Household Scale Ecological Literacy: A Green Leap Towards Achieving Sustainable Food Waste Management

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Abstract. The issue of food waste is currently a concern for various groups in the world. The availability of large amounts of food waste can be caused by consumption patterns by individuals who tend to be consumptive which are not balanced with food waste management. Efforts to reduce food waste can be linked to the application of ecological literacy in food waste management as well as regulating consumption patterns at the household scale. Therefore, this study aims to describe the implementation of food waste management by households and develop recommendations for developing food waste management that refers to ecological literacy. This study used an exploratory mixed method design with locations in Klojen and Sukun Sub-districts, Malang City, East Java, which were based on population density, household waste production, and recommendations from the Malang City Environmental Agency. The results showed that the implementation of food waste management in the aspects of planning, purchasing, cooking, and final disposal was categorized as good, the aspects of storage, consumption, and handling were categorized as fair, and the aspects of energy recovery were categorized as poor. The implementation of ecological literacy related to food waste management is categorized in good condition in all aspects. Strengthening the principles of ecological literacy at the household scale is done through the provision of waste banks and organizing competitions between households in food waste management to support sustainable food waste management.

Keywords: ecological literacy · food waste management · household · sustainable

1 Introduction

The issue of food waste is currently a concern from various circles in the world. Every year a total of 1.3 billion tons of food is produced in the world, a third of which becomes food waste or is wasted [1]. Large amounts of food waste can trigger climate change due to the increase in carbon produced, causing greenhouse gas emissions. This is because food waste can contribute 4.4 giga tons (Gt) of CO2 eq or equivalent to 8% of all greenhouse gas emissions [2]. Estimates of carbon generated from food waste reach 3.3

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billion tons of CO2 or equal to the glass biomass gas released into the atmosphere per year [3].

Indonesia as one of the countries that has a high population has a large contribution in the production of food waste. This is supported by data from the Ministry of Environment and Forestry's National Waste Management Information System (SIPSN), that the largest waste composition in Indonesia in 2020 is food waste, reaching up to 93% [4]. The high population correlates with people's consumption patterns, where the higher the population, the higher the food consumed. By mid-2022, it is known that Indonesia's population will reach 275.77 million people [5]. The high population has resulted in the production of food waste generated by the Indonesian population recorded at 67.8 million tons/year, and it is predicted that there will be 35 million kilograms of waste generated per capita in 2022 [6]. Food waste problems occur due to consumption patterns that have a major effect on increasing waste generation. The food waste problem is also supported by the poor implementation of food waste management. Indonesia as a waste importing country still has a high error rate in waste management, which is 82% [7].

The increase in food waste generated is also in line with the population growth that occurs. One of the cities in Indonesia that has a dense population is Malang City, East Java. Malang City has a large contribution in generating food waste in Indonesia. According to data from the Malang City Environmental Agency, food waste production in Malang City reaches 600 to 700 tons per day, making Malang City a waste emergency city [4]. In overcoming these problems, community involvement in food waste management is needed to minimize the amount of food waste produced. Community participation in the planning, decision-making and evaluation process of food waste management is important in the development of Indonesia's program in equipping people with the importance of environmental literacy or as a basis for food waste management through the application of ecological literacy [8].

Increasing public awareness of food waste management can also be done by increasing the application of ecological literacy. Ecological literacy is an individual's knowledge of ecological systems, environmental concerns, and actions to reduce the negative impact of environmental problems [9]. The ability to solve a problem is very important to develop as an effort to maintain the sustainability of environmental functions in the future [10]. The implementation of the concept of ecological literacy in the community is expected to be able to develop community participation in environmental cultural activities and processing of food waste produced, to form ecological literacy, the ability to solve environmental problems in the form of managing food waste produced.

Based on this context, this research is important to explore changes in consumption patterns for food waste management through ecological literacy and examine the application of ecological literacy in households so that it can support sustainable consumption patterns and food waste management. Therefore, this study aims to describe food waste management and the application of ecological literacy to food waste by households and develop recommendations for implementing sustainable food waste management based on ecological literacy in households.

