Service-Learning in a College Nutrition Class: Examination of Elementary School Lunch

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A service-learning project was implemented in a college nutrition course to examine what elementary school students *actually* consume during lunch. Students organized in teams with specific tasks for each stage of the project (data collection, analysis, interpretation). The project yielded meaningful recommendations for modifications in the school menu, which were implemented by the school district. The incorporation of service-learning is an excellent option for a general nutrition college course.

Keywords: Student research, nutritional analysis, student-centered pedagogy.

The dramatic rise in childhood obesity has reached critical proportions on a national level and has been rightfully dubbed the "childhood obesity epidemic." Several aspects of this epidemic have been documented in scientific studies and official government reports (USDA, 2008). The alarming statistics reported by federal agencies, and the current and projected costs associated with the medical treatment that stems from obesity, warrant the immediate attention of parents, scientists, policymakers, medical workers, and educators alike (Dehghan, Akhtar-Danesh, & Merchant, 2005; Marr, 2004). Unfortunately, school nutrition programs still suffer in quality, despite the best efforts by all parties involved in the process and the fact that nutrition significantly impacts student well-being and learning (CDC, 1996; McKenna, 2000; Picciano et al., 2000). Whitmore Schanzenbach (2009) makes a strong case connecting school lunch and obesity, highlighting the underlying socioeconomic factors that lead to children relying on school lunches for their meals. In order to establish the best school meal programs and nutrition education initiatives possible, it is vital to examine the present situation closely, identify strengths and weaknesses of policies and procedures, and make appropriate recommendations for improvements wherever necessary. Such comprehensive efforts are ongoing and carried out by federal agencies, professional organizations and researchers on a regional and national scale (American Dietetic Association, 2003; Stallings, Suitor, & Taylor, 2010; Stitzel, 2004; Story, 2009; USDA, 2008), and are beyond the scope of this work. Aiming to raise the next generation of citizens, parents, and voters who are better prepared to handle the various aspects of this epidemic, nutrition scientists must continue their efforts to learn as much as possible about the ever-changing patterns of food consumption during school. At the same time, instructors in higher education must intensify their efforts to raise awareness of the magnitude of the problem and teach their college students about the different dimensions of this issue. This report describes one opportunity aimed to accomplish both goals.

Although federal (USDA, 2017) and state (Oregon Department of Education, 2005) guidelines explicitly list what students *should* eat on average, little data exist as to what students really consume. In other words, school districts provide summary statistics on expenses and quantities of foods available to the students during school meals. While the school district may fully comply with federal regulations, this reporting practice may or may not accurately reflect what the students actually consume. To complicate matters even more, most peer-reviewed studies and subsequent summary reports rely heavily on the 24-hour recall method often with a follow-up interview a few days later. While such data provide a significant "snapshot" of what and how much children consume, some investigators have raised methodological concerns that affect the reliability and validity of these conclusions (Dwyer, 1995; Glanz, 2009; Gordon, Crepinsek, Briefel, Clark, & Fox, 2009; Rockett & Colditz, 1997). To be fair, the systematic and complete collection and analysis of nutritional information can be a daunting task for any investigator, school administrator, teacher, health official, or education advocate. Further, educational or nutritional interventions have not always been effective (Boon & Clydesdale, 2005; Cole, Waldrop, D'Auria, & Garner, 2006). For those who are concerned about the health of schoolchildren and interested in learning about and acting on such issues, the volume of information is staggering and often discouraging. On the other hand, the examination of such issues becomes more feasible when adequate resources are available, such as time and expertise. Service-learning courses are ideally suited for such undertakings, when the student collaborators' energy and enthusiasm is carefully guided by the instructor's plan and research skills. In order to explore whether the possibility for a meaningful analysis of student food intake during school

lunch is realistic, we incorporated a service-learning opportunity for college students enrolled in a junior-level nutrition course in a small, selective liberal arts college in the Pacific Northwest.

The course is taught as an elective in the Department of Exercise Science, and was initially designed as a lecture-only class focused on delivery of information, where students learned material from a textbook chosen for them by the instructor and recited memorized information in periodic exams. It was a natural consequence then, that the assessment of student attitudes about the course revealed that this outdated pedagogical model resulted in low degree of excitement on the part of the students, low degree of class participation, and an almost complete inability on the part of the students to connect the information presented in class with real life situations. Thus, for many of these future scientists, educators, health practitioners, and clinicians, the course did not succeed in conveying the importance of nutrition and nutrition education for the betterment of the nation's health and our society as a whole. Given that the remedy for such shortcomings falls upon the instructor, a complete overhaul of the course was undertaken. The decision was made to place particular course emphasis on the connections between the scientific investigative method as applied to a specific problem facing our broader community (Bringle & Hatcher, 1996). An examination of elementary school nutrition and nutrition policies at the local school district presented an obvious focal point for the redesigned class, and an opportunity for the incorporation of service-learning to benefit our community.

The incorporation of service-learning in the course was preceded by a review of the available literature in search of models that could be adopted for this course. In their frequently-cited paper, Eyler, Giles, and Braxton (1997) describe service-learning as the deliberate application of knowledge gained in the classroom to the service of the broader community. This definition is reflective of Kolb's (2014) model of experiential learning, where the student combines knowledge gained in coursework with personal interest in the topic and a desire to make a difference in their community. This bridge between theory and practice often offers additional benefits, such as improved student satisfaction with the course, increased self-esteem, enhanced social skills, improved academic engagement and performance, and increased desire to engage in community improvement projects (Celio, Durlak, & Dymnicki, 2011; Woods, 2002). Several service-learning models exist (volunteering, internships, mentoring, collaborations with community partners, presentation to the community), each tailored to the objectives of the student, the goals of the curriculum, the available resources, and the needs of the community (Pedersen, Meyer, & Hargrave, 2015).

