Using experiential marine debris education to make an impact: collecting debris, informing policy makers, and influencing students

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Abstract
The Shore to Statehouse project supported the creation of an open-source, replicable, undergraduate experiential course on marine debris. Funded by the National Oceanic and Atmospheric Administration, the course allowed undergraduate students in Connecticut, USA, to collect marine debris locally, then create a policy report for state legislators. Here we share the results of the project including data on four accumulation surveys on the Long Island Sound, as well as the impact on student motivation, attitudes, and behavior levels. Results include finding over 1600 individual pieces of debris totaling 19.4 kilograms (42.8 pounds). In addition, the students experienced statistically significant improvements in knowledge and behavior scores. This open-source course can be replicated, empowering students to remove debris, provide important information to local policy makers, and improve knowledge and behavior.

Keywords: marine debris, experiential, policy, Long Island Sound, attitudes, behavior, knowledge

Introduction

Marine debris or litter is a complex global issue that negatively impacts the economy as well as the health of oceans, wildlife, and potentially humans. Exacerbated by the use of single-use or "disposable" plastics, many researchers posit that education coupled with policy may improve the problem. Experiential educational efforts are one approach to this multifaceted problem. This article describes the implementation of an open source, replicable, experiential undergraduate course developed with the support of a National Oceanic and Atmospheric Administration (NOAA) Marine Debris Prevention through Education and Outreach program. The course was implemented from January to May of 2016 at the University of Hartford, a small liberal arts college (approximately 5000 undergraduates) in Connecticut, USA. The class introduced students to the issue of marine debris, guided them in the process of collecting, organizing, and identifying debris, then challenged them to use this data to write a policy brief and present it to state legislators. In addition to reporting on the debris found, we measure the impact of the course on student participants, focusing on their knowledge of marine debris, their environmental attitudes, and environmental behavior. To place these responses in context, we compare this test group to participants in a traditional laboratory-based interdisciplinary environmental course at the same University.

Marine Debris

Marine debris is a global problem impacting wildlife, potentially human health, water quality and the economy (Barnes et al., 2009, Engler, 2012, Gregory, 2009, Laist, 1997, NOAA 2014a, Wright and Kelly, 2017). Marine debris is not a new problem, but our reliance on disposable and single-use plastic items means that debris accumulates in global waterways at an astonishing rate. About 20 million tons of plastic reach the ocean annually— the five oceanic gyres contain approximately 100 million tons of marine debris (U.S. EPA, 2011, Vannela, 2012). In the 1950s global plastic production was approximately 5 million tons annually; in 2015, 322 tons were produced globally, most to create items not in use within twelve months (PlasticsEurope, 2016, Thompson et al., 2009). These numbers continue to rise, with global plastic production reaching 311 tons in 2014 and (The instances of entanglement and ingestion have increased dramatically since 1997 from impacting 267 to 557 species globally (Kühn, Rebolledo, and van Franeker, 2015). Yet ingestion and entanglement are not the only problems; the influx of decomposing plastics and the subsequent leaching of toxic chemicals poses a danger to water quality, wildlife, and potentially human health (Barnes et al., 2009, Engler, 2012, Wright and Kelly, 2017). Plastic debris produces a toxic cocktail including the chemicals from plastics manufacturing and those it absorbs from marine environments (Rochman, 2015). In addition, marine debris can serve as rafts for all manner of creatures, which use the material to travel to new ecosystems (Barnes, 2002, Kiessling, Gutow, and Thiel, 2015). Three hundred and eighty-seven taxa (including microorganisms, seaweed, and invertebrates) have been recorded rafting or floating on litter in all major global oceans (Kiessling, Gutow, and Thiel, 2015). Marine debris negatively affects a wide range of industries including tourism and recreation, shipping and yachting, fisheries, aquaculture, and agriculture (Leggett et al., 2014, Newman et al., 2015, Sussarellu et al., 2015, Wallace, 1989). While an omnipresent effect of the modern convenience- and plastics-based society, marine debris is at its core a problem that many researchers believe can be solved. The questions remain whether, when, and how society will choose to approach the problem.

