Development and Testing of Supplemental Materials for an Undergraduate Healthy Food Product Development Curriculum

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DEVELOPMENT AND TESTING OF SUPPLEMENTAL MATERIALS FOR AN UNDERGRADUATE HEALTHY FOOD PRODUCT DEVELOPMENT CURRICULUM

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Food, Nutrition, and Culinary Science

by
Breanne Halteman
December 2015

Accepted by:
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Dr. Duncan Darby
Dr. Julia L. Sharp
ABSTRACT

The goal of this research project was three-fold: (1) to follow up with students who had taken the Applied Interdisciplinary Product Development (AIPD) course two years prior to assess the long-term effect of the course on perceived self-confidence in product development skills, connectedness with the department, and preparedness to enter the industry; (2) to design, implement, and evaluate course materials educating undergraduate students about the subjects of herbs, spices, and sensory science; and (3) to evaluate the success of dissemination of a sophomore-level hybrid course on healthy food product development.

A Subject Knowledge Assessment (SKA) was designed to measure students’ knowledge of food science, packaging science, nutrition, and product development. An Exit Questionnaire (EQ) aimed to measure students’ confidence in things such as their product development skills, preparedness to enter the industry, and interdisciplinary teamwork. Focus groups with the seniors were also conducted in order to understand more about their experience with the course. Surveys of university faculty were also administered to measure faculty perception of the senior students that had taken the AIPD course compared to those who had not with respect to leadership, teamwork, and critical thinking skills. An Herbs, Spices, and Sensory Science (HSS) questionnaire was used to evaluate the sensory science knowledge gain, and herbs and spices knowledge gain as a result of the intervention.

Upon comparing the seniors who had taken the AIPD course to those who had not, significant differences were found for five of the nine statements on the exit
questionnaire pertaining to confidence in product development skills ($P < 0.05$). The question about interdisciplinary teamwork was also significantly different between the students who took the AIPD course and those who did not ($P < 0.05$). Students’ responses in the focus groups provided enriching data to support the results of the EQ and SKA. On the faculty survey, the means of all the student traits or abilities is greater than three on a five point scale, indicating that the AIPD students were generally rated slightly better than their peers in various academic traits and soft skills. Therefore it can be concluded that student seniors that had completed the AIPD course have maintained their advanced skill level over their peers in such areas as product development skills and soft skills, even two years after taking the course.

With respect to the second project goal, results from the HSS questionnaire indicate that the average score for both knowledge categories of sensory science and herbs and spices were significantly different post-intervention, with p-values of 0.0042 and 0.0169, respectively. Overall, the supplemental lectures and activities designed for an undergraduate food product development course were successful in teaching students about herbs, spices, and sensory science. Students in this course had significant knowledge gains in these subjects, making these lectures valuable tools for use in later offerings of the course.

With respect to the third project goal, it was anticipated that students who took the hybrid course, which was disseminated at a southern land grant university (LGU), would have no significant differences from students who took the existing AIPD course with respect to knowledge gains or increased confidence in food science, nutrition, packaging
science, and product development. The results of the SKA showed there was not sufficient evidence to suggest that LGU students’ percent scores, overall or in the four subject categories, are different from the Clemson University students’ percent scores, using a significance level of 0.05. Additionally, no significant differences were found between the two groups for 13 of the 14 items on the Exit Questionnaire ($P > 0.05$). Therefore it can be concluded that this course is a viable option for dissemination to other universities to successfully teach food product development to sophomore students.
AKNOWLEDGEMENTS

Words cannot express the overwhelming amount of support and encouragement I’ve received throughout my time at Clemson University. Similar to that old saying about raising children, I truly believe it takes a village to conduct thesis research.

First and foremost I would like to thank my graduate advisor, Dr. Margaret Condrasky. Thank you for being so supportive, helpful, and encouraging throughout my entire time here at Clemson. You were always looking out for me and going out of your way to make sure my experience at Clemson was everything I wanted it to be. Thank you for everything you’ve done! I would also like to thank Dr. Duncan Darby and Dr. Julia Sharp, my graduate committee members. Thank you for the countless hours and immeasurable support you’ve provided along the way. I could have never made it here without you.

None of this research could have been possible without the students who took the course and filled out countless surveys, and so my gratitude goes out to them as well. Thank you, also, Dr. Fanbin Kong, for going out of your comfort zone and taking a chance on this pilot study in educational dissemination. Thanks to Miles Quinn, Chase Reamer, and Erin Snyder for giving the AIPD students the chance to gain some hands-on experience with packaging and create something they would have otherwise been unable to.

Another huge thank you goes out to Kayla Steele and the Office of Institutional Assessment for their help with focus groups and surveys, and to the seniors who willingly came back to participate in those focus groups and complete those surveys. Dr. Sarah
Griffin, Meagan Miller, Julie Rice, and Michele Perna were also integral parts of the analysis of my data sets, and so a big thank you goes out to them as well.

I’d also like to also thank our friends from Pickens County School District, Sally Nicholson, Jennafer Pitt, and Lisa Hayes, for continuing this blossoming partnership between Clemson University students and the local school district.

Last but certainly not least, I’d like to thank my family, friends and boyfriend, Matt. They were always there to lend some words of encouragement, look over my writing, or act as my sounding board. Thank you all.

I couldn’t have asked for a bigger or better group of supporters. Words could never fully express my gratitude to each and every one of you. Thank you!
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CHAPTER ONE
REVIEW OF CURRENT LITERATURE

Introduction

The goal of this research project was three-fold: (1) to follow up with students who had taken the Applied Interdisciplinary Product Development (AIPD) course two years prior to assess the long-term impact of the course on perceived self-confidence in product development skills, connectedness with the department, and preparedness to enter the industry; (2) to design, implement, and evaluate course materials educating undergraduate students about the subjects of herbs, spices, and sensory science; and (3) to evaluate the success of dissemination of a sophomore-level hybrid course, which included both in-class and online lectures, on healthy food product development to another university. The following review of current literature highlights the educational theory behind the design of the AIPD course, as well as elucidates the need for supplementary educational materials on herbs, spices and sensory science.

Experiential Learning

There are four closely-related learning methods that all stem from the broad category of activity-based learning. Although they are all very similar in the general sense, it is important to draw out the differences, as they are distinct. The four categories of activity-based learning are collaborative learning, experiential learning, resource-based learning, and problem-based learning (McGrath 2011). Collaborative learning is based on the idea that knowledge is constructed socially rather than individually, and thus uses a teaching method in which students learn from each other. Experiential learning allows
students to gain knowledge and meaning from a particular experience rather than from a teacher. Resource-based learning encourages students to gather information using various types of media, such as books, journals, videos, and interviews with experts, to research a particular topic of interest. Lastly, problem-based learning allows students to gain better understanding of a subject by working through a real-world problem. While each of these learning methods has its own unique tactic, the underlying tenet is a shared idea of engaging students in an activity-based learning environment.

Experiential learning is defined simply as learning by doing (Hunt, 2010). This applied, hands-on approach to learning differs from the typical learning style of most other college courses where the student acquires knowledge passively. Experiential or applied learning allows students to actively absorb the information through firsthand experience. The three corners of the experiential learning triangle include the student, teacher, and experience (Figure 1.1). The most authentic learning occurs when all three elements of the triangle are working in concert (Hunt 2010). If one of these elements is missing, learning may still occur, but perhaps not as completely or authentically as possible. Many different positive outcomes have been linked to experiential learning, but some of the most commonly cited are enhanced critical thinking skills, growth in creativity, and improved self-assuredness (McGrath 2011).
Interdisciplinary Education

In *Interdisciplinarity: History Theory and Practice*, Julie Thompson Klein (1990) described interdisciplinary work as collaboration and teamwork between persons of different disciplines. The practice of interdisciplinary education began to gain prominence in the early 1970’s when the World Health Organization (WHO) began promoting interprofessional education in the public health sector (Pecukonis 2008). In response, several countries such as the United States, the United Kingdom, and Australia each developed their own programs dedicated to interprofessional education. Since the establishment of the early interprofessional programs, there has been a continued interest in promoting collaborative interdisciplinary education.

The goal of interdisciplinary learning is for students to glean new or greater understanding of their own and other disciplines (Hayes 2002). There are many benefits that come from these educational models, such as facilitation of holistic understanding of
complex situations and issues (Holley 2009). However, traditional higher education models tend to encourage students toward specialization in one narrow topic (Weld and Trainer 2007). Extreme focus on one narrow topic tends to create cognitive and social barriers between disciplines, which prevents collaboration and reduces potential for innovation (Jacobsen et al. 2009). With respect to post-graduation, however, barriers between majors in academia can be detrimental to the skills actually needed in the workforce, since most professionals will regularly work on teams with individuals from other fields. For that reason, future employees need to be able to integrate knowledge they have gained from multiple different areas as well as to be able to communicate to a diverse, interdisciplinary team (Holley 2009). Additionally, it is predicted that the generation currently entering the workforce will change jobs an average of 14 times throughout their career. Therefore, the generation entering the workforce would benefit from being knowledgeable in a variety of disciplines other than their own to make them more marketable to employers.

According to the Boyer Commission Report (1998), interdisciplinary programs should be a standard feature of any research university, and the removal of barriers to interdisciplinary education is the fourth recommendation in the report. It has been continually recognized that interdisciplinary education has many positive influences on the developing member of the workforce. According to Lefebvre et al. (2007), interprofessional training reduces stereotypes associated with professional groups, while enhancing teamwork and clarifying roles within the interdepartmental relationship. The primary barrier to interdisciplinary education in universities is the segmentation of majors
into defined departments (Boyer 1998). Although segmentation by major is necessary in order to organize college classes and allow students to declare a major, students could potentially benefit from more interdisciplinary courses. Because many careers require mental flexibility, it may benefit students to practice seeing their studies from different points of view early on in their academic matriculation.

Sophomore Year

A sophomore student is defined as a “first-time, full-time student who has persisted into the second year of academic work” (Gahagan and Hunter 2006). The definition of a sophomore student excludes students who have re-started their academic career at a new institution or with a new major. The second year is a time in which students seek to solidify their career decisions and personal goals (Anderson & Schreiner 2000). Sophomore students are finishing up their general education credits, and may also begin to feel financial pressures (Petricek 2014).

The sophomore year is a difficult transition time from the freshman year. Often times much of the institution’s resources are funneled into programming for freshmen in order to create a positive and supportive environment for the first year. However, special attention received by first year students does not carry over into the second year, leaving sophomore students with a feeling of isolation (Petricek 2014). Additionally, sophomores are not particularly involved in their major classes yet, since many institutions offer major courses in junior and senior years. During the second year, students are not yet connected to their department and may lack a sense of belonging. Often sophomores have
not yet even committed to a major. Sophomores were found to be more likely than students at other points in their academic careers to state that confirming their major selection or deciding on an appropriate career was their biggest personal problem (Gardner 2002).

The second year is a time within a student’s academic career when the least amount of support and attention is given (Graunke 2005). The disconnection felt by second year students can lead to what has been identified as the “sophomore slump”. According to Petricek (2014), characteristics of the sophomore slump include:

- lack of commitment to school;
- absenteeism;
- low educational goals;
- low extracurricular activities;
- negative perceptions of faculty-staff interactions;
- confusion about major selection;
- uncertainty about the future;
- lack of institutional support; and
- dissatisfaction with their college experience.

Although most of the research regarding institutional retention focuses on freshmen, it is important to look into the struggles of the second-year sophomore student as well. According to Coghlan (2009), sophomores are considered the least satisfied group of all college students. Several reasons students decide to leave college after completing their first year include: “financial hardships, academic concerns, and
questions about their future goals and aspirations” (Gahagan and Hunter 2006).

A national survey on sophomore year initiatives that aim to combat the sophomore slump (Tobolowsky and Cox 2007) found that the most successful initiatives are customized to the culture of the institution. For example, a research university would be most successful in engaging sophomores through undergraduate research projects.

In a study by the office of Academic Assessment and Institutional Research at Ball State University (2005), it was found that commitment to an academic major and satisfaction with faculty interactions were both significant predictors of grade point average for sophomores. The findings also suggest that institutions may want to develop sophomore-specific programs.

Children’s Nutrition

Obesity rates among children in the United States have been an increasing concern for a number of years. As of 2012, more than one-third of adults and 17% of youth in the United States are obese, making children’s nutrition a topic of paramount importance (Ogden 2013). According to the Centers for Disease Control and Prevention (CDC), people who are obese are at an increased risk for many serious diseases and health conditions, including but not limited to hypertension, type 2 diabetes, coronary heart disease, stroke, osteoarthritis, sleep apnea, body pain, and mental illness such as clinical depression and anxiety (2015). The deleterious effects of poor weight management are numerous, and can become increasingly serious, eventually resulting in death if action is not taken.
Compared to past generations, Americans consume a high amount of convenience food and food eaten away from home, which is typically low in fiber and micronutrients, and high in sodium, fat and sugar (Nelson 2010). According to the CDC’s Division of Nutrition and Physical Activity (DNPA), the average portion size has also increased exponentially over the years (2006). The majority of restaurant meals have gotten larger over time, enticing people by giving them more food for their money and creating a sense of increased value (DNPA 2006). However, the rise of portion sizes goes beyond restaurants alone. Bags of snack foods or soft drinks in the grocery store are offered in large sizes that contain multiple servings (DNPA 2006). The problem with increased portion sizes is that people tend to eat more when they are confronted with larger portions of food. In a study by Rolls et al. (2002), 51 adults received 4 meals of different portion sizes of macaroni and cheese on different days. At the conclusion of the study, the researchers found that subjects ate more as portion size increased, resulting in a 30% increase in energy consumption when offered the largest portion compared to the smallest portion. Subjects reported similar ratings of hunger and fullness despite the intake differences. At the conclusion of the study, subjects were asked if they noticed the differences in portion sizes served. Only 45% of respondents noticed the difference (Rolls et al.2002). The human propensity to eat the amount of food that is provided, combined with increasingly large portion sizes results in larger chances of weight gain for unwary consumers.

The USDA Dietary Guidelines for Americans lists current recommendations for improving health, such as reducing portion size, making healthier choices when dining
out, and balancing food and beverage intake with physical activity (2015). The Dietary Guidelines also recommend decreasing intake of sodium, saturated fats, and added sugars as well as increasing intake of fruits, vegetables, and whole grains. More specifically geared toward children’s nutrition is a program called Let’s Move!, an initiative spearheaded by First Lady Michelle Obama to encourage kids to adopt healthy habits into their lifestyle (http://www.letsmove.gov). The initiative focuses on eating healthy by using the guidelines of MyPlate, and being active by engaging in 60 minutes of activity per day for young people between 6 and 17 (http://www.choosemyplate.gov/).

With the continuing prevalence of obesity and increasing rates of convenience food consumption in the United States, it is evident that action needs to be taken to improve the health food market for future Americans. Continued support of campaigns such as Let’s Move! can ensure that children are getting the nutrition education they need to empower them to make positive lifestyle changes. Lifestyle changes can be augmented by educating the food science, packaging science, and dietetic professionals of the next generation about healthy eating, portion sizing, and how to create a balanced diet. Educating future food, nutrition, and packaging science professionals will give them the tools needed to be successful in their careers to help combat the obesity epidemic through food product development.

**Herbs and Spices for Health**

A major area of dietary concern in the United States is sodium intake. The American Heart Association estimates that 9 out of 10 Americans consume too much sodium, averaging around 3,400 mg daily (2015). The average estimated intake exceeds
the 2015 Dietary Guidelines for Americans, which recommends no more than 2,300 mg of sodium per day for the average adult (USDA and HHS 2015). Certain at-risk populations such as African Americans, people older than 50 years of age, and people who have hypertension, diabetes, or chronic kidney disease, are recommended to consume even lower amounts, not exceeding 1,500 mg daily (Bibbins-Domingo 2013). Excess sodium is a concern because it increases a person’s risk for high blood pressure, which can lead to heart disease and stroke. Cardiovascular disease is already of paramount concern in the United States, causing 610,000 deaths each year, which accounts for one quarter of total U.S. deaths (CDC 2013). In order to mitigate the cardiovascular disease epidemic, the American Heart Association has recommended adopting a low-sodium diet to reduce the risk of heart disease. The 2015 Dietary Guidelines for Americans, put forth by the United States Department of Health and Human Services (HHS), encourages the same lifestyle change. The HHS jointly with the United States Department of Agriculture (USDA), recommend that “emphasis be placed on expanding industry efforts to reduce the sodium content of foods and helping consumers understand how to flavor unsalted foods with spices and herbs” (2015). The recommendation stresses the importance of both the food industry and its consumers each doing their parts. Although removing salt from foods is often associated with a loss in flavor, adding herbs and spices can be a flavorful, healthy, low-calorie alternative to salt.

Promising research is beginning to emerge that suggests herbs and spices can support the Dietary Guidelines for Americans in two ways: by making recommended foods and healthy eating patterns more acceptable to consumers, and by their beneficial
physiological effects such as increased feeling of fullness or increased metabolism (Post 2014). For example, studies have suggested that appropriate intake of pungent spices may help in weight control (Kralis 2012). One of the chemical compounds responsible for this effect is capsaicin, which is the spicy component found in chili powder and red pepper flakes. A systematic review of evidence in the relationship between capsaicin intake and weight management revealed that regular consumption of capsaicinoids significantly reduced abdominal adipose tissue levels, reduced appetite, and reduced energy intake (Whiting 2012). Therefore, finding an application for spices will not only have positive health benefits with respect to weight management, but can also mitigate the use of sodium by enhancing the natural flavors of the food.

