

HARMONY IN PROGRESS:

**INTEGRATING SCIENCE, TECHNOLOGY,
AND
SOCIAL INNOVATION
FOR SUSTAINABLE DEVELOPMENT GOALS**



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YST019 - LEARNTORECYCLE: HOUSEHOLD WASTE DETECTION AND RECYCLER FINDER MOBILE APPLICATION

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ABSTRACT

Artificial Intelligence (AI) has become deeply embedded in daily life, offering numerous benefits and challenges across various domains, including education. AI-driven technologies in environmental education are indeed practical, since it supports the methods of experiential learning, building ecological awareness, and social responsibility. This project proposes the LearnToRecycle mobile application, which is designed within the advanced concept of improving household waste management. This application integrates YOLOv8, an AI-powered object detection algorithm to classify detected waste into categories such as paper, plastic, cardboard, glass, and metal. It is further enhanced with a geolocation feature using the Google Maps API, enabling users to conveniently locate nearby recycling facilities based on their current location. The initiative aims to address environmental current processes such as passive environmental education and low public awareness about recycling. This can encourage learning about proper waste sorting and sustainability practices, using an enjoyable method especially appealing to youngsters (children and adolescents) for developing eco-friendly behavior. In this way, it strengthens the correct ways of waste separation practices for an educational experience for users and contributing to the goal of environmental sustainability. The development process adopted an Adapted Waterfall methodology, which involved five phases including requirement analysis and data collection, design, implementation, testing, and documentation. The LearnToRecycle model achieved 89.1% accuracy in performance testing. The SUS results from 30 respondents yielded a score of 78.92, corresponding to the “Good” adjective rating. Future work includes expanding datasets to improve detection accuracy and reliability in real-world applications. More features such as game and specialized chatbot could also be added for further enhancement of the application.

Keywords – algorithm, maps and geolocation, mobile application, object detection, waste management, YOLOv8

INTRODUCTION

Current environmental education for youngsters often relies on traditional, passive teaching methods that limit engagement and practical application to real-world situations (Hu, 2024). Although interactive tools have been shown to improve student involvement and attention (Martín-Sómer et al., 2024), waste management education in many curricula remains insufficient, failing to cultivate civic responsibility or lifelong sustainable habits

(Nyika & Mwema, 2021). Additionally, low public awareness of recycling processes, with over 50% of Malaysians reportedly uninformed about solid waste management and environmental issues (Zulkipli et al., 2022). Ineffective waste disposal contributes to pollution, resource depletion, and health risks, while limited access to recycling services further discourages participation (Iparraguirre-Villanueva et al., 2023). To address these issues, this study proposes the development of LearnToRecycle, a mobile application integrating AI-powered waste detection and geolocation-based recycler finder to provide both educational and practical tools for proper waste segregation, thereby promoting environmental responsibility and sustainable living.

OBJECTIVE

- To develop a mobile solution combining AI waste detection and geolocation for accurate identification and recycling access.
- To provide a mobile application that promotes environmental education and awareness, encourages community participation, and supports SDG 4 (Quality Education) and SDG 12 (Responsible Consumption and Production).

DESCRIPTION OF THE PROJECT

The application employs the YOLOv8 algorithm, trained on a custom dataset of household waste categories, to enable precise classification of objects. Users can capture or upload images, which are processed in real time to provide immediate result and correct disposal practices, while the integrated Google Maps API assists in locating the nearest recycling facilities based on the user's current location. Additional features include educational tips on recycling guidelines and a history tracking function for reviewing past classifications. Performance evaluation demonstrated strong results, with the Confusion Matrix in Figure 1 showing an overall accuracy of 89.1%. Furthermore, Figure 2 shows the the System Usability Scale (SUS) with the score of 78.92, places the application within the "good" usability range, reflecting its effectiveness and usability as a practical tool for sustainable waste management.

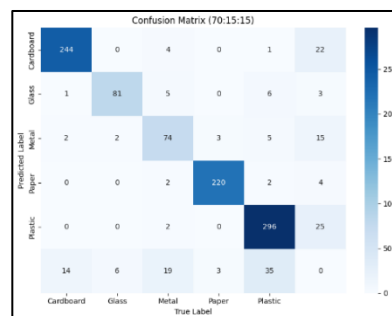


Figure 1: Confusion Matrix

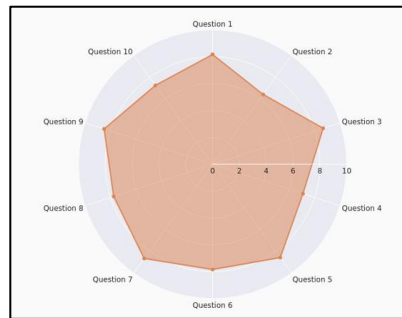


Figure 2: System Usability Scale (SUS)

NOVELTY

The novelty of LearnToRecycle lies in its seamless integration of AI-powered object detection, instant recycling guidelines, and geolocation-based facility mapping into a single mobile application. Its advanced object detection algorithm accurately identifies household waste, while the recycling guidelines provide clear, practical instructions to support user learning and awareness. The geolocation feature further enhances convenience by suggesting nearby recycling facilities, making responsible disposal both easier and more accessible. Aligned with Sustainable Development Goals 4 and 12, the application not only improves home quality of life by reducing pollution and unhygienic conditions, but also fosters early environmental responsibility by instilling sustainable habits in youngsters and families for lasting impact.

CONCLUSION

In conclusion, LearnToRecycle offers an innovative mobile solution that combines accurate waste detection, instant recycling guidance, and convenient access to nearby recycling facilities. By integrating AI-powered object detection with geolocation technology, the application not only enhances practical waste management but also promotes lasting sustainable habits. In doing so, it strengthens community environmental education and awareness, directly supporting Sustainable Development Goals particularly Goal 4 (Quality Education) and Goal 12 (Responsible Consumption and Production).

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