2 Research Methods

This research was conducted for 4 months, starting from June–September 2022 which took place in Bandulan Village and Tanjungrejo Village, Sukun District and Rampal Celaket Village and Sukoharjo Village, Klojen District, Malang City, East Java. The research location was determined using purposive sampling technique based on population density and household waste production. The population in Sukun sub-district reached 196,300 people and Klojen sub-district reached 94,112 people [5]. The implementation of waste management and the recommendations of the Malang City Environment Office are additional indicators for determining the research location.

2.1 Research Design

This study used a mixed method approach that focused on developing quantitative instruments to strengthen qualitative findings [6]. This study used an exploratory mixed method design with a taxonomy development model consisting of a qualitative research phase and a quantitative research phase that refers to the ecological literacy perspective. The choice of exploratory mixed method design is based on the need for food waste management findings through qualitative research which are then developed through quantitative research related to the application of ecological literacy.

The quantitative research phase was conducted using descriptive statistics by distributing questionnaires to 57 respondents. The qualitative approach uses an interactive model approach by collecting data, followed by data reduction, data presentation, and ends with verification and conclusion drawing related to food waste management from each household (Miles et al., 2014). Quantitative research was conducted using questionnaires distributed in the field through house to house housewives in the research location.

2.2 Stages of Research

The mixed methods approach used in this study has been modified [6]. The research implementation begins with research planning, licensing, qualitative data collection, data analysis, quantitative data collection, data analysis, and ends with the interpretation of the findings. This research procedure was conducted using the blended method, which combines online through tele-conference media and offline with the COVID-19 health protocol (Fig. 1).

Qualitative data were obtained from interviews, observations and documentation regarding the determination of food waste management and the application of ecological literacy by households. Quantitative data was obtained from distributing questionnaires aimed at exploring the application of food waste management which was then classified based on the ecological literacy framework.

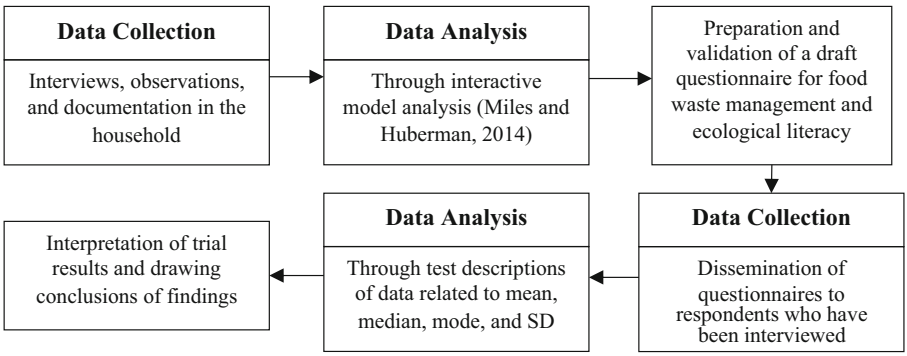

Fig. 1. Stages of Food Waste Management Research

2.3 Population and Sample

The population in this study were housewives in Sukun and Klojen Subdistricts, Malang City, East Java. Sampling in this study was determined using non-probability sampling method with purposive sampling technique. The determination of samples in qualitative and quantitative research refers to several indicators, including age 20–60 years, involvement in food waste, and plant ownership. Based on qualitative data collection, 57 respondents were obtained, which were then subjected to quantitative data collection.

2.4 Variable and Indicators

The research variables used in this study consist of independent variables and dependent variables. The independent variable used in this study is only one variable, namely food waste management. The dependent variable used in this study is the application of ecological literacy by households. The variables in the study are presented in the form of the following (Table 1)

2.5 Data Collection Techniques

Data collection was carried out with several activities, namely in-depth interviews conducted by asking questions in accordance with the research instrument. Second, observation which aims to observe general matters related to the research. The non-participant observation technique does not involve researchers in the observations made. Third, documentation which is evidence of the research activities carried out. Documentation aims to obtain records, so that the data obtained is complete, and objective [11]. The fourth is a questionnaire which is carried out by asking questions to respondents referring to the questionnaire guide. This closed questionnaire uses a Likert scale that shows the tendency of the implementation of waste management carried out.