Furthermore, many claims have been made on the positive effects that herbs and spices can have on human physiology and wellbeing. These claims include improved digestion and absorption, increased blood circulation, improved metabolic regulation, weight control, reduction of blood sugar level, and reduction of motion sickness and nausea (Kralis 2012). Additionally, many spices such as black pepper, cardamom, turmeric, ginger, chili, and cumin, are also rich in active phytochemicals including polyphenolics, carotenoids, flavonoids, and saponins (Kralis 2012). Phytochemicals, which are chemical compounds that occur naturally in plants, have long been linked to the reduced risk of chronic diseases such as cardiovascular disease and cancer (Liu 2003).

With the wide range of positive health benefits associated with herb and spice intake, along with their ability to promote a low-sodium diet by enhancing natural
flavors, it is important to educate consumers on how they can incorporate herbs and spices into their daily diet. The existing literature on the education of spices and herbs for college-age students is very limited. One pilot nutrition education intervention, Spice My Plate, implemented a program focused on teaching high school students ways to improve the quality of their diets by using herbs and spices (Berman 2014). Both the control and intervention group received one hour of standard nutrition education training at the beginning of the study. The intervention group then received an additional 9 hours of education which included cooking lessons and a grocery store tour focused on herbs and spices. Diet quality was measured both objectively via validated 3-day food logs, as well as subjectively with a questionnaire that evaluated attitudes toward healthy eating. At the end of the study, the intervention group was found to have consumed more whole grain and lean protein foods than the control group. The intervention group also had a higher reported likelihood of eating vegetables and whole grains with added spices and herbs than did the control group. This is just one example of a successful nutrition education intervention with a focus on herbs and spices.

**Sensory Science**

Within the realm of food product development is the concentration of sensory science. Defined by the Institute of Food Technologists, sensory evaluation is “a scientific discipline used to evoke, measure, analyze and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing” (Stone 2004). The human senses are used in sensory evaluation to measure the subjective
qualities of food that are important to consumers, such as degree of liking, while minimizing the objective influencers of perception, such as brand identity (Lawless 2013). Sensory science is a niche scientific discipline that is critical to consumer products companies. Companies use sensory science in order to test for attributes that often cannot be measured by a machine, because “only human sensory data provide the best models for how consumers are likely to perceive and react to food products in real life” (Meilgaard 2006).

In a food manufacturing company, the product development team relies heavily on sensory scientists to provide meaningful and actionable data on new and reformulated products. In the food manufacturing industry, the most common scenarios that require reformulation in a product are changes in product packaging, processes, and ingredients (Lawless 2013). Sensory scientists then collect data to see how the sensory properties of the food change in response to the modifications in package, process, or ingredients. The data from sensory evaluation is used to reduce the uncertainty and risks when changing product formulas, and to determine if consumers can tell a difference when the ingredients of a product are changed (IFT 2007). Sensory data also ensures cost-efficient delivery of new products with high consumer acceptability by determining what consumers like in a food product and why (IFT 2007). Repeated sensory testing occurs throughout the course of product development until the desired results are obtained. Therefore, sensory scientists are commonly integrated into the product development process, analyzing data in order to make recommendations to the developers.
Because the areas of product development and sensory science are so integrated, it is important for young professionals entering the industry to have an understanding of sensory science. Product development provides the highest number of employment opportunities for new graduates of food science programs (BLS 2013). Therefore, being able to effectively communicate with the sensory scientists and understand the different tests available can be a huge asset to a product developer. It is critical to know the basic methods of testing, their purposes, and their strengths and weaknesses in order to work with the sensory scientists and correctly select an appropriate test that will provide the answer to their question. Occasionally, product developers also need to be able to conduct their own benchtop sensory tests without assistance from the sensory team. Benchtop triangle tests are often conducted as a quick assessment of whether or not the developer is on the right track, and is executed by using a small group of other developers as the panelists. Without the basic understanding of the best practices for a sensory test, panelist responses could be inaccurate, resulting in erroneous data and lead developers in the wrong direction in their future formulations. Thus, early experiences in sensory applications are useful in undergraduate food science education.

There is a constant need for sensory scientists in the consumer products sector, especially in food manufacturing companies, and so it is important to educate undergraduates about sensory science in order to prime the next generation of professionals for entry into the industry.
USDA Higher Education Challenge

The USDA Higher Education Challenge (HEC) grant was the primary source of funding for this research project. According to the USDA website, projects supported by the HEC grant must fulfill the following purposes:

1) Address a state, regional, national, or international educational need;

2) Involve a creative or non-traditional approach toward addressing that need that can serve as a model to others;

3) Encourage and facilitate better working relationships in the university science and education community, as well as between universities and the private sector, to enhance program quality and supplement available resources; and

4) Result in benefits that will likely transcend the project duration and USDA support.

The colleges or universities eligible to receive this grant must either be an 1864, 1890, or 1994 land-grant institution, a Hispanic-serving institution, or a state controlled institution of higher education that offers a degree program in at least one area of food and agricultural sciences (HEC Grants Program).

The HEC grant aligns itself perfectly with the purposes of this research project and the Applied Interdisciplinary Product Development (AIPD) course. Firstly, the AIPD course fills an educational need by teaching food science, nutrition, and packaging science students about the process of food product development. This allows students to
gain experience in a real-world application, as well as learn to work with disciplines other than their own. Secondly, the AIPD course embodies a non-traditional approach to learning by bringing the three unique but interrelated majors of food science, nutrition, and packaging science together into one classroom and allowing them to learn from each other as peers. Thirdly, the AID course boosts relationships between concentrations within the university by encouraging professors from each discipline to work in unison in order to teach this course. Finally, the AIPD course demonstrates sustainability beyond the project duration by continuing to be offered even after the cease of funding. The results and benefits will also transcend this specific project when the students that have completed this course go on to become productive and knowledgeable members of the food, nutrition, and packaging industries, and make a difference in their respective fields.

Discussion

The broad scope of the Applied Interdisciplinary Product Development course warranted the review of a wide array of literature. The experiential learning embodied by this course encourages students to gain real world experience within a field which could potentially be their career. Bringing students together into interdisciplinary teams encourages the holistic understanding of the intricate relationship between their majors. A product development course is the perfect setting to bring all three majors of food science, packaging science, and nutrition together, as each has an integral role within the project. Students are required to develop healthy products for children, which aims to combat the growing rates of childhood obesity. By educating students on the health
benefits and uses of herbs and spices, they learn how to increase the flavor in their products while decreasing use of solid fats, sodium, and added sugars. Finally, sensory science is a vital part of the product development process, a growing part of the food industry, and vital to students’ success in this course, and so the addition of sensory science materials adds to the richness of the AIPD course as a whole.

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CHAPTER TWO
FOLLOW UP OF THE FOOD, NUTRITION, AND PACKAGING SCIENCE
UNDERGRADUATE RESEARCH COURSE ON PRODUCT DEVELOPMENT

Abstract

The objective of this research was to evaluate the long-term impacts of a two-semester Applied Interdisciplinary Product Development (AIPD) course on students in the Food, Nutrition, and Packaging Science (FNPS) department at Clemson University. Students who participated in the course as sophomores were evaluated two years later as part of a continuing research project to measure students’ perceived self-confidence in product development skills, knowledge in various disciplines other than their own, and preparedness to enter the industry. It was anticipated that these traits would be higher in students that took the AIPD course than those who did not.

A Subject Knowledge Assessment (SKA) was designed to measure students’ knowledge of food science, packaging science, nutrition, and product development. An Exit Questionnaire (EQ) aimed to measure students’ confidence in things such as their product development skills, preparedness to enter the industry, and interdisciplinary teamwork. Responses from students who took the AIPD course were compared to responses from students that did not take the AIPD course. The responses from the treatment and comparison groups was compared using a Wilcoxon Rank-Sum test (α = 0.05). Focus groups with the seniors were also conducted, along with surveys of university faculty that taught AIPD seniors in their classes. The results of the SKA show that the treatment group’s percent scores, overall or in the four subject categories, did not significantly differ from the comparison group’s percent scores. However, significant
differences were found between the treatment and comparison groups for five of the nine statements on the exit questionnaire pertaining to confidence in product development skills. There was also a significant difference between the treatment and comparison groups on the question about interdisciplinary teamwork. Students’ responses in the focus groups supported the results of the EQ and SKA. Results from the faculty survey indicated that the AIPD students generally rated slightly better than their peers in various academic traits and soft skills. Therefore the conclusion can be made that students who completed the AIPD course have maintained their advanced skill level over their peers in such areas as product development skills and soft skills, even two years after taking the course.

**Introduction**

The objective of this research was to evaluate the long-term impacts of a two-semester Applied Interdisciplinary Product Development (AIPD) course on students in the Food, Nutrition, and Packaging Science (FNPS) department at Clemson University. Students who participated in the course as sophomores were evaluated two years later as part of a continuing research project to measure students’ perceived self-confidence in product development skills, knowledge in various disciplines other than their own, and preparedness to enter the industry. It was anticipated that these traits would be higher in students that took the AIPD course than those who did not.

Throughout the AIPD course, students worked in small teams to move step-by-step through the product development process in order to create a healthy children’s food or beverage product or service. The applied, hands-on approach of the AIPD course is
different from the majority of the other classes students take by allowing them to learn through firsthand experience. By researching and developing a food product on their own, students were accountable for the success of their product, which can result in a greater sense of achievement and empowerment (Dewey 1938). Encouraging students to be actively involved in each step of the product development process also simulated a real-world working environment similar to that which they may experience when they enter the industry. A product development course is the perfect setting to bring all three majors of food science, packaging science, and nutrition together, as each has an integral role within the project. Food product development is also the largest area of employment among food scientists, making it an important course to offer to undergraduate students (BLS 2013). In a study by Saad, industry professionals were asked which skills and subjects they believed undergraduate students should learn from food product development courses (2010). The study found that industry professionals believed students should understand project management, ingredient applications, ingredient interactions, and how to formulate for large-scale production (Saad 2010). Industry professionals also desired students to have processing knowledge, packaging knowledge, and culinary skills (Saad 2010). It is therefore important for students to gain fundamental knowledge of the aforementioned topics prior to entering the industry so that they are better prepared as professionals.

Students involved in the AIPD course represented various majors, including food science, packaging science, Culinology®, and nutrition. By placing AIPD students into diverse teams, an interdisciplinary learning environment was formed. The goal of
interdisciplinary learning is for students to gain a new or greater understanding of their own discipline and that of others (Hayes 2002). The AIPD course is able to create an interdisciplinary setting by fostering an environment where students learn from and come to respect the viewpoint of other majors. The ability to work on an interdisciplinary team is a necessary skill for students to have when they enter the industry, since they will most likely be required to work collaboratively with many more departments other than simply their own. One aim of the AIPD course is to help students learn interdisciplinary teamwork skills early on in their academic career so that they will be able to apply these skills in the industry.

This research project was made possible by the Higher Education Challenge (HEC) grant program, funded by the United Stated Department of Agriculture (USDA) and the National Institute of Food and Agriculture (NIFA). The HEC grant was awarded based on the ability of the AIPD course to address an educational need, model a creative approach to addressing that need, and result in sustainable positive results beyond the project duration (USDA 2014). The research and development style structure of the AIPD course is made possible by Clemson University’s Creative Inquiry (CI) undergraduate research program. CI courses are ubiquitous across all majors at Clemson, and promote collaboration between a small team of students and a faculty mentor in order to create a solution to a problem within their field of study. In addition to earning course credits, students are able to present their research at conferences or publish their findings in scholarly journals (Weeks 2014). Some examples of other Creative Inquiry research topics within the Food, Nutrition, and Packaging Science Department are: investigating
the validity of food advertising claims; researching medical device packaging; planning and hosting student-run farmers markets; and designing nutrigenomic diets to improve metabolic syndrome symptoms. Research experience, through courses like these, encourages critical thinking and problem solving skills, and offers opportunities for students to make an impact in their field while still an undergraduate.

Methods

Participants

Students surveyed were part of a previous research study on a two-semester Applied Interdisciplinary Product Development (AIPD) course for sophomore students in the Food, Nutrition, and Packaging Science (FNPS) department at Clemson University (Weeks, 2014). The majority of the surveyed students were college sophomores at the time they participated in the AIPD course. Two years later when the majority of the AIPD students were seniors, they were asked to return to complete follow-up surveys. The AIPD seniors were surveyed in two groups. The group in the AIPD course (n=37), henceforth called the “treatment” group, consisted of students who took the 2-semester course. The comparison group (n=31) represented students who were similar in all aspects, such as major, class standing, and gender, but did not take the AIPD course. All students were requested to participate in the follow-up study, incentivized by free lunch and snacks. The response rate was 81% for the treatment group (n=30) and 74% for the comparison group (n=23). This research was approved by Clemson University’s Institutional Review Board (IRB).
Evaluation Tools

Subject Knowledge Assessment (SKA)

The Subject Knowledge Assessment (SKA) is a previously validated evaluation tool designed by subject matter experts in the Food, Nutrition and Packaging Science department at Clemson University (Weeks 2014). A copy of the SKA can be found in Appendix B. The SKA was designed to measure students’ knowledge of food science, packaging science, nutrition, and product development through a series of 30 multiple choice questions. Previously, the SKA was administered pre-course to determine baseline knowledge, and then once again post-course to determine change in knowledge. In the current study, students were asked to complete the SKA once more to see if they were able to retain the information they learned two years prior. These data were analyzed using the Wilcoxon rank-sum test to assess whether the sample distributions between the treatment and control groups were significantly different ($\alpha = 0.05$).

Exit Questionnaire (EQ)

The Exit Questionnaire (EQ) was first administered to the students upon completion of the AIPD course, and then was given to the students once more at the time of this study, two years later. The EQ aimed to measure students’ confidence in areas such as their product development skills, preparedness to enter the industry, and connectedness to the department. Student confidence was measured using a Likert scale, which is “an ordered scale from which respondents choose one option that best aligns with their view” (Losby 2012). Likert scales are commonly used to measure respondents’ attitudes by asking them to rate their level of agreement or disagreement with a
statement. The Exit Questionnaire asked students to rate their level agreement with a list of statements such as “I feel confident developing healthy products for children”. The Likert scale ranged from 1, “Strongly Disagree,” to 5, “Strongly Agree”. A copy of the EQ can be found in Appendix C. The results of these data are summarized in Table 2.2. The difference between the treatment and comparison groups’ level of agreement with each confidence statement was analyzed using a two-sided Wilcoxon rank sum test ($\alpha = 0.05$).

Focus Groups

The aim of conducting focus groups was to gauge the students’ experience in the course regarding teamwork, communication, and personal growth. Additional goals were to understand students’ perception of the course looking back two years later, and to see if students felt that the course prepared them in any way for their future careers. The total response rate for seniors willing to participate in focus groups was 16 out of 31, or 43%. Senior students were divided by major into three groups to conduct focus groups. These three groups were food science students (n=4), packaging science students (n=4) and nutrition students (n=8). A moderator guide of focus group questions, which can be viewed in Appendix G, was designed by the PI and graduate student with help from a research associate from the Office for Institutional Assessment at Clemson University. Prior to each hour-long focus group session, full confidentiality was assured, and students consented to an audio recording of the conversation. A written script was transcribed from each conversation verbatim, removing all names in the process.
These data from the focus groups were analyzed by a team of three graduate student reviewers. The reviewers were trained by an expert in qualitative and mixed methods data analysis. The expert is an associate professor in Clemson University’s Public Health Sciences Department. During the training, the team of reviewers were taught the basics of qualitative data analysis, customized a code book to fit the responses collected, practiced coding responses as a team and learned to calculate percent agreement between reviewers.

In order to create a codebook, reviewers first went through a process called “open coding”. During the open coding process, the team read through the transcript containing all responses collected from a particular question, and then identified portions of the text as being associated with a particular topic. Each topic was given a code. When a common thread was found between multiple codes, a “theme” was created to define that group of codes. Each question asked in the focus group was given its own set of themes and codes, developed from the focus group responses. The themes and codes from all of the questions were gathered together to make up the codebook.

After creating the codebook, reviewers went through the transcript once more, using the codebook to give final codes to the transcript. Reviewers were assigned specific sets of responses to code on their own, and then conferred with another reviewer to compare codes assigned to the responses and identify discrepancies. A discrepancy was identified when two reviewers assigned different codes to the same passage of text. Reviewers discussed each discrepancy until they reached a consensus on which code should be used for that passage. The percent agreement between pairs of reviewers was
then calculated by counting the total number of codes assigned within a particular passage of text, and then subtracting the number of discrepancies found between reviewers for that same passage of text. The resulting number is the number of codes agreed upon by the two reviewers, which is divided by the total number of codes assigned to the text to yield the percent agreement for that passage. The average percent agreement between reviewers was 81%, with a low of 61% and a high of 91%.

Faculty Survey

A faculty survey was administered to measure faculty perception of the students that had taken the AIPD course compared to those who had not. The objective was to compare faculty perceptions of students who took the AIPD course to those who did not take the course, in terms of leadership, teamwork, and critical thinking skills. The survey was designed by the PI and graduate assistant, and consisted of a 5-point agreement scale measuring the faculty members’ perception of AIPD students’ performance compared to other students who had not taken the course. Each faculty member was given a list of names of AIPD students within their respective discipline, to use as a reference. The professors were instructed to refer to the list of AIPD students to compare the performance of the students on that list to the performance of students who did not take the AIPD course. The survey was administered online through Qualtrics (Provo, UT). Two faculty from each of the three majors of food science, nutrition, and packaging science, that instructed senior AIPD students in their classes in were asked to complete the survey (n=6). The survey can be found in Appendix H. An email was sent to each of the faculty members, which contained the link to the survey along with the list of students
within their respective discipline that had taken the AIPD course. A 100% response rate was obtained (n=6). Descriptive statistics from the survey are reported in Table 2.4.

