Teaching and Educational Method

Analyzing and Visualization of Data: A Team Project in an Undergraduate Course Evaluating Food Insecurity in U.S. Households

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Abstract
This paper presents a case study that integrates data analysis and visualization in a team project introduced in an undergraduate course focusing on food, nutrition, and health. The project is guided by a Ten Steps framework proposed by the instructor, involving the establishment and self-evaluation of student learning goals, identification of research questions, selection of data sources and analytic tools, task allocation among students, data analysis, data visualization, and finalizing the overall project. Throughout this project, students gain valuable insights into (1) the prevalence and inequality of food insecurity in the United States; (2) practical skills in conducting data analysis; (3) effective visualization of research findings for impactful presentations; (4) cultivating advanced critical thinking and decision-making skills; (5) improving skills on teamwork, presentation, and communication, ultimately enhancing employability; and (6) gaining active and personalized learning experiences. The Ten Steps framework can be easily applied to team projects centered on data analysis and data visualization in undergraduate courses. The case study can be adapted for undergraduate courses in food security, food and nutrition, and agricultural economics.

1 Introduction

Economists are known for their adeptness in data analysis, yet effectively conveying findings to a broader audience, especially non-economists, may not be as well-established (VanderMolen and Spivey 2017). Agricultural economists have a historical track record of conducting research that balances theoretical and empirical analyses (Fox 1986), with agricultural extension research regularly communicated to benefit farmers and industry groups (Leeuwis 2013). However, challenges persist in the "big data" era, particularly in equipping our students with skills in both data analysis and the art of delivering impactful data visualization to enhance discussions and dissemination of research findings.

In the current "big data" era, companies increasingly seek proficiency in both data analysis and effective communication of findings (VanderMolen and Spivey 2017). This case study, set in a classroom project environment, is designed to provide undergraduate students a hands-on opportunity to gain practical experience in both data analytics and data visualization. Recognized as essential components of economic education (Allgood and Bayer 2016; VanderMolen and Spivey 2017), these skills are also likely to benefit students in their future career paths (Kroes, Chen, and Mangiamelia 2013). However, these critical skills are often underdeveloped and inadequately addressed in traditional educational approaches (Grenci 2022).

This paper presents a case study that integratesdata analysis and data visualization for a team project introduced in an undergraduate course focusing on food, nutrition, and health. The project's success is guided by a Ten Steps framework proposed by the instructor (see Figure 1). The Ten Steps

Figure 1: Ten Steps Implemented to Ensure the Success of the Class Project

framework includes the establishment and self-evaluation of student learning goals, identification of research questions, selection of data sources and analytic tools, task allocation among students, data analysis and data visualization, and finalizing the overall project. This approach not only increases the likelihood of project success but also provides students with active and personalized learning throughout the project. The Ten Steps framework can be easily applied to enhance the success of team projects centered on data analysis and data visualization in undergraduates.

Under the Ten Steps framework, the objective of the team project for the course was to investigate food insecurity among U.S. households during the COVID-19 pandemic. Students were challenged to conduct data analysis and data visualization for impactful presentation of their research findings. Throughout the project, students improved their skills in data analysis, data visualization, teamwork, presentation, and communication, ultimately enhancing their employability. This case study can be readily adapted for undergraduate courses in fields such as food security, food and nutrition, and agricultural economics.

2 Overview and Background of the Project

The team project has students conduct research addressing a pressing societal issue and utilizing data analysis and data visualization methods. It was introduced in an undergraduate course titled "Food, Nutrition, and Health." The students in this course decided to investigate food insecurity among U.S.

households during the COVID-19 pandemic (see details on how they chose their research question in Section 2.2). They were challenged to justify the selection of their research questions.

Despite economic growth and policy support, food insecurity remains prevalent worldwide. Figure 2 plots the population percentage experiencing moderate and severe food insecurity in different types of countries using World Bank data. Before the COVID-19 pandemic, approximately 7–8 percent of the population in high-income countries and more than half in low-income countries suffered from moderate and severe food insecurity. Figure 3 shows that approximately 10–15 percent of U.S. households experienced food insecurity, with 3–6 percent experiencing severe food insecurity before the pandemic.

