

Project Report

Development of a Community-Driven Waste Reduction Education and Action Program

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Abstract: Mismanaged and excessive waste has adverse effects on natural environments, economies, and human health. To address these waste issues, the Sustainability with Awareness and Prevention Solutions Program was developed and implemented in communities along the Mississippi Gulf Coast (USA) with the aim to provide the knowledge and actions needed to reduce or eliminate mismanaged and excessive waste. The program uses four educational modules focused on (1) microplastics in the watershed, (2) food waste, (3) single-use plastics, and (4) involvement in community prevention and removal programs. The program curriculum was written to meet education standards in Mississippi for 5th grade gifted, 6–8th grades, and 9–12th grades, and can be easily adapted to other states' curriculums. The program provides material incentives to participants so knowledge learned can immediately be translated to behavior change. The program is continually being developed to find the best methods to implement behavior change at multiple scales.

Keywords: mismanaged waste; waste reduction; prevention; awareness; education; outreach; marine debris; litter; behavior change; sustainability



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1. Introduction

As landfill space declines and communities continue to see an increase in mismanaged waste (i.e., litter) entering ecosystems, municipalities and individuals are looking for long-term solutions to these problems [1–3]. Some of the current solutions are further complicating efforts to mitigate climate change and improve human health [4–6]. For example, incineration of waste decreases the need for more landfill space, but increased respiratory diseases, exposure to toxins, carbon emissions, and other negative impacts to human health within communities [4–6]. Waste problems are often addressed through removal and cleanup efforts, becoming an endless loop of cleanup without prevention [7,8].

Established local removal and cleanup programs demonstrate the repetitiveness of mismanaged waste removal (e.g., single-use plastics) through data reports and highlight the need for stronger prevention measures in addition to cleanup efforts. Along coastal Mississippi (USA), the Mississippi Coastal Cleanup Program (MSCCP; [9]) conducts volunteer-based cleanup events monthly along beaches, parks, and harbors. Volunteer cleanup data are tracked using data forms provided by the Ocean Conservancy [10] and data entered through the Clean Swell App [11], and are reported annually. According to past Mississippi Coastal Cleanup summaries, the top five types of debris collected were cigarette butts, plastic fragments, plastic bags, beverage bottles, and plastic bottle caps [9]. Collectively, these marine debris types totaled 59,144 items, contributing to the 61,446 kg of debris removed in 2022 [9]. Similarly, the sister program of MSCCP, the Mississippi Inland Cleanup Program (MSICP), started in 2020, also tracks volunteer-removed debris using the same methods as

MSCCP [10–12]. To date, the top five items reported are cigarette butts, plastic fragments, food wrappers, firework debris, and plastic beverage caps [12]. Increased educational awareness and engagement focused on waste prevention through behavioral changes can lead to a substantial and prolonged reduction of waste and marine debris [13,14].

There is research that has explored the idea that consumers with inclined environmental mindsets are more willing to pay extra for premium, “green” products [15]. However, this is not necessarily being reflected in recent consumer reporting data, as further publications have shared that environmental literacy and eco-friendly thought expressed through surveys do not necessarily correlate with direct action from participants [15–17]. These inclinations can be explained through different social processes, including self-identity (does the participant believe they have a strong environmental identity), attitudes (do they feel passionate about the natural environment), behaviors (are they willing to buy fair trade products, pay higher fees for eco-services, etc.), and even their own demographic information [15]. The academic and scientific communities are finding similar issues that effectively link knowledge to action amongst participants. Through various environmental education and engagement models, the one that appears to be the most effective is a bidirectional, dialog-based effort that encourages intrinsic motivations by participants due to the outreach being “fun”, hands-on, and part of a personal ethos [18].

Typically, participants need a personal connection to a topic to feel that it is worth their engagement [19–21]. This connection can come in many forms, such as gaining personal benefits, participating in a passion project, topophilia (the love for a particular location or landscape), or just a baseline interest in the subject matter [21]. Creating an environment in which a subject’s motivations are met can increase the overall quality of a participatory experience, potentially produce higher-quality results, and create actionable efforts [22], such as increasing sustainability through behavioral changes. Other factors that have been identified as obstacles in offering impactful engagement programs are absence of financial support, limited engagement with instructors, and not providing the appropriate incentives for participants [21]. Incentives to create actionable efforts can include the starting materials needed to enact behavioral changes.