Results

Subject Knowledge Assessment

There were not significant differences between the treatment and comparison groups’ scores overall or in any of the four subject categories on the Subject Knowledge Assessment (Table 2.2, $P > 0.05$) The mean score between the treatment and comparison groups is similar with respect to overall score, product development, and packaging categories. The largest difference in mean score was observed in the food science category, where the treatment group scored 59.4% and the comparison group scored 50.8%, but this difference of 8.6% was not significant.

Table 2.1 Mean percent correct, standard deviation, and Wilcoxon test statistic of

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Treatment Mean % Correct (Std. Dev.)</th>
<th>Comparison Mean % Correct (Std. Dev.)</th>
<th>Wilcoxon Rank Sum Test Statistic</th>
<th>Two-Sided P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>65.2 (8)</td>
<td>63.1 (7)</td>
<td>366.0</td>
<td>0.47</td>
</tr>
<tr>
<td>Product Development</td>
<td>64.8 (17)</td>
<td>65.4 (17)</td>
<td>777.5</td>
<td>0.86</td>
</tr>
<tr>
<td>Packaging</td>
<td>66.9 (16)</td>
<td>66.4 (11)</td>
<td>381.5</td>
<td>0.73</td>
</tr>
<tr>
<td>Nutrition</td>
<td>64.2 (16)</td>
<td>68.3 (11)</td>
<td>846.0</td>
<td>0.21</td>
</tr>
<tr>
<td>Food Science</td>
<td>59.4 (19)</td>
<td>50.8 (20)</td>
<td>682.5</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Exit Questionnaire

Table 2.2 displays the results of the Wilcoxon Rank-Sum test comparing the treatment and comparison groups’ level of agreement with the confidence statements on the Exit Questionnaire (EQ).

Results indicate that the confidence ratings were significantly different between the treatment and control groups for generating ideas for new products ($P = 0.01$), collecting marketing information and conducting a market analysis ($P = 0.02$), developing a gold standard recipe ($P < 0.01$), developing a formula ($P < 0.01$), and developing healthy food products for children ($P = 0.02$). The treatment group also felt significantly different in their confidence collaborating with students that were not in their major or field of study ($P = 0.04$). The treatment group’s mean confidence ratings were higher than the control group’s ratings for all of the aforementioned statements.

The results were marginally insignificant when the treatment and comparison groups’ confidence was compared for applying changes to a recipe or formula to make it healthier ($P = 0.08$) and collecting commercial ingredients and/or materials ($P = 0.05$).

No significant differences existed between the treatment and control groups’ level of confidence in estimating cost for a new product ($P = 0.77$) or designing packaging for new products ($P = 0.95$). There were also not significant differences between the treatment and comparison group with respect to confidence in learning more from hands-on experiences than lectures ($P = 0.40$), or feeling connected to the Food, Nutrition, and Packaging Science Department ($P = 0.18$).
The results for the four statements pertaining to industry readiness were not significantly different between the treatment group and control group ($P > 0.05$). However, means for both treatment and comparison groups tended towards agreement with the industry readiness statements: “I feel confident interacting and networking with industry professionals,” “I feel confident entering the industry with my current level of knowledge and skills,” “I feel confident that I will meet the expectations of my future employer,” and “I feel confident being and advocate for my industry and/or my field of study”.
Table 2.2 Mean levels of agreement for exit questionnaire responses, and p-value of 2-sided Wilcoxon rank sum comparing treatment and comparison groups

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean (Std. Dev.)</th>
<th>Wilcoxon Rank Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treatment (n=30)</td>
<td>Comparison (n=23)</td>
</tr>
<tr>
<td>I feel confident generating ideas for new products</td>
<td>4.29 (0.59)</td>
<td>3.78 (0.80)</td>
</tr>
<tr>
<td>I feel confident collecting marketing information and conducting a market analysis.</td>
<td>3.94 (0.63)</td>
<td>3.35 (1.03)</td>
</tr>
<tr>
<td>I feel confident developing a gold standard recipe.</td>
<td>3.94 (0.96)</td>
<td>2.78 (1.13)</td>
</tr>
<tr>
<td>I feel confident developing a formula.</td>
<td>3.84 (0.97)</td>
<td>2.87 (1.18)</td>
</tr>
<tr>
<td>I feel confident applying changes to a recipe or formula to make it healthier.</td>
<td>4.50 (0.68)</td>
<td>4.04 (0.98)</td>
</tr>
<tr>
<td>I feel confident collecting commercial ingredients and/or commercial materials.</td>
<td>3.94 (0.77)</td>
<td>3.39 (1.03)</td>
</tr>
<tr>
<td>I feel confident estimating cost for a new product.</td>
<td>3.55 (1.09)</td>
<td>3.43 (1.16)</td>
</tr>
<tr>
<td>I feel confident designing packaging for new products</td>
<td>3.22 (1.23)</td>
<td>3.26 (1.40)</td>
</tr>
<tr>
<td>I feel confident developing healthy food products for children.</td>
<td>4.35 (0.66)</td>
<td>3.65 (1.15)</td>
</tr>
<tr>
<td>I learn more from hands-on experiences than lectures.</td>
<td>4.74 (0.44)</td>
<td>4.63 (0.66)</td>
</tr>
<tr>
<td>I feel confident collaborating with students that are not in my major or field of study.</td>
<td>4.71 (0.53)</td>
<td>4.35 (0.71)</td>
</tr>
<tr>
<td>I feel connected to the Food, Nutrition, and Packaging Science department.</td>
<td>4.52 (0.63)</td>
<td>4.26 (0.69)</td>
</tr>
<tr>
<td>I feel confident interacting and networking with industry professionals.</td>
<td>4.13 (0.72)</td>
<td>4.17 (0.78)</td>
</tr>
<tr>
<td>I feel confident entering industry with my current level of knowledge and skills.</td>
<td>3.84 (0.82)</td>
<td>3.86 (0.89)</td>
</tr>
<tr>
<td>I feel confident that I will meet the expectations of my future employer.</td>
<td>4.16 (0.58)</td>
<td>4.30 (0.93)</td>
</tr>
<tr>
<td>I feel confident being an advocate for my industry and/or field of study.</td>
<td>4.23 (0.62)</td>
<td>4.30 (0.82)</td>
</tr>
</tbody>
</table>

*Responses to EQ were significantly different between treatment and comparison groups (α=0.05).
Focus Groups

The key themes that arose from the focus groups are presented in Table 2.3. When students were asked about their expectations prior to taking the class, two major themes emerged from the students’ responses: to gain knowledge in product development or healthy cooking; and to work in a collaborative team with other disciplines. Subsequently, students were asked if their expectations of the course were met. Two major themes emerged from this question: there was less packaging science focus/experience than expected; and there was more culinary focus/experience than expected.

When students were asked about a time in the course where they were required to leave their comfort zone, the key themes were practice/application of critical thinking or problem solving, and being able to see other perspectives. In response to a question about their experience working in an interdisciplinary group, many students’ responses were in relation to becoming open to different perspectives/viewpoints.

The question regarding the most beneficial skill learned or knowledge gained from the AIPD course resulted in two major themes: knowledge of and experience with the product development process; and learning how to collaborate with other majors and understand the teamwork between departments. When students were asked what they were able to teach others about their major, one theme emerged about teaching others about the different department roles and responsibilities.

The students were asked if they experienced an “aha!” moment during the class, meaning a breakthrough in their work or a memorable learning experience. The two
themes that emerged from the responses to this question were related to having a breakthrough in their recipe formulation, and gaining validation or approval from others. In response to the question, “How do you anticipate using the skills you learned in this particular class in your future career,” two major themes emerged: the ability to communicate with majors other than one’s own; and the ability to integrate knowledge from multiple disciplines.

Finally, students were asked to provide suggestions on how to improve the course in the future. The major theme from students' responses was that more deadlines, direction and instruction would be helpful, as these were common in other traditional course formats. A second theme also emerged surrounding the notion that students felt unprepared to take the course as sophomores.
### Table 2.3 Key themes found within focus group responses

<table>
<thead>
<tr>
<th>Question</th>
<th>n</th>
<th>Key Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What were your expectations of the class prior to taking it?</td>
<td>6</td>
<td>To gain knowledge in product development, healthy cooking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>To work in collaborative teams with other disciplines</td>
</tr>
<tr>
<td>How were your expectations met?</td>
<td>4</td>
<td>Less packaging science focus/experience than expected</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>More culinary focus/experience than expected</td>
</tr>
<tr>
<td>Tell me about an activity that you have never done before this class, or</td>
<td>3</td>
<td>Practice/application of critical thinking or problem solving</td>
</tr>
<tr>
<td>a time you were required to leave your comfort zone.*</td>
<td></td>
<td>Insights/Seeing other perspectives</td>
</tr>
<tr>
<td>Tell me about your experience working in an interdisciplinary group. Are</td>
<td>8</td>
<td>Gained an openness to different perspectives/ viewpoints</td>
</tr>
<tr>
<td>you more confident working in teams as a result?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the most beneficial thing you learned or skill you gained from</td>
<td>14</td>
<td>Knowledge of, and experience with, the product development process</td>
</tr>
<tr>
<td>taking the AIPD course?</td>
<td>9</td>
<td>Learning how to collaborate with other majors and understand the teamwork</td>
</tr>
<tr>
<td></td>
<td></td>
<td>between departments</td>
</tr>
<tr>
<td>What were you able to teach the rest of your team about you major?</td>
<td>3</td>
<td>Department roles and responsibilities</td>
</tr>
<tr>
<td>Did you experience any “ahah!” or breakthrough moments during this class?</td>
<td>9</td>
<td>Breakthrough in recipe formulation</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Validation and approval from others</td>
</tr>
<tr>
<td>How do you anticipate using the skills you learned in this particular</td>
<td>5</td>
<td>Communication with majors other than one’s own</td>
</tr>
<tr>
<td>class in your future career?*</td>
<td>4</td>
<td>Integration of knowledge from multiple disciplines</td>
</tr>
<tr>
<td>We would like to get your feedback for improvements of this course.</td>
<td>14</td>
<td>More deadlines, direction and instruction</td>
</tr>
<tr>
<td>What would you suggest we change, remove, add or enhance in future</td>
<td>8</td>
<td>Students felt unprepared to take course as sophomores</td>
</tr>
<tr>
<td>offerings of this course?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n: number of participants that commented on the theme out of 16

*: only answered by 2 of 3 focus groups
Faculty Survey

Table 2.4 displays the responses to the faculty survey, which was used to measure faculty members’ perception of the students that had taken the AIPD course compared to those who had not taken the course. The mean ratings faculty members gave for all of the AIPD student traits or abilities are greater than three out of five, indicating that the AIPD senior students were generally rated slightly better compared to senior students that did not participate in the AIPD course. The highest mean is seen for teamwork skills at 3.88 out of 5. Across all student traits and abilities rated, overall academic performance was the only trait to receive a negative rating; one faculty member (11%) rated students in the AIPD course as “somewhat worse” in overall academic performance than students who did not take the AIPD course.
Table 2.4 Faculty survey response means, counts and percentages for the question, “How would you rate the students who completed the Applied Interdisciplinary Product Development course (on the given list) compared to those who did not take the AIPD course based on the following traits and abilities?”

<table>
<thead>
<tr>
<th>Student Trait or Ability</th>
<th>Total n</th>
<th>Mean*</th>
<th>How would you rate AIPD students compared to students who did not take the AIPD course?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Much Worse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td>Overall Academic Performance</td>
<td>9</td>
<td>3.44</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Teamwork Skills</td>
<td>8</td>
<td>3.88</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>9</td>
<td>3.56</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Leadership Skills</td>
<td>8</td>
<td>3.38</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Industry Prep</td>
<td>7</td>
<td>3.57</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Ask for Faculty Help</td>
<td>9</td>
<td>3.56</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Ask for Outside Help</td>
<td>8</td>
<td>3.38</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Knowledge Related to Major</td>
<td>8</td>
<td>3.5</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Combine Other Course Ideas</td>
<td>7</td>
<td>3.43</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

*1=“Much Worse”; 2=“Somewhat Worse” 3=“Neither Better nor Worse” 4=“Somewhat Better” 5=“Much Better”
Discussion

Subject Knowledge Assessment

No significant differences existed between the treatment and comparison groups’ scores on the Subject Knowledge Assessment (SKA), overall or in any of the four subject categories of food science, nutrition, packaging science, and general product development knowledge (Table 2.2, \( P > 0.05 \)). One reason that there were not significant differences on the SKA may be due to the fact that the time between learning information in the AIPD course and recalling it on the final test was about two years, during which time the students may have forgotten the facts asked about on the SKA. Many of the questions on the SKA were also highly specific, and so it may have been difficult for the students to recall such a particular piece of information. Another possibility that can explain the lack of significant differences between treatment and comparison groups is that although the treatment group scored significantly higher on the SKA upon completion of the course as sophomores, the comparison group may have learned this information over the last two years in their upper level classes (Weeks 2014). Therefore, over time the comparison group was able to rise to the same level of knowledge as the treatment group, yielding no significant differences in overall knowledge. For example, the only class that taught product development to sophomores was the AIPD course, and so the treatment group would have easily had a greater knowledge of product development than the comparison group at the completion of the course. However, the food science senior capstone course in product development is essentially a graduated version of the AIPD course. By taking the senior capstone course, the comparison group
would have had an opportunity to “catch up” to the treatment group students in product development knowledge. This may explain the very low difference in mean percent correct scores between the treatment (64.8%) and comparison (65.4%) groups upon final evaluation two years later. Although there were not significant differences between the treatment and comparison groups when assessed as seniors, significant differences were found at the time the students were sophomores (Weeks 2014). Therefore, the conclusion can still be made that the AIPD course is effective in providing students with advanced knowledge for their class standing as sophomores, potentially giving them an advantage in future courses.

Exit Questionnaire

The difference between the treatment and comparison groups’ level of agreement was significantly different for five of the nine statements concerning confidence in product development skills, and the statement concerning confidence in interdisciplinary teamwork. The exit questionnaire (EQ) results are in line with what were expected: that the treatment group would report significantly higher levels of confidence relating to product development skills. A significant difference was not found for the statement pertaining to department engagement, which was to be expected. The original design of the course was intended to engage students at a sophomore level, since that is the point in their academic career at which they feel disconnected. However as seniors, all of the students would have had chances to participate in department activities, join product development competition teams, and interact with professors, which all support students’ feelings of engagement with the department.
Significant differences did not exist for any of the four confidence statements about preparedness to enter the industry. The lack of difference with the statements pertaining to industry readiness was expected. Since the students were all reaching the end of their academic career, they would have all taken roughly the same set of classes, the only definite difference being whether or not they had taken the AIPD course as sophomores. Although the AIPD course was impactful at the time that they were sophomores and resulted in significant differences (Weeks 2014), taking senior courses seemed to have filled the confidence gap between the control and treatment groups, resulting in similar confidence in the groups.

Focus Groups

The aim of conducting focus groups was to gauge the students’ experience in the course regarding teamwork, communication, and personal growth. Additional goals were to understand students’ perception of the course looking back two years later, and to see if students felt that the course prepared them in any way for their future careers.

When students were asked, “What is the most beneficial thing you learned or skill you gained from taking the AIPD course?” the main theme that arose was about product development skills and knowledge. The key theme about product development underscores the results received from the exit questionnaire, where students indicated high levels of confidence in this subject. Although the treatment and comparison group did not significantly differ in the Subject Knowledge Assessment (SKA) scores, the results from both the exit questionnaire and the focus group suggest that AIPD students may have skills and confidence that may not be accurately measured on a multiple choice
test. Many students also indicated during the focus groups that the AIPD course taught them how to collaborate with other majors and understand the teamwork between departments. The theme of collaboration, which emerged from the focus groups, also supports the results of the exit questionnaire, where a significant difference existed between the treatment and comparison groups on a similar statement regarding collaboration. The results from both the exit questionnaire and focus groups together support the objective of the AIPD course to improve teamwork skills. When the students were asked about how they anticipated using the skills learned in the AIPD course in their future career, two similar themes arose again surrounding communication skills with majors other than one’s own and being able to integrate knowledge from multiple disciplines. The recurring mention of the impact of interdisciplinary work and knowledge demonstrates that working in interdisciplinary groups was a powerful experience for students in the course.

When students were asked specifically about their experience working in an interdisciplinary group, one key theme arose: students became more open to different perspectives and viewpoints. Placing students in interdisciplinary teams required them to work with people from other disciplines. In order to have a successful project, students had to learn how to work together regardless of their background, which enhanced their teamwork skills and allowed them to see the same situation from a different point of view. It is demonstrated through the results of the focus group that AIPD students have confidence in their abilities to collaborate with an interdisciplinary group, thus providing evidence that the AIPD course improves students’ teamwork skills.
When students were asked about a time during the AIPD class that they experienced an “aha moment,” many students mentioned a breakthrough in their recipe formulation, such as discovering the perfect cook time or finally finding the correct ingredients. Comparing this response regarding recipe breakthrough to the exit questionnaire results, the largest differences in confidence between the treatment and comparison groups were seen for the development of a gold standard recipe and development of a formula. The successful experiences in formulation breakthroughs, as recalled in the focus group, enhanced students’ self-assuredness in being able to develop a gold standard recipe and product formula, which is reflected in the high confidence ratings seen in the exit questionnaire.

The final question in the focus group dealt with suggestions for course improvement. Students wanted more traditional types of instruction with deadlines and direction during the class, and they felt unprepared to take the course as sophomores. The same themes had arose when students filled out the exit questionnaire two years prior, at the end of the AIPD course (Weeks 2014).

Faculty Survey

The means of all the faculty ratings of student traits or abilities is greater than three out of five, indicating that the AIPD students were generally rated slightly better than their peers. The highest mean rating of 3.88 out of 5 was seen for teamwork skills, aligning with the continuing theme that the students completing the AIPD course learned how to work with others very well. Other traits or abilities with high mean ratings were industry preparedness (3.57), critical thinking skills (3.56), and seeking help from faculty
The topics of industry preparedness and critical thinking skills both arose as themes in the focus groups, indicating that students’ confidence in these areas is showing through in their academic work.

