People, Plants, and the Planet: The Design and Impact of a Climate Change Curriculum to Support Plant Based Eating in U.S. Adolescents

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The IAFOR International Conference on Education in Hawaii 2024
Official Conference Proceedings

Abstract
This study aimed to examine the impact of climate change curriculum on 5th-grade students' food choice and sustainability considerations. Insight into the drivers of food choice and sustainability considerations that were most salient among 5th-grade students were gleaned through interviews to assist in designing and implementing a school curriculum entitled *People, Plants, and the Planet* (PPP). Six modules on climate change and sustainable food behaviors were developed that focused on food systems and plant-based eating. A cluster randomized controlled study design was implemented to evaluate its effectiveness at improving climate change knowledge, attitudes, self-efficacy, and behaviors. Four New Jersey schools in three counties participated. Three NJ schools were randomly assigned to the intervention, while the other school was assigned to the control. Within the intervention schools, one classroom was randomly assigned the full intervention (educational curriculum + cafeteria changes), and another was assigned to a half intervention (only cafeteria changes). The control group had a delayed intervention, receiving the intervention after the study was completed. To evaluate impact, participants (n=111) completed pre- and post-test surveys. An adaptive version of the Theory of Planned Behavior was used as the theoretical underpinning of the survey. At the post-test, the full-intervention group (n=48) had significantly higher mean scores in climate change and plant-based eating knowledge compared to the half-intervention (n=46) and control groups (n=17). This curriculum shows promise in being able to help shift food choices towards more plant-based foods in the context of climate change mitigation among adolescents.

Keywords: Food Choice, Adolescent Health, Diet, Dietary Intake, Environment, Climate Change, Climate Change Curriculum, K-12, School Nutrition

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Introduction

Adolescents (10-19 years) have the poorest quality diets among all age groups in the United States (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020), a problem which has significant implications for health over the life course. More than 40% of children and adolescents in the U.S. are overweight or obese (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2020), putting them at increased risk of both immediate (e.g., high blood pressure, cholesterol, fasting blood glucose) and long-term chronic health risks (e.g., heart disease, diabetes). Racial and ethnic disparities in obesity are marked, with significantly higher rates for Hispanic (25.6%) and non-Hispanic Black (24.2%) children and adolescents compared to 16.1% in non-Hispanic White counterparts (Fryar et al., 2021). While the causes of obesity are multifaceted, a key contributor is dietary intake (e.g., low intake of fruits, vegetables, and whole grains and overconsumption of energy-dense food of low nutritional quality) (Centers for Disease Control and Prevention, 2022).

Plant-based diets—diets consisting mainly of "minimally processed fruits, vegetables, whole grains, legumes [and] nuts and seeds" (Ostfeld, 2017)—hold the potential to deliver significant benefits both to the health of individual persons and to the wellbeing of non-human living things which depend on a relatively stable climate on Planet Earth. In the United States, higher adherence to a plant-based diet has been associated with a 19% reduction in cardiovascular disease mortality and an 11% reduction in all-cause mortality (Kim et al., 2019). Additional health benefits of a plant-based diet include lower risk of hypertension, high cholesterol, and overweight/obesity (Turner-McGrievy, 2017). Increasing adolescents' consumption of plant-based foods, therefore, represents a prime diet-centered strategy for significantly improving health over their lifespan. Shifting adolescents' food choices towards plant-based diets could reduce the long-term risk of chronic disease (McManus K. D., 2020). Diets higher in plant foods are also, other things being equal, better for the environment. Globally, food production is responsible for over 25% of all greenhouse gas emissions (GHGE) (Ritchie, Rosado & Roser, 2022). The production of animal agricultural products, including meat, dairy, and eggs, consumes significantly greater amounts of energy, water, land, and other resources than does the production of plant foods (Mekonnen & Gerbens-Leenes, 2020; Hedenus et al., 2014). GHGEs for livestock agriculture are correspondingly greater than those for crop agriculture. Thus, avoiding climate change's worst impacts requires reducing animal product consumption in favor of plant-based proteins (Scarborough et al., 2014). The average American adult who consumes meat is responsible for approximately twice as many dietary GHGEs as the average person who consumes a vegan diet (Tilman & Clark, 2014; Chai et al., 2019).