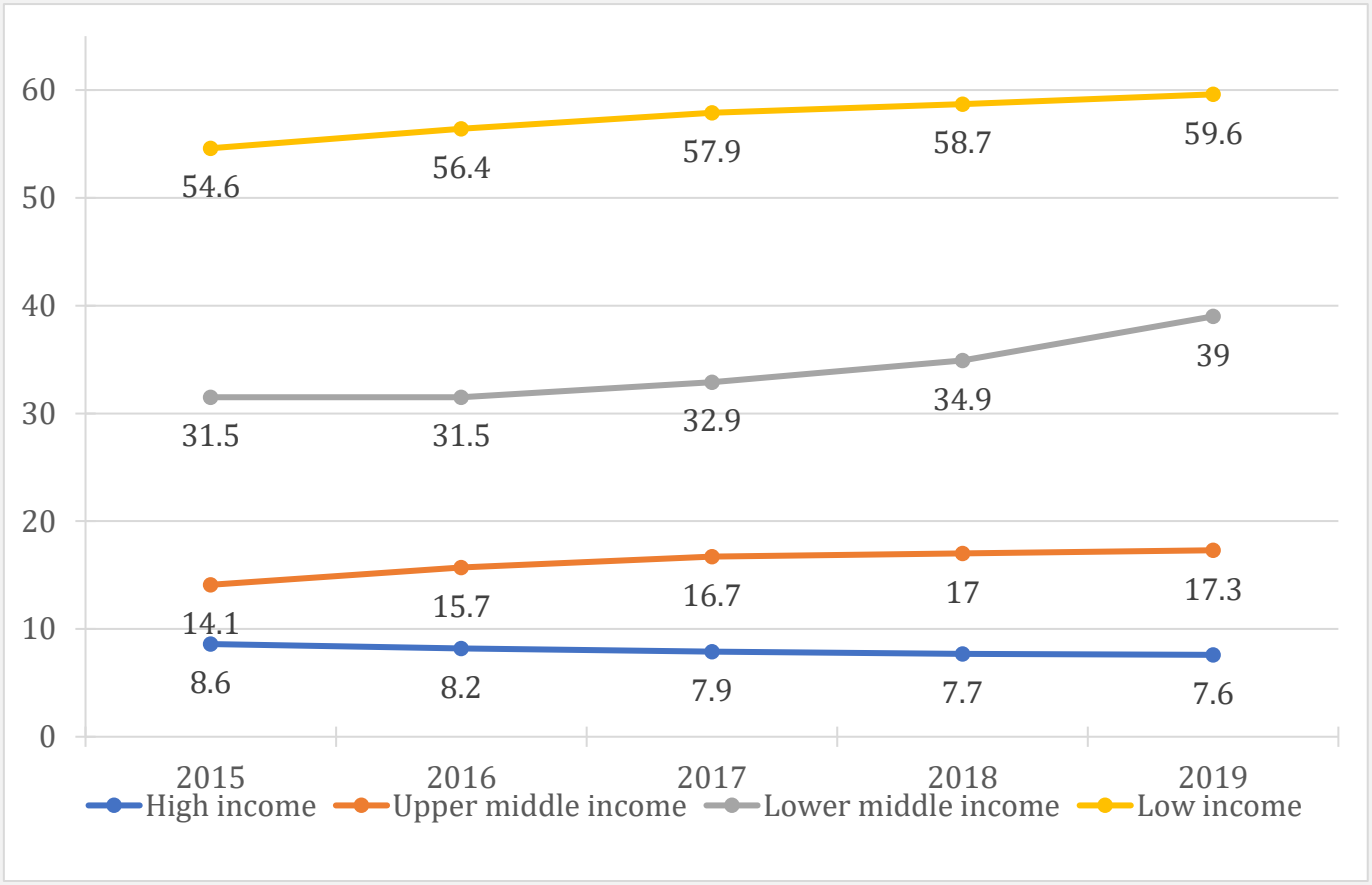


Figure 2: Trends in the Moderate and Severe Food Insecurity by Country Groups (%)

Source: World Bank Data on prevalence of moderate and severe food insecurity among population (%) at https://data.worldbank.org/indicator/SN.ITK.MSFI.ZS. Last access on November 29, 2023.

The impacts of food insecurity extend beyond physical health, affecting various aspects of individual well-being. For example, food insecurity can lead to nutritional deficiencies, affecting physical health, growth, and development, particularly in children (Eicher-Miller et al. 2009; Hanson and Connor 2014; Ke and Ford-Jones 2015). Chronic food insecurity is associated with an elevated risk of various health issues such as malnutrition, stunted growth, and a compromised immune system (Sasson 2012; Chaka 2023). Individuals facing food insecurity are more susceptible to chronic diseases and encounter greater challenges in recovering from health setbacks (Seligman, Laraia, and Kushel 2010; Nagata et al. 2019; Chaka 2023). Furthermore, food insecurity can hinder educational attainment, as hunger and malnutrition adversely impact cognitive development and concentration (Belachew et al. 2011; Faught et al. 2017). These individual-level impacts of food insecurity ripple out to affect communities, regions,

