CHAPTER I

INTRODUCTION

1.1 Background

The waste problem is one of the environmental problems that is still being studied to be solved. Many human daily activities produce waste and are difficult to avoid. According to data from *Copyright* © National Waste Management Information System (SIPSN, 2025), in 2024 the amount of waste generated is 35,313,107 tons/year. With the composition of waste based on the type of waste, namely 39.26% food waste, 19.69% plastic, 12.8% wood/twigs, 11.14% paper/cardboard, 3.41% metal, 2.55% fabric, 2.39% glass, 2.08% rubber/leather, 6.68% others.

Waste is a material or object that is no longer used and is considered to have no value or function anymore (Holimah et al., 2024). In general, waste is divided into three types, namely, organic waste, inorganic waste, and B3 waste. Organic waste is waste that comes from natural materials and can decompose naturally. Meanwhile, inorganic waste is waste that does not come from nature and cannot be decomposed naturally and tends to take a long time to decompose, usually recycled or thrown into landfills (Holimah et al., 2024). The increase in the amount of waste that continues to increase every year can cause the waste to not be managed properly. Waste that is not managed properly can have an impact on environmental pollution and can interfere with the health of the surrounding community such as causing diarrhea, dengue fever, and accidents due to sharp objects such as glass or nails (C. N. Sari et al., 2023).

One of the efforts that can be made to minimize waste problems is to sort the types of waste from the source. Waste sorting is the process of separating waste based on its material type before it is disposed of or collected (Holimah et al., 2024). Sorting waste according to its type will help prevent the accumulation of waste. The bad impact of garbage accumulation can trigger air pollution that is not good for the respiratory system, and results in the environment that can cause flooding, and also leads to health problems such as diarrhea, nausea, and vomiting. (Halodoc, 2018).

One of the factors that can cause waste to be difficult to manage properly is low public awareness about good waste management and the negative impact of littering (C. N. Sari et al., 2023). Many people are not very aware of the impact of careless waste disposal and the benefits of sorting waste based on the source. This lack of understanding often leads to some adverse

impacts that will occur such as the spread of disease, pest breeding, and environmental pollution (Indrashwara et al., 2024). To overcome these problems, it is necessary to take steps to involve the surrounding community in understanding waste management, especially those that lead to waste sorting (Lasaiba & Lasaiba, 2024).

Learning about waste can start from an early age, because it is related to children's character and habits (Rimper et al., 2023). In forming a generation that cares about nature and its sustainability, awareness in protecting the environment is important for children. Environmental education that starts early will help children understand the importance of maintaining cleanliness and environmental sustainability, one way is to instill awareness of sorting waste according to its type (Maulida et al., 2024). Education in elementary schools is a suitable place to foster environmental awareness in children (N. K. Y. A. Sari & Mahadewi, 2025).

Elementary school is the first source of education after children get knowledge from their parents and enter Kindergarten, where children get guidance, new knowledge, and formal education through a teacher (Helwend & Tuamain, 2023). Elementary schools can be used to shape children's character by providing education related to waste processing and problems. By providing education about waste, students will be given the understanding that if waste is left unmanaged, it will make waste a source of environmental pollution, a source of disease development, and also an unpleasant odor and reduce the aesthetic sense of the surrounding environment (Framita et al., 2025).

Children aged 9-12 years enter the concrete surgery phase, where the child is able to think, learn, remember and communicate smoothly, and at this stage the child has also begun to understand various kinds of readings (Novitasari & Anggapuspa, 2021). At this age, a child's ability to maintain his memory begins to be honed. In this stage, the child will also learn to do sorting (*Classification*), and settings (*seriation*) (Marinda, 2020). Based on the results of research conducted at SDN Tenggulunan, the majority of children aged 9-12 years are in grades 4 to 6 of elementary school.

Based on an interview with teachers and homeroom teacher of 4B SDN Tenggulunan Bu Okta, explained that waste sorting material has been taught at school. For the low grades (1-3) the material focuses on the difference between organic and inorganic waste. As for the high class (4-6), the discussion is more detailed down to the environmental impact. Based on the

results of the *Focus Group Discussion* on grade 4B students of SDN Tenggulunan, it was found that the majority of children did not know well the materials of types of waste such as organic, inorganic, and B3. Only 2 out of 20 students were able to name examples of each of these types of waste. And there are still many children who are confused in their application in daily life. This design contains materials on types of waste such as organic, inorganic, and B3, as well as their impact and processing in general in the environment, so that children in grades 4-6 of elementary school are considered appropriate to be the target audience to be educated about waste sorting and its impact on the surrounding environment.