**Limitations**

The students that were asked to return to complete the evaluations were mostly college seniors, so they were busy preparing for graduation. Students were two years removed from any contact about the study, and so some students felt they were receiving emails by mistake and ignored them, forgetting that they had agreed two years ago to participate in these exit surveys. Students in the comparison group forgot they were part of the study more so than the treatment group, so there was even more effort required to get the comparison group to participate. There was not a very strong incentive for students to return to complete the surveys since they were no longer receiving class credit or a grade, like they did two years ago. There was therefore a large lack of motivation to return to fill out the surveys and attend the focus groups.

A limitation of the faculty survey was that if a faculty member only knew one student of the list of AIPD students, that single student’s behavior was used to represent the entire group of students, and therefore the ratings given by the faculty member may not have been generalizable to the group. Additionally, because the administration method of the Qualtrics survey ensured confidentiality, all faculty members received the same link to complete the survey, prohibiting the researchers from tracking which faculty had and had not completed the survey. The inability to track which faculty members responded made sending follow-up reminders difficult; unnecessary reminders were sent
to some faculty that had already completed the survey, creating confusion as to whether or not they had to complete the survey a second time.

One of the limitations to the exit questionnaire and subject knowledge assessment responses was the amount of time and effort spent trying to recruit the students to return and complete the surveys. Many students made excuses about being busy or having class, but others were completely unresponsive to the numerous emails that were sent requesting them to participate. One explanation is that students receive innumerable emails per day and simply did not read the emails before deleting them. Another explanation for the lack of response could be that students did not see the personal benefit in completing the surveys, and just viewed it as a favor they would have to do for the instructors, and one more commitment to fit in their busy schedules. Thirdly, the surveys were administered at a time in the semester where many of the students were having exams, and so perhaps choosing a less busy time during the semester may have yielded a higher response rate.

Conclusions

The objective of this research study was to compare senior students who had taken the AIPD course as sophomores to senior students who did not take the course, with respect to product development skills, knowledge in various disciplines, and preparedness to enter the industry. Although there were not significant differences in the SKA results, the findings can be explained by the opportunity that the comparison group had to take a senior level product development course and close the gap in knowledge observed between them and the treatment group two years prior (Weeks 2014). A major
theme across all other evaluation tools was the advanced teamwork skills of AIPD students. Of all the AIPD student attributes listed on the faculty survey, teamwork skills was the attribute rated the highest when compared to senior students that did not participate in the AIPD course. The theme of advanced teamwork skills speaks strongly to the interdisciplinary nature of the AIPD course, and the fact that students not only see the value in the teamwork skills they gained, but that they are translating those skills over into the work they are doing in their academic careers. The results from the exit questionnaire also aligned with what was anticipated; students in the treatment group rated higher levels of confidence in five of the nine statements about product development. With regards to industry readiness, students in the treatment group were rated higher on average than those in the comparison group. The treatment group was also able to communicate during the focus groups how the skills they learned in the AIPD course will be utilized in their careers. Therefore it can be concluded that students that have completed the AIPD course have maintained their advanced skill level over their peers in such areas as product development skills and soft skills, even two years after taking the course.

**Future Recommendations**

If future seniors graduating from this course will be required to complete the same evaluation tools as in this study, more communication should take place at the time AIPD students are enrolled in the course. Making students aware of the future commitment
should help to avoid confusion during their senior year about why they are being contacted after such a long time.

The way the online faculty survey was set up in terms of confidentiality, the researchers were unable to know which faculty had already taken the survey, making it somewhat difficult to follow up with those who had not yet taken the survey. In the future, surveys should be linked to the faculty members’ email addresses so that names and identification can be removed after all surveys are completed.

A larger incentive is needed in order to entice students to return and fill out the surveys. A better response rate for the focus groups was observed for the nutrition students, which may have been due to the fact that the AIPD course instructor often saw them in the hallway and was able to speak with them face-to-face to encourage attendance. For future focus groups, efforts should be made to find opportunities of face-to-face interaction to drive increases in response rates.

References


Kayes DC. 2002. Experiential Learning and Its Critics: Preserving the Role of Experience in Management Learning and Education. Academy of Management Learning and Education 1(1):137-149.

Saad E. 2010. Synthesis of opinions from the food manufacturing industry, academia representatives, and undergraduate students reviewed to highlight the skills, knowledge and attitudes applied to the product development process. MS Thesis, Dept. of Food, Nutrition, and Packaging Science, Clemson University, Clemson, SC.

CHAPTER THREE

DEVELOPMENT AND TESTING OF SUPPLEMENTAL MATERIALS TO INCLUDE HERBS, SPICES AND SENSORY SCIENCE

Abstract

The objective of this research was to develop supplementary educational materials to teach the fundamentals of herbs, spices and sensory science to students in an undergraduate food product development course. It was anticipated that creating and presenting educational materials to students in the food product development course would result in knowledge gains in the areas of herbs, spices, and sensory science. Newly developed course materials and activities were presented to a total of 18 undergraduate students at two universities: Clemson University (n=12), and another southern land-grant university (n=6). An Herbs, Spices, and Sensory Science (HSS) questionnaire was used to evaluate the sensory science knowledge gain, and herbs and spices knowledge gain as a result of the intervention. The difference between the pre- and post-intervention scores for both subject areas was analyzed using a Paired Sample T-Test (α=0.05). Results from the HSS questionnaire indicate that the average score for both knowledge categories of sensory science and herbs and spices were significantly different post-intervention ($P = 0.0042$ and $P = 0.0169$, respectively). Overall, the supplemental materials designed for an undergraduate food product development course were successful in teaching students about herbs, spices, and sensory science, making the lectures on these topics valuable tools for use in later course offerings.
Introduction

The objective of this research was to educate students on the fundamentals of herbs, spices, and sensory science by developing educational materials to supplement a product development course curriculum. The course, titled Applied Interdisciplinary Product Development for Sophomore Students (AIPD), teaches college sophomores, and other undergraduate students, the process of food product development with a focus on childhood nutrition. It was anticipated that presenting the supplementary materials to students in the AIPD course would result in knowledge gains in the areas of herbs, spices, and sensory science.

Throughout the year-long AIPD course, students collaborated in small teams to work step-by-step through the product development process in order to create a healthy children’s food product. Product development is one of the most popular entry-level positions and internship positions that young professionals in food science can obtain, making the AIPD course an invaluable experience to have on a resume for students applying for such positions (BLS 2013). Within the realm of product development is the concentration of sensory science. Defined by the Institute of Food Technologists, sensory evaluation is “a scientific discipline used to evoke, measure, analyze and interpret those responses to products that are perceived by the senses of sight, smell, touch, taste and hearing” (Stone and Sidel 2004). The human senses are used in sensory evaluation to measure the subjective qualities of food that are important to consumers but are unable to be measured by a machine. Sensory science is widely used throughout the food industry as a means to test shelf life, ensure quality, and launch new food products (IFT 2007).
One of the key roles of the sensory science department within a food manufacturing company is to support the research and development team by determining what the target demographic of consumers likes in a food product and why (IFT 2007). Children are the target audience for whom the AIPD students are developing products, in hopes of inspiring the AIPD students to combat the childhood obesity epidemic. As of 2012, more than one-third of adults and 17% of youth in the United States are obese, making healthy eating an important concern (Ogden 2013). Educating future food, nutrition, and packaging science professionals about the importance of healthy eating and how to create a balanced diet will provide them with the tools needed to be successful in their careers combatting the obesity epidemic through food product development.

Another area for concern in health is the high sodium content in the American diet. The American Heart Association estimates that 9 out of 10 Americans consume too much sodium, averaging around 3,400 mg daily (2015). Excess sodium is a concern because it increases a person’s risk for high blood pressure, which can lead to heart disease and stroke. Cardiovascular disease is already of paramount concern in the United States, causing 610,000 deaths in the each year, which accounts for one quarter of total U.S. deaths (CDC 2013). The American Heart Association recommends adopting a low-sodium diet to prevent heart disease. Although removing salt from foods is often associated with a loss in flavor, adding herbs and spices can be a flavorful, healthy, low-calorie alternative to salt. Finding an application for spices in food products not only helps to mitigate the use of sodium by enhancing the natural flavors of the food, but also has positive health benefits with respect to weight management. Studies have suggested
that appropriate intake of pungent spices may help in weight control (Kralis 2012). One of the chemical compounds responsible for this effect is capsaicin, which is the spicy component found in chili powder and red pepper flakes. A systematic review of evidence in the relationship between capsaicin intake and weight management revealed that regular consumption of capsaicinoids significantly reduced abdominal adipose tissue levels and reduced appetite and energy intake (Whiting 2012). By educating product development students about the positive effects of replacing salt with herbs and spices, universities can potentially influence how the next generation develops new food products for children.

Methods

The motivation for this study stemmed from a review of the curriculum for the Applied Interdisciplinary Product Development Course (AIPD) for Sophomore Students developed at Clemson University (Weeks 2014). The review of the AIPD course, as well as feedback from students who had taken the course in the past, revealed a need for supplemental course materials to fill knowledge gaps of students. Two of the more prominent subjects in need of supplementation were sensory science, and the use of herbs and spices as salt-free flavorings. Lectures and activities on these topics were therefore developed and administered as supplemental materials for the pre-existing course. This research was approved by Clemson University’s Institutional Review Board (IRB).

Administration of Herbs, Spices, and Sensory Science Modules

The researcher prepared and presented two lectures: one lecture introduced students to sensory science, and the other educated students about herbs and spices, and their uses as flavorings in food products. The lectures were presented to two separate
groups of AIPD students: one group of students from Clemson University (n=12) and a second group of students from another southern land-grant university (n=6). The two lectures, one focusing on sensory science and the other on herbs and spices, were administered to Clemson students on separate days during the students’ regularly scheduled, 50-minute class time. The other land-grant university received both lectures within the same day, also within the students’ regularly scheduled class time, which lasted for 90 minutes.

The lecture on herbs and spices contained information about the difference between herbs and spices, reasons for using them in cooking, examples of common herbs and spices, examples of common spice blends, and examples of traditional seasoning and food pairings. The lecture also included information about the proper storage conditions for herbs and spices, their general shelf life, some guidelines for cooking with herbs and spices, and the general rule for how to substitute fresh herbs for dried herbs in a recipe. Finally, information was provided about the heat intensity of “hot” or “spicy” foods, the chemical compound responsible for this sensation felt on the tongue, how heat intensity is measured in food, and how to balance flavors when developing a recipe. A sample of each herb, spice, and spice blend discussed in the lecture was passed around the classroom to give students the opportunity to see and smell each of these seasonings.

The lecture on sensory science contained the definition of sensory science and an explanation of the purpose of sensory science. Students were then introduced to the five basic tastes through an in-class activity embedded in the lecture. Each student received three “sensory reference samples”, which were small samples of food that exemplified
one of the five basic tastes: sweet, salty, sour, bitter, and umami/savory. When instructed, students tasted each sample. The first sample was a chewy, fruit-flavored candy with a citric acid coating, and was representative of both sour and sweet. Students were instructed to first suck on the candy to experience the sour taste, and then were instructed to chew on the candy to taste its sweetness. The second sample was representative of the taste of salt, where students were asked to lick the surface of a potato chip. The third sample was a square of dark chocolate made with 70% cocoa, which represented the taste of bitterness.

After the activity about the five basic tastes, students were taught the difference between taste and flavor through a second activity. Taste is the sensation of substances touching the tongue, including the five basic tastes of sweet, salty, sour, bitter and umami, whereas flavor describes the perception of taste, smell, and mouthfeel together (Center for Smell and Taste 2015). For the activity, each student received a small plastic cup containing 10 chewy, fruit-flavored candies; two candies for each of the five flavors contained in the candy bag. Students were instructed to close their eyes and use one hand to close their nose. Students then used their other hand to reach in the cup and randomly select one of the candies and place the candy in their mouth. Keeping their eyes and nose closed, students were asked to chew the candy and guess which flavor they think the candy is. Students were next asked to open their nose and guess the flavor once more. Finally, students opened their eyes and examined their cup to see which color of candy was missing, indicating which flavor they selected. The exercise was used to demonstrate the importance of your sense of smell when determining flavor.
After the second activity, the lecture continued by teaching students how to properly design a sensory evaluation test, and giving students an overview of the three general types of tests. The remaining portion of the lecture discussed the three main sensory evaluation tests in detail, such as the objective of each test, the type of panelists that data is gathered from, and the type of situation in which a food manufacturing company would use the test.

At the end of the lecture, students completed a third hands-on learning activity by participating in a triangle test. In a triangle test, panelists receive three samples of a food product: two samples of the same product and one that is different. The panelist must determine by sensory evaluation which of the samples is different from the other two (Lawless and Heymann 2013). This is a common test used for comparing the sensory properties of an original product to a reformulation of the same product. For the activity, each student received three samples of kettle-cooked potato chips in small sample cups. Each cup was labeled with a unique three-digit number. Students received a paper ballot with the following instructions: “Please taste all three samples in order, from left to right, and then circle the number that corresponds to the sample that is DIFFERENT from the other two.” Below the instructions, the three, three-digit numbers were listed for the students to circle. At the bottom of the ballot was space for the students to write their reason for selecting the sample they chose as the “odd” sample. The two types of potato chips used for the activity were original kettle-cooked potato chips and the same brand of 40% reduced fat kettle cooked potato chips. Students were given time to evaluate the samples before the three-digit sample codes and corresponding type of potato chip were
written on the whiteboard in the front of the class for students to check if they selected the correct sample. In the industry, sensory scientists use statistics to determine whether panelists can truly discriminate between samples, or if they are randomly guessing the correct answer, by testing if the percentage of correct responses is above the level that is expected by chance (Lawless and Heymann 2013). To demonstrate a simplified version of sensory data analysis, a tally of the number of students who answered correctly was collected and divided by the total number of students that participated in order to determine the percentage of students who answered correctly. This percentage of correct responses was compared to 33%, which is the percent chance of someone randomly guessing the correct sample. This activity concluded the sensory science lecture.

Herbs, Spices, and Sensory Science Questionnaire Development

In order to evaluate students’ baseline knowledge prior to administration of the lectures, an Herbs, Spices, and Sensory Science (HSS) questionnaire was developed by the researcher. A copy of the HSS questionnaire can be found in Appendix D. The HSS questionnaire consisted of eleven multiple choice questions: five questions about sensory science, and six questions about herbs and spices. The items of the questionnaire pertaining to sensory science were derived from materials developed by the Institute of Food Technologists, as well as two sensory science textbooks (IFT 2007, Stone and Sidel 2004, Lawless and Heymann 2013). Some examples of the sensory science questions include, “What is the difference between flavor and taste?” and “The five basic tastes are sweet, salty, sour, bitter, and_____.” The items of the questionnaire pertaining to herbs and spices were constructed using various sources including websites of international
flavoring companies and The Food Network. Some examples of sensory science questions asked are, “What is the difference between an herb and a spice?” and “What is the general rule for substituting fresh herbs for dry herbs?”

The Herbs, Spices and Sensory Science (HSS) questionnaire was validated by a test-retest method. Test-retest reliability is measured by administering a questionnaire at different time points to the same group of people, and measuring the degree to which scores are consistent between tests (Craig 2015). If scores from a questionnaire are consistent between tests, the questionnaire can be considered a dependable and repeatable form of measurement. A convenience sample of students in the Food, Nutrition, and Packaging Science Department at Clemson University was used to test the reliability of the HSS questionnaire. The convenience sample contained students of similar demographic characteristics to the AIPD students for whom the survey was designed. Pearson’s Correlation Coefficient was used to measure the correlation between responses from the initial test to the responses of the re-test. The purpose of measuring the correlation was to identify questions with low correlation in order to improve the clarity of wording in those questions. Four of the eleven questions on the HSS questionnaire had fairly low correlation from pre to post on the test-retest, but given that it is likely that convenience sample subjects had no prior knowledge of sensory science, herbs, or spices, random guessing could be the cause of the low correlation. The questions with low correlation were re-worded for additional clarity before administering the questionnaire to the AIPD students.
The Herbs, Spices, and Sensory Science (HSS) questionnaire was administered in a pre/post manner to students enrolled in the Applied Interdisciplinary Product Development classes at Clemson University (n=12) and another land-grant university (n=6). First administration of the questionnaire (pre-test) occurred during the first week of the semester to measure students’ baseline knowledge prior to learning about herbs, spices and sensory science. A total of 18 students completed the questionnaire online via Survey Monkey (www.surveymonkey.com). Demographic information of the surveyed students is provided in table 3.1.