Abundant evidence exists to demonstrate the mutually beneficial relationship between students in service-learning opportunities and the community partners they serve (e.g., Rinaldo, Davis, & Borunda, 2015). Service-learning has become a staple in many campuses across the nation precisely because of the opportunities it presents for the students who learn through practice, and for the communities that benefit from the resources and energy students bring to their work sites. The design of service-learning courses offers considerable flexibility regarding the student learning objectives of the course depending on the needs of the community, and the literature includes descriptions of such programs in a multiple settings such as health centers, schools, hospitals, senior centers, agricultural settings, etc. (Anstee, Harris, Pruitt, & Sugar, 2008; Pedersen et al., 2015; Pedersen, Woolum, & Gagne, 2007).

The incorporation of service-learning projects in specific courses must be guided by two factors: the learning outcomes for students and the specific needs of the community partner(s). Science courses that emphasize an appreciation for the scientific world view and the role of science in society offer excellent possibilities for faculty and students to collaborate with members of the community. In these courses the main component of learning consists of the applications and significance of science for a select population. Accordingly, students learn to appreciate how basic science is translated to applied science, where the results and knowledge gained in the laboratory can be used to benefit a group of people. Such science outreach activities are not unique in the field of nutrition education (Chabot & Holben, 2003; Johnson, 2005; Wood, 2003). Service-learning efforts to increase children's knowledge about nutrition through games (Poehlitz, Pierce, & Ferris, 2006); meal planning and preparation for local agencies (Raspberry, 2006); supporting children in any capacity (Ash, 2003); or demonstrating increased food consumption among students from low socioeconomic strata across a month-long period (Behrman et al., 2014) have been described before. However, as best as can be determined from the available literature, no study has examined the specific elements of the diet actually consumed by the elementary school students during school lunch, thus complicating efforts to improve meal planning.

In combining the need to learn more about elementary student lunch dietary habits with the educational objective of service-learning for undergraduates, this project aimed at accomplishing two objectives: explore the potential to quantify and assess the actual nutritional intake of elementary school students during school lunch, and provide undergraduate students an opportunity for real, "hands-on" research that actually resulted in policy changes and improved dietary habits for children. It is the combined effect of these two objectives that made this experience unique and interesting for the college student investigators.

Methodology

This study aimed at combining a service-learning opportunity for undergraduate students in a nutrition class with the need to conduct a nutritional analysis of lunch intake in elementary school students. This service-learning opportunity best fits the *project model* as described by Pedersen et al. (2007), where the students and the school district's nutrition contractor collaborated to improve food offerings for elementary school students. All aspects of this project were designed and coordinated by the students in consultation with the course instructor, and followed the six-stage model described by Anstee et al. (2008). Briefly, the first stage consists of establishing community partnerships prior to the start of the project or course to identify specific needs. The second stage includes the creation of a partnership with the students in the course. Only after this step is completed can students enter the third stage: training in the project's methodology. The fourth stage consists of the work that actually takes place in the community, and the fifth stage includes analysis of findings and connections with course material. The objective of the sixth and last stage is a report to the community partners with possible solutions addressing the need(s) identified in stage one. In planning for the project, the author was aware that previous studies have shown that students who may be unfamiliar with service-learning courses may experience discomfort and reduced satisfaction with these projects (Clayton & Ash, 2004). Others have noted decreasing motivation among students involved in service-learning opportunities when the students encounter obstacles such as scheduling conflicts, transportation issues, and less than optimal conditions at their service-learning site. (Darby, Longmire-Avital, Chenault, & Haglund, 2013).

Accordingly, and with regard to creating course-appropriate student learning outcomes, the first step in the whole process was to make certain that such a service-learning project was even feasible. This report highlights the importance of clear communications between the course instructor and the community partners regarding expectations and outcomes. For this reason, one of the class sessions each week was dedicated to planning work, addressing student questions and concerns, reviewing experimental procedures such as standardization of serving sizes and data analysis, discussing impressions, and reminding students of the objectives of the study. Finally, students formed groups and presented their analysis for each of the analyzed variables during formal class presentations. After feedback from their peers and the course instructor, these conclusions were collated into a report that was submitted to the School District and the nutrition contractor.

Since this was a preliminary attempt at a systematic study of what children eat during lunch, the process had to be carefully coordinated and monitored. The college students were exceptionally motivated and worked hard to arrange every detail of data collection and analysis. As a result, the project was completed on time and with only minor problems. On select days, data were not collected from the desired number of children from each school due to malfunction of the digital cameras, or because students simply failed to return for their post-meal picture. In all, data from only 11 students from all five schools and over 2 years could not be included in this analysis.

Approval Process

Prior to the commencement of the study, the author, who is also the course instructor, secured permission for this service-learning project from the local School District officials and the company contracted to provide school lunches. Over the years, the University and the local School District have established a series of meaningful connections, primarily through the Graduate School of Education, internship and volunteer opportunities for our students, and outreach efforts. The final project was designed by the author and was met with enthusiastic support by the School District officials and their catering contractor. The nutrition students were allowed to visit the meal preparation facility, and the District's nutritionist explained the process through which meals are planned, with particular emphasis on the constraints placed by federal standards and financial realities. The project was of particular interest to the District officials responsible for school meals, as the lack of resources prevents meaningful evaluation of what students actually consume at school. In a subsequent reflection assignment, it became evident that the District's input was particularly valuable to the students who were able to create connections between "ideal" school nutrition plans and "financially feasible" school nutrition plans. We subsequently contacted the principals

of three elementary schools (selected based on convenience and geographic diversity) and received permission to conduct this study in their schools over the span of two years. Select information about the schools is presented in Table 1.

	School 1 Year 1	School 1 Year 2	School 2 Year 1	School 3 Year 2	School 3 Year 1	School 4 Year 2
Total number of students	316	334	318	380	313	337
Students attending more than 90% of school days	75%	76.50%	89%	86.30%	85%	87%
English Learners	39%	46%	46%	9%	6%	<5%
Economically disadvantaged	>95%	>95%	55%	59%	47%	23%
Students with disabilities	25%	26%	12%	18%	18%	17%
School ranking (in %, compared to all other schools in the State)	15<S1<44	S1<5	15<S2<44	44<S3<90	44<S4<90	44<S5<90
School rating (compared to other schools with similar demographics)	Below average	Below average	Average	Above average	Above average	Below average

Table 1. Demographic profiles for the schools involved in this study. School 1 was part of the study for both years. These profiles partially reveal the diversity of students in these schools in terms of socioeconomic factors, academic performance, and state rankings. (S1-S5 correspond to school numbers).