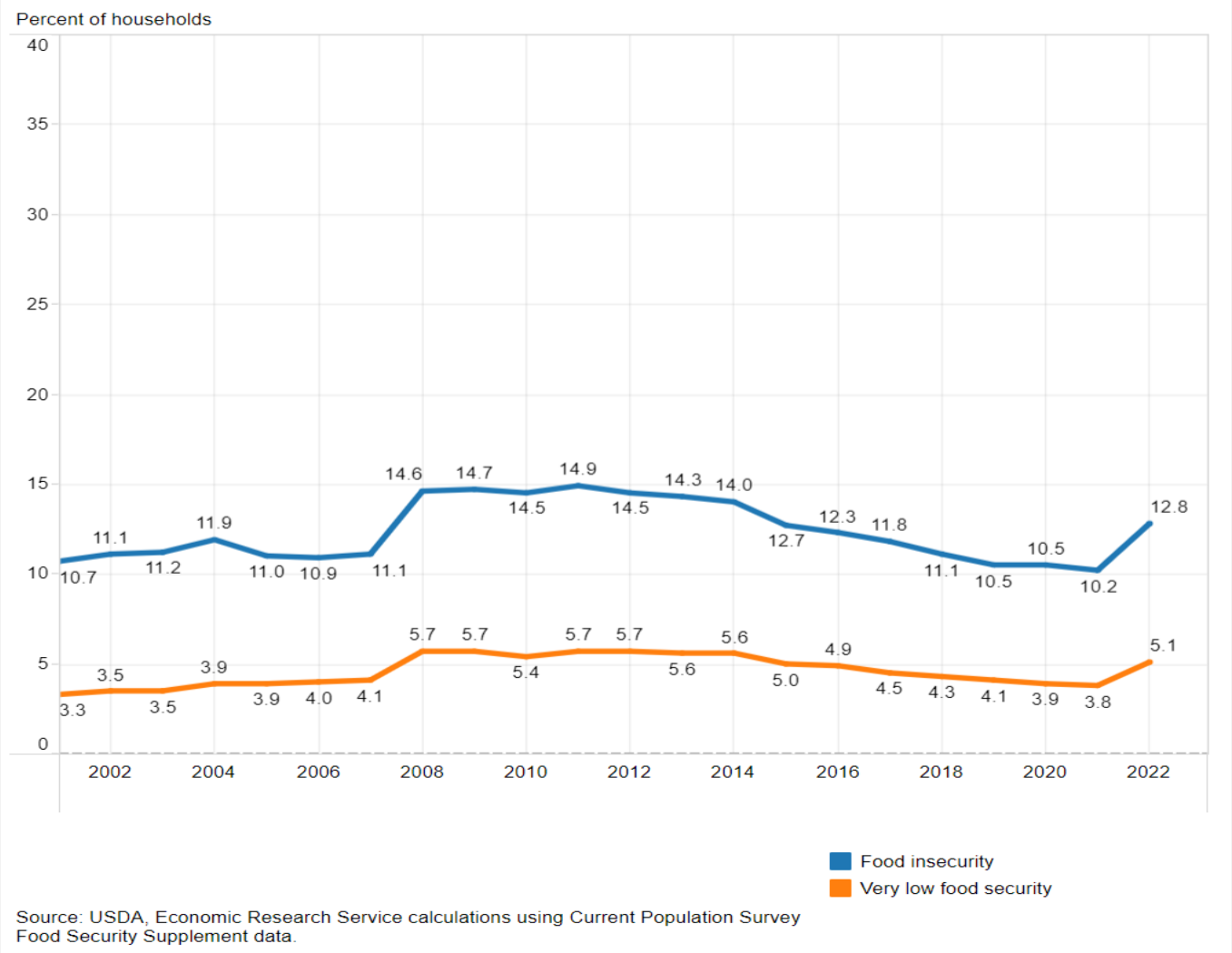


Figure 3: Trends in the Prevalence of Food Insecurity and Very Low Food Security Across U.S. Households (2001–2022)

Note: Estimated by the Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) at https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/interactive-charts-and-highlights/ Last access on November 29. 2023.

and nations, hindering workforce productivity (Agarwal and Herring 2015), exacerbating socioeconomic disparities (Otsuka 2013), destabilizing communities (Hendrix and Brinkman 2013), and placing an additional burden on health care infrastructure and resources (Baer et al. 2015; Tarasuk et al. 2015; Berkowitz et al. 2018).

The COVID-19 pandemic unleashed economic, social, physical, and emotional upheavals, affecting individuals across diverse backgrounds and socioeconomic status. One of the most pervasive and urgent challenges arising from the crisis was escalated food insecurity. The United States had a food insecurity problem prior to the pandemic, with approximately 10.54 percent of households being low food secure and 4.11 percent being very low food secure in 2019.

Based on this motivation, the specific objectives of the team project are to (1) investigate the prevalence and inequality of food insecurity of U.S. households; and (2) provide visualization of research findings for an impactful presentation.

3 Ten Steps Framework for Team Project Design and Implementation

Figure 1 outlines the ten steps implemented to ensure the success of the class project. The first five steps, including the establishment of learning goals, identification of research questions, selection of data sources and tools for data analysis, and the streamlined allocation of tasks among students, are pivotal to the project's success and require iterative deliberations and discussions. The subsequent four steps, including data analysis, discussion of research findings, data visualization, and project finalization, demand both individual and collaborative efforts. Additionally, in the last step, students were also provided with an opportunity to reflect on their learning experiences and evaluate the achievement of their learning goals. In this section, we delve into the specific activities conducted in each step.

3.1 Step 1: Establishing Learning Goals

Achievement goal theory stands out as a prominent framework for understanding student motivations, academic engagement, and achievement (Leeuwis 2013; Urdan and Kaplan 2020). The establishment of learning goals, for both the class project and individual students, serves to align commitment, responsibilities, and expectations between the instructor and students. It also engages students in active, personalized, and iterative learning.

For this class, the instructor delineated and discussed the following learning goals for this project with the class: (1) cultivating independent and interdependent learning through individual and teamwork efforts; (2) fostering active, personalized, and iterative learning; (3) developing skills in data analysis and data visualization; (4) improving presentation and communication skills; (5) gaining firsthand experience in scientific research and publishing; and (6) applying critical thinking to comprehend current events and enhance informed decision-making.

Each student was required to establish individual learning goals, with an option to revise these goals. Table 1 provides a comprehensive summary of individual students' learning goals, categorized into the following areas: improving data analysis skills; gaining knowledge about food, nutrition, and economics while staying attuned to current events; mastering the utilization of infographics to highlight research findings; and refining skills in teamwork, communication, presentation, and time management. These student-established learning goals aligned well with the instructor's goals.

These established goals served as reference points for students to assess their progress and accomplishments throughout the project. They were provided with chances to communicate and deliberate on their goals with the instructor. Upon the completion of the project, they were also required to evaluate the achievement of their learning goals (see the 10th step in Figure 1). The iterative nature of this process encouraged adaptable and reflective assessments of personalized learning and growth.

3.2 Step 2: Identifying Research Question

A well-crafted research question, vital for the success of class projects, should align with course content, resonate with current events, captivate students, and be achievable within the designed time frame. In line with the learning goals for this class project, the instructor required the use of data analysis to address the research question. Additionally, to empower students to take ownership of the project, the instructor facilitated discussions for students to explore potential research questions and allowed them to select the research question for their project.

The students gravitated toward examining food insecurity among U.S. households during the pandemic, primarily due to its relevance to the course, current events, and personal interests. They were challenged to further justify the importance of their research question (see Section 2 for detailed background). Recognizing the significance of this issue, students decided to address food insecurity in the United States. Once the research topic on food insecurity was well justified as interesting and relevant, students were introduced to several U.S. Department of Agriculture (USDA) reports on food insecurity (Coleman-Jensen et al. 2022) to build their knowledge of the topic. Additionally, they were

Table 1: Individual Students' Learning Goals and Their Self-Evaluation for the Team Project

Learning Goals	Selective Quotes from Students
A. Improve data analysis skills	1) *"The process of extracting and analyzing data was new to me."* *2) "Even though the data analysis and charts were not used in the brief, I created the analysis based on race and employment loss and found an unfortunate correlation between minority populations and increased loss of employment income."* *3) "Gaining practice with Excel taught me most of all that data analysis and research overall is an ongoing process which cannot be expected to be completed overnight. It is a long and detailed process that allows for revisions, organization, and eventually, conclusions."* *4) "I had to really think outside the box and understand the data. It was my first time using Excel, and the census to this capacity. So it was a challenge but I learned so much."* *5) "All of my work was done on Excel/spreadsheets, which helped me to sharpen my skills and learn some new things on Excel."* 6) *"I also learned how to utilize Excel to create graphs. It was the first time I used Excel to such lengths so I'm really proud of how much I challenged myself."* *7) "I was able to use my critical thinking and analysis skills to understand what the data was telling me."* *8) "There was so much trial and error, something I was not expecting with research. At first, it was frustrating because I kept having to change and correct my data. But I would eventually learn that this is all part of the process. Now, I can confidently say I know what to expect with research and to know not to give up on the first try."*
B. Gain knowledge and strengthen connection with current events	*1) "From my outcome and other classmates' graphs, I understood better about the issue of food insecurity from different aspects."* *2) "Have a better understanding of what food and nutrition have tied to each other with the process of economics."* *3) "This project motivated me to apply my critical thinking about current events."* *4) "Get a better sense of what research is."*
C. Learn how to use Infographic to highlight research findings	*1) "During the process, I understood what components are necessary for infographics as well as visualizing data."*

Table 1 continued.