During the last week of the semester, the post-test of the HSS questionnaire was administered to determine students’ change in knowledge after the intervention. All students (n=18) completed the post-test questionnaire in the same online format as the pre-test, yielding a 100% response rate. Student scores on the survey were not part of the final grade for the course. For analysis, questions were separated into two groups of sensory science and herbs and spices. The responses were analyzed using SAS 9.3 (Cary, NC). A paired t-test was used to compare the percent correct responses pre-intervention to percent correct responses post-intervention (α = 0.05).
Table 3.1 Demographic information of Clemson University and Land-Grant University students

<table>
<thead>
<tr>
<th>Demographic Category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Standing</td>
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<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Sophomore</td>
<td>10</td>
<td>56</td>
</tr>
<tr>
<td>Junior</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>Senior</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>8</td>
<td>44</td>
</tr>
<tr>
<td>Nutrition</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>Packaging Science</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Agribusiness</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Food Marketing</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>100</td>
</tr>
</tbody>
</table>

Results

Data and descriptive statistics for the individual questions in the Herbs, Spices, and Sensory Science (HSS) questionnaire are presented in Table 3.2. The frequency of correct responses increased from pre- to post-test for all 5 of the questions regarding sensory science, and for 5 of the 6 questions pertaining to herbs and spices. The two questions that exhibited the largest increase in frequency of correct responses from pre to post were, “Which sensory test should be used to determine if a difference in sensory properties exists between an original product and a reformulation?” and “what is the difference between flavor and taste”. For the question regarding the sensory test used for product reformulation, 6 students answered correctly pre-intervention (33%) compared to 12 correct responses post-intervention (67%). For the question regarding the difference between taste and flavor, the frequency of correct responses increased from 9 (50%) in the pre-test to 15 (83%) in the post-test. The questions, “when should you add spices
during cooking” and “which sensory test should be used to determine if consumers like a newly developed food product” both showed a frequency increase of 5 (27%) from pre to post. The only question where the frequency of correct responses decreased was, “what is the difference between an herb and a spice,” where the difference between pre and post was $n = 1$ (6%).

**Table 3.2 Frequencies and percentages of correct answers pre- and post-course for the Herbs, Spices and Sensory Science Questionnaire**

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency Correct Responses (% Correct)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the difference between an herb and a spice?</td>
<td>Pre: 12 (67) Post: 11 (61)</td>
</tr>
<tr>
<td>Which of the following herbs is NOT typically found in Italian Seasoning?</td>
<td>Pre: 13 (72) Post: 17 (94)</td>
</tr>
<tr>
<td>What is the general rule for substituting fresh herbs for dry herbs?</td>
<td>Pre: 10 (56) Post: 13 (72)</td>
</tr>
<tr>
<td>On average, how long do ground spices last before losing their flavor and aroma?</td>
<td>Pre: 10 (56) Post: 14 (78)</td>
</tr>
<tr>
<td>When should you add spices during cooking?</td>
<td>Pre: 12 (67) Post: 17 (94)</td>
</tr>
<tr>
<td>Which scale is used to measure the heat intensity of spicy foods?</td>
<td>Pre: 4 (24) Post: 6 (35)</td>
</tr>
<tr>
<td>Which sensory test should be used to determine if consumers like a newly developed food product?</td>
<td>Pre: 7 (58) Post: 12 (67)</td>
</tr>
<tr>
<td>The five basic tastes are sweet, salty, sour, bitter, and ___</td>
<td>Pre: 15 (83) Post: 17 (94)</td>
</tr>
<tr>
<td>Which sensory test should be used to determine if a difference in sensory properties exists between an original product and a reformulation?</td>
<td>Pre: 6 (33) Post: 12 (67)</td>
</tr>
<tr>
<td>What is the name of the sensory evaluation software used to create the product’s sensory attribute questionnaire, collect the data and analyze results?</td>
<td>Pre: 6 (33) Post: 10 (56)</td>
</tr>
<tr>
<td>What is the difference between flavor and taste?</td>
<td>Pre: 9 (50) Post: 15 (83)</td>
</tr>
</tbody>
</table>

The results of the paired t-test, which compared the percentage of questions answered correctly from pre to post, are presented in Table 3.3. The largest mean percent
knowledge gain was observed in the sensory science category (24%). The knowledge gain in the herbs and spices category averaged a 16% increase. The average of the two subject categories combined resulted in an overall knowledge gain with a mean of 20%. The knowledge of both herbs and spices and sensory science were significantly higher post-intervention ($P = 0.004$, and $P = 0.017$, respectively). The overall knowledge as a combination of both subject areas was therefore also significantly different ($P = 0.001$).

**Table 3.3 Results of paired t-test comparing pre to post of percentage correct overall, and percent correct in the spices and herbs and sensory science categories**

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean % Correct Pre (Standard Deviation)</th>
<th>Mean % Correct Post (Standard Deviation)</th>
<th>Mean % Difference (Std. Dev.)</th>
<th>Paired T-Test Test Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Correct Overall</td>
<td>52.5 (20.1)</td>
<td>72.7 (19.7)</td>
<td>20 (22)</td>
<td>3.80</td>
<td>0.001*</td>
</tr>
<tr>
<td>Herbs &amp; Spices</td>
<td>49.4 (29.2)</td>
<td>73.3 (27.4)</td>
<td>16 (20)</td>
<td>3.31</td>
<td>0.004*</td>
</tr>
<tr>
<td>Sensory Science</td>
<td>56.5 (18.2)</td>
<td>72.2 (19.8)</td>
<td>24 (35)</td>
<td>2.67</td>
<td>0.017*</td>
</tr>
</tbody>
</table>

* Designates a significant difference ($\alpha = 0.05$).

**Discussion**

Significant differences were found from pre-test to post-test for both subject areas of sensory science and herbs and spices ($P = 0.004$ and $P = 0.004$, respectively). A significant difference was also observed for overall change in knowledge, with a p-value of 0.001 (Table 3.3). The largest knowledge gains were seen for the questions, “Which sensory test should be used to determine if a difference in sensory properties exists between an original product and a reformulation?” and “what is the difference between flavor and taste”. This is of notable importance because the answers to both of these
questions were demonstrated by the in-class activities. The sensory test used to determine the difference between two products is a triangle test, which was demonstrated using potato chips, and the difference between taste and flavor was demonstrated with the chewy, fruit-flavored candies. The fact that these two questions exhibited the highest increase in frequency of correct answers from pre to post suggests that students may commit information to memory more readily from hands-on learning activities as opposed to lecture-based learning.

Neither Clemson University nor the other participating Land-Grant University offer a sensory science course, but the general principles are taught as a unit within upper-level product development courses for food science students. Since students taking the AIPD course have not yet taken upper-level courses, the sensory science lecture in the AIPD course was most likely their first exposure to the topic, allowing for the significant gain in knowledge in the subject of sensory science. The use of herbs and spices is not a primary topic in food science curriculums either, making it a novel subject to be taught in this setting and attributable to the significant gains in knowledge from the lecture on herbs and spices.

Limitations

The students in the AIPD course only received a very brief exposure to the two topics of herbs and spices and sensory science. Fifty minutes does not allow for much time to absorb the breadth of information presented, which can result in limited or varied knowledge gains from the students. Additionally, students received only one exposure to the HSS material, and it was at a point later on in the course where students did not have
much opportunity to apply their newly learned knowledge. There was a wide variation in amount of information absorbed by students, shown by the large standard deviation. Some potential reasons behind the large variation are because some students need repeated exposure to topics in order to commit the information to memory, or because some individuals learn best from a learning style other than the ones used in this study. The small sample size may also limit the ability to generalize the results.

Conclusions

Based on the results from this pilot study, the supplemental lectures and activities designed for an undergraduate food product development course were successful in teaching students about herbs, spices, and sensory science. The greatest increase in knowledge from pre to post was observed for the information that was presented in an applied setting with in-class activities, suggesting that students may more readily commit information to memory in a hands-on learning format than in a traditional lecture setting. The materials developed for this pilot study, including the Herbs, Spices, and Sensory Science (HSS) Questionnaire, lecture materials, and instructions for the in-class activities, will be made available to the instructors of future AIPD courses for permanent integration into the course curriculum. Students in the product development course had significant knowledge gains in the subjects of herbs, spices and sensory science, making the lectures on these topics valuable tools for use in later course offerings.

Future Recommendations

When using the herbs, spices and sensory science materials in the future, the HSS questionnaire should be administered as a graded quiz after the lecture is given so that the
students are encouraged to review the material again. Administration of a graded quiz will not only provide motivation to learn the materials in order to receive a good grade, but will also increase the students’ chances in remembering the material for a longer period of time since repeated exposure to information typically increases the likelihood of permanent memory. Another method to encourage repeated exposure could be to present the lecture earlier on in the curriculum, and then work with each individual group during the product development stage to facilitate use of herbs and spices in their product. Product development experience with herbs and spices will give students an opportunity to use their knowledge in an applied setting, which is a major tenet of the AIPD course. Another benefit to presenting the material earlier in the course is that students will learn about sensory science, and more specifically hedonic testing, prior to taking their food products to an elementary school for testing. Presenting the sensory science lecture would be a way to introduce students to what they will be doing later on in the course and would teach students the best practices of sensory science before they apply what they learn.

References


CDC, NCHS. Underlying Cause of Death 1999-2013 on CDC WONDER Online Database, released 2015. Data are from the Multiple Cause of Death Files, 1999-2013, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Accessed Aug. 3, 2015.


CHAPTER FOUR

COMPARING KNOWLEDGE GAINS BETWEEN STUDENTS IN THE APPLIED
INTERDISCIPLINARY PRODUCT DEVELOPMENT COURSE AND THE
STUDENTS IN THE HYBRID COURSE MODEL

Abstract

The objective of this research was to develop a hybrid curriculum that can be used for online dissemination of a previously developed course at Clemson University, titled Applied Interdisciplinary Product Development (AIPD). The AIDP course is a two-semester course designed to teach college sophomores and other undergraduate students the process of product development with a focus on childhood nutrition, as well as expose students to the different majors within the Food, Nutrition, and Packaging Sciences Department. It was anticipated that students taking the new hybrid course would have no significant differences from students taking the existing course with respect to knowledge gains or increased confidence in product development skills. A pilot study of the hybrid course was conducted at a southern land-grant university (LGU) with a group of 6 students. A comparison group of 12 students participated in the existing course concurrently at Clemson University. A Subject Knowledge Assessment (SKA) was designed to measure students’ knowledge of food science, packaging science, nutrition, and product development. An Exit Questionnaire (EQ) aimed to measure students’ confidence in items such as their product development skills, preparedness to enter the industry, and interdisciplinary teamwork. Data from the SKA and EQ were analyzed using a Wilcoxon Rank-Sum test to compare the responses from Clemson University to
those from LGU ($\alpha = 0.05$). The results of the SKA show there is not sufficient evidence to suggest that LGU students’ percent scores, overall or in the four subject categories, are different from the Clemson University students’ percent scores ($P > 0.05$). Additionally, no significant differences were found between the two groups for 13 of the 14 items on the Exit Questionnaire ($P > 0.05$). Therefore, the conclusion can be made that the hybrid course is a viable option for dissemination to other universities to successfully teach food product development to sophomore students.

**Introduction**

The objective of this research was to develop a hybrid curriculum that can be used for dissemination of a previously developed course at Clemson University, titled Applied Interdisciplinary Product Development (AIPD). The AIDP course is a two-semester course designed to teach undergraduate students the process of food product development with a focus on childhood nutrition, as well as expose students to the different majors within the Food, Nutrition, and Packaging Sciences Department. The AIPD course has seen success at Clemson University in the past, resulting in significant improvements in students’ knowledge of food science, nutrition, and product development (Weeks 2014). Therefore, the AIPD course is anticipated to have success when disseminated to other universities as well.

Throughout the course, students worked in small teams to move step-by-step through the product development process in order to create a healthy children’s food or beverage product. The applied, hands-on approach used in the AIPD course is different from the majority of the other classes students take by allowing them to learn through
firsthand experience. By researching and developing a food product on their own, students are accountable for the success of their product, which can result in a greater sense of achievement and empowerment (Dewey 1938). Encouraging students to be actively involved in each step of the product development process also simulates a real-world environment similar to that which they may experience when they enter the industry. Not only is product development the largest area of employment among food scientists (BLS 2013), but it is also a common discipline among food science, nutrition, and packaging science majors. Therefore, it is important that undergraduate students have some experience in product development before entering the industry.

Students involved in the AIPD course represented various majors, including food science, packaging science, Culinology®, agribusiness, food marketing, and nutrition. By placing these students into diverse teams, an interdisciplinary learning environment was formed. The goal of interdisciplinary teaching and education is to help students gain a new or greater understanding of one’s own discipline and that of others (Hayes 2002). The AIPD course fosters an environment where students learn from and come to respect the viewpoint of other majors. Being able to work on an interdisciplinary team is a necessary skill that students should have when they enter the industry, since they will most likely be required to work collaboratively with many other disciplines. One aim of the AIPD course is to help students learn interdisciplinary teamwork skills early on in their academic career so that they will be able to apply these skills in the industry.

The practical focus of the AIPD course is on creating healthy food products for children. As of 2012, more than one-third of adults and 17% of youth in the United States
are obese, making healthy eating an important concern (Ogden 2013). By educating the food science, nutrition, and packaging science professionals of the next generation about healthy eating and how to create a balanced diet, the AIPD course can give students the tools needed to be successful in their careers combatting the obesity epidemic through food product development.

This research project was made possible by the Higher Education Challenge (HEC) grant program, funded by the United Stated Department of Agriculture (USDA) and the National Institute of Food and Agriculture (NIFA). The HEC grant was awarded based on the ability of the AIPD course to address an educational need, model a creative approach to addressing that need, and result in sustainable positive results beyond the project duration (USDA 2014). The research and development style structure of the AIPD course is made possible by Clemson University’s Creative Inquiry (CI) undergraduate research program. CI courses are ubiquitous across all majors at Clemson, and promote collaboration between a small team of students and a faculty mentor in order to create a solution to a problem within their field of study. In addition to earning course credits, students are able to present their research at conferences or publish their findings in scholarly journals (Weeks 2014). Some examples of other Creative Inquiry research topics within the Food, Nutrition, and Packaging Science Department are: investigating the validity of food advertising claims; medical device packaging research; planning and hosting student-run farmers markets; and designing nutrigenomic diets to improve metabolic syndrome symptoms. Research experience, through courses like these,
encourages critical thinking and problem solving skills, and offer opportunities for students to make an impact in their field while still an undergraduate.

**Methods**

**Participants**

The instructor at the land-grant university (LGU) recruited for the hybrid course by visiting similar classes within the food science department at the university and speaking to students about the course. Any students interested in the hybrid course were encouraged to contact the instructor, an assistant professor of food science at the university, for enrollment. A total of six students enrolled in the course and received three credits for completion. Prior to the start of the hybrid course, all participants were required to complete pre-tests to gauge baseline knowledge in subjects such as food science, nutrition, packaging science and product development. Students were also asked to sign a participant consent form agreeing to participate in this research study, which can be found in Appendix A. This research was approved by Clemson University’s Institutional Review Board (IRB).

The hybrid course spanned one semester in the spring of 2015. Students were charged with creating a new healthy children’s food product, working through all stages of the product development process, from ideation and gold standard development to nutrition analysis and creation of point-of-sale packaging. Although support was lent by a faculty member at the land-grant university as well as a remote team from Clemson University, the effort was largely student-led, experiential learning. Upon completion of
the course, students were required to give a final presentation to the instructors, turn in a completed technical report, and complete the post-questionnaires for this study.

Another course was administered simultaneously at Clemson University, but followed the traditional two-semester format in which the course was originally designed. The AIPD students were also recruited by classroom visits, as well as emails and flyers. The 12 students enrolled in the AIPD course were split into 3 teams, consisting of 4 students each, to develop healthy products geared toward children. The demographic characteristics of students from both universities are displayed in table 4.1.

**Table 4.1 Demographic information of the Land-Grant University students enrolled in the hybrid AIPD course, and the Clemson University students enrolled in the traditional course**

<table>
<thead>
<tr>
<th>Demographic Category</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Standing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clemson University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Sophomore</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Junior</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Senior</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Land-Grant University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Sophomore</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Junior</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>Senior</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Major</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clemson University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Nutrition</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Packaging Science</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Land-Grant University</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Science</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Nutrition</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Food Marketing</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Agribusiness</td>
<td>1</td>
<td>17</td>
</tr>
</tbody>
</table>
Course Description

The hybrid one-semester course offered at a southern land-grant university (LGU) was adapted from a previously successful two-semester course offered at Clemson University, titled Applied Interdisciplinary Product Development (AIPD). The adaptations made to the AIPD course included: condensing the course length from two semesters to one; supplementing the curriculum with digital educational materials; and introducing video conferencing sessions to facilitate communication between LGU students and Clemson University faculty. The digital educational materials included introductory videos as well as lecture presentations recorded using Adobe Presenter. The recorded lecture presentations covered topics such as children’s nutrition, packaging science, sensory science, and product development. The syllabus for the hybrid course, including short descriptions of all course activities, is offered in Appendix F.

The hybrid three-credit undergraduate course was offered as a part of the LGU’s special topics offerings within the Food Technology department. Students met with their faculty mentor for about 50 minutes per week. In addition, students participated in semi-weekly labs which included product development time in the culinary research kitchen. The first few weeks of the course consisted of lectures on various topics including childhood nutrition, packaging science and sensory science. Some of these lectures were presented in person by Clemson University faculty, who travelled to the land-grant university campus to present. Students also participated in ideation activities, which encouraged students to begin working together as a team and solve problems through the
eyes of various disciplines. In one ideation activity, students were provided the following scenario:

*You have decided to start your own fleet of food trucks. Decide what type of cuisine you would like to serve and three signature dishes. For one of the dishes, describe items that will be of primary concern/importance to each department involved in the product development process.*

The students worked in small teams to come up with a food truck concept, and then decided upon the most important culinary, food science, nutrition, packaging science, and marketing considerations for their food truck.

For the remainder of the semester, students were tasked with developing an original, healthy children’s product. The student product development team first brainstormed potential product ideas and conducted preliminary market research to find current market trends. The students decided to develop roasted red pepper hummus with whole wheat pita chips. A deeper market analysis was conducted to research current market trends in hummus, determine the market size and potential for an individually-portioned hummus snack, and identify current competitive brands. Benchtop testing in the culinary research kitchen allowed the students to develop a gold standard recipe for their product. Students converted the gold standard recipe into a commercial formula, and then identified commercial ingredient suppliers from which to source bulk ingredients. The students also conducted a sensory evaluation test for their product by recruiting other students at the land-grant university to act as sensory panelists. The product development team also took a field trip to the Clemson University campus to tour the packaging
science facilities, conduct a nutritional analysis of their product using Genesis Nutrition Labeling Software (Salem, OR), and consult with Clemson faculty and students about their product. Prior to visiting the Clemson University campus, students from the land-grant university had drawn a logo and cartoon for the package of their product and sent it to a team of upperclassmen packaging science students at Clemson. From that sketch, Clemson students designed graphics for the package using computer aided design software. These graphics, along with a 3D prototype package for the hummus and pita chips, were shared with the LGU students on the day they visited.