One of these schools, School 1 was selected during both years of the study. The parents of the students were informed of the study objectives and methodology by the school principals prior to our visit to the schools and offered signed consent. There were no objections or concerns raised regarding the objectives of the study or the methods used since no child could be individually identified. Names were never recorded and the images taken were only of the food trays and never of student faces. Furthermore, all the college students who visited the school cafeterias and were in contact with the children followed the established protocols for volunteering at schools within the local district, such as completing background checks. All methods and procedures were approved by the University Institutional Review Board.

Course Administration

All the university students (n=55) who enrolled in the one-semester spring offering of the nutrition course over two separate years were presented with the opportunity to opt out of this service-learning project; they all volunteered for this project. Each year, students were separated into two-member teams, with a three-member team coordinating the entire project. In communication with the school principals, the student teams visited each school every day for a week. Each data collection team made a minimum of three visits to a school. The rotation of the teams was established by the coordinating team; key criteria included equal distribution of the workload, prevention of time conflicts and transportation issues, all the while ensuring the objectives of the project were met.

All the students participated in the data collection stage of the project.

Obtaining digital images

Every two-member student team was equipped with a digital camera and all students were trained in the use of the cameras. On any given visit, only 30-40 K-3 school students were selected through simple random sampling (every third student in one school one day, every fourth student the next day, and so on) at each school throughout the lunch hour, and their lunch trays were photographed twice: immediately after they had completed their food selection and right before they returned their used trays. For the purpose of matching the before and after images, the students were issued a numerical identifier, and the investigators recorded the child's age, gender, and school on a form (Figure 1). The elementary school students were asked to only eat items on their own food tray, but it was not possible for the service-learning students to monitor food exchanges and ensure the young children's adherence to this request. In all, n=869 elementary school students participated in this project, randomly selected as they proceeded through the school lunch line in each of the three schools. There was no consideration of whether the same children were selected on any given day, as this was not part of our experimental objectives. Particular care was taken to completely eliminate the potential for identification of the children.

Analysis of nutritional content

Before the images were collected, we received a complete copy of the week's menu from the School District's meal contractor, who cooperated fully with this project. After obtaining pictures from the school visitations, the student teams were organized in different teams, as they prepared to move to the data analysis stage of the project. Each student team was tasked with compiling data from the pictures onto a spreadsheet, such as number of servings consumed for each individual, type of entrée, choice of milk, etc. Food intake was estimated by two students working independently from each other by subtracting the leftover food from what the child had placed on the tray (Figure 1). Serving sizes on the student trays were estimated by comparing to images of standard serving size obtained at the start of each day. Every item on the tray was recorded in the nutrient analysis. While actual measurement of volume and weight of food before and after a meal would be ideal, this was not feasible in this setting. Thus, while this limitation may present a methodological flaw, our estimates in serving sizes were highly correlated for all measures (inter-rater reliability $0.89<r<0.97$, data not shown). The independent estimates of food intake from the two members of the data entry team had to agree before the serving size for each meal was entered into the spreadsheet. The student coordinators served as arbiters on the few occasions where agreement on the number of servings for a food item could not be reached. All the students participated in the data analysis stage of the project. The analysis of nutrient content and caloric value for each of the items on the menu was conducted with the use of nutritional analysis software using the ESHA nutritional database.

Figure 1. Photograph of a child's food tray before food was consumed (left) and before it is returned (right). All items on the tray were consumed, except the chocolate milk. The sequence was recorded as one serving of entrée, one serving of carrots, one serving of cucumbers, ½ serving of ranch dressing, and ½ serving of chocolate milk.

Data Analysis

After all data were entered in the spreadsheet, the students elected to limit the nutritional analysis of the consumed food to the following measures: calories, fat (g), saturated fat (g), sodium (mg), calcium (mg), and iron (mg). The selection of these variables was connected to the course content and reflected the importance

of these nutrients for health and well-being. Malnutrition involving these variables presents risks for cardiovascular disease, hypertension, osteoporosis, and anemia (Picciano et al., 2000). We calculated the total values for each of the variables for each of the students while separating the entrée data from the rest of the consumed food before we added these values together. The entrée data were separated since the entrée presented a unique opportunity to analyze the main part of the meal and make recommendations that could be impact the dietary composition of the entire meal. As a final step, students formed new work groups to analyze the data and present their conclusions regarding each of the nutritional variables measured. They also compared the values for each of the variables tested to the values listed in the National School Lunch Program (USDA, 2017) regulations listed in Table 2.

Nutrients and energy allowances	Minimum requirements Grades K-5
Energy allowances (calories)	650
Total fat (% of actual total food energy)	Less than 30% from fat per school week.
Saturated fat (% of actual total food energy)	Less than 10% over a school week.
RDA for calcium (mg)	276
RDA for iron (mg)	3.3

Table 2. Minimum weekly averages for energy and nutrient allowances for school lunches (USDA, 2017). These variables were identified for analysis by the students through their course work as important for the health of the schoolchildren.

All nutrient data were compared between schools for each of the two years of the study (ANOVA, α set at 0.05) but no statistically significant differences between schools were identified, so the data from each year were pooled. Comparisons of data between Year 1 and Year 2 were made (Student's t-test, α set at 0.05 for all analyses), and where differences between years were found, they were reported separately, otherwise they were combined and reported as one set.

Assessment of Student Learning

The evaluation of students' opinions and feelings about this service-learning project was focused and brief, as modeled by Lambright and Lu (2009). After all, while certainly incorporating the hallmarks of service-learning described by Smith et al. (2011), the class did not explicitly address issues of civic responsibility and engagement using models of collaborative development or even purposeful integrative learning. While these issues were certainly discussed in the context of our collective civic responsibility for social improvement, there was certainly not enough time to cover background information, organize the study, collect and analyze data and collate the report. For these reasons, at the completion of the project students were asked to respond anonymously to a short survey containing specific questions (Table 3, below), with an opportunity for open feedback at the end. All responses were based on a 5-point Likert scale from "Strongly Disagree" (marked as 1) to "Strongly Agree" (marked as 5). These questions were compiled from a list of assessment tools available online at the Learn and Serve website (Corporation for National and Community Service, 2005), the Student Assessment of their Learning Gains (SALG) site, and the Online Evaluation Resource Library (n.d.). The instructor also conducted interviews with the student coordinators who had oversight of the entire project. A recent change in the course designation (it is now part of the General Education curriculum) provides greater flexibility in addressing these issues in more detail, granting the students a more structured approach to civic engagement.