2.6 Data Analysis

2.6.1 Qualitative Data Analysis

Data analysis in this study uses an interactive data analysis model that begins with data collection, followed by data reduction, data presentation, and verification and conclusion drawing [12]. The data that has been obtained will be classified based on data collection sub-techniques and selected data that can answer the formulation of research problems so that final conclusions can be drawn.

Table 1. Indicators on Research Variables

Variable	No	Indicator	Operational Definition
Food Waste Management	1	Planning	Planning of vegetable waste, waste sorting, preparation of shopping lists
	2	Shopping	Management of raw material purchases and selection of low-priced products
	3	Storing	Storage of leftovers, either over a short or long period of time
	4	Cooking	Changes in cooking intensity due to the COVID-19 pandemic
	5	Eating	Internal motivations that affect the diet
	6	Managing leftover	Removal of residual fruit peels on plants, composting, and reuse of used goods
	7	Energy recovery	Processing food waste into renewable energy
	8	Disposal	Disposal of residual waste through processing and sorting results
Ecological Literacy	1	Knowledge	Knowledge of ecology and handling environmental problems
	2	Behavior	Individual awareness and habits that are in line with environmental sustainability
	3	Affective tendency	Factors in the individual related to environmental awareness
	4	Attitude	Actions taken on environmental problems that occur
	5	Cognitive skills	Cognitive skills applied in protecting the environment

2.6.2 Quantitative Data Analysis

The data of this study are related to the response of the questionnaire submitted referring to the likert scale model related to food waste management and the application of ecological literacy. Quantitative data analysis is carried out using descriptive statistical methods that aim to find the highest score, lowest score, median, mean, mode, and standard deviation.

Table 2. Data Validity Criteria Guidelines

Score interval	Criterion
X > 85	Excellent
85 < X ≥ 70	Good
70 < X ≥ 55	Enough
55 < X ≥ 40	Not good enough
X < 40	Bad

a. Mean (M)

$$M = \frac{\sum xi}{\sum f}$$

b. Median

$$Me = b + p\left(\frac{\frac{1}{2}n - F}{f}\right)$$

c. Modus

$$Me = -p\left(\frac{b1}{b1 + b2}\right)$$

d. Standard deviation

$$SD = \frac{\sqrt{\sum fi.xi^2 - (fi.xi)^2}}{n(n-1)}$$

Information: n = Sample count

Interpretation of the results is carried out by reviewing the average results referring to the guidelines for data validity criteria in Table 2.

2.6.3 SWOT Analysis and QSPM Analysis

SWOT analysis was performed to identify factors from waste management findings and the application of ecological literacy by comparing external and internal factors. QSPM analysis is selected to evaluate the strategy based on internal-external factors by giving it a weight of 1–4 (Fig. 2).

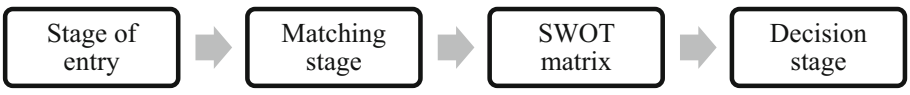

Fig. 2. Stages of SWOT and QSPM Analysis

3 Results and Discussion

3.1 Household-Scale Food Waste Management

Food waste management plays an important role in reducing the availability of waste consumed by society. The implementation of food waste management consists of planning, shopping, storing, cooking, eating, managing leftovers, energy recovery, and disposal [13]. Food waste generated by households is not only limited to the consumption stage, but also includes the initial purchase to the final disposal (Fig. 3).