Adolescents today are deeply concerned about environmental and social justice issues, especially those related to climate change (Parker & Igielnik, 2020; *Climate Change Ranks Highest as Vital Issue of our Time – Generation Z Survey*, 2019). Given the strong relationship of plant-based diets to both human health and sustainability, there is an opportunity to harness the connection and passion adolescents have for sustainability to increase consumption of plant-based foods (i.e., fruits, vegetables, whole grains). A curriculum on food and its impact on planetary and human health would be well-positioned to give adolescents information about the sustainability of food. The purpose of such an educational intervention would be to equip adolescents with knowledge needed to choose foods that are both healthier for humans and better for the environment. There is ample evidence in the literature indicating that nutrition education, particularly when grounded in

theories of behavior, integrated into the existing curriculum, and designed to incorporate feedback from students, teachers, and administrators, can lead to positive changes in the dietary practices of young people, including increased consumption of plant-based food and decreased consumption of animal food products (Meiklejohn et al., 2016). In 2020, New Jersey became the first state to require public schools to include climate change education in the K-12 curriculum (State of New Jersey, 2020). This requirement has created a need for new and expanded environmental education curricula that can be used by New Jersey educators across the state. Within school-based nutrition education, however, teaching about healthy food and eating in ways that also center the health of the planet is a still-emerging area of educational practice.

The *People, Plants, and the Planet* curriculum was implemented in three schools across New Jersey. These schools represented three different geographical and economical areas in the state; urban low-income, urban middle-income, and rural middle income. One additional school served as a full control school. The purpose of this pilot study was to assess whether the new curriculum would be successful at improving 5th-grade students' knowledge, attitudes, self-efficacy, and behaviors around climate change and plant-based eating.

Methods

Description of Intervention

Prior to the development of the educational intervention for this study, a systematic narrative review was conducted to identify peer-reviewed studies that examined educational interventions and curricula that teach about climate change and/or sustainability with the intension of shaping adolescent knowledge, attitudes and/or behaviors related to food. Out of 6,639 publications considered, nineteen were positively identified as peer-reviewed studies that quantitatively assessed the effectiveness of an educational interventions to encourage healthy eating through the lens of sustainability and climate change. Thirteen of these studies found that curricula highlighting the relationship between environmental sustainability and healthy, plant-based foods resulted in either increased knowledge about good nutrition, or increased consumption of plant-based foods (Antón-Peset et al., 2012; Bersamin et al., 2019; Brain et al., 2015; Cornelius et al., 2014; Costarelli et al., 2022; Eugenio-Gozalbo et al., 2022; Evans et al., 2012; Figueroa-Piña et al., 2021; Jones et al., 2012; Jones et al., 2017; Jones, 2020; Sellman & Bogner, 2013; Prescott et al., 2019). Six studies found no such positive relationship between the intervention and any predicted outcome. Successful interventions tended to share a few attributes, including mixing substantive academic content with engaging activities, creating curricula comprised of, at most, 5-10 separate lessons, and explicitly linking lessons about sustainable food systems to students' dietary choices, rather than relying on students to make this connection on their own (Brain et al., 2015; Prescott et al., 2019).

Building on prior work, the project team developed a curriculum titled *People, Plants, and the Planet* (PPP). PPP consisted of six modules (Table 1), each of which focused on a different aspect of the relationship between food systems, climate change, and plant-based food choices. Each module included two 35-minute lessons that were delivered on separate days of a designated week. The first lesson in each module featured a 10-minute instructional video and associated teacher-led activities. The second lesson in each module centered on an expanded activity to explore and apply concepts from the previous lesson more fully. The entire curriculum was designed to be delivered over the course of six weeks (one module per

week). Lessons were aligned to the N.J.'s Student Learning Standards for Climate Change Education (State of New Jersey, 2020) as well as the Next Generation Science Standards (Achieve, 2013) and were taught by a team of 10 undergraduate, trained students from Rutgers University.

Module	Key concepts introduced in first lesson	Extended activity for second lesson
The greenhouse effect and things people use	Greenhouse gases trap heat on earth; human activities can lead to more greenhouse gases in the atmosphere	Students brainstorm how different foods are related to the production of pollution, including greenhouse gases
Food systems, resources, and outputs	Food systems require inputs and produce outputs. Greenhouse gases can be an output of food systems.	Students brainstorm what inputs and outputs are part of the production of five different food products, including fruit salad and cooked hamburger
Changes to the land from food production	On-farm production of animal-based foods requires more land than plant-based foods—resulting in greater GHGE	Students create visual aids, like posters, to communicate the relationship between increased land consumption and GHGE
Food and the other greenhouse gases	Growing crops and raising animals for food produce other greenhouse gases—not just CO^2	Students conduct an experiment to demonstrate the potency of different greenhouse gases
Greenhouse gases after food leaves the farm	Stages of food systems other than production—like processing and distribution—also produce greenhouse gases	Students brainstorm differences in greenhouse gas outputs post-farmgate for two different foods
Carbon footprint	GHGE related to an activity, thing, or person can be captured in a single number	Students use a carbon footprint calculator to evaluate animal-based vs. plant-based meal menus