Learning Goals	Selective Quotes from Students
	2) *"I also learned so much about creating my infographics such as labels and bar labels."*
	3) *"Had to put infographic together with rest of class and helped me look at fine details like theme colors, types of graphs, and placements."*
D. Improve teamwork ability	1) *"Working with the different class members and seeing the styles of data analytics and organization allowed for me to learn from them and to adapt my style for analytics. It also allowed me to get a good taste of what is genuinely needed and not when it comes to publishing data because of feedback from our connection with our professor."*
	2) *"I felt happy to help others make graphs and communicate a lot with them* [student peers]. *Also, I appreciate those who supported me when I asked about problems."*
	3) *"Collectively, the members of the class created a group chat to be able to reach out to contact and update each other, ask questions, confirm due dates, and to offer suggestions on how to improve each respective part of the overall deliverable. Also, we were able to send our data to ensure that other people were able to contextualize what they were individually studying. The result of this was a cohesive project, and a smooth road to get there because of effective communication."*
	4) *"In-class check-ins from Dr. Jin certainly improved the flow of this project compared to projects completed in previous courses. These meetings allowed for ideas and suggestions to be exchanged, and since they were held in front of other students, they allowed for suggestions on how to solve the relevant problem from more people. Additionally, they provided opportunities to discuss lingering problems with Excel/data analysis in groups before chapter lectures began."*
E. Improve time management skills	1) *"I tried to submit all assignments many days in advance, so as to avoid an emergency at the last minute, which could interfere with the timely delivery of all documents and spreadsheets. This surely was beneficial, as it allowed for the most thought and analysis to be completed, as well as allowing me to then become a resource to my classmates who struggled with different problems throughout the process, helping them from experience."*
	2) *"I made sure to work on my assigned task every week especially on the weeks where my data was still incorrect."*
F. Improve employability	1) *"Gaining practice with Excel, extracting data from the Census, and using functions of Excel to find measures of center, standard deviation, and to create charts were all immensely helpful for the future, whether in classes or in the workplace."*

exposed to various definitions of food (in)security from diverse organizations and challenged to adopt a specific definition to address their research question. For example, based on the 1996 World Food Summit (Food and Agriculture Organization 2008), food security is defined as the condition when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life. This definition highlights four primary dimensions of food security: physical availability of food, economic and physical access to food, food utilization, and stability of the other three dimensions over time. Yet, students found it challenging to locate data to measure these four dimensions.

The Food and Agriculture Organization (FAO) employs the Food Insecurity Experience Scale (FIES) to classify a person as food insecure when lacking regular access to enough safe and nutritious food for normal growth, development, and an active and healthy life.[1] Contributing factors to food insecurity include the unavailability of food and/or lack of resources to obtain food. Severe food insecurity occurs when people are unable to meet their minimum food requirements over a sustained period.

U.S. Agency for International Development defines food security and nutrition as access to - and availability, utilization, and stability of - sufficient food to meet caloric and nutritional needs for an active and healthy life (U.S. Agency for International Development 2019). Food insecurity is characterized by extreme poverty, hunger, malnutrition, and increased vulnerability to food shocks, stresses, and stunting.

The USDA distinguishes two types of food security.[2] Low food-secure households have enough food to avoid substantially disrupting their eating patterns or reducing food intake by using coping strategies and leveraging government and community food assistance programs. Very low food-secure households are those who are forced to disrupt their normal eating patterns and reduce food intake as they have insufficient money or other resources to expend on food. Given that students focused on food security in the United States, adopting the USDA definitions of food insecurity made it relatively easier for them to locate appropriate data to address their research question.

After several group discussions, the students opt to adopt USDA's definitions of food (in)security, facilitating their search for publicly available data of U.S. households. Specifically, the students initially aim to examine (a) the prevalence and inequality of food insecurity of households in the United States; (b) the support and assistance received by food insecure households; and (c) food insecurity for children.

3.3 Step 3: Identifying Data Sources

The instructor first provided an overview of different types of data (e.g., cross-sectional vs. panel data, qualitative vs. quantitative data, primary vs. secondary data), using both publicly available data sets and survey data used by the instructor for research. In line with the course content, the instructor also outlines various nationally representative data sets commonly used by applied economists and policymakers. Through this exercise, students were exposed to various data sources and gained a better understanding of how data are utilized by researchers and policy makers.

Among the various data sources students explored, they chose the Household Pulse Survey conducted by the U.S. Census Bureau. This 20-minute online survey focuses on how the COVID-19 pandemic affected households throughout the United States economically and socially. Initiated in April 2022, the survey collected information about the COVID-19 vaccine, income, employment, and child care

[1] Details of the FAO's definition of food (in)security can be found at https://www.fao.org/hunger/en/ Last access on November 27, 2023.

[2] See details on the definitions of low- and very low-food security by the U.S. Department of Agriculture, Economic Research Service at https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/). Last access on April 21, 2024.

along with social-demographic information.[3] Participants were asked about whether their households experienced food insufficiency in the last seven days, with response options ranging from (1) enough of the types of food wanted; (2) enough food, but not always the types wanted; (3) sometimes not enough to eat; and (4) often not enough to eat.[4] Aligning with the USDA's definition of food security, students classified households as low food secure if they chose "sometimes not enough to eat," and very low food secure if they chose "often not enough to eat."

