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Cultivating Geographical Thinking: A Framework for Student-Led Research on Food Waste

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Abstract

Research has consistently demonstrated the wide-ranging benefits of student-led research, from increased student engagement to higher retention and graduation rates. Despite these calls to increase research opportunities for students, however, the availability of practical, easy-to-implement research frameworks in disciplinary-specific settings remains limited. For geographers, in particular, student-led research provides an opportunity for students to engage in the craft of geography, learning how to solve spatial problems in a real-world context. This paper presents a practical guide to working with students to develop and analyze a case study on food preferences and food waste. The subject of food waste provides an accessible framework for analyzing a range of geographic issues, from culture to globalization to industry. Specifically, this paper builds on the methodology utilized by a team of undergraduate researchers who examined the issue of food waste using both quantitative and qualitative techniques and adapts this project so it could be used in a variety of classroom settings. Student-led research can and should be expanded in geography, offering students a deeper understanding of spatial problem solving and a better understanding of geography as a discipline.

Keywords

undergraduate research; pedagogy; case study; food waste; agriculture

How do students learn how to think geographically? If geography is primarily about memorizing place names, the locations of rivers, and vocabulary terms, then reading a textbook and attending a traditional lecture will likely suffice. If, however, geography includes critically thinking and asking questions about the places and features found in the world, then student-led research should be a key aspect of the learning experience. Researchers have continually called for an increased emphasis on student-led, inquiry-based research. Geography, in particular, presents an opportunity for students to learn more about the world around them while also engaging in the research process. When investigating and learning more about agricultural systems, for example, students often know relatively little about how food is grown, marketed, and sold. Furthermore, students might be similarly unaware of the ways in which their own food preferences shape and are shaped by the larger agricultural system. The subject of agricultural systems cuts across cultural boundaries and provides an accessible framework for students to understand broader geographic, environmental, and research concepts.

In this paper, we present a practical, actionable guide to working with students to develop and analyze a case study on food preferences and food waste. This paper does not include the results of an empirical case study, but was written collaboratively with a team of four undergraduate students who developed, implemented, and analyzed their own food waste research project. Together, we adapted our project to be utilized by educators in the classroom, whether that classroom is at a small secondary school in a rural area or a large university in a populous city. As we seek to inspire the next generation of geographers, we should work to find ways to integrate students into the research process; this paper aims to provide a useful, easily adaptable foundation on which to do so.

Learning through Independent Research

Research undoubtedly plays a key role in the development of geographers within graduate programs, but for some, graduate school is the first encounter with the practice of geography. However, undergraduate research in particular has consistently been associated with higher levels of retention, cognition, and professional growth. In a nationwide survey of the effects of undergraduate research, Russell, Hancock, and McCullough (2007) found positive gains for undergraduates across the board, with no one type of research activity or form of mentoring required for successful outcomes. Furthermore, while the researchers concluded that longer projects were more likely to lead to interest in graduate education, all projects led to an increased understanding of the research process and an increase in students' confidence as researchers (Russell et al., 2007). Hathaway, Nagda, and Gregerman (2002) similarly found that undergraduate research involvement not only impacts student retention but also influences what students do after graduation, finding an increased likelihood of students pursuing graduate education among those who had participated in undergraduate research projects. Even for those who do not continue on to graduate school, undergraduate research participation is associated with positive long-term academic achievements in terms of graduation rates (Craney et al., 2011). For underrepresented groups, in

particular, the inclusion of undergraduate research opportunities could have significant long-term effects (Craney et al., 2011; Matsui, Liu, & Kane, 2003; Gregerman, Lerner, von Hippel, Jonides, & Nagda, 1998).

While research activities vary across discipline and institution, instilling enthusiasm, rather than following of a particular research framework, was a critical ingredient in driving student success (Russell et al., 2007). Additionally, early exposure to research and inquiry-based learning is associated with positive long-term outcomes (see Healey, 2005a). Russell et al. (2007) advocate for including research opportunities earlier in a student's academic career, even within elementary, middle, and high schools, as well as for freshmen and sophomore undergraduates (see also Ishiyama, 2002). Too often, research opportunities, whether independent or alongside seasoned faculty members, come at the conclusion of the academic experience as a capstone or thesis rather than as an integrated part of the academic curriculum.