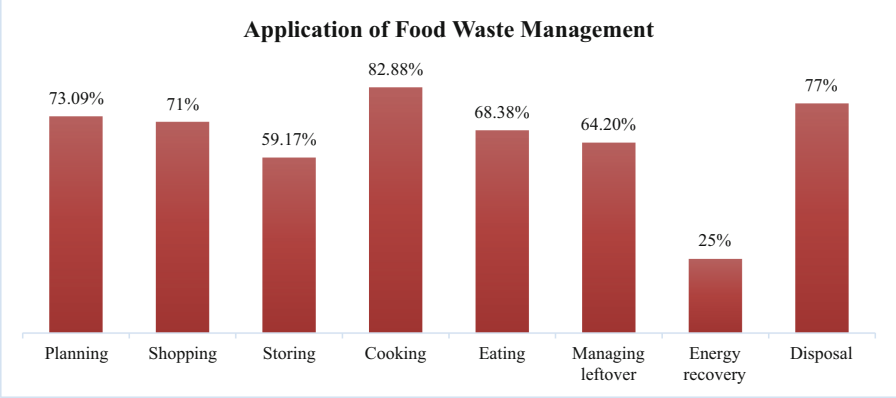

Fig. 3. Application of Food Waste Management

The implementation of food waste management in the indicators of planning, purchasing, cooking, and final disposal was classified as good; the indicators of storage, consumption, and waste handling were classified as fair; and the final disposal indicator fell into the poor category. Food waste management in the cooking indicator has the highest percentage value, which is 82.88%. This is supported by the implementation of the cooking indicator, which has a large role in consumption by households and thus has a large impact on the implementation of food waste management. Food waste management in the cooking indicator by households is realized in adjusting the amount of consumption when cooking according to household needs.

The implementation of energy recovery as part of food waste management has the lowest percentage value because it has not been implemented at the household scale. Energy recovery is still unevenly applied at the household scale due to limited supporting facilities so it is necessary to provide facilities to support energy conversion from food waste. Waste processing into renewable energy is still limited due to low biogas education [2]. Food waste management that has been implemented by households still does not include aspects of energy recovery, namely food waste processing as an alternative to renewable energy. Food waste management also needs to be identified related to individual internal and external factors that influence the implementation of food waste management carried out by households.

... if I have implemented food waste management before or also after the COVID-19 pandemic. There's no big difference... (Interview with housewives, Initials E, dated July 13, 2022, at 15.39 WIB, Sukun District).

Food waste management carried out by households can be caused by several factors, including household busyness, knowledge about food waste, self-motivation, intensity of training and education, external encouragement, and other factors. Household busyness consists of daily work, household obligations, and other activities that can reduce the intensity of housewives in food waste management. Knowledge about food waste owned by housewives can determine the application of food waste management carried out. Providing training and education by the government can increase the active participation of the community in managing the waste produced. This is because it can provide additional knowledge and skills that can be used to manage food waste. Food waste management can also be caused by self-motivation factors consisting of laziness and personal responsibility and external encouragement consisting of the active role of community leaders in initiating food waste management. On the other hand, there are other factors that can cause the implementation of food waste management to be less than optimal, including personal conflicts between each person, conflicts between groups, and conflicts between groups.

... Increased consumption, especially such as the consumption of milk, vitamin C supplements, must add more papaya fruit, of course, increase consumption that contains a lot of vitamin C... (Interview with housewife, Initials A, dated June 30, 2022, at 08.25 WIB, Sukun District)

The implementation of food waste management in Sukun sub-district has limitations in local government intervention related to the provision of waste banks. In contrast to Sukun Sub-district, the implementation of food waste management in Klojen Sub-district is more structured through regular waste processing programs and the provision of waste banks, but experiences obstacles in management regeneration and internal conflicts.