Addressing Marine Debris

Experts provide a range of recommendations to address this pervasive issue including educating communities, encouraging behavior change, and developing policies. In describing the scope of their work under the MARLISCO program (Veiga et al., 2016) remark on the importance of society becoming aware of and taking responsibility for the problem. Sheavly and Register (2007) note a link between knowledge and consumer choice regarding the use and disposal of waste. Umuhire and Fang (2016) observe that concern for and knowledge about coasts and oceans may increase a person's engagement in marine conservation. Yet, in a study of Chinese students, they find that while many showed concern for the oceans, they lacked knowledge (Umuhire and Fang, 2016). In evaluating the knowledge and behavior of British schoolchildren, Hartley et al. (2015) determine that interventions can improve knowledge of the issue and self-reported behaviors. The relationship between environmental knowledge, attitudes, and behaviors is complex (Kruse and Card, 2004, Owens and Halfacre, 2005, Thapa, 2010). Increasing or improving environmental knowledge does not necessarily yield improved environmental behaviors (Oskamp, 2002; McKenzie-Mohr, 2000). The barriers that prevent environmental behavior change are varied and complex (Horhota et al., 2014, Oksamp, 2002). Gifford (2011) notes that environmental sustainability requires overcoming both structural and psychological barriers. He defines these psychological barriers, including limitations on the way we understand a problem, having ideologies that run counter to pro-environmental change, the way in which we compare ourselves to others (particularly in terms of our perception of their contribution to the problem), the way that humans proceed along a given path to avoid the costs and behavioral change associated with altering that path in a significant way, that we discount the work of authorities, that we have perceptions about the risks associated with change, or that humans ultimately engage in "positive but inadequate" changes in behavior (Gifford, 2011, p. 290). He delves deeply into each, remarking that to achieve environmental sustainability we must work toward understanding and overcoming these barriers. Environmental education has been promoted as an effective way to help individuals consider their relationship to complex environmental problems.

Environmental education instills knowledge, improves attitudes, and imparts efficacy and empowerment (Athman and Monroe, 2001). It not only increases information, but also includes critical thinking, problem solving, and decision-making via experiential learning (Athman and Monroe, 2001). Service learning is one form of experiential learning that includes service that meets a community need and reflection on that service (Bringle and Hatcher, 1996). Service learning takes many forms—it may include students engaging in work that helps them to practically apply what is learned in the traditional classroom (e.g., The Innocence Project, where law students examine the cases of incarcerated individuals they believe may be falsely accused) but it may take much simpler form. Undergraduate service learning often includes volunteering to address a community need (i.e., clean a beach, tutor a child, serve at a soup kitchen) that connects with the themes of a course (respectively, environment, education, or social policy). The use of experiential education to ignite student knowledge about and connection to the environment has proven beneficial. In evaluating the role of service learning on sustainability education, Helicke (2014) finds it allows students to delve deeply, experience autonomy, and gain a sense that sustainability goals can be achieved. Experiential learning in the context of marine debris often includes beach cleaning. Beach cleanups are not simply about the event, but about helping individuals connect the presence of litter with human behavior (Bravo et al., 2009). The authors of the Proceedings of the 5th International Marine Debris Conference (5IMDC) (2011) express the important role of removal in prevention strategies, explaining that participating in a beach or shoreline cleanup improves awareness and leads to changed behaviors. They write that the information gleaned from cleanups can help society understand the importance of the issue (5IMDC, 2011). Wyles et al (2017) compare student responses to a range of coastal activities. Participants were assigned to beach cleaning, rock pooling, and coastal walking (Wyles et al, 2017) and measured on variables including awareness, mood, intentions, and the restorative value of the activity. They found all three activities yielded positive mood and pro-environmental intention; that beach cleaning and rock pooling yielded higher awareness about marine environments; and that beach cleanups were most meaningful but least restorative (Wyles et al, 2017). Bell et al. (2003) conclude that having students collect and interpret environmental data can improve comprehension. In this way, combining learning with beach cleanups has proven effective.