Students decided to work with the first 48 weeks of data in the Household Pulse Survey, collected from April 2020 to August 2022, as shown in Table 2. Each survey reached out to a significant number of participants, and those who answered the survey represented the U.S. population aged 18 years old and above. It was the first time many have handled such a substantial amount of data, as indicated by their self-evaluation of their learning goals (see Table 1 for details).

Table 2: Data from the Household Pulse Survey by the U.S. Census Bureau

Phase	Dates	Week
Phase 1	April 23, 2020–July 21, 2020	Weeks 1–12
Phase 2	August 19, 2020–October 26, 2020	Weeks 13–17
Phase 3	October 28, 2020–March 29, 2021	Weeks 18–27
Phase 3.1	April 14, 2021–July 5, 2021	Weeks 28–33
Phase 3.2	July 21, 2021–October 11, 2021	Weeks 34–39
Phase 3.3	December 1, 2021–February 7, 2022	Weeks 40–42
Phase 3.4	March 2, 2022–May 9, 2022	Weeks 43–45
Phase 3.5	June 1, 2022–August 8, 2022	Weeks 46–48

Students were then asked to review their research question for the subsequent evaluations: (1) assessing if the data set identified could effectively address their research questions; and (2) determining which variables should be extracted from the data set for their project. This process presented an opportunity for iterative learning. For example, students found that the Household Pulse Survey data did not provide information for them to examine food insecurity for children during this period, leading to the revision of research questions. They acknowledged data limitations and adjusted their focus accordingly. Specifically, they dropped the third research aim on food insecurity for children.

Additionally, the instructor discussed the sampling methods of the Household Pulse Survey. Recognizing the potential challenges for undergraduate students, the objective of this discussion was to provide them with an opportunity to comprehend how authentic research was conducted, including the

[3] Details of the U.S. Census's Household Pulse Survey can be found at https://www.census.gov/data/experimental-data-products/household-pulse-survey.html. Last access on May 29th, 2024.
[4] This survey question can be found on page 19 of the Household Pulse Survey Questionnaire at https://www2.census.gov/programs-surveys/demo/technical-documentation/hhp/Phase_4-1_HPS_Questionnaire_English.pdf. Last access on April 21, 2024.

complexities of sampling. The representation of the sample is critical in validating and generalizing research findings.

3.4. Step 4: Identifying Data Analytic Tools

The instructor provided a brief overview of various programming software commonly used for data analysis, including Excel, STATA, R, and SAS, with a particular focus on STATA and Excel. This discussion expanded their understanding and knowledge of tools for data analyses.

Collaboratively, the instructor and students delved into the structure of their identified data set and research questions they aimed to address. They worked toward assessing specific tools for data analysis that would help them achieve their goals within the designated time window, enhancing their proficiency in using these tools.

Despite the advantages of using STATA, students decided to employ Excel for data analysis for the following reasons. First, it was the first time they were engaging in authentic research requiring data analysis, and they found it challenging to learn STATA within the tight timeframe required to complete the project. Second, Excel was deemed sufficient for addressing their research needs and its proficiency could prove useful in their future jobs.

An Excel tutorial was given by the instructor. Suggested Excel Tutorial are *Excel Basics for Data Analysis* in *Coursera*.[5] This tutorial includes five modules: Introduction to Data Analysis using Spreadsheets, Getting Started with Using Excel Spreadsheets, Cleaning and Wrangling Data Using Spreadsheets, Analyzing Data Using Spreadsheet, and the Final Project.

3.5 Step 5: Streamlining and Allocating Tasks among Students

Given their refined research questions and the identified Household Pulse Survey data, the instructor and students deconstructed the overall research aims into categories outlined in Table 3, including (1) food expenditures, distinguishing between home and away from home; (2) trends in the prevalence of low and very low food security; (3) disparities in food insecurities based on race and household income levels; (4) self-reported reasons for food insecurity; and (5) assistance and support received by food-insecure households, including free meals, groceries, and Supplemental Nutrition Assistance Program (SNAP) benefits. These results will be represented using key concepts such as time trends, mean, and standard deviation, which have been thoroughly discussed and demonstrated using Excel.

To effectively allocate tasks among students, they were asked to share their background, including majors, research experiences, and skills. Concerns about distributive justice in grading team projects (Kidder and Bowes-Sperry 2012; Clarke and Blissenden 2013; Riebe, Girardi, and Whitsed 2016) and issues like social loafing and free riding (Kidder and Bowes-Sperry 2012) are well documented in the literature. To address these concerns, the students engaged in a discussion to ensure fair workloads.

Among the identified questions, the instructor allocated tasks to individual students based on their initiative and the instructor's evaluation of their backgrounds. Table 3 summarizes the specific tasks for each student, with the understanding that individual grades would be based on the quality of the team project, as well as individual performance and effort. Simultaneously, the team strategized on the division of labor, ensuring responsibility and accountability among team members. Furthermore, since it was the first time for all students to conduct empirical research requiring analyses of "big data," each student was teamed up with their peers so that they could support and help each other.

[5] This Coursera course can be found at https://tinyurl.com/Excel-4-Data-Analysis. Last access on April 21, 2024.

Table 3: Each Student's Focus Area and Student Groups for Tasks on the Team Project

Student	Tropical Area for Each Student	Groups
S1	Food spending	S1 and S2
S2	Trends of food insecurity and comparison with the pre-pandemic period	
S3	Prevalence of food insecurity by household income levels	S3 and S4
S4	Disparities of food insecurity by race	
S5	Self-reported reasons for food insecurity	S5, S6 and S7
S6	Percent of food insecurity households received either free meals/groceries or SNAP benefits	
S7	Where did food insecurity households receive help	
S8	Background paper	With S1–S7

3.6 Step 6: Conducting Data Analysis

The instructor provided a tutorial on Excel, with a specific focus on data analytic commands. Additionally, key concepts such as population and sample, mean, median, variance, standard deviation, and statistical tests (e.g., Student t test) were reviewed and demonstrated using Excel, as detailed in Table 4. A couple of students with prior experience in Excel were designated as leaders for the data analysis tasks. Furthermore, the instructor and students jointly established a set of steps for compiling, cleaning, and organizing data before proceeding with the data analysis.