Another study that discussed the lack of understanding of waste materials was also carried out by 7th period KKN-BBK students of Airlangga University in Purwoharjo Village on 47 students from grades 2-6 of SDN 4 Purwoharjo which revealed that there are still many students who do not understand the difference between organic, inorganic, and simple B3 waste, so that household waste is often mixed and makes it difficult to manage the school environment (Unairnews, 2026). Another research was also conducted by Salsabila et al. conducted at SDN Panyaweuyan, explaining that students' understanding of waste sorting has not been fully formed, students still experience obstacles in waste processing, especially in identifying the types of organic and inorganic waste (Salsabila et al., 2025).

Apart from the lack of education about waste sorting in schools, the learning media used also needs to be improved so that children are more interested in learning it. A teacher can build a reading context that is relevant to students' interests and needs through the use of learning media. One of the criteria for a good learning media for children is that the media must attract children's attention. This aims to make children more focused on the message conveyed through the learning media (Emelia et al., 2025). Learning media is something that can convey an important role and can influence students' thoughts, feelings, and interests to be able to participate in learning. The use of learning media in the teaching-teaching process can increase new interests, increase learning motivation, and increase students' understanding of the lessons being discussed (Qomariyah et al., 2022).

Books are a medium that acts as a source of information (Rakhman et al., 2023). Books are an important component that must exist in educational institutions. Books play an important role in the learning process and the development of science. Books can contain science, information, and entertainment. Through reading books, students will get a lot of indirect experience (Susiyani & Rijanto, 2016).

Based on the results of the questionnaire that has been distributed to children in grades 4-6 at SDN Tenggulunan, it was revealed that the majority of children like picture/illustration books more than other types of books. As many as 98.5% of children feel that pictures in books can help them understand the content of books. Another study on the importance of illustrations in books was also conducted by Fatmawati & Afryaningsih on elementary school students in West Kalimantan regarding their literacy skills, revealing that less than 45% of students in each school showed that students could not understand the meaning of the content of reading. Even 20% of students are indicated to be unable to read fluently. The results of interviews conducted with students and teachers indicate that this problem occurs due to several factors, one of which is the lack of interest of students caused by boredom when seeing a reading full of text without images that become visual stories/texts (Fatmawati & Afryaningsih, 2023).

An illustration book is a book that contains visuals to tell or provide information in a manuscript. This book is used to help facilitate the child's thinking process, because the visuals can help translate existing information. Thus, it will make it easier for children to capture words and images more clearly and make it easier to remember information obtained abstractly in their brain (Firmansyah et al., 2022). Through this statement, it can be concluded that the existence of illustrations or pictures in books will be more interesting for children. The presence of illustrations in many ways will attract the appeal of reading books, stimulate curiosity and be able to arouse motivation to read them (Fatmawati & Afryaningsih, 2023).

The interview related to interesting learning media for children was also conducted with Mrs. Okta, as the homeroom teacher of class 4B of SDN Tenggulunan. According to him, children easily feel bored and sleepy when teachers only explain directly in front of the class and the media only through ordinary package books. Children are more enthusiastic about practical methods and using digital media.

Interactive books are learning media that unite elements such as text, images, audio, video, as well as manipulative elements such as *pop-up, pull tab,* or *flip the flap.* This book allows for two-way interaction, namely between the user and the content of the book (Az Zahro & Wahyuningsih, 2025). The use of interactive books can increase students' reading interest, comprehension, and engagement and also enrich the learning experience in a fun way (Az Zahro & Wahyuningsih, 2025). An interactive book is a type of book that presents images, text, and sound that are packaged flexibly and can be studied at any time (Novianti & Tirtoni, 2024). Based on the description above, interactive illustration book media is a medium that is suitable

for use as a learning medium for children. Through colorful visualization and a combination of interesting elements and manipulative elements, it will make children not easily bored and interested in reading and learning the learning medium.