Engaging the public in cleanup efforts can also allow more and potentially better research on marine debris. In a study of a decade of citizen science cleanups in Britain led by the Marine Conservation Society, Nelms et al (2017) note that large scale volunteer efforts, when held to high scientific standards, produce valuable and voluminous data which would be difficult to produce otherwise. A citizen science project whereby about 1000 schoolchildren in coastal Chile and on Easter Island collected data on the abundance and distribution of debris found they were able to produce scientifically reliable data (Hidalgo-Ruz and Thiel 2013). In a comparative assessment of citizen science marine collection and that of professional scientists, Hidalgo-Ruz and Thiel (2015) find that high quality reliable data is possible through citizen science, though is most likely in cases including simple and clear protocols, volunteer training, professional supervision, and data validation.

Legislation is often recommended as a complement to education efforts when addressing the problem of marine debris. Derraik (2002) suggests consciousness-raising education paired with legislation. Sheavly and Register (2007) stress the importance of education coupled with strong policies that are enforced. The 5th International Marine Debris Conference proceedings describe the importance of integrating the local context into any policy choices (5IMDC, 2011). Carman et al. (2015) also find policy enforcement critical to solving this pervasive problem. Researchers and experts concur that powerful work to address this pervasive issue will connect education (notably on the sources of marine debris) and the local context with any relevant policy recommendations.

Researchers recommend that to effectively solve the wicked problem of marine debris, we must engage in education, consider human action, provide alternative consumer options, and incorporate policy solutions (Derraik 2002, Sheavly and Register 2007). The Shore to Statehouse project addresses these recommendations by creating an open-source college service-learning course that engages students in marine litter collection. Students catalog the debris to better understand the nature of a complex global problem in the local context, then analyze the debris and research how to prevent similar materials from infiltrating the ocean. Finally, they produce a report of their results and share it with state legislators. This article describes the pilot implementation in the spring of 2016 in Connecticut, USA. We share the results of the collection as well as the impact of the class on student attitudes, behaviors, and knowledge.

Materials and Methods

Course design

The course was created in the fall of 2015 and piloted in the spring of 2016 at the University of Hartford, Connecticut, a private liberal arts college of approximately 5000 undergraduate students. Thirty-five students took part in the 300-level undergraduate seminar course on the topic of marine debris, pollution, and policy. In many ways this was a typical upper-level seminar course, including course readings, in-class activities and discussions, student presentations, and content lectures. As a seminar course, content and curriculum relied strongly on reading and discussion. Course readings included *Marine Pollution: What everyone needs to know* (Weis, 2014), *Bottled and Sold* (Gleick, 2011), *Plastic: A Toxic Love Story* (Freinkle, 2011), and *Marine Anthropogenic Litter* (Bergmann, Gutow, and Klages, 2015). In addition, students read dozens of scientific peer-reviewed articles to complete assignments. Full details of the class curriculum, developed by the author, can be found on the webpage: https://ctmarinedebris.wordpress.com/.

Course assignments included writing reflective essays about the experience of collecting marine debris, as scholars have noted the importance of reflection in service learning (Billig, 2000). In addition to reflection, the students created a Tumblr site researching the items found during the cleanups and their respective environmental and health risks, referencing peer-reviewed literature. Students worked to research the impacts to wildlife, health, and water quality associated with each subgroup of debris (e.g., rubber fragments, fishing litter). Students also noted whether the item could have been recycled, and the availability of more sustainable options. In other words, they were asked to make explicit connections between what was found, the associated harm, and how similar items might be kept out of the world's oceans. Students created a policy report for state legislators to share the results of the clean up activities. The report did not advocate for any one policy but instead shared information about how other communities have addressed the issue through a range of policy options. We presented to the legislators on June 22nd, 2016.