Project-based learning in a small group has been found to improve student engagement through knowledge sharing and discussion (Almulla 2020). Consequently, the students were given the opportunity to form small groups for collaborative data analysis, as indicated in Table 3.

3.7 Step 7: Discussing Research Findings

In this step, each student presented individual research findings. As a group, they collectively discussed all the findings and identified key insights. Through this exercise, they gained a better understanding of their research findings and linked research results with policy implications.

The team summarized their key results as follows. During the pandemic, U.S. households spent, on average, $293.67 weekly on food both at home and away from home. Broken down by region, households in the West had the highest food spending ($317.72), while those in the Midwest had the lowest ($295.23). The prevalence of low and very low food security was 8.62 percent and 2.26 percent in 2020; 7.39 percent and 2.12 percent in 2021; and 8.27 percent and 2.65 percent in 2022, respectively. Inequality of food insecurity was pronounced—disproportionately affecting people of color, low-income households, households with employment income loss, and households with children. Given that these household types had a disproportionately higher prevalence of food insecurity before the pandemic, the pandemic elevated the inequality of food insecurity to even more serious levels.

The top reason given by survey respondents for food insecurity was found to be a lack of affordability resulting from income loss and inflated food prices (43.78 percent). Among food insecure households, 22.22 percent of households received free meals and/or groceries, and 32.03 percent received SNAP benefits. Most food insecure families received free groceries and/or meals from shelters and soup kitchens (51.34 percent), followed by food pantries or food bank (28.73 percent), families and friends (26.86 percent), religious organizations (26.80 percent), and meal on wheels and other food deliveries (23.70 percent).

Table 4: Data Analytic Concepts Reviewed		
Concept	**Definition**	**Example**
Population	A population is a complete set of individuals with certain characteristics	All the households in the United States
Sample	A sample is a part of fully defined population	The surveyed households in the Household Pulse Survey in the United States
Mean	An average of a variable	Average household income
Median	The value in the middle of a variable, implying that 50 percent of data points have a value smaller or equal to the median and 50 percent of data points have a value higher or equal to the median	Median household income
Variance	Variance is the expected value of the squared deviation from the mean of a random variable	Distribution comparisons of several household income distribution with different variances/spread
Standard Deviation	The standard deviation is obtained as the square root of the variance.	
Student's t test	The Student's t-test is to test whether the means of two normally distributed samples are equal.	Test whether Hispanic and non-Hispanic white households have the same probability of experiencing food insecurity

3.8 Step 8: Conducting Data Visualization

Existing research consistently demonstrates that creative expression promotes active and personalized learning (Kousoulas 2010; Brown 2015; Beghetto 2021). Creative expression not only makes experiential learning enjoyable, but also stimulates reflections that are important in active and personalized learning. Additionally, students on this project were tasked with creating appealing data visualization to present their research findings.

After considering various options, the team decided to utilize an infographic project to present their findings in a visualizing and compelling way. Utilizing infographics allows students to actively engage with their research findings, enhancing their understanding, retention of information, and presentation and communication skills (VanderMolen and Spivey 2017).

Given their selection of an infographic, the instructor led them to *Choices,* a journal of the Agricultural and Applied Economics Association (AAEA). *Choices* features data visualizations that focus on timely and important topics grounded in sound economics and are sometimes presented through infographics. This serves as an excellent resource for agricultural and applied educators aiming to involve students in infographic projects. The instructor and students collectively reviewed several infographics downloaded from *Choices* and identified the strengths and weaknesses of each.

We then discussed how to design their own infographic. The following questions and requirements were presented and discussed: (1) What is your favorite infographic, and what aspects contribute to your preference? (2) Considering the infographics shared by the instructor from *Choices*, what features do you

appreciate the most and find less appealing? (3) What is your preferred method for presenting the findings of the specific aspect of food insecurity you have concentrated on? (4) Would combining the preferred infographics from all team members result in a visually cohesive and compelling presentation? During the discussion session, students explored diverse strategies to make their findings visually appealing and coherent.

A suggested tutorial focusing on visualizing data includes the first two modules in the Coursera course titled "Data Visualization and Dashboards with Excel and Cognos."[6] These two modules are "Visualizing Data Using Spreadsheets" and "Creating Visualizations and Dashboards with Spreadsheets." A suggested tutorial for infographics is "Design and Make Infographics (Project-Centered Course)" at *Coursera*.[7]

3.9 Step 9: Finalizing the Class Project

The class project comprises two components: a background paper and an infographic. Students completed the background paper first by synthesizing research findings from each student, incorporating the objectives and data sections. Subsequently, they selected key findings to highlight in their infographic. Both the background paper and the infographic underwent multiple rounds of revision. We showcased both the early and final versions of the infographic. The early version, presented in Figure 4, spanned four pages but failed to captivate the audience with the key findings. In contrast, the final version, presented in Figure 5, not only zeroed in on the key findings, but also presented them in a well-organized and aesthetically pleasing manner. In the end, students presented their project in class and elaborated on what they learned from the project.

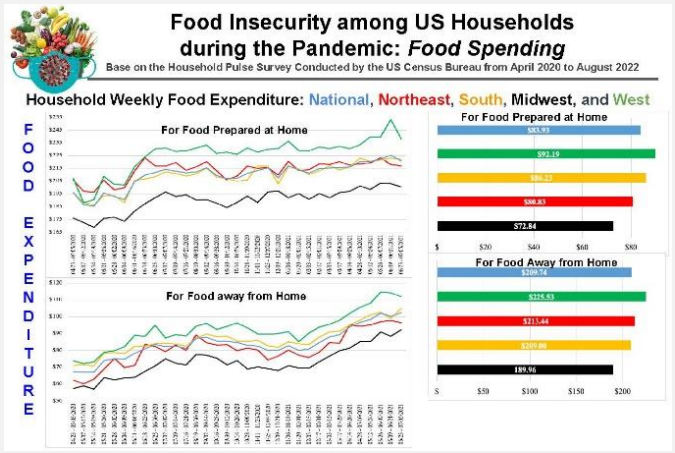
3.10 Step 10: Reflecting the Achievement of Learning Goals

At the outset of the project, students were asked to establish their learning goals, with an option to revise these goals. These goals served as reference points for assessing their progress and accomplishments throughout the project. Students had opportunities to communicate and deliberate on their goals with the instructor. The iterative nature of this process encouraged an adaptable and reflective assessment of their personalized learning and growth.