Research Project Results

This service-learning project yielded valuable nutritional data that guided the recommendations for dietary changes in the elementary school menu. As a result of these changes in the school menu, students benefited from lower calorie and fat options.

Total Caloric Consumption

The distribution of caloric consumption was wide (Figure 2). The average caloric consumption was slightly lower than the minimum caloric intake determined by federal guidelines (USDA, 2017) (582±182 vs. 650 calories respectively). Since the design of the study did not include monitoring the same children each day, it is not possible to identify individual trends in caloric consumption. Thus, for the children (n=227, or 26%) with very low caloric consumption (<400 kcal), we are left to speculate that perhaps certain children did not find anything interesting in the menu, or they were simply not hungry during any particular day. On the other hand, those children (n=97 or 11% of all children) whose caloric intake was high (>800 kcal) may simply have enjoyed too much of one specific item on the menu on a particular day. More interesting to note is that the majority of these high caloric intake points (93 of 97) occurred during the first year of the study, reflective of either the nature of the student body or minor changes instituted as a result of this work (see below). Our analysis indicated that high caloric intake was associated with high-fat entrees, such as pizza dippers and cheese nachos, items not included at all as options in the school district's menu in Year 2.

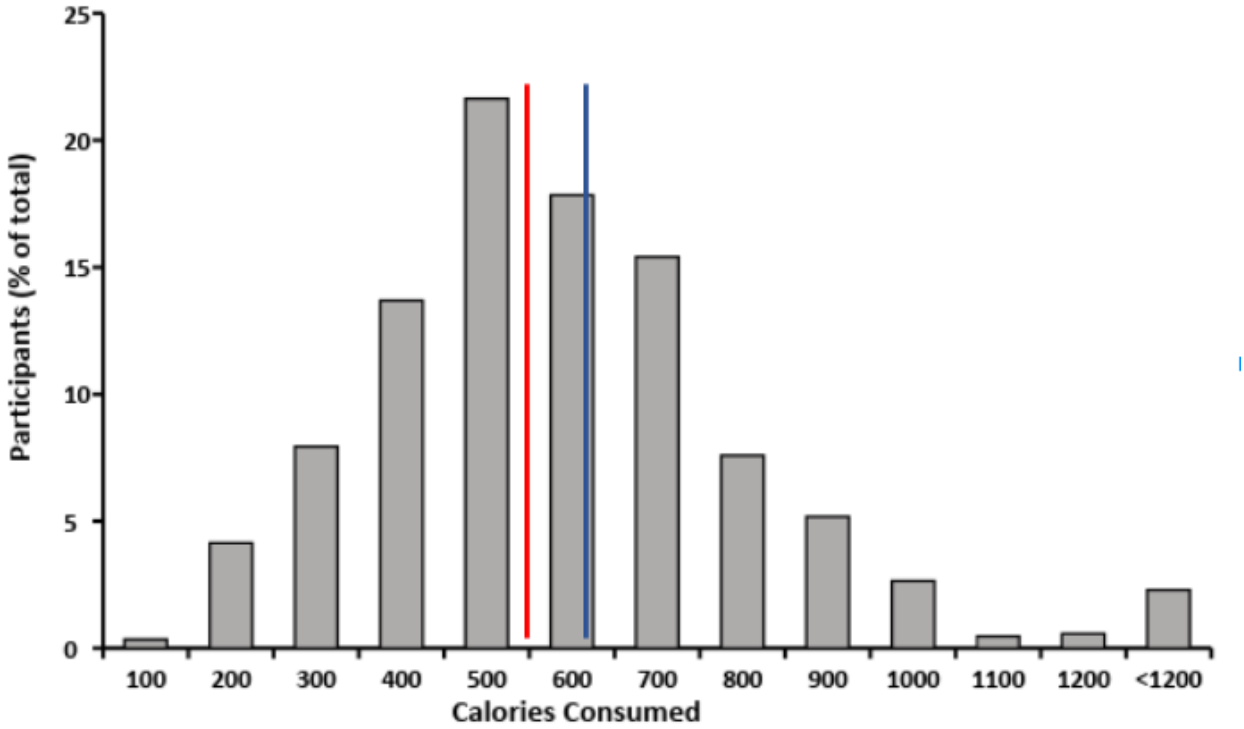

Figure 2. Distribution of caloric intake. The median caloric intake (582 calories, red line) was lower than the minimum standard established by the USDA Food and Nutrition Services (2017) (650 calories, blue line). This federal standard also applies to the School District in this study, and refers to the Traditional Food-Based Menu Planning Approach.

Calories Consumed

The average protein consumption was 19.33g, greater than the 8g standard established by the USDA (2016) for this age group. Federal guidelines adopted by the school district in this study mandate that caloric consumption from fat should not exceed 30% of the total caloric intake (USDA, 2017). This percentage is appropriate when a balanced meal is consumed, based on the aforementioned recommendations. However, as illustrated in Figure 3, we concluded that overall the consumption of fats by elementary school students in this study (35.7±15.7 % of all calories) far exceeds the federal standard. Even though we have individual students' data for the specific dates they were sampled, because of our sampling method we cannot draw any conclusions regarding individual students' consumption of fat on a weekly basis or their predisposition towards obesity. Thus, our data do not justify additional comments regarding daily

consumption of fats by individual students, nor was this objective part of the study.