At the completion of the course, students gave a final presentation, wrote a technical report about their product, and completed post-course questionnaires administered by the researchers of this study. The components of the technical report included an executive summary, product description, market analysis, gold standard recipe, commercial formulation, nutritional analysis, pricing, sensory evaluation test results, packaging description with pictures, and conclusion. Clemson University students completed all of the same activities listed above, but over the course of two semesters. The first semester consisted mostly of lectures, ideation sessions and field trips, and the second semester was focused primarily on developing a children’s food product. The three teams at Clemson University developed three children’s food products: whole wheat sweet potato pancakes, seasoned parsnip fries, and a chocolate peanut butter banana smoothie.
Evaluation Tools

Subject Knowledge Assessment (SKA)

The Subject Knowledge Assessment (SKA) is a previously validated evaluation tool designed by subject matter experts in the Food, Nutrition and Packaging Science department at Clemson University (Weeks 2014). A copy of the SKA can be found in Appendix B. The SKA was designed to measure students’ knowledge of food science, packaging science, nutrition, and product development through a series of 30 multiple choice questions. The SKA was administered pre-course to determine baseline knowledge, and then once again post-course to determine knowledge gains. Students’ scores on the assessment were not part of their grades for the course. The SKA data were analyzed using the Wilcoxon rank-sum test to assess whether the sample distributions were significantly different between Clemson University and LGU students ($\alpha = 0.05$).

Exit Questionnaire – Quantitative

The Exit Questionnaire (EQ) was a post-only assessment tool which was divided into two parts. The first part of the questionnaire measured students’ confidence in items such as their product development skills, interdisciplinary teamwork skills, and preparedness to enter the industry. Student confidence was measured using a Likert scale, which is “an ordered scale from which respondents choose one option that best aligns with their view” (Losby 2012). Likert scales are commonly used to measure respondents’ attitudes by asking them to rate their level of agreement or disagreement with a statement. The Exit Questionnaire measured students’ confidence by asking students to rate their level agreement with a list of statements such as “I feel confident developing
healthy products for children”. The Likert scale ranged from 1, “Strongly Disagree,” to 5, “Strongly Agree”. A copy of the EQ can be found in Appendix C. These data were analyzed using the Wilcoxon rank-sum test with an alpha level of 0.05 to assess whether the sample distributions were significantly different.

Exit Questionnaire – Qualitative

Qualitative data is beneficial for learning how participants experience a setting or process, as well as the meanings they give to the experience, and how they interpret the experience (Richards and Morse 2013). The second part of the questionnaire was a series of short-answer questions that asked students about their experience taking the AIPD course. The qualitative data from the Exit Questionnaire (EQ) were analyzed by a team of three reviewers. The team of reviewers was trained in qualitative data analysis by an associate professor in Clemson University’s Public Health Sciences Department, who is an expert in qualitative and mixed methods data analysis. During training, the team reviewed the basics of qualitative data analysis, practiced coding responses as a team, customized a codebook to fit the collected responses, and learned to calculate percent agreement between reviewers. During the process of coding the EQ data, the team read through all of the responses collected for a particular question, and then identified portions of text as being associated with a particular topic. Each topic was given a code. When a common thread was found between multiple codes, a “theme” was created to define that group of codes. Each question on the EQ was given its own set of themes and codes, developed from the questionnaire responses. The themes and codes from each of the questions were gathered together to make up the codebook.
After the training, reviewers were assigned specific sets of responses to code on their own, and then conferred with another reviewer to compare codes assigned to the responses and identify discrepancies. A discrepancy was identified when reviewers assigned different codes to the same passage of text. Reviewers discussed each discrepancy until they reached a consensus on what the code should be for that passage. The percent agreement between pairs of reviewers was then calculated by counting the total number of codes assigned within a particular passage of text, and then subtracting the number of discrepancies found between reviewers for that same passage of text. The resulting number is the number of codes agreed upon by the two reviewers, which is divided by the total number of codes assigned to the text to yield the percent agreement for that passage. The average percent agreement between reviewers was 74%, with a low of 56% and a high of 89%.

Results

Subject Knowledge Assessment

Summary results of the Subject Knowledge Assessment (SKA) are shown in Table 4.2. Mean difference values (MDV) were calculated by subtracting percent correct pre-course from percent correct post-course and taking the average difference of all students. The highest knowledge gains for land-grant university (LGU) students were seen in the subject areas of nutrition and packaging science, showing a 12% and 9% increase, respectively. These same two categories also revealed the largest increase for students at Clemson University, with an increase of 5% in packaging science scores, and a 4% increase in nutrition scores. A large 16% decrease in score was observed in the food
science category for LGU students. Clemson students’ scores also decreased 3% in the food science category. Standard deviations of scores for both universities’ students were shown to vary widely, the largest of which was in the general product development category. As seen by the results of the Wilcoxon Rank-Sum test, LGU students’ percent scores, overall or in the four subject categories, do not significantly differ from the Clemson University students’ percent scores ($P = 0.05$).

**Table 4.2** Mean differences and Wilcoxon Rank Sum test statistic of Subject Knowledge Assessment (SKA) results comparing Clemson University and Land-Grant University Students ($\alpha = 0.05$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Difference (%)</th>
<th>Wilcoxon Rank Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>± Standard Deviation (%)</td>
<td>Test Statistic</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Total Correct</td>
<td>2 (12)</td>
<td>43.0</td>
</tr>
<tr>
<td>Nutrition</td>
<td>4 (16)</td>
<td>63.0</td>
</tr>
<tr>
<td>Food Science</td>
<td>-3 (24)</td>
<td>38.5</td>
</tr>
<tr>
<td>Packaging Science</td>
<td>5 (16)</td>
<td>48.0</td>
</tr>
<tr>
<td>General Prod. Dev.</td>
<td>2 (25)</td>
<td>54.5</td>
</tr>
</tbody>
</table>

Exit Questionnaire – Quantitative

The descriptive statistics from the level of agreement questions of the Exit Questionnaire are shown in tables 4.3 and 4.4. Results in table 4.3 show that all LGU students ($n = 6; 100\%$) agreed or strongly agreed that they felt confident generating ideas for new products and developing a gold standard recipe. When rating confidence in applying changes to a recipe or formula to make it healthier, 83% of LGU students ($n = 5$) agreed they were confident in doing so. The majority of LGU students ($n = 4; 66\%$)
also agreed they felt confident developing a formula and felt confident developing healthy food products for children. With respect to interdisciplinary teamwork, all LGU students ($n = 6; 100\%$) agreed or strongly agreed that they felt confident collaborating with students that are not in their major or field of study. Most LGU students ($n = 5; 83\%$) agreed that they learn more from hands-on experiences than lectures.
Table 4.3 Descriptive Statistics from the Exit Questionnaire responses of students from the Land-Grant University (n=6)

<table>
<thead>
<tr>
<th>Question</th>
<th>Level of Agreement [n (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel confident generating ideas for new products</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td></td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident collecting marketing information and conducting a market analysis</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing a gold standard recipe</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing a formula</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident applying changes to a recipe or formula to make it healthier</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident collecting commercial ingredients and/or commercial materials</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident estimating cost for a new product</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident designing packaging for new products</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing healthy food products for children</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I learn more from hands-on experiences than lectures</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident collaborating with students that are not in my major or field of study</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident interacting and networking with industry professionals</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident entering industry with my current level of knowledge and skills</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident that I will meet the expectations of my future employer</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Results from table 4.4 indicate that all Clemson students (n = 12; 100%) agreed or strongly agreed that they felt confident generating ideas for new products and developing healthy food products for children. When rating confidence in developing a gold standard and applying changes to a recipe or formula to make it healthier, 92% of Clemson students (n = 11) agreed they were confident in doing so. The same amount of Clemson students (n = 11, 92%) also agreed or strongly agreed that they learned more from hands-on experiences and felt confident collaborating with students in majors other than their own. The majority of Clemson students felt confident estimating cost for a new product (n = 10, 83%), conducting a market analysis (n = 8, 67%), and collecting commercial ingredients (n = 8, 67%). The area of lowest agreement was the feeling of confidence entering the industry with the current level of knowledge and skills, where 5 Clemson students disagreed (42%) and 1 student strongly disagreed (8%).

Table 4.5 displays the results of the Wilcoxon Rank-Sum test comparing the distribution of responses between Clemson University students and LGU students. The distributions differed significantly between the two groups for the question about developing healthy products for children (Z = 25.0, \( P < 0.05 \) two-tailed). All other distributions were not significantly different between CU and LGU, although the questions regarding students’ confidence in substituting healthy ingredients and learning more from hands-on lectures were marginally insignificant (\( P = 0.05 \) and \( P = 0.08 \), respectively).
Table 4.4 Descriptive Statistics from the Exit Questionnaire responses of students from Clemson University (n=12)

<table>
<thead>
<tr>
<th>Question</th>
<th>Level of Agreement [n (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel confident generating ideas for new products</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>I feel confident collecting marketing information and conducting a market analysis</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing a gold standard recipe</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing a formula</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident applying changes to a recipe or formula to make it healthier</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident collecting commercial ingredients and/or commercial materials</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident estimating cost for a new product</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident designing packaging for new products</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident developing healthy food products for children</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I learn more from hands-on experiences than lectures</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident collaborating with students that are not in my major or field of study</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident interacting and networking with industry professionals</td>
<td>0 (0)</td>
</tr>
<tr>
<td>I feel confident entering industry with my current level of knowledge and skills</td>
<td>1 (8)</td>
</tr>
<tr>
<td>I feel confident that I will meet the expectations of my future employer</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Table 4.5 Results of the Wilcoxon Rank-Sum test comparing mean agreement levels of Clemson University Students to Land-Grant University students

<table>
<thead>
<tr>
<th>Question</th>
<th>Wilcoxon Rank-Sum Test Comparing Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test Statistic</td>
</tr>
<tr>
<td>Generate Ideas for New Products</td>
<td>51.0</td>
</tr>
<tr>
<td>Conduct a Market Analysis</td>
<td>57.0</td>
</tr>
<tr>
<td>Develop a Gold Standard Recipe</td>
<td>48.0</td>
</tr>
<tr>
<td>Develop a Formula</td>
<td>40.0</td>
</tr>
<tr>
<td>Substitute Healthy Ingredients</td>
<td>36.5</td>
</tr>
<tr>
<td>Collect Commercial Ingredients</td>
<td>48.0</td>
</tr>
<tr>
<td>Estimate Cost of New Product</td>
<td>38.0</td>
</tr>
<tr>
<td>Design Packaging</td>
<td>48.0</td>
</tr>
<tr>
<td>Develop Healthy Products for Children</td>
<td>25.0</td>
</tr>
<tr>
<td>Learn More from Hands-On</td>
<td>40.0</td>
</tr>
<tr>
<td>Collaborate with Other Majors</td>
<td>55.0</td>
</tr>
<tr>
<td>Network with Industry Professionals</td>
<td>57.5</td>
</tr>
<tr>
<td>Enter Industry with Current Knowledge</td>
<td>54.0</td>
</tr>
<tr>
<td>Meet Expectations of Employers</td>
<td>61.0</td>
</tr>
</tbody>
</table>

Exit Questionnaire – Qualitative

In the second part of the Exit Questionnaire, students were asked a series of short answer questions. These questions addressed topics such as their motivation to take the course, the advantages and disadvantages of taking the course at their class standing, and
suggestions for course improvement. The results of the qualitative data coding are shown in Table 4.6, along with selected verbatim quotes from students.

In response to motivation to take the course, three major themes emerged: to gain knowledge in product development or healthy cooking; to gain hands-on experience in product development; and because of general interest in the course. For the question, “Has this course made you feel more or less involved in the Food, Nutrition, and Packaging Science Department? How so?” two themes emerged: the ability to interact with department members and students; and the ability to gain knowledge in other fields of study.

The question about the advantages of taking the course at the students’ current class standing yielded the following themes: the ability to gain a competitive advantage over other sophomore students in terms of overall knowledge; and the opportunity to prepare for future courses or future career. The question regarding disadvantages taking the course at the students’ current class standing resulted in one key theme: lack of prior knowledge or experience.

The two emergent themes surrounding the benefits of interaction with students in majors other than one’s own were that students gained knowledge in other fields of study, and that students gained experience collaborating and/or working on a cross-functional product development team.

When students were asked, “How has this course helped you in terms of overall gains in knowledge?” two themes arose: students gained knowledge in the product development process, and students gained knowledge in packaging science. The next
question asked the students if the course helped them in terms of product development experience, which yielded the following themes: students gained knowledge in the process, resources and methods of product development; and students gained hands-on experience.

Finally, the students were asked for their suggestions in improving the course, which resulted in one major theme: more time to work on the product development or more time to work with their team.

Table 4.6 Key themes found in participant responses to the short answer questions of the Exit Questionnaire, including responses from student at Clemson University and the Land-Grant University (n=18)

<table>
<thead>
<tr>
<th>Key Themes</th>
<th>n_p</th>
<th>Participant Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>What was your motivation to take this course?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To gain knowledge in product development or healthy cooking</td>
<td>10</td>
<td>“I am passionate about helping children be healthier, and that starts at an early age. I thought I would get to design a package and do some cooking to learn more about the food science department, so it sounded like a good, fun CI.”</td>
</tr>
<tr>
<td>To gain hands-on experience in product development</td>
<td>6</td>
<td>“I thought it was a perfect hands-on experience to take an idea and completely bring it to life. It was my first experience coming up with a product and making it a reality”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“To get hands-on experience of what it would be like to develop a new product”</td>
</tr>
<tr>
<td>Because of general interest in the course</td>
<td>5</td>
<td>“It looked like a unique experience that I could learn a lot from”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“It sounded like fun!”</td>
</tr>
<tr>
<td>Has this course made you feel more or less involved in the Food, Nutrition, and Packaging Science Department? How so?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to interact with department members and students</td>
<td>15</td>
<td>“More [involved]; I now know more faculty members and have learned about accessible tools I didn’t know about before”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“More [involved]; being able to interact with different professors and different majors makes you more aware of the options in the field and helps expand your horizons”</td>
</tr>
</tbody>
</table>
| Ability to gain knowledge in other fields of study | 9 | “More involvement because I have a better understanding of what other majors in my department are like”
“More [involvement]. I had only very basic knowledge about these departments and how they interact with my major prior to this class”

| What were the advantages of taking this course at your class standing? |
| Ability to gain a competitive advantage over other sophomore students in terms of overall knowledge | 7 | “It helped me to learn more about my career path before I was a junior or senior”
“Learning from upperclassmen and working with students who will be in future classes with me”

| Opportunity to prepare for future courses or future career | 6 | “It helps me decide what I like, and what I have an aptitude for, in real life examples, and helps me guide my plan as to what job or internship I may want in the future”
“It gave me insight to what I could potentially be doing if I were able to go into the food packaging emphasis”

| What were the disadvantages of taking this at your class standing? |
| Lack of prior knowledge or experience | 10 | “I felt I did not have enough knowledge from the packaging courses I have taken to be able to contribute more to my group”
“I had not taken food engineering nor food microbiology yet, to know those aspects of the industry”
“I did not have all the nutrition knowledge I needed”

| In what ways, if any, did you benefit from working with students from other majors? |
| Gained knowledge in other fields of study | 13 | “Listening to and watching the packaging majors work was great because we don’t see that side very often. Seeing how they go through the development process, and all the parts they take into consideration was helpful”
“I learned a little bit more about packaging and culinary science than I probably ever would have learned if I wasn’t exposed to their fields in this class”

| Gained experience collaborating and/or working on an interdisciplinary product development team | 5 | “I learned how to work in a group when I knew nothing about what they study and they know nothing about what I study, and how it can be combined.”
“Diversified ideas lead to a sound and solid product that could be much more successful”
“We got different perspectives and some students were proficient in areas others weren’t, and vice versa”

| How has this course helped you in terms of overall gains in knowledge? |
| Gained knowledge in the product | 8 | “I learned a lot about the process of product development such as conducting a market analysis, creating a commercial
| development process | formula, dealing with pricing, etc.”  
|                     | “Having knowledge of how one would come up with,  
|                     | produce, package, test, and sell a product”  
| Gained knowledge in packaging science | 4 | “Understanding the packaging side and gaining confidence in the whole process”  
|                     | “I learned Adobe Illustrator for package design, and abilities to motivate and work with others”  
| How has this course helped you in terms of product development experience? | 13 | “We went through the whole development process hands on and making decisions with a group. Experience is the best way to learn”  
|                     | “I didn’t know, before this course, how many different steps were involved with product development”  
|                     | “This was my first product development program so it helped me see the overall process and all of the steps to it”  
| Gained hands-on experience | 5 | “It has given me great experience in all facets of product development”  
|                     | “I now have the experience of developing a product”  
|                     | “More experience in the kitchen and with ingredient suppliers”  
| What changes, if any, would you make to this course? | 4 | “More kitchen time and specify days for the whole team to spend on packaging in the packaging lab to see more of the process”  
|                     | “Instead of spending the first semester in a lecture setting I would have students start their products earlier so they had more time and opportunity to advance them”  
|                     | “Start working with exact teams in the fall and do the market analysis then. That way culinary production can start at the beginning of the spring semester”  

n: number of participants that commented on a theme out of 16 total participants

Discussion

Subject Knowledge Assessment

Results from the Subject Knowledge Assessment (SKA) show no significant differences between LGU students and Clemson University students, overall or in the four subject categories (Table 4.2; \( P > 0.05 \)). All students exhibited higher post-course scores compared to pre-course scores in their overall score and in the subject categories
of nutrition, packaging science, and food product development. However, a decrease was observed in percent of food science questions answered correctly, which was a result that was not expected. The unexpected decrease may have occurred for a number of reasons. One reason for the unexpected decrease in scores may be due to the fact that the time between learning the food science information and recalling it on the post-test was about 7 months, during which time the students may have forgotten the information. Many of the questions on the SKA were also highly specific, and so if by mistake a specific fact about food science was left out of one of the lessons, or a student was absent the day the information was discussed in class, the students may have missed that learning opportunity, and, in turn, the answer to that question on the SKA. Additionally, the format of the AIPD course was mainly self-driven, and so the expectation was that students would be self-motivated to learn the material. The researchers expected the students would utilize all the tools given to them, such as lecture capture recordings and assigned readings. However, most students seemed to prioritize the product development tasks over gaining subject knowledge, and therefore may not have made an effort to commit the information learned to memory.

