

# Implementation of Real-World Experiential Learning in a Food Science Course Using a Food Industry-Integrated Approach

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**Abstract:** Success skills have been ranked as the most important core competency for new food science professionals to have by food science graduates and their employers. It is imperative that food science instructors promote active learning in food science courses through experiential learning activities to enhance student success skills such as oral and written communication, critical thinking, problem solving, and team work. The aim of this study was to incorporate “real-world” experiential learning into a food product development course. Undergraduate students enrolled in a food product development course worked on a semester-long product development case study developed by the Instructor of the course and the Manager from ACH Food Companies, Inc. The case study was presented to students in the form of a product development competition. Students were placed into groups and given the task to develop a cake mix with specified parameters. At the end of the semester, student groups participated in a case study competition to showcase their product concepts. Each student group gave a PowerPoint presentation and was evaluated using selected criteria. Students rated the course overall as being very good. Students perceived the case study to be beneficial and informative regarding employer (ACH’s) expectations. Students recommended that the Instructor minimize restrictions/specifications for product concepts and increase the quantity of course/laboratory meetings per week. This approach will continue to be used and further evaluated as an approach to incorporate active learning and provide food science undergraduates with a sense of employer expectations.

**Keywords:** education, experiential learning, food science, real-world, teaching

## Introduction

Food Science undergraduate and graduate programs are facing a serious challenge to continue to graduate qualified individuals to fill industry, government, and academic positions (William 2006; Chikthimmah and Floros 2007). In order for food science graduates to effectively address agricultural workforce needs, they must possess research and professional skills, be able to apply knowledge, and think critically (William 2006; Chikthimmah and Floros 2007; Roberts and others 2010). To ensure that food science undergraduates obtain the necessary academic training and professional development, undergraduate food science program curricula should cover 5 core competencies: food chemistry and analysis, food safety and microbiology, food processing and engineering, applied food science, and success skills (IFT 2011).

Of the 5 core competencies, employers have ranked success skills as the most important core competency for new food science professionals to have (Morgan and others 2006) because success skills were used more often than the other core competencies (Clark and others 2006). Examples of success skills include: oral and written communication, critical thinking, problem-solving, professionalism, and team work (IFT 2011). The 2nd most important core competency was applied food science indicating that employers expect food science graduates to be able to apply food science knowledge in “real-world” situations (Morgan and others 2006). This competency requires students to use higher order cognitive skills such as analyzing, evaluating, and creating (Anderson and Krathwohl 2001).

Students are not typically taught success skills or how to apply food science knowledge but acquire such skills through participation in hands-on activities such as group projects (Morgan and others 2006). Students learn and acquire skills best when learning is active (Columbia 2015). Active learning enhances student motivation, encourages higher order thinking, and increases the retention of information (Pugsley and Clayton 2003; Briers 2005; Cano 2005; Cherney 2008; Coker 2010). The use of discussion

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groups and practical experience produce a 50% and 75% retention rate of information compared to a typical lecture which produces a 5% retention rate of information (Collaboration 2014).

One approach that has been widely used by several disciplines to promote active learning is providing students with experiential learning opportunities (Reitmeier 2002; Pugsley and Clayton 2003; Cano 2005; Bohn and Schmidt 2008; Coker 2010). Bohn and Schmidt (2008) defined experiential learning as “occurring when students participate in a contrived “real life” activity, reflect upon that activity, use critical analysis skills to derive useful knowledge, meaning, and insight from the experience, and then incorporate their new understandings into their daily lives.”

The objective for this study was to incorporate “real-world” experiential learning into a Special Topics in Food Science and Technology course entitled Food Product Development by creating and implementing a food industry case study. The Instructor of the course collaborated with the Product Development Manager of oils and baking mixes (Manager) from ACH Food Companies, Inc. (ACH) to create a case study that addressed a real ACH product development problem. The goal of the case study was to enhance student success skills and higher order cognitive skills and promote awareness of employer expectations. The purpose of this paper is to discuss the approach used to incorporate experiential learning in an academic setting through collaboration with a food company.