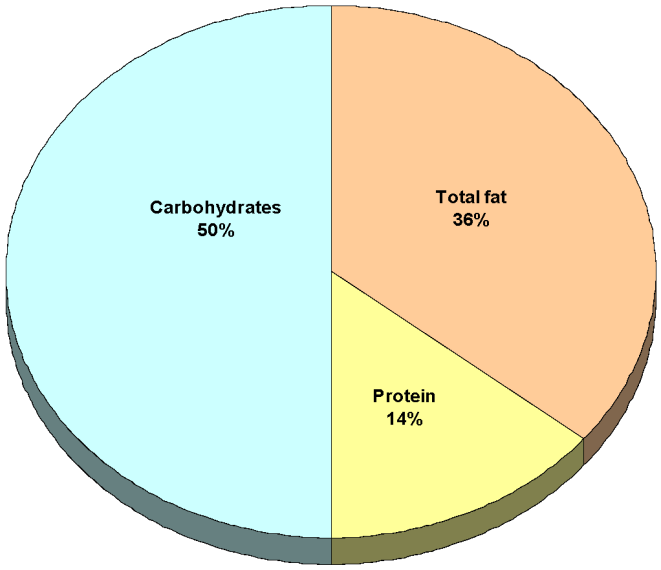

Figure 3. The percent contribution of each macronutrient to the total caloric intake.

An important distinction regarding fat consumption must be made between Year 1 and Year 2 in the study. A t-test for calories from fat between the two years revealed significant differences (251.4 calories for Year 1 vs. 148.6 calories for Year 2, p= .0017). Furthermore, even though the percent of calories from fat remained above federal standards during both years, it decreased from 38.3% to 32.7% from Year 1 to Year 2. It is not clear whether this reduction reflects differences in the student population or changes implemented in the school nutrition program as a result of preliminary reports from this work from the Year 1 data.

Consumption of Saturated Fat

Another disturbing aspect of overconsumption of fat is the increased consumption of saturated fat, and the risks associated with his trend. The average saturated fat consumption was 12.56% of the total caloric intake, again surpassing the federal standard of no more than 10% of calories derived from saturated fat. The binomial distribution illustrated in Figure 4 indicates that a subset of the study population (n=62, 13%) consumed more than 15% of their calories from saturated fat. A subsequent review of the actual distribution of values for saturated fat consumption (Figure 5) reveals that, for Year 1, a cluster of high values around Days 2 and 3 accounts for this increased consumption of saturated fat. From the actual records it is deduced that for Day 2, the majority of children consumed pepperoni pizza (52.7%) and chicken burger (24.7%) with 12.5 g and 8.53 g of saturated fats per serving respectively, and for Day 3, the majority of children consumed pizza dippers (26%) and cheese nachos (36%) with 6g and 26g of saturated fat respectively. There were significant differences between Year 1 (71.6 calories from saturated fat, 10.9% of the total caloric intake) and Year 2 (50.2 calories from saturated fat, 11.1% of the total caloric intake). Thus, the increase in percent saturated fat consumption is reflective of lower total caloric intake despite the lower total fat intake in Year 2.

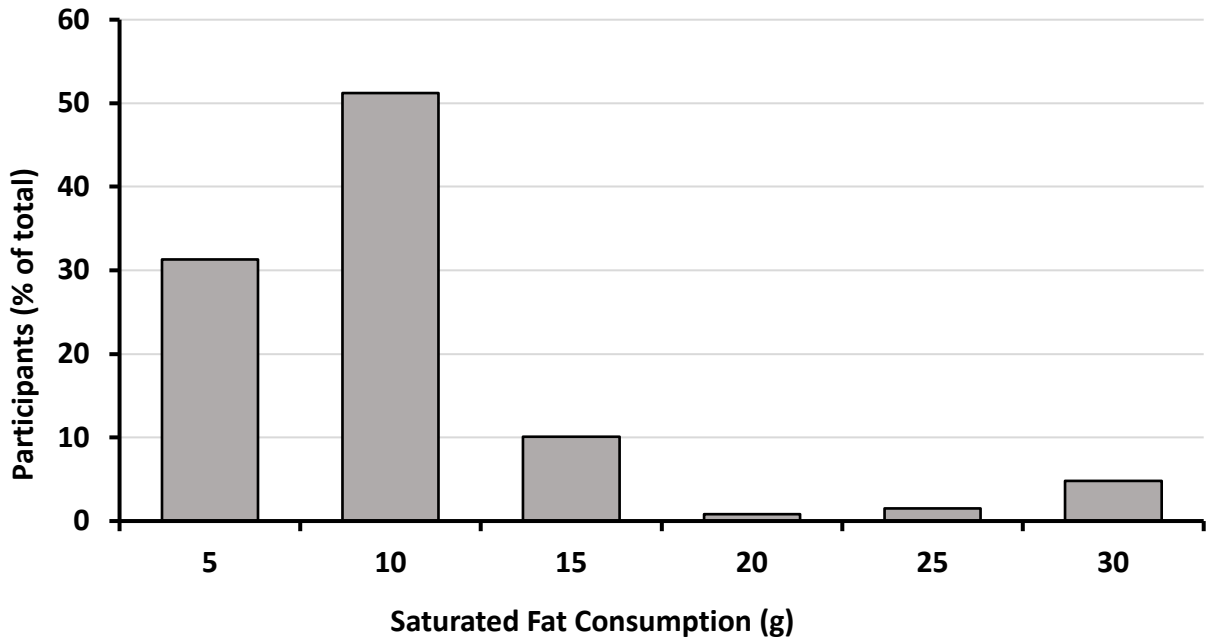

Figure 4. Distribution of saturated fat intake. The mean saturated fat intake (12.56% of total calories) was higher than the minimum standard (lower than 10% of total caloric consumption) established by the USDA, Food and Nutrition Services (2016).