Leveraging this previous research, the Sustainability with Awareness and Prevention Solutions Program was formed. This program aims to engage the public in a supportive way that limits the amount of additional time, effort, and financial responsibility usually needed to implement behavior changes around excessive waste. Through a hands-on curriculum, participating members will be able to model environmental stewardship in their own spaces and share learned information with their peers. The tangible incentives offered through this program can facilitate the formation of environmental identities, attitudes, and behaviors in making the first actionable efforts in support of their personal and community waste reduction needs.

2. Project Overview

2.1. Setting

A team of extension, outreach, and education specialists from the Mississippi State University (MSU) Coastal and Marine Extension Program, based in Biloxi, Mississippi (USA), secured funding from the EPA Gulf of Mexico Program to develop a program focused on reducing individual and collective waste with an emphasis on single-use plastics along the US Gulf Coast. The program, Sustainability with Awareness and Prevention Solutions (hereby SWAPS; [23]), was developed and piloted with a focus on the lower (southern) six counties of coastal Mississippi. SWAPS specific areas of focus during program development are Hancock, Harrison, Jackson, Stone, Pearl River, and George counties. The SWAPS team has spent years working directly within the coastal counties and has well-established relationships with schools, educators and other extension professionals within the broader region. Additionally, the programmatic focus area is an underserved region with respect to income disparity and environmental injustice according to geographic diversities [24,25]. According to US Census data, the median household income ranges

from USD 57,383 (Jackson County) to USD 47,385 (George County) with an average of 32.7% of households in all six counties earning less than USD 35,000 a year [25]. The Federal Poverty Level for 2023 is USD 30,000 (for a family of four) [26].

The SWAPS program engages with a diverse population and is implemented through in-classroom prevention education, educational workshops, and action initiatives. The four educational modules developed by the project team increase and reinforce subject knowledge and actionable steps and provide participants with material incentives to implement behavior changes based on the module topic. For example, providing reusable metal water bottles to participants in Module 1 allows for an immediate behavior change and directly reduces the use of single-use plastic beverage bottles.

2.2. Program Development

To begin addressing the overall goal of reducing individual and collective waste, four SWAPS modules were developed to meet state and specific school district curriculum criteria while focusing on issues within the community (i.e., microplastics in the coastal Mississippi watershed) [27]. The project team developed the program curriculum specific to Mississippi education standards for grades 5–8, including the 5th grade gifted program, and grades 9–12. Different versions were created to meet the standards for each age group of students. The current version of the program curriculum can be found on the program website along with quizzes, lesson plans, and activity guides for educators [23]. The intent is for the program curriculum to be continually updated by the program team as more research becomes available. The larger curriculum modules were designed to expand on the in-person lectures and provide more in-depth instruction on each of the topics through additional presentations, videos, literature, and quizzes. The in-person classroom lectures and hands-on activities are led by the SWAPS team and provide a basic introduction to the topic, and were designed to fit into a one to two hour time frame due to school block schedules. The in-person learning consists of a 20–30 min presentation before moving to hands-on learning activities. Lectures are short to allow for more time for hands-on activities. The main focuses of in-classroom learning and educational workshops are hands-on experiences to facilitate learning with activities and give participants exposure to scientific equipment and data collection techniques as well as direct engagement with professionals in the field. The in-class presentations and larger curriculum are publicly available and provided to teachers and educators. These materials include the shorter “in-class” presentations normally led by the SWAPS team as well as the full curriculum that is a more in-depth look at the modules and takes several days to complete. The larger curriculum includes lesson plans, quizzes, a comprehensive test, and a hand-on activities guide for teachers and students, covering each of the modules in depth. The SWAPS modules were developed to give educators the resources to be flexible in their classrooms and decide how in-depth to explore each module.

2.3. Incentives

Material incentives and program promotional items were strategically selected to increase in perceived value as participants became more engaged throughout the program while providing the materials needed to implement immediate behavior changes. This is a beneficial strategy for SWAPS because (1) participants receive the resources needed to enact a long-term behavior change in their life, and (2) incentives persuade people to attend consecutive workshops. Incentives provided to participants completing the modules are currently the following: (1) reusable aluminum water bottle, (2) reusable metal cutlery set, (3) beeswax wraps, and (4) 100% cotton tote. Additionally, schools and organizations that work with SWAPS through all four modules are eligible to receive a water refill station at no cost plus a USD 1000 stipend to cover the cost of installation.