## Materials and Methods

### Overview

Food Product Development was a Special Topics in Food Science and Technology course that discussed the food product development process. The course was offered as an elective by the Dept. of Food Science and Technology at The Univ. of Tennessee (UT) located in Knoxville. The course was designed to be a capstone-type course that required students to recall and utilize fundamental concepts and principles learned in other food science courses such as food chemistry, food microbiology, food analysis, and sensory evaluation. The course also provided students with hands-on laboratory experience. The overall objectives for the course were to: (1) improve students’ ability to locate needed information, (2) develop students’ ability to find solutions and/or reach conclusions to questions and problems using a systematic approach, and (3) improve students’ oral and written communication skills and critical thinking skills.

The course was 1st offered during fall 2013 and was offered again in spring 2014. The structure of the course had been for students to work in small groups to create a concept for a new food product and then work throughout the semester to develop a prototype for the concept.

A new approach was implemented into the course during spring 2015 to demonstrate to students the “real-world” application of food science principles and concepts. Students were placed into small groups to work on a “real-world” case study throughout the semester. The case study was developed by the Instructor of the course and the Manager from ACH. The case study dealt with an actual ACH food product development problem.

### Collaboration

ACH was interested in collaborating with the Dept. of Food Science and Technology at UT to provide students with opportunities to interact with food science professionals so that they become aware of employer expectations, have a realistic sense of

tasks that they may encounter while working for a food company, and build relationships with professionals in the food industry. As a result, the Instructor of Food Product Development and the Manager from ACH decided to collaborate and present a “real-world” ACH case study to undergraduates. Both the ACH Manager and Instructor believe that undergraduate food science curricula need more collaboration and interaction with professionals from the food industry.

### Case-study agreement

UT and ACH developed a case study and confidentiality agreement that outlined the terms and conditions of the ACH case study such as the roles and responsibilities of ACH and UT (that is, Instructor), confidentiality, intellectual property, and publicity. A student case study agreement was also developed (see Figure A1 for Student Case Study Agreement template) outlining the need for confidentiality and the role of intellectual property. All students who wanted to participate in the ACH case study had to sign the Agreement before the ACH case study was presented. One of the terms and conditions required by ACH was that students transfer all rights, title, and ownership that they had in the work product and any materials resulting from their participation in the ACH case study, so students were not required to participate in the ACH case study. Any student who did not want to participate in the ACH case study had the option to participate in an alternative case study developed by the Instructor.

### Participants

There were 12 students who enrolled and completed the Food product development course in spring 2015. All 12 students decided to participate in the ACH case study. The classifications of students ranged from sophomore to senior. Because the students varied in classification and educational background (that is, food science courses completed), the students were placed into groups based on the food science courses that they had previously taken and were currently enrolled in.

### Design of the ACH case study

The ACH case study was a semester-long experiential learning activity. The ACH case study was presented to students in the form of a product development competition. Students were placed into groups of 3 and given the task of developing a cake mix with specified parameters such as the quantity and type of ingredients permitted and the instructions for consumer preparation. Student groups had to (1) research available cake products and recipes, (2) conduct a competitor analysis, (3) identify ingredients to be used, (4) conduct benchtop cake mix formulation trials, (5) develop consumer preparation instructions, (6) conduct test bakes using developed cake mix formulations and consumer preparation instructions, (7) evaluate test bakes, (8) test 2 ingredient variables to determine how a change in ingredient can impact sensory attributes of the cake, (9) finalize cake mix formulations and consumer preparation instructions, and (10) give a PowerPoint presentation for product development competition.

### Course format

Food Product Development was a 3 credit hour course. Students earned 1 credit hour by meeting collectively once a week with the Instructor. Students earned the remaining 2 credit hours by working on the case study independently in their groups. Students were required to establish at least 1 laboratory meeting per week. The Instructor provided 3 student office hours per week, and

ACH provided 2 consulting hours per week. Students were also able to schedule appointments with the Instructor and contact the ACH Manager via email or phone. ACH made 3 campus visits during the semester.

