended questioning guidelines so that informants can explain their experiences, views, and involvement more freely. The interview guidelines were prepared based on the focus of the research, namely the condition of waste management, the role of school residents, support for facilities and infrastructure, integration of environmental education, as well as supporting and inhibiting factors for program implementation. The number of informants is not rigidly set from the beginning, but is adjusted to the needs of data in the field. Data collection is stopped if the information obtained has shown a recurring pattern and no significant new information is found.

Documentation is used to complement and strengthen the data from observations and interviews. Documentation can be in the form of photos of school environmental conditions, photos of waste management activities, program records, picket schedules, environmental education posters, school policies, activity reports, waste bank data, *Adiwiyata* Program documents, and other relevant documents. The document is used to see evidence of the implementation of waste management activities and to compare written policies with practices that occur in the field. The use of documentation also helps researchers obtain data that cannot always be directly observed at the time of the study.

Secondary data is obtained from school documents, government regulations, environmental program reports, and relevant scientific sources. School documents are used to understand the direction of established waste management policies, programs, and procedures. Meanwhile, scientific journals, books, and policy documents are used to build a conceptual framework and strengthen the interpretation of research results. The literature is not positioned as a substitute for field data, but is used to provide theoretical context and compare research findings with previous

research results on waste management, environmental education, and environmental care behaviors.

Data collection is carried out through several interrelated stages. The initial stage is carried out by preparing research instruments in the form of observation guidelines, interview guidelines, and a list of documentation needs. The researcher then conducted preliminary observations to recognize the general condition of the school and determine the relevant areas of the research focus. After that, the researcher conducted more in-depth observations, interviews with informants, and collected supporting documents. All data obtained are recorded, recorded if the informant agrees, and compiled systematically to facilitate the analysis process.

Data analysis was carried out interactively from the time the data collection process took place until the research was completed. Analysis refers to the stages of data condensation, data presentation, and conclusion withdrawal and verification as stated by Miles *et al.* (2014). Data condensation is carried out by selecting, focusing, simplifying, and grouping data that are relevant to the research objective. At this stage, the data from observations, interviews, and documentation are classified based on themes, such as waste management policies, facilities and infrastructure, sorting processes, waste treatment, school community involvement, integration of environmental education, and obstacles to program implementation.

The data that has been condensed is then presented in the form of a systematic narrative description. The presentation of data was carried out by describing the condition of waste management in schools in a sequential manner, starting from the source of waste, type of waste, management mechanism, parties involved, to the results and obstacles found. The presentation of data can also be supplemented with a summary table of findings if needed to clarify the relationship between field conditions, interview results, and documentary evidence. The presentation of data aims to help researchers see patterns, relationships, and differences in information obtained from various sources.

The last stage is the withdrawal and verification of conclusions. Conclusions are compiled based on the pattern of findings that emerged from observations, interviews, and documentation. The researcher did not immediately establish conclusions at the beginning of the analysis, but continued to check the data obtained so that the conclusions produced were in accordance with field conditions. Verification is carried out by comparing information between informants, matching the results of interviews with the results of observations, and examining the suitability between school documents and ongoing practices. In this way, the conclusions of the research can describe the waste management system in schools more accurately and can be accounted for.

The validity of the data is maintained through source triangulation and triangulation techniques. Source triangulation is carried out by comparing information obtained from school principals, teachers, students, education staff, cleaners, and other relevant parties. The triangulation technique was carried out by comparing the results of observations, interviews, and documentation. The researcher also double-checks important information to key informants to ensure that the researcher's interpretation does not deviate from the conditions intended by the informant. This step is done to increase the credibility of the data and reduce the possibility of bias in the interpretation of research results.

In the implementation of the research, the researcher pays attention to the ethics of the research by asking permission from the school before collecting data. The informant was given an explanation of the purpose of the research, the expected form of involvement, and the use of the data provided. The identity of the informant can be disguised to maintain their confidentiality and convenience. The data obtained is used only for research purposes and is presented objectively according to the conditions found in the field.

RESULTS AND DISCUSSION

The results of the study show that waste management in the school environment has an important role in supporting the creation of a clean, healthy, comfortable, and sustainable learning environment. Waste management is not only related to environmental cleaning activities or disposing of waste in its place, but also related to the process of forming awareness, responsibility, and environmental care behavior in school residents. In the context of environmental education, schools have a strategic position because they can integrate the value of caring for the environment through policies, learning activities, daily habituation, and direct involvement of students in waste management activities. Based on the results of observations on the implementation of waste management in schools, there are five main aspects that need to be considered, namely the characteristics of school waste, the system of sorting and providing facilities, organic waste treatment, the integration of waste management in environmental education, and obstacles and strategies for strengthening programs.