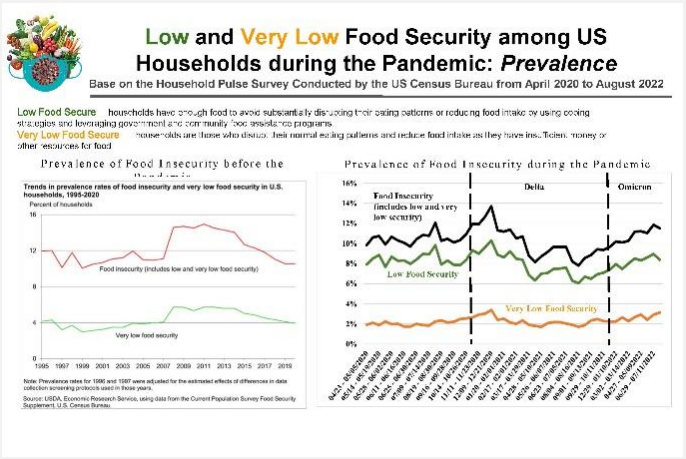
As shown in Table 1, many students underscored their exposure to and knowledge acquisition about food security and food economics. They articulated an increased awareness of and sensitivity to current events. Progress was reported for data analysis and data visualization skills, with several students experiencing the use of Excel for data analysis for the first time. One student shared, "*It was my first-time using Excel and the Census [data] to this capacity. So it was a challenge, but I learned so much*."

Several students recognized the iterative nature of research. One student emphasized that "*data analysis and research overall is an ongoing process which cannot be expected to be completed overnight*." They learned that "*it is a long and detailed process that allows for revisions, organization, and eventually, conclusions*." Despite initial challenges, students understood the importance of perseverance in research, with one sharing, "*There was so much trial and error, something I was not expecting with research. At first, it was frustrating because I kept having to change and correct my data*." They learned to anticipate challenges and not give up on the first try. Some students expressed pride and ownership upon completing their work, with one stating, "*It was the first time I used Excel to such lengths so I'm really proud of how much I challenged myself*."

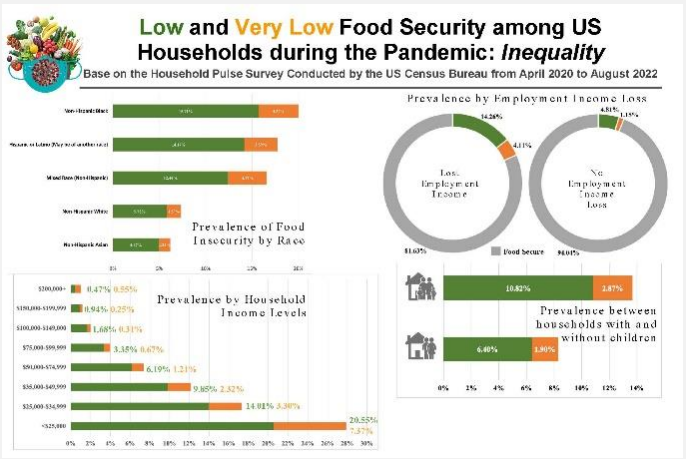
[6] The details of this course can be found at https://tinyurl.com/Excel-4-Data-Visualization. Last access on April 21, 2024.
[7] The details of this course can be found at https://www.coursera.org/learn/infographic-design#modules. Last access on April 21, 2024.



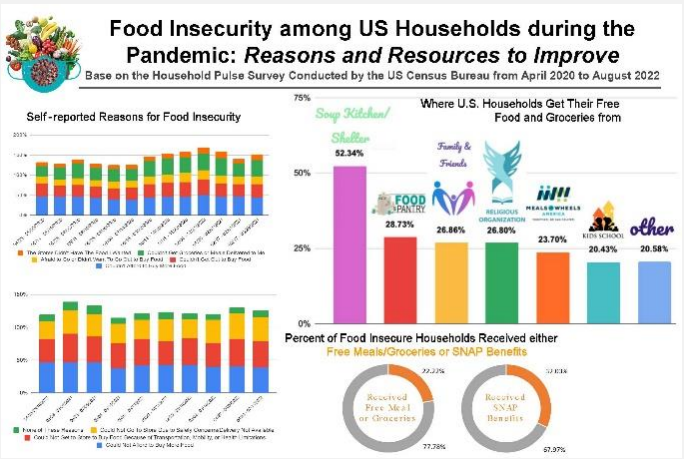
(a) Page 1



(b) Page 2



(c) Page 3



(d) Page 4

Figure 4: Early Version of the Infographic Presentation of the Research Findings

Effective teamwork and communication were pivotal to project success, as highlighted by a student who emphasized the collaborative efforts of this class:

> "*Collectively, the members of the class created a group chat to be able to reach out to contact and update each other, ask questions, confirm due dates, and to offer suggestions on how to improve each respective part of the overall deliverable. Also, we were able to send our data to ensure that other people were able to contextualize what they were individually studying. The result of this was a cohesive project, and a smooth road to get there because of effective communication*."

Furthermore, students emphasized the transferrable nature of the improved skills to enhance employability, with one student stating, "*Gaining practice with Excel, extracting data from the Census, and using functions of Excel to find measures of center, standard deviation, and to create charts were all immensely helpful for the future, whether in classes or in the workplace*."