3.2 Application of Ecological Literacy in Food Waste Management

The implementation of food waste management can also be identified which refers to the principles of ecological literacy with indicators of knowledge, habits, affective tendencies, behavior, and cognitive abilities [14, 15]. Based on the results of data interpretation in Fig. 4, all indicators in the principles of ecological literacy are classified as good. The knowledge indicator has the highest value of 79.99%, which means that community knowledge in food waste management is good. This condition is evidenced by some households already having knowledge in processing food waste into compost products, liquid organic fertilizer, and eco-enzymes.

Ecological literacy formed through the implementation of food waste management makes people have the knowledge, concern and practical competencies needed as an effort to solve various existing environmental problems [9]. Efforts that have been made to housewives are realized through food waste processing activities that are integrated with the environment. Activities that have been carried out such as composting with the Takakura method that utilizes the remaining food ingredients produced. These activities are able to increase the experience of housewives, so that adequate and more meaningful knowledge is formed as an effort to realize the expected environmental conditions. The

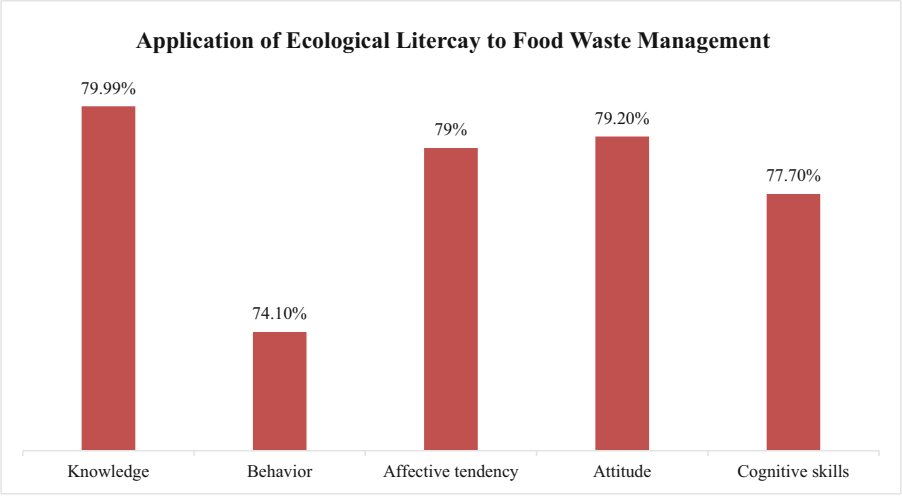

Fig. 4. Application of Ecological Literacy to Food Waste Management

application of composting techniques through the Takakura method can encourage the application of good ecological literacy, especially on indicators of knowledge, skills, affective tendencies, and cognitive abilities.

The application of ecological literacy in households is also encouraged by the "Kampung Bersinar" program organized by the Malang City Environmental Agency. This program initiates each household to do greening and organic waste processing, so that indicators of knowledge, affective tendencies, behavior, and cognitive abilities also increase. Klojen sub-district has a combination of diverse and interconnected ecological literacy applications between indicators because it is involved in the "Kampung Bersinar" program, while Sukun sub-district still varies. Indicators of knowledge and cognitive abilities of household actors in waste management in Sukun Sub-district are applied through composting using takakura media. Education related to integrated food waste management also needs to be carried out by the government. In this case, the Malang City Environmental Agency through environmental cadres has an important role in initiating each household to participate in the management of food waste produced.

3.3 Recommendations for Sustainable Food Waste Management Based on the Principle of Ecological Literacy

Findings related to food waste management and the application of household ecological literacy can produce strategy recommendations as green stepping in the implementation of sustainable food waste management. Based on the identification results in the SWOT analysis, it was found that food waste management has strengths and opportunities that can be applied and strengthened through collaboration. The S-O strategy is based on the matrix that has been prepared by prioritizing collaboration between local governments and households in food waste management and the application of ecological literacy as a strategy for implementing sustainable food waste management.