Table 1: Module Content

Study Setting and Participants

This study received Institutional Review Board approval at the authors' university prior to recruitment of participants. In each of the three intervention schools, there was a randomly assigned full intervention class and a randomly assigned half intervention class. The full intervention classes received the six modules and were exposed to cafeteria changes to promote food waste reduction and student consumption of plant-based foods. The half intervention classes were exposed to cafeteria changes but did not receive any of the educational lessons until after the study was completed. The urban low-income school district participated as a control school which did not receive any of the interventions (educational lessons or cafeteria changes). The cafeteria changes were based off the Smarter Lunchrooms Movement, a research-based program created by Cornell University's Center for Behavioral Economics in Child Nutrition Program in 2009 that promotes eight main strategies to encourage student selection of healthier foods in school cafeterias (Mumby et al., 2018). Some of the strategies include cutting fruits instead of serving whole to allow for easier consumption and intentional placement and advertisement of foods (Mumby et al., 2018). One additional class from the fourth school was utilized a full control sample; these adolescents did not receive any interventions.

Data Collection

The Theory of Planned Behavior was used to develop the evaluation survey. Multiple-choice knowledge questions were based on objectives for each lesson and were reviewed for construct validity. Questions related to climate change and plant-based eating attitudes, self-efficacy, and behavioral intentions used a five-point Likert scale (See appendix for assessment). The 50-question survey included 18 multiple choice questions assessing student knowledge about climate change and plant-based eating, and 32 Likert scale questions: Attitudes (7), Self-Efficacy (5), Behavioral Intentions (6), Perceived Behavioral Control (5), and Climate Friendly Behaviors (9). A $20 Amazon gift card was provided as an incentive to complete both the pre- and post-test surveys.

There was a total of 126 5th-grade students from the four schools that met the inclusion criteria to participate in this study. In attempt to have participants that were evenly distributed across different geographical areas in NJ, 32% of these students were from a coastal area of NJ, 28% were from a rural area, and 40% were from an urban area (Table 2). Most students in the costal and urban schools identified as Hispanic. Most students in the rural school identified as White. Approximately 8% of all the students within the four schools identified as Black and 4% identified as Asian (Table 2).

School	Town in New Jersey	Experimental or Full Control	Total Numbers of 5th-Grade Students	Race[1]
School A	Long Branch (Coastal)	Experimental	40	White: 24.7% Black: 7.8% Hispanic: 65.3% Asian: 0.3%
School B	Newton (Rural)	Experimental	35	White: 48.9% Black: 8.8% Hispanic: 35.0% Asian: 2.1%
School C	Paterson (Urban)	Experimental	26	White: 4.3% Black: 5.6% Hispanic: 89.2% Asian: 0.9%
School D	Paterson (Urban)	Full Control	25	White: 0.8% Black: 9.1% Hispanic: 89.4% Asian: 0.6%

[1]2021-2022 enrollment data from the N.J. Department of Education representative of the entire school, reported by the districts

Table 2: Demographics

Data Analysis

Data analysis was conducted primarily using IBM SPSS (Chicago, IL, version 28). Descriptive statistics of all study outcomes stratified by treatment group (control, half-intervention and full-intervention) were analyzed. Analysis of Covariance (ANCOVA) controlling for baseline scores examined significant differences at post-test of all study outcome variables (i.e., knowledge, attitudes, self-efficacy, behavioral intentions, perceived behavioral control, engagement with climate friendly behaviors) among the intervention (half

and full) and control groups. Partial eta-squared indicated small (η2 = 0.01), medium (η2 = 0.06) and large (η2 = 0.14) effect sizes of significant ANCOVA findings (Table 3).

Results

Of the 126 students, 118 received parental consent to participate, and only 111 students completed both the pre- and post-test surveys. The final analytical sample was 111 participants with 94 in the experimental group and 17 in the full control group. Within the experimental group, 48 received the full intervention, and 46 received the half intervention.

Internal consistency reliability of study outcome variables as determined by Cronbach alpha coefficients ranged from poor to good (Table 3) with knowledge (α = 0.42) and attitude (α = 0.35) scales performing poorly. Examination of between group differences of study outcomes controlling for baseline scores revealed significant differences in climate change and plant-based eating knowledge scores (Table 3). That is, at post-test the full-intervention group had significantly higher mean scores in knowledge compared to the half-intervention and control groups with a large effect size (η2 = 0.29). No other survey outcomes had significant mean score differences among treatment groups at post-test.