The Boyer Commission provided a framework for this inclusion of undergraduate research in their 1998 report *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*. The report calls for a new model of undergraduate education to explicitly include research-based and inquiry-based learning (Kenny et al., 1998). While the report specifically targets research universities, the commission's recommendations and the call for students and faculty to collaboratively share in the teaching and learning process, we argue, is fundamental to the learning experience. Students should not be excluded from the research process if they attend community colleges, small public universities, or even local secondary schools, but rather these venues should seek to find new and innovative ways of, as the commission explored, removing barriers to the research process and including new classroom frameworks that put research activities at the center. Indeed, there has been a continued call for the broader integration of student-led research in undergraduate education for some time. In 1996, for example, the National Science Foundation asserted that undergraduate research is critical, specifically advocating for supporting undergraduate research activities beyond traditional "research" universities (NSF Advisory Committee, 1996).

Thinking outside the confines of the traditional research university or capstone independent research experience is critical for the expansion of student-led research across the curriculum. Linn, Palmer, Baranger, Gerard, and Stone (2015) reviewed studies of undergraduate research and found evidence for the need to integrate research experiences across the curriculum and not just in isolated and fragmented projects. While research has shown that longer-term research projects lead to an increase in the positive outcomes for students (Zydney, Bennett, Shahid, & Bauer, 2002; Russell et al., 2007), perhaps a more comprehensive integration of student research throughout the academic experience could produce similar benefits. Rather than engage in a year-long or semester-long guided thesis project, for example, a student might participate in inquiry-based learning in an introductory science class, then take part in a fieldwork case study in a social science course before leading a team of undergraduate researchers in an upper-level special topics class. In this way, undergraduate research becomes a central focus of the academic experience rather than an isolated event. Moreover, the

benefits of undergraduate research are not limited to students. As Zydney et al. (2007) found, undergraduate research can provide significant benefits to a faculty member's quality of life. At a prestigious research institution, a professor might have a sizeable grant enabling a team of skilled, graduate researchers to conduct in-depth, academic analysis. At many more institutions, however, research support is limited and teaching loads often cut into the time a faculty member can devote to research. Thus, incorporating students into the research process can allow a faculty member even with a sizeable teaching requirement and no funding for research activities to engage in academic scholarship. Undergraduates could even be integrated within the publication process, as this project and research by Walkington and Jenkins (2008) demonstrates. Researchers at all levels can be supported to publish works within disciplinary, pedagogical, and open-access venues.

Within geography and the social sciences, the inclusion of undergraduate research could yield disciplinary-specific benefits. Most investigations of undergraduate research benefits and experiences, however, is general and there has been a call for more disciplinary-specific case studies (Healey, 2005a). Our research seeks to answer this call by providing a practical and easily accessible framework for geography and environmental science faculty to integrate undergraduate research into the curriculum. Participation in undergraduate research has consistently been found to benefit students both psychologically and professionally (Hunter, Laursen, & Seymour, 2006; Ishiyama, 2002). As Hunter et al. (2006) demonstrate, this type of activity develops a student's ability to think scientifically. Ishiyama (2002) similarly found gains in the ability of students to think analytically and logically among those who had conducted undergraduate research. Undergraduate research provides a critical and beneficial opportunity for students to learn by doing, and Healey (2005b) calls for the development of disciplinary-specific spaces of research-based learning. In this model, geography students can shift from being consumers of knowledge to producers of knowledge, gaining valuable personal and professional skills in the process (Walkington et al., 2011). For geographers, engaging students in research opportunities would be an effective way to train students how to think *geographically*.