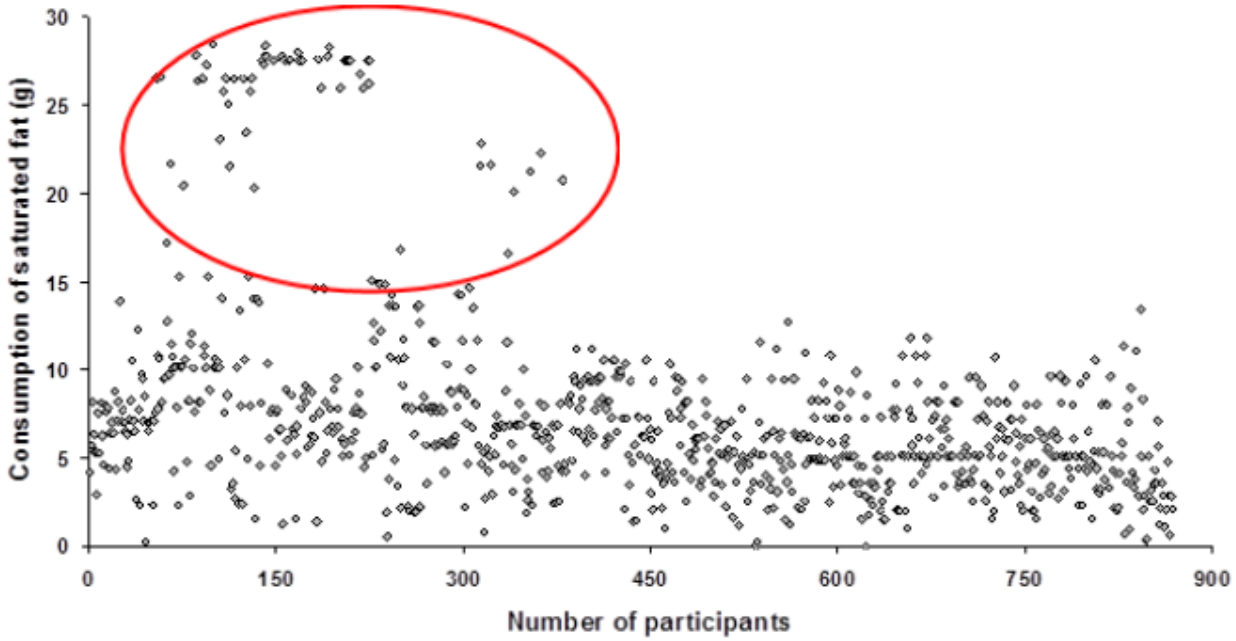

Figure 5. Distribution of saturated fat consumption. High saturated fat consumption during the first year of the study (circled in red) is attributed to the cluster circled in red that resulted from the consumption of pizza, cheese nachos, and chicken burgers.

Mineral Intake

The USDA Food and Nutrition Service Guidelines (2017) require a minimum intake of calcium of 276 mg for this age group. The results of this project indicate that the students in this study far exceed this requirement (median value of 350 mg), with no significant differences between the years. This is an encouraging finding at first glance, but it becomes somewhat problematic when about half of this intake is due to consumption of products high in saturated fats, as outlined above.

While iron consumption (median value of 3.12 mg) almost met the federal standard (3.3 mg) it is apparent from the distribution of iron intake (Figure 6) that a significant number of students (n=478, 55%) fail to meet this minimum acceptable standard.

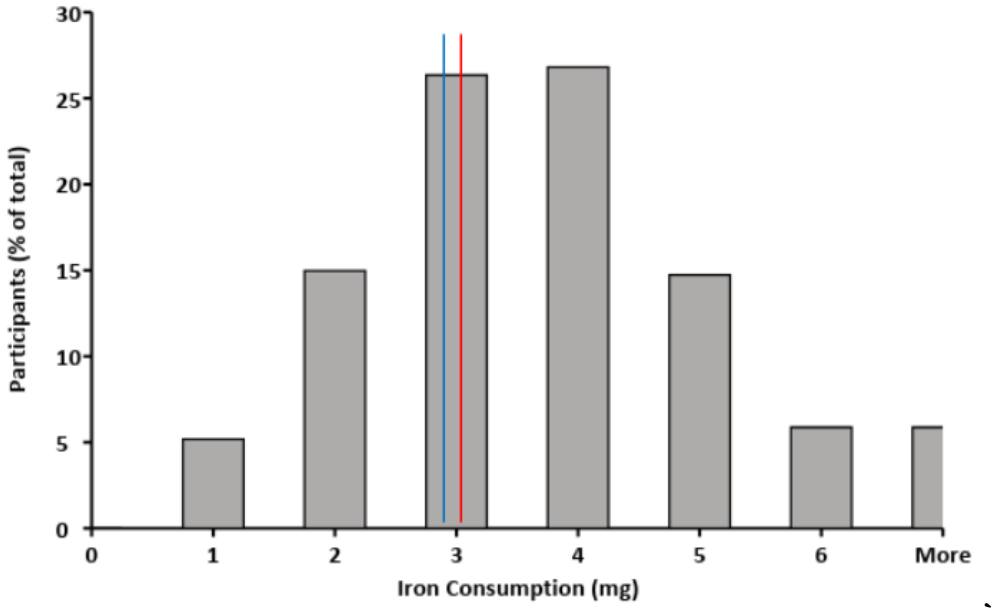

Figure 6. Distribution of iron intake. The median iron intake (blue line) was slightly lower than the minimum standard established by the USDA Food and Nutrition Services (2017) (red line).

With regard to sodium intake, there were significant differences between the mean values for the two years (320±167 mg for Year 1 vs. 750±96 mg in Year 2, p< .001). Further analysis for Year 2 revealed that the entrees, fruit, and vegetables contained more than twice as much sodium than the rest of the food items combined (508±131mg vs. 242±67mg respectively, p< .001, figure 7).