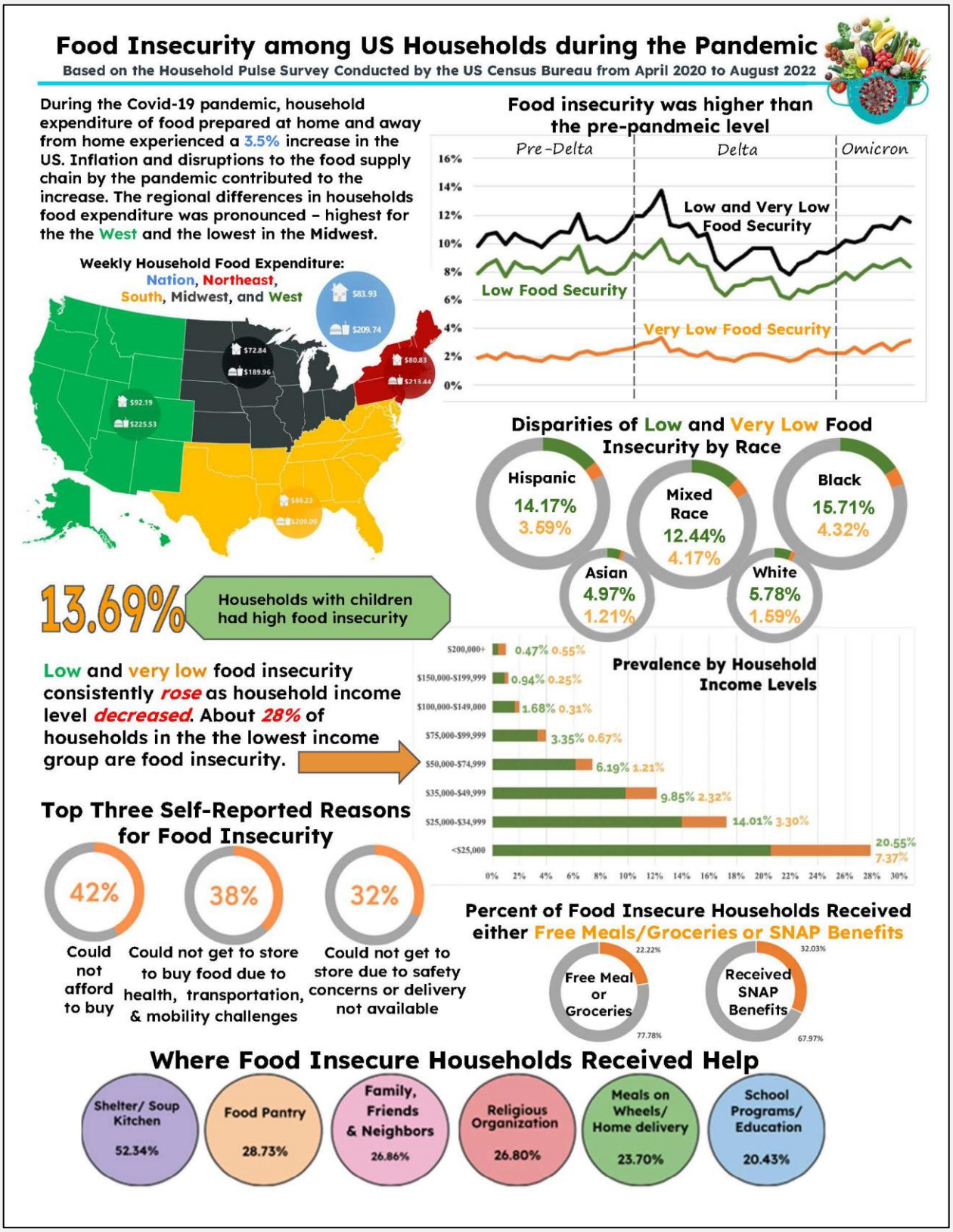


Figure 5: Final Version of the Infographic Presentation of the Research Findings

4 Student Evaluation of the Team Project

The iterative process embedded in the Ten Steps framework, illustrated in Figure 1, played an important role in fostering both active and personalized learning, evident through the following specific components: (a) the continuous cycle of establishing, refining, and evaluating individual learning goals throughout the project, which provided ongoing opportunities for active and personalized learning; (b) from identifying the research question to securing data and utilizing software for analysis and visualization, students engaged in both individual deliberations and team and discussions, contributing to active and personalized learning; and (c) while students worked independently on their tasks, collective discussion, group learning sessions for both data analysis and software, and mutual assistance between students created valuable team learning opportunities for active and personalized learning.

To assess students' perceptions of the project's role in their active and personalized learning, five questions were incorporated into the Rutgers student teaching evaluation survey for this course. Participants were required to express their agreement with the statements listed in Table 5 on a scale from one (strongly disagree) to five (strongly agree). Although only four students completed the evaluation, their responses provided some insights.

As shown in Table 5, each student attested to the project's efficacy in fostering active learning on both an individual and collective level, contributing to their personalized learning. Furthermore, they acknowledged the pivotal role of learning goals in shaping their personalized learning experiences.

Table 5: Students' Perception on Active and Personalized Learning from Course Evaluations

Statement	4 (Agree)	5 (Strongly Agree)
Learning goals specified by individual students were helpful for personalized learning	75% (N=3)	25% (N =1)
The project improved personalized learning	25% (N=1)	75% (N=3)
The project engaged students in active learning individually as well as a group	0% (N =0)	100% (N=4)
The project brought learning into students' daily life	50% (N=2)	50% (N=2)

Note: Four students completed the student teaching evaluation in the end of the semester.

5 Conclusions

This paper presents a case study that integrated data analysis and visualization in a team project on food security in the United States introduced in an undergraduate course focusing on food, nutrition, and health. The project's success is guided by a Ten Steps framework that includes the establishment and self-evaluation of student learning goals, identification of research questions, selection of data sources and analytic tools, task allocation tasks among students, data analysis and data visualization, and finalizing the overall project. The Ten Steps framework can be easily applied to enhance the success of team projects centered on data analysis and visualization for undergraduate courses.

Throughout this project, students gained valuable insights into (1) the prevalence and inequality of food insecurity in the United States; (2) practical skills in conducting data analysis; (3) effective visualization of research findings for impactful presentations; (4) cultivating advanced critical thinking

and decision-making skills; (5) improving skills in in teamwork, presentation, and communication, ultimately enhancing employability; and 6) gaining active and personalized learning experiences.

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