If student research is such an important component of learning how to think like a geographer, and in understanding how geographic research is conducted, then we should seek to integrate these experiences across the curriculum, rather than as isolated or stand-alone projects. Just as undergraduate research has shown to be beneficial for students, collaborative learning is associated with positive learning outcomes. Researchers have demonstrated the positive effects of active learning (Prince, 2004), problem-based learning (Spronken-Smith & Harland, 2005), research-based instruction (Gersten & Dimino, 2001), flipped classroom and case-study approaches (Herreid & Schiller, 2013), fieldwork (Fuller, Rawlinson, & Bevan, 2000; Haigh & Gold, 1993), and even role playing (Deaton & Cook, 2012). Furthermore, classes need not become entirely "flipped," or completely adopt a team-based learning model, to see benefits from active and engaged learning (Prince, 2004). Student research and its integration within the geography classroom has the potential to expose more students to actual practice of geography, particularly among underrepresented groups. In addition,

integrating more hands-on, student-led research activities at the secondary school level will better equip students to examine the world through a geographic lens as global citizens, whether they go on to higher education or not. By utilizing both new approaches to student research and new pedagogical approaches, we could better equip our students with geographic skills and increase their interest in geographical research.

Research Study Design

This case study is adapted from a research project created alongside four undergraduate students at the University of Mary Washington in Fredericksburg, Virginia, USA. Each of the students is a coauthor of this paper and has worked to create a case study that could be used in a variety of classroom settings. Broadly, the goal of this case study is to better understand how food preferences are shaped and reshaped by a country's food system and its culinary history. Within the United States, a country with no cohesive culinary tradition and a powerful industrial food system, understanding food preferences offers an opportunity to lift the veil, as Pollan (2006) might say, and uncover where our food really comes from. Even in a more rural area with a rich culinary heritage, examining one's individual food preferences and then researching food preferences as a class can provide a framework for investigating how food preferences might vary, change, or persist over time. As a group, we as researchers are supportive of the open education model and have specifically designed this study with openly available resources in mind.

Research topics in geography stretch far beyond what many people, particularly students in primary and secondary schools, first think of when hearing about the discipline. In fact, it is difficult to think of a phenomenon in which geography does not play a role. When thinking both spatially and analytically, problems presented in literature, documentaries, or day to day interactions become possible for students to examine from a geographic perspective. To do this we recommend presenting a class with a spatial problem, such as the issue of food waste and having a discussion as to what research questions can be developed based on the issue and the appropriate methodologies. For our study, a segment on food waste from the television series *Last Week Tonight with John Oliver* peaked our interest and resulted in a comprehensive study of the topic. One of the key articles published on the discourse of food production and food waste, "Food Security: The Challenge of Feeding 9 Billion People," explicitly pointed to the reduction of food waste as a critical way to enhance food security (Godfray et al., 2010). The authors noted that in developed countries "consumers have become accustomed to purchasing foods of the highest cosmetic standards; hence, retailers discard many edible, yet only slightly blemished products" (Godfray et al., 2010, p. 816). If cosmetic standards, that is, the desire to eat "perfect" foods, is a significant contributor to food waste in developed countries, than additional research is needed into how the very notion of "perfection" is shaped and whether or not these perceptions are spatially mediated. Furthermore, if consumers in these areas are indeed demanding food of the highest cosmetic standard, as the authors assert, this creates a standard of perfection that is biased toward the industrial food system. As farmer's markets have grown, perhaps as a reaction against the growth of industrial food

companies, research into these alternative food markets has similarly expanded (see Brown, 2001). Most research on farmer's markets, however, concerns issues of price (see Sommer, Wing, & Aitkens, 1980; Marr & Gast, 1991; Larsen and Gilliland, 2009), accessibility (see Larsen and Gilliland, 2009; Cole et al., 2013), performance (see Alkon & McCullen, 2010), and alternative food systems more broadly. The discussion of how farmer's markets contribute to or mitigate food waste as well as the role of farmer's markets shaping consumer preferences within a larger agricultural system remains unexplored. For geographers, this is, pun intended, fertile ground. Even novice geographers can agree on the basic idea that space matters, where we are matters, and how we look at food is largely dependent upon geography. Despite this, research into the role of geography in shaping food waste practices, and the impact of food waste on the landscape, remains limited. Out of this background research, our team derived a set of explicitly geographic research questions concerning the production of food, the locations of food purchases, and how consumer preferences might contribute to food waste.