Based on the data in Table 3, the most influential strategy to implement is the WO strategy with a total score of 2.31. The SO strategy can also be a recommendation because it has a high total score, but the WT strategy is not recommended because it has the lowest total score. The SO strategy can also be a recommendation because it has a high total score, but the WT strategy is not recommended because it has the lowest total

Table 3. QSPM Matrix

Key Factors	**Weight**	**Alternatif Strategi**							
		SO		**ST**		**WO**		**WT**	
		AS	**TAS**	**AS**	**TAS**	**AS**	**TAS**	**AS**	**TAS**
Strength									
Personal awareness in protecting the environment	0,11	4	0,56						
Cooking as needed	0,09	3	0,39						
Sorting before final disposal	0,12	3	0,3						
Habits in food waste management	0,14	4	0,2						
Weakness									
Ability to process food waste	0,13			4	0,2				
Unstructured planning	0,09			3	0,4				
Excess purchases of groceries	0,09			2	0,3				
Poor grocery storage	0,09			2	0,2				
Limited knowledge in the processing of food waste into renewable energy	0,14			3	0,26				
Opportunity									
The “Kampung Bersinar” program from the Environment Agency	0,33					4	1,32		
Active environmental cadres in each RW	0,33					3	0,99		
Threat									
Limited waste bank facilities in each kelurahan	0,21							3	0,63
The mechanism for disposal and processing of food waste remains unclear	0,13							2	0,26
TOTAL		14	1,45	14	1,36	7	2,31	5	0,89

score. The strategies implemented include the provision of waste banks equally in each urban village, the preparation of waste management mechanisms, and the recruitment of environmental cadres according to qualifications, competencies, and commitments.

1. Provision of Waste Banks Equally for Each Village

An evenly distributed waste bank facility will make it easier for the community to manage the household waste produced. The provision of these facilities can also improve ecological literacy at the household scale, especially in the aspects of habits, affective tendencies, and behavior.

2. Preparation of Waste Management Mechanisms

The ignorance of some household actors in waste management causes household waste (including food waste) to be poorly managed. The preparation of a waste management mechanism can facilitate household actors in food waste management. The proposed waste management mechanism is as follows:

a. Households generate domestic organic and inorganic waste. Organic waste generated can be in the form of food waste, while inorganic waste generated consists of plastic, cardboard, and glass.
b. The waste bank conducts waste segregation based on weight and type, including food waste, plastic waste, cardboard waste, and glass waste.
c. The compost house makes fertilizer products and handicrafts with outputs in the form of organic liquid fertilizer, compost, and handicrafts.

2. Preparation of Waste Management Mechanisms

Environmental cadres play an important role in educating the public on household-scale food waste management. Therefore, recruitment of environmental cadres based on qualifications and technical competencies is also necessary. Technical competencies that environmental cadres must have are related to knowledge and skills related to social science, community empowerment, environmental ecology, environmental communication, and stakeholder analysis. On the other hand, environmental cadres must also have a commitment in initiating the community in waste management. This commitment must uphold the responsibility to invite the community to process waste and educate the community regarding integrated waste management in accordance with the lessons learned.

The application of the principles of ecological literacy at the household scale can be focused on increasing knowledge and skills in food waste management, to support sustainable food waste management. Collaboration between stakeholders, namely the government, the community, and the private sector can be a strategy in accelerating household-scale food waste management so as to reduce the availability of waste as well as efforts to mitigate climate change in the long term.

4 Conclusion

Based on the findings found, the following conclusions were obtained:

1. The application of waste management in the indicators of planning, purchasing, storage, cooking, consumption, food waste handling, and final disposal has a greater value under conditions of changing consumption patterns. The application of energy recovery in conditions of changing and stagnant consumption patterns has the same value because it has not been applied at the household scale.
2. The application of ecological literacy principles in changing consumption patterns has a higher value than stagnant consumption patterns, namely in indicators of knowledge, habits, and behavior. Indicators of affective tendencies and cognitive abilities in households have higher values in conditions of stagnant consumption patterns than changing consumption patterns.
3. Recommendations for the implementation of sustainable food waste management are carried out through the provision of waste banks evenly in each urban village in Malang City, the preparation of food waste management mechanisms, and the recruitment of environmental cadres in accordance with qualifications, competencies, and commitments.