In the current era, the development of digital technology has developed so rapidly. Many children have started to use gadgets not only for entertainment, but also as a digital-based learning medium. Based on the results of a questionnaire given to students in grades 4-6 of SDN Tenggulunan Sidoarjo, as many as 86.8% of children are quite familiar with mobile phone digital media in daily life. As many as 61.6% of children feel that *mobile phones* help in their learning process. And through an explanation from Mrs. Okta, it was revealed that learning in schools today has started to use digital methods, and children tend to be more interested in these learning methods than using the media of ordinary package books. With digital media, children will not get bored quickly because the media used allows users to interact, create, and communicate. One of the current technological innovations that raises opportunities to provide more varied and innovative learning, is the use of *Augmented Reality (AR) technology*.

Augmented Reality is a combined technology between two-dimensional or three-dimensional virtual objects in a real environment that will be able to produce or project at the same time (Nita et al., 2022). *Augmented Reality* has made it easier to convey information and has been used in many fields. This interactive feature allows for a user to interact directly with virtual objects which makes the experience different from before (Octavian, 2022).

Despite the rapid development of technology, the use of technology-based learning media, especially at the elementary school level, is still relatively low (Purwanto et al., 2025). Application *Augmented reality* in the world of education has not been implemented and applied as a supporting media for interactive education at various levels starting from elementary school, and there are no educational institutions that apply this feature as a mandatory media used as a means of learning (Indrawan et al., 2021). Even though the application of *Augmented reality* In the realm of education, it has the advantage of presenting learning materials in a more concrete and relevant form. This technology not only provides a visually appealing experience but also a more comprehensive and contextual understanding for students. In addition, AR can create an adaptive and personalized learning environment. AR tailors the learning experience in a way that *real time* that suit the needs of students, by analyzing the user's response to the virtual elements displayed. By making the most of the potential of AR, education can become more inclusive, interesting, and effective (Tohir et al., 2024). In addition, the application of AR

in elementary education is the right step, because children in elementary school education are in the concrete operational phase of their cognitive development, so that students can interpret concepts more effectively with concrete visualizations and practical experiences (Suryaman et al., 2025).

Based on the explanation above, interactive learning media is based on *Augmented Reality* will be a suitable medium for children in grades 4-6 of elementary school, especially 9-12 years old. With the help of interactive learning media based on *Augmented Reality*, it will increase children's interest and motivation for learning materials. The learning process will be more interesting and easy for children to understand (Aprilia et al., 2025). With the help of AR, the teaching of subjects that require visualization can be improved and compared to learning without the use of AR or with conventional learning methods (Indrawan et al., 2021). Application *Augmented Reality* in the illustration book will be able to provide a new atmosphere and experience for children in getting information by interacting directly with the book through *Augmented Reality.* With this media, it is hoped that it can make it easier for children to understand the material about waste sorting, as well as be able to foster positive habits in managing waste from an early age.

The method used in this design uses the ADDIE (*Analysis, Design, Development, Implementation, Evaluation) development model*. The data collection technique was carried out by a combination of *Focus Group Disscussion*, interviews, questionnaires, and observations. An interview was conducted with one of the elementary school teachers at SDN Tenggulunan to find out the learning media carried out at school. Then interviews were also conducted with children's book illustrators to find out the creation and criteria for good books for children. Then *a Focus Group Discussion* was also carried out to elementary school children to find out their understanding of waste and types of waste. Through questionnaires, it is used to find out children's interest in picture books and *mobile phones*. As well as observations were carried out in bookstores and school environments.

Research on the same topic has existed before with the title "Designing an Interactive Book on the Importance of Sorting Waste in an Effort to Form a Habit of Sorting Waste for Children" conducted by Ajeng Ayuning Pertiwi in 2016. In this design, the media used to convey information is an interactive illustration book based on *a flap elevator.* The topics discussed in the design contain the impacts of not sorting waste, waste in the vicinity, and the waste process after being disposed of in the garbage can. This is different from the author's

design purpose. The author focuses on the introduction of waste sorting based on its type, namely organic, inorganic, and B3 waste. And the media used by the author is an AR (*Augmented Reality*) based interactive illustration book medium. Through this interactive book, students will be invited to know more about waste, especially in the types of waste based on its nature. The AR features in this design will later be contained in 2D animations, in order to provide a more *immersive* and interactive experience for readers.

1.2 Problem Identification

1. Lack of understanding of students about waste sorting in grade 4B elementary school, SDN Tenggulunan.

   Based on the results of an interview with Mrs. Okta as the homeroom teacher of class 4B of SDN Tenggulunan, explained that waste sorting material has been taught at school. For the low grade (1-3) the material is only limited to introducing the difference between organic and inorganic waste. As for the high class (4-6), the material is more detailed to contain an impact on the surrounding environment.