The topic of food preferences and food waste can provide a suitable foundation for student-led research projects in a variety of classroom settings. This project might begin, as ours did, with an in-depth discussion of research questions pertaining to the issue and appropriate methodologies. Next, students can delve into the topic in more detail, and the level of detail and background research expected will vary based on the institution and grade level of the students. In a lower-level geography class, an instructor might conduct much of this background research while students in an upper-level undergraduate course might conduct their own literature reviews. For our research team, this background research consisted of examining the catalysts of food waste, our focus being food preferences, and fleshing out the subtopics that drove our specific questions for the study. While discussing food waste our research team came up with three key areas of inquiry regarding the food waste issue: consumer preferences as a driver of food waste, factors that contribute to food preferences, and food waste as part of our food system as a whole. The specific questions that drove our research were as follows:

1. How does geography impact consumer's perceptions of produce quality?
2. How do consumer food preferences affect how food is marketed and how much is wasted?
3. How does geography, specifically, shopping in a supermarket versus at a farmers' market, affect consumer buying preferences?

We encourage instructors to adapt these research questions as dictated by the needs of their courses and the level of their students, but would strongly advise instructors to be mindful of allowing the creation of research questions to be largely a student-led endeavor.

As part of our creation of research questions, we as a research team began by reflecting on our own experiences with grocery shopping. A class of students could also partake in this process by critically discussing, either as an entire class or in small

groups, their own shopping experiences. For our project, we considered both farmer's markets and grocery stores and consumer behaviors at each. We also explored the ideas of convenience and seasonality as factors that drive food preferences. We then contemplated the effects of marketing and displays at both farmer's markets and grocery stores. Finally, we examined consumer's behaviors at each of these locations. For example, we knew anecdotally that consumers often rummage through produce bins looking for the "perfect" product. Does this desire for perfection vary based on geography? We also questioned whether the location of where the purchase was made, the geography of where the item grew, or the physical appearance contributed to the decision of the consumer. These questions could easily be adapted to a variety of classroom settings, and in areas with a more cohesive food culture, issues of cultural preferences and culinary traditions might also be considered.

After the research questions are finalized, students and instructors can then develop a suitable methodological framework. While deciding on a method it is important to think about the type of results desired, as this will vary by institution. An instructor with a small, undergraduate research team, such as in our case, might ultimately desire work that is publishable in an academic journal, while an instructor in a primary or secondary school might wish to have the students create a poster that can be displayed in the classroom. Helping students understand the connections between research questions, methodology, and results is an important task in their development as independent researchers. This is also an opportunity for instructors to discuss the differences between qualitative, quantitative, and mixed methodologies. For our research project, one key methodology was a survey on food preferences that was distributed it to our entire student body, faculty, and staff. A survey of this nature allows for a large number of responses which in turn enables statistically driven results (Hay, 2016). As Secor (2010) maintains, the quality of survey data depends on sampling methods and the quality of the questions themselves. Following the guidelines developed by Secor (2010) and others, we brainstormed survey questions as a team, writing and revising questions that addressed our research questions and would yield both valid and reliable results (see Secor, 2010). We most often developed answer categories based on the Likert scale, which is commonly used in social science research (Visser and Jones III, 2010). Additionally, we frequently used pictures in the survey questions primarily to understand packaging, marketing and display, and appearance preferences. Many of our questions were linked to one another by citing a change, such as knowing the location of sale, a new sign, or location where the item grew, and then restating the previous question. This was intended to strengthen the rigor of our survey and ensure accurate conclusions.

Writing the questions could be divided among the students based on the type of question or topic. Instructors might introduce the concept of rigor and lead students in a discussion of how to ensure their results are reliable and replicable, such as through asking similar questions, rewording questions, and providing space for additional comments. Our research team accomplished the task of writing survey questions in stages beginning with a brainstorm as a group, writing the questions, and then meeting again to discuss and edit questions to ensure they answer the research questions we

identified. Once we finalized the survey questions, we distributed the survey using a software package supported by the university. However, instructors can easily utilize a variety of free online survey resources such as Google Forms or Survey Monkey. Furthermore, while we sent our survey to our entire university community and received around 700 responses, even a small-scale survey, sent out to the class as a whole or to a few classes would still yield meaningful results.