Characteristics and Sources of Waste in the School Environment

The results of the study show that the waste produced in the school environment generally consists of organic waste and inorganic waste. A lot of organic waste comes from student food scraps, leftover foodstuffs from the canteen, dry leaves, grass from pruning, and other plant parts from the school garden area. The existence of organic waste shows that consumption and school environmental maintenance activities are the main source of biodegradable waste generation.

Meanwhile, inorganic waste comes from various daily activities of school residents, especially the use of plastic bottles, plastic cups, food packaging, plastic bags, straws, paper, cardboard, and other product packaging. Learning activities also produce paper waste from the use of worksheets, photocopies of materials, administrative papers, and student assignments. This type of inorganic waste has the characteristics of being more difficult to decompose naturally so it requires more targeted handling through sorting, reuse, and recycling.

The existence of these various types of waste shows that schools need to have a management system that is in accordance with the characteristics of the waste produced. When organic and inorganic waste are mixed in one place, the treatment process will become more difficult. Organic waste can create odors, attract insects, and accelerate the emergence of unhygienic environmental conditions. On the other hand, inorganic waste that can actually still be reused will lose its use value if mixed with food scraps or other wet waste. Therefore, identifying the type and source of waste is an important initial stage in building an effective school waste management system.

Waste Sorting System and Availability of Supporting Facilities

One of the steps taken by schools in managing waste is to provide garbage bins sorted by type of waste. These bins are generally divided into organic, inorganic, and residue bins. The provision of these facilities shows that there are efforts by schools to build a habit of sorting waste from the source. Waste sorting is an important stage because it determines the success of the next treatment process.

The existence of segregated garbage cans also has an educational function. Students are not only directed to dispose of waste in its place, but also accustomed to recognizing the type of waste they produce. Through these habits, students can understand that not all waste has the same treatment. Food waste and dry leaves can be processed into compost, while plastic bottles, paper, and cardboard can be collected for reuse or channeled through recycling activities. The residual

waste that cannot be processed needs to be managed separately so as not to pollute the school environment.

However, the effectiveness of the waste sorting system is highly dependent on the consistency of its implementation. The provision of sorted waste bins will not give optimal results if school residents do not understand the function of each waste bin or do not have the habit of sorting waste correctly. In some conditions, mixed waste is still found even though sorting facilities have been available. This condition shows that physical facilities need to be supported by continuous education, supervision, and real examples from teachers and education staff.

In addition to sorted waste bins, schools also need other supporting facilities, such as temporary waste storage areas, cleaning equipment, information media regarding waste sorting, and organic and inorganic waste treatment facilities. The availability of adequate facilities can strengthen the implementation of waste management programs while creating a more orderly and comfortable school environment. Thus, the waste sorting system is not only a routine activity, but also part of the school culture that supports environmental education.

Organic Waste Treatment Through Composting Activities

The results of the study show that one form of waste management that can be applied in schools is organic waste treatment through composting activities. Organic waste such as dry leaves, grass, food scraps, and other plant parts can be collected to be processed into compost. This process is a relevant alternative because organic waste is one of the most widely generated types of waste from daily activities in the school environment.

Composting activities provide direct benefits to schools. Organic waste that was previously only disposed of can be processed into fertilizer that is useful for plants, school gardens, or greening activities. The use of compost can reduce schools' dependence on chemical fertilizers while strengthening the concept of sustainable resource utilization. In addition, this activity also has the potential to reduce the volume of waste that must be disposed of in landfills.

In the aspect of environmental education, composting can be used as a contextual learning medium. Students can learn directly about the process of decomposition of organic matter, the role of microorganisms, the importance of maintaining soil fertility, and the relationship between waste and the natural cycle. This kind of learning is easier to understand because learners not only receive theoretical explanations, but also observe and engage in real processes.

The involvement of students in composting activities can also form a sense of responsibility for the environment. Students can be involved in the process of collecting dried leaves, sorting organic matter, preparing compost materials, monitoring the decomposition process, and utilizing compost for school plants. Through this involvement, students learn that waste is not only an item that must be disposed of, but can be processed into a resource that still has beneficial value.

Integration of Waste Management in Environmental Education

Waste management in schools is not only carried out through technical activities, but also needs to be integrated in the environmental education process. The results of the study show that waste management activities can be applied through classroom learning, extracurricular activities, community service, waste bank programs, environment-based projects, and routine cleaning activities. This integration is important so that waste management is not understood as the responsibility of the janitor alone, but as the responsibility of all school residents.