**Exit Questionnaire – Quantitative**

In the quantitative portion of the exit questionnaire, the majority of students from the land-grant university either agreed or strongly agreed to five of the nine statements pertaining to confidence in product development skills, compared to students from Clemson University who agreed to eight of the same nine statements. The product development skills that showed neutral or low confidence in the students from LGU were
the ability to collect a market analysis, collect commercial ingredients, estimate cost for a new product, and design product packaging. Clemson students also exhibited low confidence in designing product packaging. These findings align with some of the known shortcomings of the course. The land-grant university does not have the facilities for package design on campus, nor does the university offer packaging science as a major. Therefore, the team from the land grant university relied solely on a group of upperclassmen packaging majors at Clemson University to facilitate the creation of their package. For those students at Clemson where the facilities are available, many of them also relied on the same group of upperclassmen, since the AIPD students were not yet knowledgeable enough to design a package on their own. Because the AIPD students did not design their package first-hand, the students may have learned packaging knowledge and had an input in design, but did not get enough experience with creating a package that they would have confidence in their sole ability to perform this task. Furthermore, the sourcing of commercial and ingredients and costing of new products go hand-in-hand, and with the fast-paced nature of the condensed, one-semester hybrid course, the schedule did not allow enough time for thorough review of this topic and assistance in sourcing. Having only one semester to create a product from ideation to finish has shown to be a challenge, both in this offering of the course and others (Weeks 2014). Finally, the market analysis at LGU was done almost solely by the team member who was an agribusiness major, and so it is possible that the other students on the team didn’t receive the hands on experience with that part of the project enough to gain confidence in it.
There was a high level of agreement by both universities in the two questions relating to learning methods, which indicated that students learned more from hands-on experiences than lectures and felt confident collaborating with students other than those in their field of study. The positive experience students indicated having with the learning methods in the AIPD course reinforces the hypothesis that students benefit from an applied and interdisciplinary learning environment. The confidence students have in working with other majors will be beneficial both in future courses and in the workforce.

Finally, with respect to the three questions gauging industry readiness, the majority of Clemson students and LGU students agreed with two of these statements. Students from both universities had low confidence in the same statement regarding readiness to enter the industry with their current level of knowledge and skills. Lower confidence was expected since all of the students from LGU were underclassmen (n=6, 100%), and 83% of students from Clemson (n=10) were underclassmen.

Overall, no significant differences were found between the Clemson University students and Land-Grant University students for 13 of the 14 confidence statements on the exit questionnaire (Table 4.5; $P > 0.05$). Therefore, the results from these two universities are comparable, which suggests that the dissemination of the hybrid course was successful. The quantitative Exit Questionnaire results also support the hypothesis that students in the hybrid AIPD course would have no significant difference from students taking the existing course with respect to increased confidence in product development skills.
Exit Questionnaire – Qualitative

The majority of the students indicated that their motivation for participation in the AIPD course was to either gain knowledge or hands-on experience in product development or healthy cooking. When asked about their gains in product development knowledge and experience after taking the AIPD course, the majority of students also responded positively to this question, indicating that the expectations of the course were met. The high response regarding gains in product development knowledge is discordant with the results from the product development category results for the Subject Knowledge Assessment (SKA). The contradiction in results between tests may be due to the fact that the students may not have known the exact answers to the SKA questions, but generally feel as though they have gained knowledge and confidence in other areas of product development. The results from the SKA also displayed a high standard deviation, and so perhaps the students toward the upper end of the standard deviation were the same students that rated their confidence in product development skills highly.

When asked about the benefits of interacting with other majors, many students commented on the theme of gaining knowledge about other fields of study, and gaining experience working on an interdisciplinary team. These themes of interdisciplinary knowledge and interdisciplinary skills strengthen the results seen in the quantitative part of the exit questionnaire, where 100% of LGU students (n=6) and 92% of Clemson Students (n=11) either agreed or strongly agreed that they were confident working on an interdisciplinary team. One of the fundamental goals of the AIPD course was to allow students of various majors to come together under one common objective, working
together and learning from one another. The results of the Exit Questionnaire suggest that the AIPD course was successful in meeting that goal.

Limitations

The small sample size limits the generalization of the findings, which should therefore be interpreted with caution. The course was also administered in a short time frame of one semester for the land-grant university students. The original curriculum spans one full school year of two semesters, the first semester involving mostly didactic learning through lectures, industry field trips, and ideation activities, and the second semester revolving almost entirely around working through the product development process. Condensing a thirty week course into fifteen weeks requires the sacrifice of a large amount of both lecture material and time spent in the lab.

More recorded lectures from Clemson’s course facilitators would be beneficial. These additional online materials will give students in future hybrid courses the opportunity to view lectures as an assignment outside of class, freeing up more time in class to focus on the development of a food product. Having a short lecture recorded about each of the steps of the product development process and how to execute them would give students the guided direction in the course that they expressed was needed. Creating the product development lecture may also alleviate the need for Clemson facilitators to make trips to the site of the course or make video conference calls.

The lack of accessibility to a lab or kitchen space in which to create a food product also proved to be an issue that hindered the team of students from the land-grant university. In future renderings of the AIPD course, it would benefit the university
administering the program to have a designated area for product development, fit with the proper supplies and equipment needed by the students. Implementing the course at a remote campus may also be easier if the university already has a packaging science program. One of the key strengths of the AIPD course at Clemson is that students are able to enter the packaging science labs and create the packages themselves or with the help of others, and without facilities to do so, some of the experiential parts of the course are lost.

Conclusions

All four teams met the course objective by combining food science, nutrition, and packaging science skills and knowledge to develop an original, healthy children’s food product, complete with commercial packaging, and an accurate nutrition label. All teams also successfully gave a final presentation and provided a technical report. Product and packaging photos and descriptions can be found in appendix E. The technical report and final product produced by the LGU students were equivalent in quality to those produced by Clemson University students. Therefore, with respect to the course objectives, students were successful in reaching these goals.

With respect to the research objectives, it was anticipated that students taking the new hybrid AIPD course at the land-grant university would have no significant differences from students taking the existing course with respect to knowledge gains or increased confidence in product development skills. The results of the SKA show there is not sufficient evidence to suggest that LGU students’ percent scores, overall or in the four subject categories, are different from the Clemson University students’ percent
scores ($P > 0.05$). Additionally, no significant difference was found between the two groups’ self-confidence ratings for 13 of the 14 items on the Exit Questionnaire. Therefore the conclusion can be made that the hybrid AIPD course is a viable option for dissemination to other universities to successfully teach food product development to sophomore students.

**Future Recommendations**

In order to successfully disseminate the hybrid AIPD course to other universities, some strides need to be taken to better facilitate distance learning. Some short quizzes or tests could be added into the curriculum of the hybrid course, encouraging students to study and retain the knowledge presented throughout the semester. The addition of short quizzes could prevent passive learning during lectures and facilitate larger knowledge gains overall by the end of the course.

The professor leading the course at the distance university should also have a strong understanding of the product development process in order to help students through the course. Having a co-instructor of a different discipline, such as nutrition or packaging science, would also be ideal in order to reinforce the interdisciplinary nature of the course and to help the students in areas other than the expertise of the primary instructor. Another recommendation for future dissemination opportunities would be to set aside a day prior to the start of the semester to “train the trainer”. Someone familiar with the AIPD course could meet with the future instructor of the hybrid course to go over the curriculum and familiarize the future instructor with the materials and activities.
Preparation through training can increase the confidence of the instructor and better prepare and empower the instructor to successfully lead the course.

With respect to the course evaluation tools, it could be helpful to administer the quantitative part of the exit questionnaire prior to the course as well as post-course. Doing so would allow for analysis of growth in confidence from pre- to post-course. Without a comparison group for contrast, the only analysis that can currently be done of the EQ data is simple reporting of descriptive statistics, and with the sample size being so small, the data do not lead to an overall generalization.

Finally, the creation of additional online tools and resources is recommended to facilitate greater knowledge gains in students taking the AIPD course. By having a wider range of resources available online, students could be even more self-guided in the product development process, and would be able to access the tools as many times as needed to clarify the topic of interest. Online lectures and tools could also be assigned as homework to be completed outside of class, allowing professors to administer even more information within the short span of the course.

References


APPENDICES
Appendix A

Participant Consent Form

Consent Form for Participation in Research
Clemson University
Culinology, Nutrition and Packaging in Undergraduate Applied Research

You are invited to participate in a research study conducted by Margaret Condrasky. The purpose of this research is to learn more about student knowledge, cultural competency, experience, attitude, critical thinking and problem-solving skills gained in a two course sequence. Members will include Food, Nutrition, and Packaging Science students who will work together on industry-driven lab activities.

Your participation will involve answering questions on standard University questionnaires that you take routinely; allowing the researchers to use all work completed during or for the course; as well as program specific items collecting the kinds of information described above. These program specific items may include surveys, audiorecorded focus group discussions, or videorecorded group interactions. Data will be collected over the course of the two-semester course sequence and at graduation time. Additionally, FNPS faculty who have taught you during your program of study will be asked to complete a survey about you at the end of the project. All research materials will be kept indefinitely for research purposes.

There are no known risks associated with this research, however it may be that answering some of the questions on the forms may seem personal. You do not need to answer any question which makes you feel uncomfortable. Your responses will help us understand the potential benefits of this new two-course sequence to students in the department.

We will do everything we can to protect your privacy. Your identity will not be revealed in any publication that might result from this study. Your name will not appear on the surveys. The only people who will be able to see your answers to the questions will be the people conducting the research and those who oversee the way that Clemson University does research. Your confidentiality will be ensured by our locking of all materials in a file and destroying the forms at the conclusion of the project.

You do not have to be in this study. You may choose not to take part and you may choose to stop taking part at any time. However, since the research study is an integral part of this course sequence, you will have to drop the course in order to stop taking part in the study. You will not be punished in any way if you decide not to be in the study or to stop taking part in the study. If you decide not to take part or to stop taking part in this study, it will not affect your relationship with FNPS or your grades in any way (except that dropping the course will affect your grade for this course according to University policies on dropping courses).

If you have questions or concerns about this study or if any problems arise, please contact Margaret Condrasky at Clemson University mcondra@clemson.edu at 864-656-6554. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Institutional Review Board irb@clemson.edu at 864-656-6460.

Consent

I have read this form and have been allowed to ask any questions I might have. I agree to take part in this study.

Participant’s signature: ___________________________ Date: _________________

A copy of this form will be given to you.
Appendix B

Subject Knowledge Assessment (SKA)

Name ____________________________

Please select the best answer for the following multiple choice and True/False items.

1. Which has the highest amount of monounsaturated fat?
   a. Corn
   b. Canola
   c. Fish
   d. Palm
   e. Olive

2. The USDA’s recommended portion size for a single serving of meat for the average 8 year old is?
   a. 2 to 4 ounces
   b. 5 to 7 ounces
   c. 6 to 9 ounces
   d. Less than 10 ounces

3. A majority of sodium in the American diet comes from:
   a. Eating out
   b. Adding salt at the table (salt shaker)
   c. Processed packaged foods
   d. Naturally found in foods

4. Which of the following is a better alternative to table salt for sodium reduction?
   a. Sea salt
   b. Kosher salt
   c. Non-iodized salt
   d. None of the above

5. Which of the following is a major source of saturated fat in children’s diets?
   a. Full-fat dairy products
   b. Sugary cereals
   c. Peanut butter
   d. All of the above

6. Which of the following is a good source of iron in children’s diets?
   a. Beans
   b. Leafy green
   c. Eggs
   d. All of the above
7. Children should acquire an assortment of which of the following nutrients?
   a. Carbohydrates, proteins, fats, vitamins and minerals
   b. Carbohydrates, proteins, vitamins and minerals
   c. Carbohydrates, vitamins, minerals and fiber
   d. None of the above

8. Which of the following menus best emphasizes the addition of dark green and dark orange vegetables as well as whole grains to children’s menus?
   a. Chicken tenders in a seasoned almond and whole-wheat flour crust and oven-fried with a side of sweet potato fries
   b. Fettuccine alfredo made with whole-wheat fettuccine and matchstick slices of zucchini with a sprinkling of sweet peas
   c. Whole-wheat pizza dough coated in a flavorful tomato sauce with added pumpkin puree and low-fat turkey pepperoni, spinach and cheese
   d. All of the above

9. Fats have more than twice the amount of calories in one gram than protein or carbohydrates.
   a. True
   b. False

10. Total daily fat intake should make up approximately what percentage of total calories?
    a. 5%
    b. 15%
    c. 25%
    d. 40%

11. You are asked to join a group of students to evaluate a new product developed for the purpose of increasing the consumption of fiber. The students are asked to give their opinion on this new product. What type of panel have you been asked to participate on?
    a. A descriptive panel
    b. A discriminative panel
    c. An affective panel

12. A market analysis would be found in the following:
    a. A business plan
    b. A business proposal
    c. A marketing plan
    d. All of the above

13. A gold standard is the same as a formula.
    a. True
    b. False
14. When writing a technical report the first person voice should be used.
   a. True
   b. False

15. The order for which product development should occur is:
   a. Testing, prototype, launch
   b. Market analysis, prototype, testing
   c. Testing, market analysis, launch
   d. Market analysis, development, testing

16. The primary product packaging material holds.touches the food product.
   a. True
   b. False

17. The secondary product packaging material holds.touches the food product.
   a. True
   b. False

18. When testing the shelf stability of a new food product the two main tests to consider are pH and texture.
   a. True
   b. False

19. A trend in food design and development is to provide for gluten free products which exclude:
   a. Rice, corn, and rye
   b. Wheat, rye, and barley
   c. Buckwheat, corn, and barley

20. Nutrition labeling/claims are created by the manufacturer to suit the product and package.
   a. True
   b. False

21. An entrée created for a vegan diner may contain:
   a. Cheese and nuts
   b. Seafood and greens
   c. Nuts and seeds
   d. Cheese but no meat
   e. Meat and Fruit
22. A functional product development team includes members from each of:
   a. Marketing, R & D, company president
   b. Operations, marketing, R & D
   c. Company president, marketing, sales

23. Marketing analysis is
   a. Completed by the president of a company to get heads up
   b. Expensive thus not necessary
   c. Completed early in the product development process

24. A peer review manuscript is one that is passed to colleagues for review and editing prior to submission to a journal
   a. True
   b. False

25. More than one may be true: Which of the following are common primary functions of food packaging?
   a. Contain the product
   b. Assist in dispensing of the product
   c. Prevent consumer access to the product
   d. Preserve the product
   e. Promote world peace through the product
   f. Communicate about the product
   g. Keep the product from harming the environment

26. More than one may be true: Which of the following are the broad classes of materials available for packaging?
   a. Metals
   b. Tin
   c. Glass
   d. Composites
   e. Corrugated
   f. Ceramics
   g. Polyethylene
   h. Plastics

27. Pick the best answer: What is a transmission rate?
   a. Measure of how long perishable foods will last in a package
   b. Measure of efficiency of my car
   c. Measure of how fast a material will travel through a package wall
   d. Measure of how fast the sun’s rays get here in vacuum
   e. Measure of the time from packaging a food product until it reaches the consumer
28. More than one may be true: Which of the following are true of FDA and food packaging?
a. FDA does not care about packaging, as it is neither a food nor a drug
b. FDA has the authority to regulate food packaging
c. FDA approves packaging materials to be in food contact
d. FDA harasses packaging producers because they are big government
e. FDA does not approve packaging: they just set the regulations and measure against them
f. FDA has a mission to protect food consumers, so they are interested in food packaging

29. Pick one: In which class of material is aluminum can (predominantly)?
a. Metals  
b. Tin  
c. Glass  
d. Composites  
e. Corrugated  
f. Ceramics  
g. Polyethylene  
h. Plastics

30. Pick one: In which class of material is a flexible tune pouch (predominantly)?
a. Metals  
b. Tin  
c. Glass  
d. Composites  
e. Corrugated  
f. Ceramics  
g. Polyethylene  
h. Plastics
31. One or two sentences: You develop a product to be flavorful and nutritional, and to fight childhood obesity. It makes a big splash on the market. After it is on the market for 6 months, a television news show reports that they tested your product and found that some nutrient levels are half of what the label reports. What might have happened? If you have no idea, state so.