Once the survey is disseminated, analyzing the results can also be done at various depths based on the scale of the project. While we used SPSS, a powerful software package for statistical analysis, using Excel or the freely available Google Sheets would work as well. The level of statistics run on the data can also vary based on the course and the desired outcomes. With a lower level group of students, analyzing the survey results can provide a framework for discussing basic descriptive statistics while an upper level course might engage in more advanced inferential statistical tests. Instructors can easily adapt our methodological framework in a way that fulfills their course objectives and fits within their existing resources. The exploration of food preferences and food waste is meant to provide a powerful springboard for discussions of geographic principles and methodologies and a way for students to begin the practice of geographic research. Below, we provide a more concrete framework for implementing a case study of this nature in both a lower-level and an upper-level geography course and then proceed to discuss the process of bringing this into a classroom at those levels.

Engaging in Student-Led Research in the Classroom

While faculty members may already work alongside undergraduate students on research projects, it is the integration of this research into the classroom setting that can provide an even wider benefit. So often, students are unaware of what *doing* geography actually looks like and might not seek out opportunities for independent research if they do not fully understand what those research projects entail. The sheer breadth of geography as a discipline enables geographic research to integrate into a variety of classroom settings, and we encourage educators to find ways of scaffolding their own research projects into their courses.

This particular case study on food waste and food preferences is well-suited for classes exploring agricultural systems, such as Human Geography, or courses that examine the connections between nature and society, such as an Environment and Society course. In an upper-level course, this research project might provide a way for students to apply course concepts and conduct more in-depth analysis whereas in an introductory course, students could use this case study as a foundation to develop a better understanding of particular concepts or ideas. We outline both approaches in detail below, followed by a general discussion of the importance of undergraduate research and the experiences of our research team.

Lower level courses that incorporate research-based learning in their curriculum can give students valuable experience in the research process and confidence working independently as well as with peers. When designing the curriculum at this level, it is important to present research topics in a broad sense. Interdisciplinary topics that are

open ended, for example, allow for a multitude of approaches across different subject areas which would be appealing to a wide variety student interests. With students in lower-level classes, instructors might provide students with relevant background information that they can review and discuss, whereas this background research might be carried out by the students themselves in an upper-level course. In addition, while we developed our survey collaboratively, an instructor in a lower-level course might provide students with a basic skeleton framework of a set of survey questions that students could then edit. Students could also make a decision on how to utilize the survey data. Research shows that a challenge with implementing a project of this nature in a lower-level course is keeping students engaged. One solution to this problem, following Simm and David's (2002) recommendation, would be to provide students with a relatively high degree of freedom to design and implement the project based on their interests. This freedom should be balanced, however, with sufficient guidance from the instructor so that students avoid feeling overwhelmed. Another solution, particularly when working with students who are conducting independent research of this nature for the first time, would be to engage in role play exercises. During class, for example, students could have the opportunity to role play an interview or conduct a mock focus group. Another tactic is to create teams that have specific research objectives, which allows students to separate based on their interests and work on an aspect they are motivated to study. Creating an inclusive environment is critical in order to ensure each student benefits from this type of learning. Students who feel they have played a key role in the research project will be more engaged and will likely have higher learning outcomes.

As in a lower level course, incorporating research into an upper level course exposes students to high level geographical concepts and strengthens the student's research skills. While the lower level course is more of an introduction to research, the upper level course can be an opportunity for students to critically engage in research they are interested in. In order to foster interest in a topic, it is helpful to start off with basic readings that inform students about the themes of the course. For example, if this particular upper level course is on human environment relationships, students could read scholarly articles on the subject or read a longer novel, such as Pollan's *Omnivore's Dilemma* (2006) on the American industrial food system, to spark their interest and generate ideas for research topics. The first half of the research project or course could be devoted to reading texts while the second half would be focused on the actual research methodology and analysis, giving students time to think deeply about a research topic.

Students in an upper level course could be given more freedom while still being provided with guidance and a support system. In a smaller class, each individual student can choose a topic they are passionate about and then work in a group with other students to get feedback on research goals and research design. In a larger class, it would be more appropriate to assign students to small groups instead of having each student do an individual project. Group and class discussions throughout the research process are important because they allow students to receive constructive feedback from

their peers and from the instructor. In this way, the class as a whole is learning from each other and is gaining a better understanding of research.