Beach cleanups

We conducted four marine debris beach collection trips, using the basic protocols detailed in the Opfer, Arthur, and Lippiatt (2012) *NOAA Marine Debris Shoreline Survey Field Guide* for accumulation surveys. In each case we arrived at low tide, flagged a stretch of shoreline in 10-meter segments, then walked transects systematically, scanning the ground for debris. During the Meigs Point cleanups, systematic walking was made difficult by the rock-covered coastline. This rocky feature, however, also trapped a great deal of debris, making the beach a fruitful collection site. The area covered by each cleanup and the amount of time spent at each site varies, as shown in Table 1.

Student analysis

To better understand the potential impact of the marine debris course, the author measures students' knowledge of marine debris, environmental attitudes, and environmental behaviors. We measure variables in the following way:

- Knowledge of marine debris via the Talking Trash and Taking Action: Ocean Conservancy and National Oceanic and Atmospheric Administration Marine Debris survey (NOAA, 2014b).
- Environmental attitudes through the New Ecological Paradigm (NEP) Scale (Dunlap et al., 2000). The NEP is used globally as a pre- and post- measurement to better understand "the effects of some intervention or activity, such as the impact of educational programs on environmental world views" (Anderson, 2012, p. 260). It has been described as "the most widely used measure of environmental values or attitudes, worldwide" (Anderson, 2012, p. 260).
- Environmental behaviors were measured with the Environmentally Responsible Behavior Index (ERBI) described by Thapa (1999) and developed by Smith-Sebasto and D'Costa (1995). The instrument, developed and field-tested on hundreds of undergraduate students, has a high internal consistency reliability (.94), and high concurrent validity (82%) (Smith-Sebasto and D'Costa, 1995).

To account for the assumption that students taking an environmental course might already have knowledge of marine debris, somewhat positive attitudes about the environment, and pro-environmental behaviors, we compare our results to a traditional laboratory-based environmental class. Our comparison students were participants in the course AUCT120: Living in the environment. It is important to note that this comparative course includes off-campus field trips, but not service learning of any kind, particularly not environmental cleanup experiences. This course is not an experimental control, but instead provides context for the changes in knowledge, attitude, and behavior students might experience in a typical environmental course. The web description of this course is as follows:

> AUCT 120 Living in the Environment: This integrative course in the sciences is an introduction to basic ecological principles governing the relationship of natural resources to modern society. Selected topics emphasize the importance of the interrelationships between the natural sciences, humanities, and social sciences in the understanding of environmental problems, and the suggestion of possible ways of dealing with them. (University of Hartford, 2017)

Students in both classes are given a web-based survey[1] at the beginning and end of the semester. Pre- and post-scores for each variable are summed. We compare pre- to post- mean scores for each variable to understand if changes occurred. We then compare

[1] Cronbach's alpha of responses to survey instrument: α=0.89 (Wessa, 2017).

post-score means of both classes, using t-tests to understand if any observed differences are statistically significant.

Results[2]

Beach cleanups

The course participants conducted four collection trips. As this course was taught in Connecticut from January to May, weather became a complicating factor on multiple occasions. Every scheduled trip was affected by weather. The first three beach cleanings (February 6th and 7th, 2016) took place immediately after a snowstorm on February 5th. The beach beyond the high tideline was covered in several inches of snow and was therefore inaccessible. Winter collecting was beneficial as it allowed us to work outside of wildlife nesting seasons, particularly that of the globally threatened and endangered piping plover. This enabled us to meet with approval from state agencies and land managers. Collection sites were state parks in Connecticut on the Long Island Sound: Bluff Point State Park and Coastal Reserve (February 6), Hammonasset Beach (February 7), and Meigs Point, Hammonasset (February 7 and April 2).