During year one, the SWAPS team partnered with the Biophilia Club of St. Martin High School (Ocean Springs, MI, USA) to pilot community workshops that accompanied each module. The goal of these two-hour workshops was to involve the extended family of

students and the broader community in sustainability education and fun weekend activities. Incentives for participating in these workshops were of a higher monetary value in an effort to boost participation. Incentives provided were a countertop water filter and three filter replacements, a vermicompost bin or bokashi compost kit, beeswax wraps, and a community cleanup plus 100% cotton totes. Each workshop reciprocated the content of each module in a brief open discussion followed by the action component. Students had the opportunity to teach new participants and their guardians about the program and demonstrate leadership skills by aiding the project team in leading the action component activities. The benefits of this approach are (1) reinforcing content students learned in the classroom and (2) gaining professional development skills that are often incorporated into school district criteria.

2.4. Modules

Each of the four learning modules created discusses local and global issues focused on waste and prevention education. Modules were designed to be learned consecutively and have slightly overlapping content. The modules presented below reflect waste issues along coastal Mississippi, specifically for the Pascagoula and broader coastal Mississippi Watersheds (HUC: 03170006; 03170009). Modules include discussion of current scientific research, the importance of data collection and the role of citizen science, small- and large-scale waste prevention and removal programs, and actionable steps for waste prevention on multiple scales. A list of module learning outcomes can be found under module descriptions below. Lists of essential materials and approximate pricing can be found in Tables 1–4. Instructions and sources of information used in each of the modules are cited in each module description.

Table 1. Brief descriptions of educational workshops and supplies for Module 1.

Materials Needed	Quantity	Price (USD in 2024)
Glass filtering flask with upper tubulation—2000 mL	1	48.95
Magnetic filter funnel with lid—500 mL	1	168.99
Vacuum pump	1	71.22
Vacuum pump tubing—6.3 × 9.5 mm	1	6.17 per 0.3 m
Reinforced pump tubing—9.5 mm	1	1.72 per 0.3 m
Water sample collection—16 oz	1	13.44
47 mm diameter, 0.45 μM mesh gridded filters	100	23.49
Dissection scope	1	177.99
Forceps	6	7.99
Petri dishes	25	8.99
Permanent marker	12	6.79
Tape	2	4.25
Total		532.00

Table 2. Brief descriptions of educational workshops and supplies for Module 2.

Materials	Quantity	Price (USD in 2024)
Plastic bin with lid—64.3 L	1	10.98
Cordless drill	1	99.99
Drill bit—4 mm	1	6.97
Sandpaper	1	14.97
Coconut fiber bedding—7.57 L	2	12.99
Distilled water—250 mL	1	1.34
Paper shredder	1	102.28
Red Wiggler worms (<i>Eisenia fetida</i>)	1000	39.95
Food scale	1	14.98
Compost pail	1	28.95
pH/moisture testing meter	1	9.99

Table 2. *Cont.*

Materials	Quantity	Price (USD in 2024)
Corrugated cardboard	11.4 L	Donated
Food scraps (16 oz worms = 4 oz food per day)	Variable	Donated
Total		344

Table 3. Brief descriptions of educational workshops and supplies for Module 3.

Materials	Quantity	Price (USD in 2024)
Metal tins with lids—1 oz	64	28.95
Unrefined raw food-grade cocoa butter	16 oz	15.53
White beeswax pellets	160 oz	100.00
Unrefined coconut oil	1	8.74
Crockpot	1	14.99
Ladle—1 oz	1	4.55
Wooden stir sticks	50	6.99
Measuring cups and spoons	1	9.99
Spatula set	1	9.99
Reusable protective table covers 1.5 × 2 m	1	9.99
Permanent marker	12	6.79
Total		117.00

Table 4. Brief descriptions of educational workshops and supplies for Module 4.

Materials	Quantity	Price (USD in 2024)
Gloves	100 (pairs)	9.78
Clipboards	5	9.95
Pencils	12	2.99
Trash bags	50	12.97
Five—1 gallon buckets	3	12.10
Hand scale	1	6.99
Ocean Conservancy Data Sheets	Variable	Printable or provided
Clean Swell App	-	No charge
ETAP Plastic Brand Audit Data Sheets	Variable	Printable or provided
Total		55.00

Module 1 introduces how watersheds function and the impact of stormwater runoff and pollution including microplastics within the Pascagoula and broader coastal Mississippi Watersheds. Participants learn about the prevalence, sources, and types of microplastics commonly found in the environment. The larger curriculum discusses watersheds and stormwater runoff as it relates to plastic waste and discusses potential effects on human health, the economy, and the ecology of the Mississippi Sound and surrounding watersheds. The hands-on component focuses on filtering water samples, then classifying and counting microplastics following the protocols of Sartain et al., 2017 [28]. Participants observe microplastics and learn changes they can make to reduce their plastic footprint in an effort to reduce microplastics entering the watershed. Participants are provided with a reusable water bottle in order to practice learned objectives and reduce the use of single-use water bottles.