In an upper level course, it is also important to expose students the relevant methodologies whether they are qualitative or quantitative, though the depth of exposure will vary by course. For example, in a topical course, teaching students step by step how to create a survey, and analyze survey results is one way to get students more engaged in the material and interested in independent research while also providing them with a new skill set. . At the end of the semester it can be rewarding for students to share their research with the rest of the class in the form of a mock conference. Allowing students to share their work in this way can make the students more excited about their research and their findings, and encouraging students to become more interested in conducting research in the future. In an upper level course students are able to become more autonomous and creative with their research. By the end of the course, students will be able to understand literature on a topic, develop a research project they are passionate about, and strengthen skills as both students and researchers. For our research project, our research team, in addition to the on-campus survey, designed a set of in-depth interview questions. We went out to four different locations, including two farmer's markets, a local supermarket, and a community-supported agricultural distribution, and conducted a total of 13 interviews. At each site, team-members asked questions based on our interview guide and developed follow-up questions based on participant responses. These interviews were then transcribed by the student research team members, coded using a qualitative analysis software package, and then analyzed. For the instructor, conducting this type of qualitative research alongside a team of students proved to be far more fulfilling than conducting solo research, but for the students as well, this provided an opportunity to experience the work of being a "real" geographer. For an upper-level geography or environmental science course, students could easily conduct similar interviews at a field study location or even on campus. This research project is specifically designed to be adaptable to any institutional framework. Finally, it is important to remember that for many students, this is likely their first experience conducting independent research, and so as with our project, there should be an emphasis on process as much as, or even more than, the final finished product.

Conclusions and Recommendations

Student-led research projects provide a valuable way for students to practice the craft of geography hands-on. While some might assume that geography is primarily a discipline of map-makers, modern geographical research is wide-ranging and is poised to provide a meaningful spatial context to pressing global issues. A geographical study of food waste following the framework we propose encourages students and faculty to think geographically by synthesizing information and drawing conclusions about an important global issue. Furthermore, this topic presents an accessible point of entry for students to engage in independent research at a variety of academic levels, building their spatial and analytical thinking.

By engaging in independent research, students are exposed to an array of geographic topics, strengthening their research and analytical skills, and allowing them to broaden

their academic interests. As our team can attest to, conducting independent research cultivates a sense of intellectual curiosity and excitement about the discipline. Research demonstrates that students who participate in these kinds of programs have consistently positive outcomes because they are exposed to techniques that connect what they're learning to real-world problems, better preparing them in their future careers and academic pursuits. Even if they do not continue into graduate school, research shows that the skills gained from research activities help students in the remainder of their academic career and improve graduation rates. For these reasons, opportunities for student-led research should continue to be emphasized and expanded across all education levels. In geography, discipline specific research projects are an effective way for students to learn how to think geographically, thus improving the discipline as a whole. Thinking geographically involves the rejection that learning is just about consuming information; rather it is an interaction with the information that depends on deep analysis and reflection.

It is clear from the related literature and from our survey findings that geography plays a critical role in shaping our food preferences, though geographic research into this topic, as well as spatial perspectives on food waste, remains limited. We aim to expand this research and continue to explore food system models that can ultimately mitigate food waste and reshape consumer perception. Ultimately, for this project, our research group was able to collaborate and brainstorm with one another in order to produce a more comprehensive understanding of food waste and an introduction to research methods in geography. At every stage of our research, we worked as a team to provide input, ideas, and guidance. Being part of a research team requires students to be autonomous, have efficient time management skills, and be a team player. Important skills such as these should be implemented across all education levels through undergraduate research. As we have learned, when students are introduced to undergraduate research early on in their academic career they are more likely to continue with undergraduate and, in some cases, graduate research. As described earlier, students can investigate an impactful topic such as their local food system, work individually on research skills, and collaborate with others to gain a better understanding of geographical problems. The end result of integrating undergraduate research into the classroom curriculum and engaging in research with students will be students who understand how to think geographically and who have the skills to go beyond the classroom solving complex geographical problems.

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