Use this for short answer questions 32 to 34. You test a product in two packages. One is metalized. The other has a clear, high oxygen barrier. The product is attractive, so your Marketing team prefers the clear package. After a shelf-life test, product testing shows the following:

<table>
<thead>
<tr>
<th>Package / Time</th>
<th>Flavor</th>
<th>Vitamin A levels</th>
<th>Product softness</th>
</tr>
</thead>
<tbody>
<tr>
<td>None / Fresh</td>
<td>Excellent</td>
<td>100 % RDA</td>
<td>Excellent</td>
</tr>
<tr>
<td>None / 3 months</td>
<td>Very rancid</td>
<td>10 % RDA</td>
<td>Hard</td>
</tr>
<tr>
<td>Metalized / 3 months</td>
<td>Somewhat rancid</td>
<td>90% RDA</td>
<td>Good</td>
</tr>
<tr>
<td>Clear / 3 months</td>
<td>Somewhat rancid</td>
<td>50% RDA</td>
<td>Hard</td>
</tr>
</tbody>
</table>

32. What does migration mean with respect to packaging and why is it important to food scientists, nutritionists and culinary scientists? If you have no idea, state so.

33. What does scalping mean with respect to packaging and why is it important to food scientists, nutritionists and culinary scientists? If you have no idea, state so.

34. Why do we see a difference in product softness between the metalized and clear barriers? If you have no idea, state so.
Short answer items continued:
35. How would you describe sensory evaluation?

36. Why is it important to consider the panelist when conducting a sensory test?

37. What are the elements of a scientific article?

38. Why is statistics important in sensory evaluation?

39. If you were asked to conduct a sensory panel, what would be your first three steps?

40. How would you define a peer-reviewed article?

41. When conducting scientific research, what steps should be followed?

42. What are some of the tools that can be used for marketing research?

43. What are the components of a formula?

44. Product formulation is required to assist the developer in what areas?

45. What are the activities/components within the product formulation process?
<table>
<thead>
<tr>
<th>Subject Area Categories for Subject Knowledge Assessment (SKA) Questions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Subject Area</td>
</tr>
<tr>
<td>Which has the highest amount of monounsaturated fat?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>The USDA’s recommended portion size for a single serving of meat for the average 8 year old is?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>A majority of sodium in the American diet comes from:</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Which of the following is a better alternative to table salt for sodium reduction?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Which of the following is a major source of saturated fat in children’s diets?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Which of the following is a good source of iron in children’s diets?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Children should acquire an assortment of which of the following nutrients?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Which of the following menus best emphasizes the addition of dark green and dark orange vegetables as well as whole grains to children’s menus?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Fats have more than twice the amount of calories in one gram than protein or carbohydrates.</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Total daily fat intake should make up approximately what percentage of total calories?</td>
<td>Nutrition</td>
</tr>
<tr>
<td>You are asked to join a group of students to evaluate a new product developed for the purpose of increasing the consumption of fiber. The students are asked to give their opinion on this new product. What type of panel have you been asked to participate on?</td>
<td>Food Science</td>
</tr>
<tr>
<td>A market analysis would be found in the following:</td>
<td>General</td>
</tr>
<tr>
<td>A gold standard is the same as a formula.</td>
<td>Food Science</td>
</tr>
<tr>
<td>When writing a technical report the first person voice should be used.</td>
<td>General</td>
</tr>
<tr>
<td>The order for which product development should occur is:</td>
<td>Food Science</td>
</tr>
<tr>
<td>The primary product packaging material holds/touches the food product.</td>
<td>Packaging</td>
</tr>
<tr>
<td>The secondary product packaging material holds/touches the food product.</td>
<td>Packaging</td>
</tr>
<tr>
<td>When testing the shelf stability of a new food product the two main tests to consider are pH and texture.</td>
<td>Food Science</td>
</tr>
<tr>
<td>A trend in food design and development is to provide for gluten free products which exclude:</td>
<td>Nutrition</td>
</tr>
<tr>
<td>Nutrition labeling/claims are created by the manufacturer to suit the product and package.</td>
<td>Nutrition</td>
</tr>
<tr>
<td>An entrée created for a vegan diner may contain:</td>
<td>Nutrition</td>
</tr>
<tr>
<td>A functional product development team includes members from each of:</td>
<td>Food Science</td>
</tr>
<tr>
<td>Marketing analysis is</td>
<td>General</td>
</tr>
</tbody>
</table>
A peer review manuscript is one that is passed to colleagues for review and editing prior to submission to a journal

| More than one may be true: Which of the following are common primary functions of food packaging? | Packaging Science |
| More than one may be true: Which of the following are the broad classes of materials available for packaging? | Packaging Science |
| Pick the best answer: What is a transmission rate? | Packaging Science |
| More than one may be true: Which of the following are true of FDA and food packaging? | Packaging Science |
| Pick one: In which class of material is aluminum can (predominantly)? | Packaging Science |
| Pick one: In which class of material is a flexible tune pouch (predominantly)? | Packaging Science |
Appendix C

Exit Questionnaire (EQ)

Name: _______________________ 

Exit Questionnaire

Over the past two semesters, you have participated in a research project as either a test subject or a control subject. This survey will be used to evaluate your experience. Please thoughtfully and honestly respond to the following short answer and multiple-choice questions.

Basic Information

Major:
Please check one box for each of the following statements.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel confident generating ideas for new products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident collecting marketing information and conducting a market analysis.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident developing a gold standard recipe.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>I feel confident developing a formula.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident applying changes to a recipe or formula to make it healthier.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident collecting commercial ingredients and/or commercial materials.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident estimating cost for a new product.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident designing packaging for new products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident developing healthy food products for children.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I learn more from hands-on experiences than lectures.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident collaborating with students that are not in my major or field of study.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel connected to the Food, Nutrition, and Packaging Science department.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident interacting and networking with industry professionals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident entering industry with my current level of knowledge and skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident that I will meet the expectations of my future employer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel confident being an advocate for my industry and/or field of study.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please answer the following questions with 1-2 sentences:

1. What are your career goals? (Ex: job title and/or description, industry, company)

2. What was your motivation to take this course?

3. Has this course made you feel more or less involved in the Food, Nutrition, and Packaging Science Department? How so?

4. What was your class standing at the time you began this course? (i.e. freshman, sophomore, junior, senior)

5. What were the advantages of taking this course at that class standing?
6. What were the disadvantages of taking this course at that class standing?

7. What were you expecting to learn from this course?

8. Were your expectations met?

9. What activity or activities did you learn from the most during the first semester? Please list both the activity and what you learned.

10. What activity or activities did you learn from the most during the second semester? Please list both the activity and what you learned.
11. In what ways, if any, did you benefit from working with students from other majors?

12. How has this course helped you in terms of overall gains in knowledge?

13. How has this course helped you in terms of cultural competency?

14. How has this course helped you in terms of product development experience?

15. How has this course helped you in terms of critical thinking and/or problem-solving skills?

16. What changes, if any, would you make to this course?
Appendix D

Herbs, Spices, and Sensory Science Questionnaire

1. What is the difference between an herb and a spice?
   a. The two words are interchangeable
   b. An herb is the leafy portion of the plant and a spice is from any other part of the plant
   c. Spices taste spicy, while herbs are more mild in flavor
   d. Herbs are used fresh, and spices are dried

2. Which of the following herbs is NOT typically found in Italian Seasoning?
   a. Bay Leaves
   b. Oregano
   c. Basil
   d. Thyme

3. What is the general rule for substituting fresh herbs for dry herbs?
   a. Use half the amount of fresh herbs than dry herbs
   b. Use the same amount of fresh herbs as dry herbs
   c. Use three times more fresh herbs than dry herbs
   d. Use five times more fresh herbs than dry herbs

4. On average, how long do ground spices last before losing their flavor and aroma?
   a. 6 months to 1 year
   b. 2-3 years
   c. 4-6 years
   d. Spices never lose their flavor and aroma

5. When should you add spices during cooking?
   a. Timing does not matter
   b. Both whole and ground spices should be added near the beginning
   c. Both whole and ground spices should be added near the end
   d. Whole spices should be added toward the beginning and ground spices should be added toward the end

6. Which sensory test should be used to determine if consumers like a newly developed food product?
   a. Triangle test
   b. Duo-trio test
   c. Hedonic test
   d. Paired-comparison test
7. The five basic tastes are sweet, salty, sour, bitter, and ______.
   a. Savory
   b. Pungent
   c. Tart
   d. Creamy

8. Which sensory test should be used to determine if a difference in sensory properties exists between an original product and a reformulation?
   a. Triangle test
   b. Focus group
   c. Hedonic test
   d. Ranking test

9. What is the name of the sensory evaluation software used to create the product’s sensory attribute questionnaire, collect the data and analyze results?
   a. SAS
   b. Excel
   c. Compusense
   d. TasteLab

10. What is the difference between flavor and taste?
    a. None; these words are synonymous
    b. Flavor is used to describe the perception of taste, smell, and mouthfeel together, and taste is limited to only sensations experienced on your tongue like sweet, salty and bitter;
    c. Flavor is the sensory impression of a food unique to that food item (i.e. “blueberry” flavor), and taste describes the way the food feels in your mouth

11. Which scale is used to measure the heat intensity of spicy foods?
    a. Capsaicin
    b. Heymann
    c. Hedonic
    d. Scoville

Correct Answers: 1) b; 2) a; 3) c; 4) b; 5) d; 6) c; 7) a; 8) a; 9) c; 10) b; 11) d
## APPENDIX E

**Student Project Descriptions, Photographs, and Packaging Graphics**

<table>
<thead>
<tr>
<th>Description</th>
<th>Product</th>
<th>Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Handcakes:</strong> Whole wheat and sweet potato pancake sticks for easy, hand-held snacking</td>
<td><img src="image1" alt="Handcakes Product" /></td>
<td><img src="image2" alt="Handcakes Packaging" /></td>
</tr>
<tr>
<td><strong>Snippies:</strong> Baked parsnip fries with Creole seasoning</td>
<td><img src="image3" alt="Snippies Product" /></td>
<td><img src="image4" alt="Snippies Packaging" /></td>
</tr>
<tr>
<td><strong>Olaf’s Choco-Peanut Butter Blizzard:</strong> Smoothies made with milk, banana, whey protein powder, cocoa powder, and powdered peanut butter, lightly sweetened with agave nectar</td>
<td><img src="image5" alt="Olaf's Choco-Peanut Butter Blizzard" /></td>
<td><img src="image6" alt="Olaf's Choco-Peanut Butter Blizzard Packaging" /></td>
</tr>
<tr>
<td><strong>Rockin’ Red Hummus:</strong> Roasted red pepper hummus and whole wheat baked pita chips</td>
<td><img src="image7" alt="Rockin’ Red Hummus" /></td>
<td><img src="image8" alt="Rockin’ Red Hummus Packaging" /></td>
</tr>
</tbody>
</table>
# Appendix F

## Syllabus for the University of Georgia

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
</table>
| Week 1 Class | Syllabus and Class Schedule  
Introductions to the project  
Surveys:  
- Subject Knowledge Assessment  
- Research Consent Form  
Handout: Children’s Nutrition Criteria  
Homework Assignment: Supermarket Kid’s Food Product |
| Week 2      | Martin Luther King, Jr. Day – No Class  
Assignments:  
- Watch introductory videos on eLearning  
- Food Truck Ideation |
| Week 3      | Student Presentations of Supermarket Items  
Student discussions of food truck ideations  
Adobe Presenter Lectures:  
- Culinary Nutrition, Product Development, and Children’s Nutrition  
Product Development Toolkit (also see accompanying PowerPoint slides)  
Group Work: Begin lab notebook for recording all meetings, goals, and next steps.  
PD Toolkit: Ideation & Screening - come up with product ideas and decide on best 2-3 to make in lab.  
Assignment: Student Satisfaction Inventory survey (only complete pgs. 1 & 2) |
| Week 3 Lab  | Lab: Kitchen Lab Tour and Culinary Fundamentals  
Group Work: Gold Standard Recipe development for PD project  
Handout: Gold Standard vs. Commercial |
| Week 4      | Lecture Videos:  
- Quick Introduction to Packaging (see Adobe Presenter)  
- Tools for Technical Writing and Market Research  
Handout: Tools for Technical Writing  
Group Work: Market analysis (see Toolkit) |
| Week 5      | Lecture: Sensory Evaluation (3 parts – See Adobe Presenter)  
Ideation Activity: Food Trucks  
Assignment: IRB Training |
| Week 5 Lab  | Product Development in kitchen lab to finalize gold standard recipe (see Toolkit) |
| Week 6      | Lectures:  
- Culinology and Culinary Basics  
- Packaging Science Part I (See Adobe Presenter) |
| Week 7          | Lecture: Packaging Science Part 2 (See Adobe Presenter)  
|                | Group Work: Commercialization (see Toolkit)  
|                | Healthful food supplier directory & IFT Yellowbook  
| Week 8         | Consultation: Dr. Coffee (sensory evaluation and culinary science)  
|                | Group Work: Plan Focus Group  
| Week 8 Lab     | Prepare samples for focus group  
|                | Focus group at Elementary School  
| Week 9         | Spring Break – No Class  
| Week 10        | Group Work: Packaging Materials, Design, and Graphics  
|                | Consultation with Dr. Darby – Packaging  
|                | Group Work: Written Proposal (see Toolkit), Prepare team report*  
| Week 11 Class  | Group Work – Commercial Ingredients and Materials  
| Week 11 Lab    | Product Development in Kitchen Lab  
| Week 12        | Group Work: Nutrition Profile (Facts Panel, Ingredient Statement, Allergens)  
| Week 13 Class  | Group Work - Process Flow  
| Week 13 Lab    | Product Development in Kitchen Lab  
| Week 14        | Group Work: Final Report  
| Week 14 Lab    | Prepare samples for final presentation  
| Week 15        | Group Presentation of Product Development Plan  
| Finals Week, exact date and time TBD | Surveys:  
|                | • Subject Knowledge Assessment (optional)  
|                | • Student Satisfaction Inventory (optional; only complete pages 1 & 2)  
|                | • Creative Inquiry Evaluation (optional)  
|                | • Exit Questionnaire |
Appendix G
Focus Group Moderator Guide

1. What were your expectations of the class prior to taking it? How did this course meet those expectations?

2. Tell me about an activity that you have never done before this class, or a time you were required to leave your comfort zone. This can include completing an assignment in a discipline other than your own, or just a completely new task that you had never performed before.

3. How did this course affect the way you think about group work? Are you more confident working in teams as a result?

4. How have the assignments/projects/coursework in the program strengthened your communication skills, oral and written?

5. Were any of you the only [food science, nutrition, packaging science] major on your team? Were you able to teach the rest of your team about your major?

6. Were any of you the team leader of your product development group? Tell me about your experience leading your peers. What were the most difficult parts?

7. Did you experience any “aha!” moments during this class?

8. What is the most beneficial thing that you learned or skill that you gained from this course?

9. In what areas do you feel best prepared for your upcoming career? Are there any courses in your program that you would add, drop or alter in any fashion to better prepare you?

10. How do you anticipate using the skills you learned in this particular class in your future career?

11. We would like to get your feedback for improvements of this course. What would you suggest we change, remove, add or enhance in future offerings of this course?
Appendix H
Faculty Survey

First we would like to gauge your perception of importance on the following experiences undergraduates may participate in. Please think of undergraduates in your academic discipline of food science, nutrition, or packaging science when answering these questions.

How important is it to you that undergraduates in your discipline do the following before they graduate?

<table>
<thead>
<tr>
<th>Experience</th>
<th>Very Important</th>
<th>Important</th>
<th>Somewhat Important</th>
<th>Not Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participate in an internship, co-op, field experience, student teaching, or clinical placement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participate in a community-based project (service-learning) as part of a course</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Complete a culminating senior experience (capstone course, senior project or thesis, comprehensive exam, portfolio, etc.)</td>
<td></td>
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</tr>
</tbody>
</table>

Throughout the remainder of the survey we would like you to compare students who took the Bundling of Careers for Children’s Product Development Creative Inquiry to students who did not take this course. The list of students who took this course has been provided for you. Please refer to that list when answering the following questions.

How would you rate the students on the given list, compared to those that did not take the course, on the following traits and abilities?

<table>
<thead>
<tr>
<th>Trait</th>
<th>Much better</th>
<th>Somewhat better</th>
<th>Neither Better nor Worse</th>
<th>Somewhat worse</th>
<th>Much worse</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall academic performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork skills</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Critical thinking skills</td>
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<tr>
<td>Leadership skills</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Preparedness to enter industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to seek out answers/ask</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Very Often</td>
<td>Often</td>
<td>Sometimes</td>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------</td>
<td>------------</td>
<td>-------</td>
<td>-----------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>for help from faculty</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Knowledge of topics in their respective major</td>
<td></td>
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</tr>
<tr>
<td>Ability to combine ideas from different courses while completing an assignment</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ability to seek out answers/ask for help from outside of the department or the university</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

During the current school year, about how often have you done each of the following with the undergraduate students you teach or advise?

<table>
<thead>
<tr>
<th></th>
<th>Very Often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Talked about their career plans</td>
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<tr>
<td>Discussed course topics and/or research opportunities outside of class</td>
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<tr>
<td>Advise them with their academic career, including courses specific to their interests</td>
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Please think of a senior-level course that you instruct within your discipline. Keep this course in mind when answering the following questions. Please answer the following based on the list of students provided to you compared to others taking a senior level course you instruct.

In your selected course section, how well does the given list of student do the following compared to others taking your course?

<table>
<thead>
<tr>
<th></th>
<th>Much better</th>
<th>Somewhat better</th>
<th>Neither Better nor Worse</th>
<th>Somewhat worse</th>
<th>Much worse</th>
<th>Unsure</th>
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</thead>
<tbody>
<tr>
<td>Combine ideas from different courses when completing assignments</td>
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<td>Include diverse perspectives in course discussions or assignments</td>
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<td>Try to better understand someone else’s view by imagining how an issue looks from his or her perspective</td>
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