In learning activities, teachers can relate waste issues to relevant materials in various subjects. For example, science learning can discuss the process of decomposition of organic waste

and the impact of waste on the environment. Social subjects can examine people's consumption behavior and its impact on waste production. Meanwhile, project activities can encourage students to make products from used materials, conduct plastic reduction campaigns, or design waste management solutions in the school environment.

Extracurricular activities and school programs also have an important role in strengthening environmental education. Community service activities can build habits of maintaining environmental cleanliness. Waste bank programs can teach the economic value of inorganic waste that can still be recycled. Meanwhile, environment-based projects can increase students' creativity and ability to solve problems related to waste issues. Through these activities, students can develop knowledge, attitudes, skills, and habits that support environmentally friendly behavior.

However, the integration of waste management in learning has not always run optimally. In some conditions, waste management activities are still carried out in a limited way to certain activities, such as community service, environmental day commemorations, or school cleaning programs. These activities are indeed beneficial, but the impact can be less sustainable if not supported by daily habituation and consistent integration in the learning process. Therefore, schools need to make waste management part of the learning culture, not just additional activities that are carried out at certain times.

Implementation Constraints and Strategies for Strengthening Waste Management

The results of the study show that the implementation of the waste management system in schools still faces a number of obstacles. One of the main obstacles is the uneven awareness of school residents in disposing and sorting waste according to its type. Some students still throw garbage without paying attention to the category of garbage cans available. This condition can cause organic, inorganic, and residue waste to mix, making it difficult to process further processing.

Limited facilities and infrastructure are also factors that affect the effectiveness of waste management. Not all schools have an adequate number of sorted bins, organic waste treatment areas, waste bank facilities, or inorganic waste storage sites. These limitations can hinder the implementation of the program, especially when the volume of waste generated is quite high. In addition, the lack of support staff and routine supervision can also cause waste management programs to not run consistently.

Another obstacle found is that the integration between waste management programs and learning activities has not been optimal. In some conditions, waste management is still seen as a supporting activity and has not yet become a planned part of the education process. In fact, if waste management is consistently integrated into learning, students can gain more meaningful hands-on experience. Waste management activities can be a means to build environmental knowledge, practical skills, cooperation, discipline, and social responsibility.

To increase the effectiveness of waste management, schools need to strengthen internal policies that govern the implementation of programs in a clear and sustainable manner. These policies can include waste sorting rules, reducing the use of single-use plastics, cleaning schedules, responsibilities for each class, canteen management, and routine evaluation of school environmental conditions. Clear policies need to be accompanied by socialization and supervision so that they can be understood and applied by all school residents.

Schools also need to increase the participation of all school residents through a targeted division of roles. The principal can provide policy and facility support. Teachers can integrate environmental issues in learning and provide examples to students. Students can be involved in

sorting, composting, waste banks, and environmental campaigns. Education staff and canteen managers also need to support the implementation of the program through waste management in accordance with school procedures. The collaboration of all parties is an important factor so that waste management does not stop as a formal activity, but develops into environmental habits and culture in schools.

Overall, waste management in the school environment has great potential to support environmental education. An effective management system not only produces a cleaner and healthier school environment, but also forms students who have awareness, skills, and responsibility for environmental sustainability. Therefore, waste management needs to be carried out in a planned, participatory, and sustainable manner through policy support, adequate facilities, learning integration, and the active involvement of all school residents.

CONCLUSIONS AND SUGGESTIONS

Based on the results of the study, waste management in the school environment has an important role in creating a clean, healthy, comfortable, and sustainable learning environment. The waste generated in schools consists of organic waste, such as food scraps and dry leaves, as well as inorganic waste, such as plastic, paper, and food packaging. Waste management has been carried out through the provision of sorted waste bins, sorting activities, organic waste processing through composting, as well as the implementation of environmental activities such as community service, waste banks, and environment-based projects. These activities not only help reduce waste generation, but also become a means of environmental education that can form awareness, responsibility, and environmentally caring behavior in students. However, the implementation of waste management still faces obstacles in the form of lack of awareness among some school residents, limited facilities and infrastructure, and the lack of optimal integration of waste management programs in learning activities.

Schools need to strengthen waste management systems through clear policies, provision of adequate waste sorting and treatment facilities, and regular supervision of program implementation. Environmental education also needs to be integrated more consistently in learning and school activities so that students not only understand the concept of waste management theoretically, but are able to apply it in daily life. In addition, the involvement of school principals, teachers, students, education staff, cleaners, and canteen managers needs to be increased through clear division of roles and sustainable activities. With the support of all school residents, waste management can develop into a school culture that is able to support the creation of a cleaner, healthier, and environmentally friendly educational environment.

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