At the end of this module, participants should be able to

- briefly explain the water cycle and discuss what a watershed is and how it functions;
- discuss how stormwater runoff affects plastic breakdown and litter movement in our watershed; and
- identify the five types of microplastics, the effects microplastics have on human health and/or our ecology, and identify at least one way to prevent microplastic pollution.

Module 2 describes food systems, excessive food waste, and composting techniques. Participants learn about global and national (USA) food waste issues and the effects on the economy, environment as well as actions to reduce food waste and increase food security at a personal and community level. The larger curriculum discusses methods to store foods for less waste, local food production, food recovery, and composting techniques at multiple scales. For the hands-on activity participants explore different composting techniques for different needs including multi-bin systems, and vermiculture composting following methods written by the Rodale Institute [29]. In-class participants build vermicomposting bins for their classroom or organization and received a set of reusable cutlery to continue eliminating single-use plastics and reinforce low-waste ideas associated with food and food packaging.

At the end of this module, participants should be able to

- briefly explain the food cycle;
- discuss the different parts and the importance of building a local food cycle;
- identify and discuss food waste, the effects of food waste on climate change and ways to reduce food waste; and
- identify and discuss a variety of composting techniques.

Module 3 describes the lifecycle of common plastics, emphasizing the seven most common consumer single-use plastics. Participants learn about the history of plastic, false solutions, and how habit changes can reduce the amount of plastic production and waste. The larger curriculum covers the impacts of plastic at all points in the life cycle, how to start new habits around plastic, and the importance of reusable alternatives to eliminate plastic use. The hands-on component has participants making food-grade DIY reusable lotion tins following the methods developed by the SWAPS team and MSICP [12,30].

At the end of this module, participants should be able to

- identify the seven most common resin types used in consumer goods packaging;
- identify and discuss false solutions to plastic pollution; and
- discuss plastic pollution and ways to reduce plastic use.

Module 4 is an open discussion-type presentation in which participants identify ways to become involved in local waste prevention and removal programs. As referenced earlier, the Mississippi State University Coastal and Marine Extension Program coordinates waste prevention and mismanaged waste-focused programs and subprograms. These include the Mississippi Coastal Cleanup [9], Mississippi Inland Cleanup [12], Plastic Free Gulf Coast [31], and Derelict Trap Reward Programs [32] that can be found on our No Litter Movement website [33]. The goal of the final module is to increase awareness and environmental stewardship through these complementary programs. Through the larger curriculum portion of the course, participants learn about the projects' goals, various data collection techniques, opportunities to be involved, and guidance on how to organize local removal and prevention initiatives developed by MSCCP and MSICP [33]. The hands-on component includes data collection techniques [34–36], virtual reality learning focused on mismanaged waste through a VR-based learning activity developed by Mississippi State University [37], and analysis of unmanned aerial system (UAS) footage being collected to identify plastic debris on Deer Island, Mississippi. Data.

At the end of this module, participants should be able to

- discuss the importance of prevention, cleanups, and data collection;
- discuss the basics of organizing a prevention or removal program; and
- access the resources to implement a cleanup with a brand audit through the request a bin program.

3. Results

Since inception, the SWAPS program team efforts thus far have resulted in over 220 h of direct education across seven counties in Mississippi, for nearly 5000 people through over 65 workshops, festivals, and formal teaching events. As of April 2024, the program has

provided 2000 100% cotton totes, 1500 aluminum beverage bottles, 1400 reusable cutlery sets, and 1700 beeswax wraps. Additionally, the program has provided six water refill stations to schools and organizations that participated so that people can continually be proactive in making sustainable choices. The project team is slated to provide another 2000 of these reusable incentives over the remaining portion of the three-year initial funding period in an effort to directly reduce marine debris.