			Control Group (n=17)		Half Intervention Group (n=46)		Full Intervention Group (n=48)		ANCOVA between group differences over time [a]		
		N = 111	Baseline	Post	Baseline	Post	Baseline	Post			
Measure (total possible score range)	# Items	Cronbach's α	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*F*	*P*	Partial Eta-Squared
Knowledge (0 to 100)[b]	18	.418	43.14±18.38	35.29±17.34	45.17±14.23	46.38±15.01	42.59±14.82	60.19±21.08	21.856	<.001	.290
Attitudes (0 to 7)[c]	6	.350	3.42±0.44	3.31±0.58	3.39±0.90	3.40±0.50	3.40±0.48	3.44 ±0.47	1.38	.256	.025
Self-Efficacy (0 to 5)[d]	5	.717	3.24±0.75	3.17±0.59	3.57±0.84	3.41±0.69	3.41±0.66	3.47±0.65	1.987	.142	.036
Behavioral Intentions (0 to 6)[e]	6	.812	3.11±0.72	3.29±0.73	3.43±0.89	3.04±0.93	3.20±0.75	3.22±0.70	1.461	.237	.027
Perceived Behavioral Control (0 to 5)[f]	5	.633	2.88±0.53	3.11±0.69	3.16±0.74	2.99±0.73	2.94±0.69	3.10±0.65	1.458	.237	.027
Engagement with Climate-Friendly Behaviors (0 to 9)[g]	9	.831	3.06±0.88	3.20±0.64	2.89±0.98	2.72±0.90	2.619±0.63	2.85±0.74	1.364	.260	.025

Note: For Partial Eta-Squared, η^2 = 0.01, 0.06, and 0.14 indicates small, medium and large effect sizes, respectively.

[a] Analysis of Covariance controlling for baseline scores with Bonferroni correction.

[b] Higher scores indicate greater knowledge on climate change and food waste concepts.

[c] Higher scores indicate positive attitudes towards climate-friendly behaviors.

[d] Higher scores indicate greater confidence towards adopting climate-friendly behaviors.

[e] Higher scores indicate greater intentions towards adopting climate-friendly behaviors.

[f] Higher scores indicate greater perceived ease of control over adopting climate-friendly behaviors.

[g] Higher scores indicate greater frequency with engaging in climate-friendly behaviors.

Table 3: Assessment Outcomes

Conclusion

This pilot study aimed to assess whether an environmental education curriculum, that focuses on the planetary and human health benefits of increasing plant-based food choices, would be successful at increasing 5th-grade students' knowledge about the relationship between climate

change and plant-based foods, attitudes toward climate change and plant-based eating, and actual food consumption decisions. There is ample evidence to indicate nutrition education, when grounded in theories of behavior, integrated into curriculum can lead to positive changes in young people (Meiklejohn et al., 2016). There is currently a climate change education mandate for K-12 schools in New Jersey (State of New Jersey, 2020); however, there are a limited number of curriculums that have been proven to have a successful impact on students. The *People, Plants, and the Plane*t curriculum takes a step at filling this gap by providing a full curriculum that has been piloted in classrooms and resulted in a positive knowledge outcome. Results from the pre-intervention survey and the post-intervention survey indicate that students' knowledge significantly increased because of the multi-modal curriculum. These findings are consistent with previous studies that have found success in improving students' knowledge by teaching climate change lessons through the lens of food systems. (Brain et al., 2015; Prescott et al., 2019).

While there was no change in attitude, self-efficacy, behavioral intentions, perceived behavioral control, and climate friendly behaviors, the findings may have been impacted by several limitations. The student surveys used to represent the findings used self-reported data only. Self-reported data may be affected by personal biases, such as social desirability. Additionally, this study followed students over a short period of time. A longer follow-up study that follows the students over several years can show the long-term impacts of this curriculum and would provide additional insight into the effects of this educational intervention. Furthermore, while adolescence is a period in development when they begin to have more autonomy over their food choice, they still rely heavily on food choices that are being made in the home. This study was limited to reaching students in the classroom rather than including an at-home component to the intervention. Future studies may benefit by including an at-home component and following the students for a longer time to assess the intervention's long-term impacts. In conclusion, this study addressed the need for an impactful climate change education curriculum. This curriculum's impact is represented by the significant increase in knowledge found among the study participants. The results of this study may be beneficial to educators and policymakers who are involved in climate change education for U.S. adolescents. Moreover, as more states begin to require climate change curriculum be taught in schools, this curriculum can be used to meet the needs of educators with the potential to address curriculum requirements while simultaneously influencing students to make better food choices.

Acknowledgements

This research project was funded by an Agriculture and Food Research Initiative grant received from the National Institute of Food and Agriculture, as well as the Robert Wood Johnson Foundation. This work would not have been possible without the assistance of Shannon Barlow, Elisa England, and undergraduate students from Rutgers University that dedicated their time and efforts to this project.

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