   Based on the results of the *Focus Group Discussion* conducted on grade 4B children at SDN Tenggulunan on October 10, 2025, it was found that there are still many children who do not know well the differences between types of waste such as organic, inorganic, and B3. Only 2 out of 20 students were able to name examples of each of these types of waste. And there are still many children who are confused in their application in daily life.

   This shows that education about the use of this facility still needs to be improved better and can motivate its application in daily life. From this statement, education is needed to form self-awareness to sort waste from an early age so that it can have a long-term positive impact (N. K. Y. A. Sari & Mahadewi, 2025).

2. The lack of interest in learning media for children.

   Based on the results of a questionnaire distributed to children in grades 4-6 of SDN Tenggulunan, it was revealed that the majority of children liked picture/illustration books over other types of books. As many as 98.5% of children feel that pictures in books can help them understand the content of books. Through this statement, it can be

concluded that the existence of illustrations or pictures in books will be more interesting for children. The presence of illustrations in many ways will attract the appeal of reading books, stimulate curiosity and be able to arouse motivation to read them (Fatmawati & Afryaningsih, 2023).

The results of the interview with Mrs. Okta as the homeroom teacher of class 4B of SDN Tenggulunan, explained that children easily feel bored with the material presented only through direct explanations from teachers and package books. They are more interested in the material delivered with practice and digital media. It can be concluded that an interesting and interactive learning media with an illustrative visual approach is needed that can help children understand the content and material of the book.

3. The application *of Augmented reality* has not been utilized to the fullest in elementary school learning.

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   Despite the rapid development of technology, the use of technology-based learning media, especially at the elementary school level, is still relatively low (Purwanto et al., 2025). Application *Augmented reality* in the world of education has not been implemented and applied as a supporting media for interactive education at various levels starting from elementary school, and there are no educational institutions that apply this feature as a mandatory media used as a means of learning (Indrawan et al., 2021).

   Augmented reality is a technology that not only provides a visually appealing experience but also a more comprehensive and contextual understanding for students. AR tailors the learning experience in a way that *real time* that suit the needs of students, by analyzing the user's response to the virtual elements displayed. By making the most of the potential of AR, education can become more inclusive, interesting, and effective (Tohir et al., 2024).

From the explanation above, it can be concluded that interactive digital-based learning media such as *Augmented reality* is needed to increase children's interest and motivation for learning materials so that they are more interested and understand the content of reading.

1.3 Problem Formulation

Based on the background description and problem identification above, the following problem formulation was obtained:

"How to design an AR-based (*Augmented Reality*) interactive book about waste by type as a learning medium for children aged 9-12 years?"

1.4 Problem Limitations

Based on the explanation of the background, problem identification, and problem formulation above, the following problem limitations can be found:

1. This Augmented *Reality-based interactive book* is targeted at elementary school children in grades 4-6 and in the age range of 9-12 years.
2. The content in the book is centered on information about waste, especially on types of waste based on its nature (organic, inorganic, and B3), impact on the environment and waste management in general.
3. The focus of the research lies in the design and application of AR-based interactive learning media, not in an in-depth examination of the AR programming system itself.
4. The approach strategy uses illustration images to attract the child's attention.

1.5 Purpose of Planning

The purpose of designing an interactive illustration book with *Augmented Reality* technology regarding waste sorting is as follows:

1. Increase understanding of elementary school students related to waste, especially in types of waste through interactive illustration books.
2. Finding and designing learning media that makes it easier for students to understand waste-related materials with interactive illustration book media.

3. Designing learning media that is more interesting and easy to understand for elementary school children through *Augmented reality-based media* as a form of digital technology integration that is in accordance with the development of the digital era and children's interests in the current era.

1.6 Benefits of Planning Results

The benefits of designing *an Augmented Reality-based* interactive illustration book about waste sorting are as follows:

1. Elementary school children with an age range of 9-12 years can understand material about waste, especially types of waste and at the same time can awaken the habit of caring for the environment from an early age.
2. Creating an interesting and exciting learning atmosphere for children.
3. It can be an additional learning tool that can help the environmental thematic teaching and learning process with more varied and interactive methods.
4. It becomes a reference material for future research that wants to expose technology-based teaching media for elementary school children.