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References

1. Food and Agriculture Organization. 2017. Key facts on food loss and waste you know!. URL: http://www.fao.org/save-food/resources/keyfindings/en/. Diakses tanggal 21 Agustus 2022
2. Sunyoto, Saputro, D. D., & Suwahyo. 2016. Pengolahan Sampah Organik Menggunakan Reaktor Biogas di Kabupaten Kendal. Jurnal Rekayasa. 14(1): 29-36.
3. Wulandari, W. & Asih, A. M. S., 2020. Perilaku Rumah Tangga terhadap Food Waste di Indonesia: Studi Literatur. Yogyakarta, Seminar Nasional Teknik Industri Universitas Gadjah Mada 2020.
4. MENHLK. 2020. KLHK: Indonesia Memasuki Era Baru Pengelolaan Sampah. URL: http://Ppid.Menlhk.Go.Id/Siaran_Pers/Browse/2329. Diakses tanggal 23 Agustus 1011
5. BPS, P. M. 2022. Badan Pusat Statistik Kota Malang. Available at: https://malangkota.bps.go.id/publication/2022/02/25/f0956410736a31dde7f7af54/kota-malang-dalam-angka-2022.htm Diakses tanggal 15 Juli 2022
6. Hidayat, S. I., Adhany, Y. H. dan Nurhadi, E. 2020. Kajian Food Waste untuk Mendukung Ketahanan Pangan. AGRIEKONOMIKA 9(2): 171-182.
7. Darnas, Y., Audiana, M., Nizar, M., Yolanda, R., & Amrina, E. 2021. Pengelolaan Sampah Dengan Metode 3R Berbasis Gampong (Pilot Project: Gampong Serambi Indah, Kecamatan Langsa Barat, Kota Langsa). Jurnal Civronlit Unbari. 6(2): 45-53.

8. Dewi, N. M. N. B. S. 2020. Kajian Partisipasi Masyarakat Dusun Bone Puteh Dalam Pengelolaan Sampah. Sosial Sains Dan Teknologi 1(1): 32-40.
9. Prastiwi, L., Sigit, D. dan Ristanto, R. 2020. Hubungan Antara Literasi Ekologi Dengan Kemampuan Memecahkan Masalah Lingkungan Di Sekolah Adiwiyata Kota Tangerang. Jurnal Pendidikan Matematika dan IPA 11(1): 47-61.
10. Azrai, E. P., Ernawati, E., & Sulistianingrum, G. 2017. Pengaruh Gaya Belajar David Kolb (Diverger, Assimilator, Converger, Accommodator) Terhadap Hasil Belajar Siswa Pada Materi Pencemaran Lingkungan. Biosfer: Jurnal Pendidikan Biologi. 10(1): 9–16.
11. Cresswell, J. W. 2014. Research Design, Qualitatives, Quantitative, and Mixed Methods Approcahes. 2014 ed. United State of America: Sage Publications.
12. Basrowi & Suwandi. 2008. Memahami Penelitian Kualitatif. Jakarta: Rineka Cipta.
13. Miles, M. B., Huberman, A. M., & Saldana, J. 2014. Qualitative Data Analysis, A Methods Sourcebook (3 ed.). USA: Sage Publications
14. Schanes, K., Dobernig, K., and Gozet, B. 2018. Food waste matters - a systematic review of household food waste practices and their policy implications. Journal of Cleaner Production 182: 978-991
15. Sari, D. A., Andayani., dan Sarwiji, S. 2022. Ecological Literacy to Improve Students Awareness in Maintaining Contained in Indonesian Language Books for Foreign Speakers. Journal of Positive School Psychology 6(4): 4119-4126
16. McBride, B. B., Brewer, C. A., Berkowitz, A. R., dan Borrie, W. T. 2013. Environmental Literacy, Ecological Literacy, Ecoliteracy: What do we mean and how did we get here?. Ecosphere 4(5): 1-20