

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The implementation of the ESD-STEM solid waste management project has had an impact on students' engineering design skills and sustainability actions. This learning actively involves students in identifying environmental problems around them, designing and developing technology-based solutions, and sharing the results of their products as a form of meaningful contribution. These activities provide students with contextual, meaningful learning experiences that raise their awareness of the importance of individual roles in supporting environmental sustainability.

First, for students' engineering design skills, the ESD-STEM solid waste management project can be applied to improve students' engineering design skills through the engineering design process. This result is indicated by the students' final score of 76.5%, which falls into the 'Good' category. This score is not significantly different from previous studies in STEM learning, which reported scores of 75%. Although the increase is not significant, it still shows that integrating STEM and ESD does not reduce effectiveness; rather, it slightly improves results. Overall, Group 3 achieved the highest score with a final score of 80.7%, while Group 2 achieved the lowest score at 70.8%. These achievements were influenced by the experience students gained during the learning process, as well as their prior experiences or initial abilities. However, time constraints, challenges in assembling the technology, and teamwork also influenced the results achieved.

Second, for student sustainability actions, hypothesis testing was conducted with results showing a significant difference between the experimental class and the control class after learning ($p\text{-value } (0.029) < \alpha (0.05)$). However, the increase in student sustainability actions in the experimental class is still classified as low to moderate, based on the N-Gain value the average is 0.25 with 58.1% for the moderate category and 41.9% for the low category. Nevertheless, these results suggest that the implementation of the ESD-STEM solid waste management project

has led to increased student engagement in sustainability actions. Through the ESD-STEM solid waste management project, students can develop awareness, motivation, and a positive intention to make changes. These results are influenced by several factors, including students' knowledge, awareness, and the environment surrounding them.

5.2. Recommendation

To support the improvement of more meaningful engineering design skills and sustainability actions among students, the learning experience should provide more opportunities for students to explore ideas through discussion with peers, with the teacher, or by drawing on literature. Additionally, more effective technical guidance is necessary during product assembly to help students address any difficulties that may arise. More detailed instructions in the worksheets also need to be considered, so that students can follow the learning process in a more focused and effective manner.