The course participants spent fewer than six hours in total collecting and found over 1600 individual pieces (19.44 kg or 42.8 pounds) of debris. Table 1 details the type and amount of material found at each site.

Table 1. Locations of and details about cleanups as well as material found by category

Location	**Bluff Point State Park**	**Hammonasset Beach**	**Meigs Point, Hammonasset**	**Meigs Point, Hammonasset**	
Date	6 Feb. 2016	7 Feb. 2016	7 Feb. 2016	2 April 2016	
Length of beach	200 meters	200 meters	50 meters	150 meters	
Depth of beach	10 meters	20 meters	50 meters	25-50 meters	
Collection time	1.5 hours	1.5 hours	0.5 hours	2.5 hours	
Participants	22	10	10	14	**Total**
Plastic	45	35	24	896	1000
Metal	5	3	13	54	75
Glass		15	4	27	46
Fiberglass			3	3	6
Rubber		2	5	30	37
Wood and paper	2	8	2	40	52
Asphalt and brick		1		2	3
Assorted materials	4	4	39	361	408
Total	56	68	90	1413	1627

[2] Data sets available on the author's Research Gate page: https://www.researchgate.net/profile/Katharine_Owens

Table two shows the relative proportion of material found including piece and weight by category. Plastics were the highest proportion of the debris found by piece (61.5%) with the catch all category of assorted mixed materials yielding the highest proportion by weight (46.0%). Table three provides a breakdown into subcategories for the two most numerous categories: plastics and assorted materials.

Table 2: Weight in grams, total number of pieces, and the proportion of each by category

Type of material	Total weight in grams	Proportion of total weight	Total pieces	Proportion of total pieces
Plastic	3152.5	16.2%	1000	61.5 %
Metals	1852.0	9.5%	75	4.6 %
Glass	635.0	3.3%	46	2.8 %
Fiberglass	544.0	2.8%	6	0.4 %
Rubber	964.0	5.0%	37	2.3 %
Wood And Paper	2228.0	11.5%	52	3.2%
Asphalt And Brick	1120.00	5.8%	3	0.18%
Assorted Materials	8944.00	46.0%	408	25.1 %
Total	**19,439.5**		**1627**	

Table 3: Subgroups of each category including total number of pieces and weight.

Type of material	Number of pieces	Weight in grams
Plastics Hard plastic fragments	326	1018.0
Foam plastic fragments	100	11.5
Plastic Utensils and straws	16	33.0
Film plastic fragments	176	302.0
Plastic food and drink packaging and containers	132	869.0
Plastic cup pieces	135	257.0
Plastic bags	33	156.0
Plastic, nylon, other rope	28	406.0
Balloons and Balloon fragments	54	100.0
Assorted Materials Items related to smoking (e.g., cigarette butts, cigar tips, rolling papers and packaging, plastic lighters)	129	92.0
Accessories (e.g., sunglasses, hair ties)	21	191.0
Home goods (e.g., pen, flyswatter, clothesline, wire cage, money)	28	2288.0
Health and Beauty (e.g., comb, weave,	17	522.0

Epi-pen, wrapped condoms, feminine hygiene products, band aids, lip gloss)		
Wearable goods (e.g., clothing, shoes, fabric pieces, sunglasses)	51	1985.0
Children's toys	7	65.0
Pet accessories (e.g., dog waste in plastic bags, rawhide bone)	4	401.0
Large cable	1	1650.0
Fishing items (e.g., lures, bobs, lines, pole pieces)	126	446.0
Recreational materials (e.g., Frisbee; golf balls)	24	1304.0

Assessing the collected materials indicates the debris is overwhelmingly plastic and comes primarily from human use (as opposed to industry, manufacturing, commercial fishing or shell fishing).