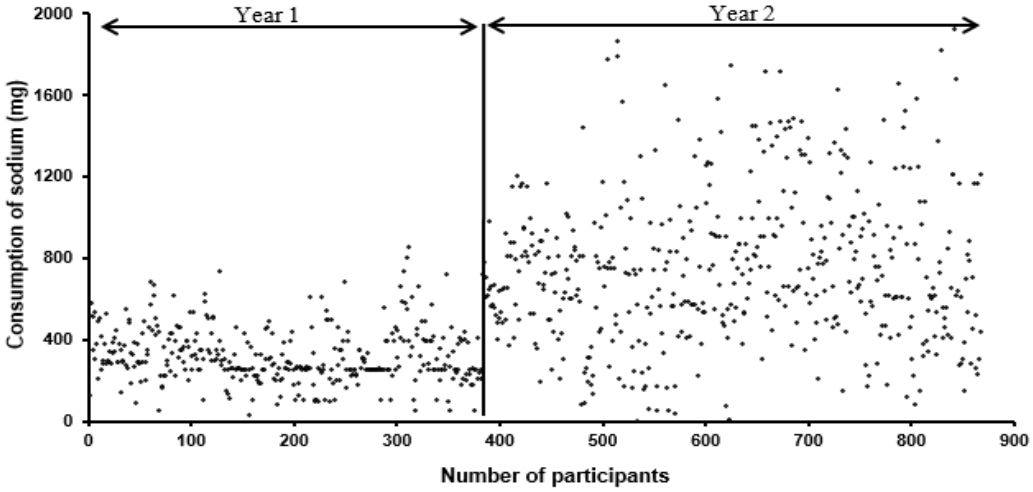

Figure 7. Sodium consumption across the two years indicates that students (n=195, 39%) consumed more than one third (800 mg) of their sodium Upper Limit during the lunch meal, considerably more than the 640mg of sodium limit established by the USDA Food and Nutrition Service (2017).

Assessment of Student Learning

The second major objective of this study was to guide students through the implementation of this service-learning project for the benefit of the elementary school students. The college students were successful in organizing themselves in teams, assigning tasks to each team, and administering every aspect of this project in a timely manner. In addition, each team was assigned to compile information on one aspect of the analysis (fat consumption, sodium intake, etc.) along with a presentation of the potential benefits or drawbacks of this diet for the young students. The final report submitted to the local school district and the changes that were implemented as a result of it, are offered as evidence that the nutrition students were able to connect theory to practice, and successfully bridge classroom instruction with real-world application of knowledge. Carrying out this research project from conception through the planning stage, to data collection and analysis was a most rewarding experience for the college students, many of whom had never participated in such an undertaking (Table 3).

It must be noted that there are no clear criteria established to comprehensively evaluate student learning gains during service-learning projects. According to Smith et al. (2011), high-quality service-learning is composed of six hallmarks: integrated learning; community service; collaborative development and management; civic engagement and a sense of community responsibility; contemplation; and evaluation and disclosure. Each of these elements is assessed using a survey and questionnaires specifically designed to measure self-efficacy, civic responsibility, satisfaction, and training quality. Some investigators have used the Four Square Reflection Tool originally developed by Kaye (2004) to assess how students felt about their work (Williams, 2016). Others elected to assess their programs through surveys designed specifically for their activities that included both Likert-scale questions and open-ended questions specific to the project (Darby et al., 2013). However, as Jenkins and Sheehey (2012) clearly articulated, there is no "best method" to assess students' perceptions of the effectiveness of the service-learning project and the benefits to their own intellectual growth.

QUESTION	SCORE
You understood the purpose and objectives of this research project.	5.00
Your participation in this project familiarized you with several aspects of the scientific investigative method.	4.93
You found this model of learning better than the more traditional lecture-based approach.	4.93
You feel that your work in this project has the potential to make a difference in the way school meals are prepared.	4.64
This experience gave you confidence to undertake your own research or senior project.	4.64
You believe that such service-learning activities clearly enhance your educational experience.	5.00
You believe that such service-learning experiences actually make a difference in our community.	5.00

Table 3. Student responses to the survey reveal a high degree of satisfaction with this service-learning opportunity. A 5-point Likert scale was used (1=Strongly Disagree, 5=Strongly Agree).

The overwhelmingly positive student responses reveal a high degree of satisfaction with this service-learning project. Individual student comments at the end of the survey and in the course evaluations also indicated a high degree of satisfaction with this approach to learning, and the opportunity to interact with school district officials and learn about the realities of school nutrition planning. It was especially rewarding for the students that their work eventually resulted in positive changes in the school nutrition plan. Of particular note were the comments related to the administration of this project, since, without exception, students appreciated having the opportunity to take ownership of the project and the freedom to practice what they had learned in their courses. The end-of-course interviews between the instructor and the student leadership teams provided suggestions for future improvements, such as possibly expanding this project to middle and high schools, following the same cohort of students throughout their elementary school years, and providing internships with the school district's nutrition contractor. A major benefit that stems from this experience is that the Department adopted a new option for students to satisfy their senior capstone requirement. Students can now elect to conduct a service-learning senior project, working alongside our community partners. Among others, such senior projects have resulted in the establishment of athletic training for students with disabilities, a set of resources available for those students seeking post-graduation careers in health care, creation of a student guide to statistical analysis software, and the development of a coordination protocol for organizations serving poor and homeless residents in our city.

Conclusions and Recommendations

This project had a dual purpose: first, to examine the feasibility of examining what children *actually* consume during lunch at their schools, and second, to provide undergraduate students with an opportunity to participate in research that could have a real impact on the quality of the school lunch in elementary school students. It was not our intent to provide specific comparisons between schools (based on socioeconomic criteria, size of the school, etc.), or between grades or gender, so such criteria were not considered in the present study. The study design had to be simple enough for the students to be able to complete the project before the end of the semester-long course. At the same time, the study was designed to provide an opportunity to identify any areas for improvement in the school nutrition plan so appropriate recommendations would be made. Our outcomes indicate that such work is possible; our observations and analysis resulted in new knowledge, and yielded educational benefits for those students who engage in service-learning research projects.

Recommendations for School Meals

Several studies have documented the importance of providing high quality school meals for children (Clark & Fox, 2009). Thus, the availability of nutritious school meals rightfully constitutes a high priority for school districts and federal authorities alike. However, making nutritious foods available to these young children does not necessarily mean they will actually consume the food. The considerable complexities associated with providing nutritionally well-rounded meals to students, while at the same time balancing availability of produce, fiscal constraints, and social policies (American Dietetic Association, 2003) are beyond the scope of this report. The same is true for other methodological concerns, such as the socioeconomic makeup of the student body at each of the schools. Qualifying the effects of these efforts on improving children's nutritional intake has been more challenging, and work continues (USDA, 2017). Several investigators have pointed out that special care must be exercised when consumption of foods is concerned, especially given the inherent weaknesses of some research techniques (Dwyer, 1995). This study is offering a methodological approach that may be helpful in future studies.