4. Discussion

SWAPS is a program focused on providing participants with the knowledge and materials needed to immediately begin behavioral changes to reduce plastic waste. The goal is to implement a four-module education series in a variety of settings with diverse participation including in-classroom through local schools, summer programs, continuing education programs, and community workshops. SWAPS intends to reach these diverse populations that all learn differently and have different levels of understanding and needs by providing numerous avenues of instruction.

One of the goals for SWAPS is to provide an opportunity for the students who have SWAPS in-class experience to teach and share their knowledge directly with the community. Workshops hosted by St. Martin High School provided a baseline of potential opportunities and barriers to community participation. Opportunities included reinforcement of in-class knowledge and skills gained while students taught friends and families newly found skillsets. Module 1 was an example of this, with students teaching other participants how to filter and identify microplastics. Barriers presented included scheduling conflicts with work, other extracurricular activities, and time commitments. However, the SWAPS team intends to continue implementing extracurricular workshops aligned with each module and providing the opportunity for participating school students to teach using their knowledge and skills gained through in-class learning, but these workshops will need to be adjusted to increase community participation.

Overall, the response to SWAPS has been positive, with feedback coming from students, teachers, and parents, as well as observing students using their provided incentives at their schools. Reusable cutlery sets were the most desirable amongst program incentives given out by SWAPS. The most popular module was DIY alternatives to plastic. Specifically, making reusable lotion tins was favored by students, parents, and educators. This activity was also the most expensive with respect to startup costs but also put money back into the local economy by purchasing beeswax from a local apiary. SWAPS will continue to adjust and build out a robust program using continuous feedback. A main program goal is to reach diverse populations in Mississippi and adjust the content to fit specific ecosystems and the needs of communities within other regions of Mississippi and throughout the gulf coast region. The structure of the modules will allow educators to modify content for other regions along the northern Gulf of Mexico. Moving forward, SWAPS will be teaching several 2024 summer program workshops with adults and children in partnership with other local environmental organizations.

Some lessons learned and priorities identified after the first year of the program included verifying that all content within the modules had the vocabulary and information needed to meet school standards criteria and that all statements within the program were directly supported by cited peer-reviewed literature. A list of standards met is available on the website [23]. Another lesson learned included the hands-on beeswax wrap activity in Module 3. It was overwhelmingly popular among program participants, but the most time-consuming. Switching to DIY beeswax crayons saved a considerable amount of time during class and supported the same module objectives. Lastly, several educators have reinvented the program back into their classrooms. At the moment, the limiting factor is personnel time to implement the program at multiple sites simultaneously. To alleviate the issues, the program team has expanded to a targeted "Train the Trainer" model (described in paragraph below) by providing hands-on training and making a module curriculum available on the website that includes all information needed to teach the program.

Moving forward, the SWAPS team intends to utilize the Land-Grant Cooperative Extension to extend into other parts of Mississippi through a “Train the Trainer” model. Currently, Mississippi has 82 counties, each with at least one Extension agent representing Mississippi State University. By offering to train other Extension agents on how to best teach the SWAPS Program combined with the education resources developed, this program could easily be expanded across the state. Some challenges this proposed work would bring are (1) identifying personnel in other locations who are willing and able to administer the program, (2) maintaining funds to continually purchase incentives and other programming supplies, and (3) identifying how to best engage with a wide range of audiences.

Another future step for SWAPS will be to enhance program evaluations and long-term behavior change research. Currently, the program evaluation tools are built as traditional program evaluations that focus primarily on program satisfaction with no personally identifiable information and, thus, no follow-up data collection. However, the SWAPS team recognizes the need to partner with evaluation specialists to develop short-, mid-, and long-term tracking strategies for program participants that will enable further research on the effectiveness of this programming. While the program is in high demand and has shown anecdotal evidence of success, more thorough research is needed to identify and document lessons learned so that the program can continually be adapted to maximize impact.

5. Conclusions

The first year of SWAPS program development and initial pilot implementation has led to the creation of a program consisting of four adaptable modules that contain complementary in-person and larger curriculum components. The response to SWAPS has been overwhelmingly positive, but with identified areas for improvement, such as enhanced evaluation strategies, substituting activities within modules, and expanding the reach of the program through a “Train the Trainer” model. As such, SWAPS will be continually adjusted based on evaluation data and other feedback to improve the impact of the program. As more materials are developed and finalized, they will be publicly available on the website [23]. Overall, SWAPS should lead to a more-educated and engaged public and behavioral changes that reduce waste and mismanaged waste.

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