Student assessment

We want to understand whether the students in the marine debris class will experience any change in their knowledge, attitude, and behavior scores and if so, whether any increases will be greater than that of the comparison group. Forty-one students participated in the AUCT120 class while thirty-five students took the Marine Debris course. While response rates were high for participants in the classes, responses for each course are somewhat lower than total participant numbers.

First, we test the hypothesis that students in the marine debris class will experience increases in scores when comparing pre- and post- tests. Dependent-sample t-tests are one-tailed and set at the 0.05 level. We also analyze the comparison group to put results into context. When examining the experiential learning course (n=24), student knowledge increases between the pre-test (M=7.6, SD=1.4) and post-test (M=8.5, SD=0.8) in a statistically significant way $t(23)= -3.15$, p=0.002. Reported environmental behaviors also increase between the pre-test (M=63.2, SD=19.0) and post-test (M=77.2, SD=18.1) in a statistically significant way $t(23)= -5.24$, $p<0.0001$. When considering attitudes for the students in the experiential course, scores increase from pre-test (M=54.9, SD=14.0) and post-test (M=56.5, SD=14.8) but not in a statistically significant way $t(23)= -1.43$, p=0.08. In the comparison course (n=26), student knowledge increases between the pre-test (M=7.42, SD=1.1) and post-test (M=7.62, SD=1.3) but not in a statistically significant way $t(25)= -0.82$, p=0.2109. Reported environmental behaviors increase between the pre-test (M=58.7, SD=11.5) and post-test (M=65.6, SD=13.9) in a statistically significant way $t(25)= -3.14$, p=0.002. In addition, student attitudes increase from pre-test (M=56.1, SD=6.77) and post-test (M=59.7, SD=9.35) in a statistically significant way $t(25)= -2.59$, p=0.008.

Next, we compare the two classes on post-test means of knowledge, attitudes, and behavior. Post-scores are slightly different than the above-listed means because this is an independent samples t-test of all participant responses while the previous analysis is a dependent samples t-test of students who completed both pre and post tests. Independent samples t-tests are one-tailed and significance is set at the 0.05 level. Students in the experiential marine debris course (*n*=27) have higher post-scores in knowledge of marine debris (*M*=8.5, *SD*=0.75) than students (*n*=32) in the comparison course (*M*=7.5, *SD*=1.27). The difference is statistically significant $t(52)= 3.67$, $p<0.001$. Participants in the experiential marine debris course (*n*=27) also have higher post-scores for environmental behavior (*M*=76.2, *SD*=18.0) than students (*n*=32) in the comparison course (*M*=66.7, *SD*=13.5). These results are also statistically significant $t(48)= 2.26$, $p=0.014$. When evaluating environmental attitudes, the students in the experiential learning course (*n*=26) have slightly lower scores (*M*=59.19, *SD*=8.40) than students (*n*=32) in the comparison group (*M*=59.22, *SD*=9.02). The difference is quite small and not statistically significant $t(55)= -0.0115$, $p=0.50$.

In summary, both groups experienced a mean increase in knowledge of marine debris, though only slightly for the comparison group. The marine debris course group's changes in knowledge were statistically significant while those of the comparison group were not. Both groups also experienced an increase in mean environmental attitude scores, though while the marine debris students' increase was both small and not statistically significant, the comparison students experienced a significant increase. Both groups experienced a statistically significant increase in mean environmental behavior scores, however the marine debris students' scores improved by over twice as many points as the comparison group. When comparing post-test results, marine debris course participants have higher knowledge scores and behavior scores than the comparison group and the results are statistically significant. When considering attitude, the post-test scores are not different in a statistically significant way.

Discussion

Marine debris collection

The analysis of this litter allows a range of actors to understand the global problem of marine debris in the local context. While the cleanup surveys do not provide information about accumulation rates over time, they provide students with clear information and hard data to share with local politicians. In this case, it helps students understand both that there is a local aspect to this global problem and that marine debris accumulating on shores in Connecticut is overwhelmingly plastic from community and municipal sources. No policy change resulted directly from this study, as it was supported by federal funding and as such could not be used to advocate for specific policy. Instead, the students shared results with politicians on the Connecticut General Assembly's environmental committee who have been working for several years to construct policies to address marine debris in the state.