The first question this study addressed was whether, given the concerns over current data collection methods, it was possible to obtain accurate data that reflect what students actually consumed during school lunch. One of the most important aspects of this project was the opportunity for the college students to apply their newly acquired knowledge on nutrition and the application of the scientific investigative method towards answering a "real world" question: "What do the students actually consume during school lunch?" At the completion of the analysis, and as part of their course assessment, the nutrition students compiled their conclusions in a report that was then presented to officials from the school district and the company contracted to provide the school meals. The report was received very well by both school district officials and the contractor, and small changes in the school meal plan were implemented (such as reducing the frequency of high-calorie and high-fat items such as cheese nachos).

It was clear from the second part of our study that these changes constituted a considerable improvement in the quality of the choices available to the children during lunch. We elected to conduct an analysis on a random

sampling of students as they went through the lunch line. Given the consistency of school schedules, it would have been possible to collect data from the same group of children every day. Furthermore, and assuming appropriate clearance from parents and school administrators, it would be feasible to collect additional data from these students, such as age, gender, anthropometric characteristics, socioeconomic status, etc. Such measures are commonplace in the field, and would allow for individual comparisons between the federal standards and weekly dietary consumption by students (Condon, Crepinsek, & Fox, 2009). Furthermore, such variables may shed some light as to the reasons behind the choices the students make during lunch (Anderson & Butcher, 2006). However, this was not our intent; this service-learning research project demonstrates that collection and analysis of such data is possible, but only general conclusions can be drawn from this work.

Even with these constraints, however, our analysis revealed some interesting findings. After the first year we identified some areas where improvements could be made, such as removal of menu items with high caloric value, high fat and saturated fat content. These we pointed out to the school administrators and, as illustrated by our data for Year 2, the small changes were implemented and resulted in reduced total calorie intake, reduced fat and saturated fat consumption, and no reduction in calcium intake. These changes reflect a necessary component in the battle against childhood obesity (Schanzenbach, 2009). The increase in sodium consumption from Year 1 to Year 2 was a surprising finding, one that may result in some changes regarding material used, and/or cooking and preservation processes.

In addition to the rather straightforward observations listed above, a number of comments can be added. For example, it was noted that when students formed lines during lunch, those students who were first in line selected chocolate milk until there was no more chocolate milk available. The students who followed them selected regular milk as an acceptable alternative, indicating that perhaps, if chocolate milk (and the additional calories) were eliminated from the menu, students would still consume regular milk. Another observation involved the minimal consumption of vegetables. Many children placed fruits and vegetables on their trays, but returned them, often untouched. In addition, consumption of canned fruit with syrup far exceeded consumption of fresh fruit. All of our observations are in line with other published reports (Crepinsek, Gordon, McKinney, Condon & Wilson, 2009; Whitaker, Wright, Finch, Deyo, & Psaty, 1993). During the interpretation of our results we remained mindful of the fact that we measured independent meals as opposed to weekly averages, yet this approach may be appropriate in its own right (Schanzenbach, 2009). In interpreting this data we were mindful of the *Hawthorne* effect (Dickson & Roethlisberger, 1966), namely the fact that students would eat differently, either on their own or due to influences from their parents or guardians, given that they knew their food consumption would be evaluated. We were also cognizant of additional variables, such as whether students had a breakfast or snack earlier in the day, or whether regular access to healthy food was available to this group.

While the school district and its contracting partner make all relevant data on food costs and volume of goods consumed readily available to the public, this project is unique in that it specifically analyzed the actual caloric consumption and nutrient intake of students during a single meal. It must be emphasized from our interactions with them and their attention to the results of our study, that the company that supplies school lunches works hard to provide comprehensive and nutritional options for students. Undeniably, the task of nutritionists, dietitians, administrators, and food servers is not easy. There is no question that studies need to shed light into the childhood obesity epidemic and identify ways to reverse this negative trend (American Dietetic Association, 2003). This report provides educators with a template to incorporate such educational outreach practices and conduct research within the nutrition curriculum.

Comments Regarding the Service-Learning Project

This service-learning opportunity proved to be a valuable lesson for the college students enrolled in the nutrition class. The project addresses the need to blend the scientific enterprise (identification of a problem, data collection, data analysis, and recommendations) to a real problem or concern to a segment of the population. At the completion of the analysis, and as part of their course assessment, the nutrition students compiled their conclusions in a report that was then presented to officials from the school district and the company contracted to provide the school meals. The report was received very well by both school district officials and the contractor, and small changes in the school meal plan were implemented. It was clear from our study that these changes constituted a considerable improvement in the quality of the choices available to the children during lunch.

Through this project the students learned the requisite material associated with the course, but more importantly, they applied this knowledge to improve lunch meals in our local school district. The student comments indicate that such evaluations and analyses are possible, but require considerable time and energy commitment. However, when students are included in the research process, the demand is manageable and the work is enjoyable. The students were unequivocal in their enthusiasm for this work, and their satisfaction with this service-learning opportunity. Students appreciated this real-world application of science and the opportunity to engage in research as part of their course work, in alignment with the most current standards in science pedagogy. In future iterations of the course, the instructor plans to incorporate specific activities to address the hallmarks of service-learning as articulated by Smith et al. (2011). This service-learning opportunity facilitates hands-on student learning, complements the existing array of excellent nutrition education tools (Ash, 2003; Poehlitz, Pierce, & Ferris, 2006; Rasberry, 2006), and presents evidence that service-learning provides unique opportunities for meaningful positive changes in elementary school nutrition.

Acknowledgments

The author expresses gratitude to all the students who participated in this service-learning opportunity, for their diligence, work ethic, and attention to every detail. Their enthusiasm made this service-learning opportunity a very rewarding experience. Many thanks to the Salem-Keizer School District officials, the school principals, the teachers, and the K-3 students who were eager to assist us with this project. Finally, the author expresses his appreciation to the reviewers whose thoughtful and insightful comments were very helpful in crafting the final version of this manuscript.

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