Student Assessment

The marine debris course participants experience a statistically significant increase in knowledge while the comparison group does not. This is expected, as the marine debris course focuses on the topic of marine pollution and litter, while it is one of many topics in the more general environmental class. Both the comparison and test group students experience an increase in environmental attitude scores, yet only the gains of the comparison group are statistically significant. The marine debris group begins the semester at a higher level, while the comparison students experience greater gains over time. This result may reflect the frustration and/or apathy that develops when focusing on a large intractable global problem like marine debris. The comparison and the test group yield statistically significant increases in environmental behavior. The marine debris course participants begin the semester with higher scores and realize greater gains over time. This indicates that experiential learning with reflection linking the environmental problem to individual behavior has the capacity to impact environmental behaviors. While the increase in knowledge and behavior scores for the student participants is promising, the results are limited.

Weaknesses with the student study include relatively small sample sizes and a need for replication to better understand if the results hold true at a range of institutions with varying populations. While the course clearly had meaningful impacts in the short-term considering knowledge and behavior, this analysis cannot capture long-term changes. It should be noted that the knowledge questionnaire focused on marine debris, yet the attitude and behavior questionnaires dealt broadly with the environment. As such, the results provide information about more general environmental attitudes and behavior, which may be muted in comparison to their attitudes and behaviors around the issue of marine debris. Using more marine-litter specific measurements in the future will clarify the impact of this course. In addition, while efforts were made to find comparable courses, the courses are not taught by the same professor and have different content in addition to the critical difference of experiential learning.

This analysis reveals that experiential learning may positively influence knowledge and behavior while the results for attitudes are not strong. While for many educators the appeal of experiential learning is that it provides hands-on experiences for students, it may also be true that this first-person hands-on examination of a large problem can make that problem seem insurmountable. Reading about the floating soup of plastic in ocean gyres makes the issue seem a distant problem. Picking up hundreds of bits of plastic from your local beach is more immediate. In other words, cleaning debris from a beach may have the unintended impact of making students feel as if an environmental problem is overwhelming. Does understanding a problem in such a tactile way inspire or depress? Can it do both? Inspiring one to change behaviors while depressing one about the state of the world’s environment? Perhaps. Further study will be needed to pull apart the complex ways that experiential environmental learning influences student knowledge, behavior, and attitudes. In future, similar research would benefit from replication with new populations (i.e., outside of a small liberal arts college in New England), a more explicit test/control design, using marine-litter specific measures on all three variables, and delving deeper into the way attitudes may or may not change.

Conclusions

Communities around the world grapple with how to address the pervasive problem of marine debris. The Shore to Statehouse project[3] allows students to learn about

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[3] Please see the Storify devoted to the meeting with legislators (http://bit.ly/28SwdpP). All materials (syllabi, reading guides, etc), tools, and information associated with the course can be found at the website dedicated to the project (https://ctmarinedebris.wordpress.com/). The student Tumblr can be found at (http://bit.ly/2bbxuav). The final policy report can be found on our project webpage (https://ctmarinedebris.wordpress.com/policy-brief/).

the critical topic of marine debris, remove litter, and inform policymakers. In Connecticut, participants removed over 1600 pieces of debris (61.5% of which was plastic) while improving their knowledge and behavior in a statistically significant way. While participant attitudes did not improve appreciably, these preliminary results demonstrate the value of experiential learning on the issue of marine debris. As all class materials are freely available, others may implement the course in new situations to better understand its value. In this way, citizen debris collection can become a part of a larger process that raises awareness in communities while shedding light on the local context of the issue. The data gleaned, in turn, can be used to both connect citizens to their own consumption patterns and to inform policymaking.

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