Figure 1 shows the weekly course schedule for students. During the 1st 2 weeks of the course, the Instructor provided students with a course overview and students completed laboratory safety training to work in the food product development teaching laboratory and a research tutorial. The Instructor discussed the food product development process and group dynamics before student groups were formed for the ACH case study. The Instructor wanted to provide students with fundamental background information about the stages of product development and address factors that could potentially impact the functionality and progress of student groups such as personality type, individual behavior, leadership, and communication. Students were introduced to ACH, and the Manager from ACH gave a PowerPoint presentation to provide background information about ACH and its reason(s) for involvement in the course. Students subsequently received, reviewed, and signed the Student Case Study Agreement. The Instructor and the ACH Manager collectively presented the ACH case study. Students were given the ACH case study objective, outline, guidelines, and requirements.

Students had to research available cake mix products and recipes, analyze competitors, and select ingredients to use for the cake mix. They also had to create the method to use for the cake mix and consumer preparation instructions. Each group submitted a project resource identification sheet to indicate the materials it needed as well as a project testing plan (Figure 2). Each group subsequently had a phone conference call with the Manager and two Food Scientists from ACH. The Instructor was present with the students during the conference call. Each group introduced themselves, gave a brief market and competitor analysis summary, and discussed their proposed product concept and testing plan. Students were questioned by and received feedback from ACH. ACH provided the student groups with gift cards to purchase ingredients that could be obtained from local stores. ACH ordered and shipped any ingredients that could not be obtained locally.

Once students obtained all of the necessary ingredients, they conducted benchtop cake mix formulation trials and test bakes. Students also tested two selected ingredient variables. After the students spent 2 weeks working on their cake mix formulation trials and test bakes, the Manager and a chef from ACH made a visit to assess student progress. The Manager and chef evaluated cake samples baked by the students and provided feedback. Students also had the opportunity to observe the test bakes and progress of each group. Students utilized feedback to finalize their cake mix formulations and consumer preparation instructions in preparation for the food product development competition.

During the last 3 weeks of the course, students worked solely on a group paper (see Figure 3, for paper guidelines) for the course and their PowerPoint presentation for the food product development competition.

### ACH case study competition

The food product development competition was conducted during the designated final exam time for the course. Each group gave a PowerPoint presentation about the cake mix formulation that it worked on throughout the semester as well as the 2 ingredient variables tested to a panel of judges. Each member of the group had to actively participate during the presentation. The judges consisted of the Instructor, an ACH chef, and an ACH

Technical Coordinator. After each group finished giving its presentation, the group provided the judges with samples of its baked final cake mix and exited the room so the judges could rate its presentation and evaluate its cake.

Student groups were evaluated using a food product development competition scoring rubric adapted from a written proposal rubric used by the Georgia 4-H for its food product development contest (Georgia 2003; see Figure 4). Student groups were evaluated using the following criteria: product name and description, originality of product, product recipe, formulation trials, market research, sensory evaluation plan, prototype, oral communication, and questioning. After all groups had presented, the scores for each group were tabulated by the judges. The group with the highest overall score was declared the winner and received a gift from ACH.

### Course grading

Given the task, duration of the course, and variation in student skill levels, the Instructor could not be certain that students would have a viable product prototype to present by the end of the semester. So, students were not graded on their final product prototype. The ACH case study competition served as a way to evaluate student success in terms of creativity and prototype development. Student grades for the course were calculated using the following criteria: attendance/participation (25%), project resource identification (10%), product testing plan (15%), assignments (10%), PowerPoint presentation (15%), and paper (25%). Instead of the students having a final exam, they participated in the product development competition during the designated final exam time.

### Course and ACH case study evaluation

The course was evaluated using an online evaluation form (Table 1) administered through the UT Student Assessment of Instruction System (SAIS). At the end of the ACH case study, an anonymous survey was administered to the students to evaluate the ACH case study approach. Students were asked to answer the following questions:

- What are 3 things that you liked the most about the course?
- What are 3 things that you liked the least about the course?
- What are your feelings toward the use of food company case studies?
- What recommendations do you have to improve the course?

The ACH case study was also assessed through observations by the Instructor and ACH Manager.

### Results and Discussion

All enrolled students in the course participated in the ACH case study experiential learning activity.

Table 2 shows mean scores for student group PowerPoint presentations. Overall, the students received the highest mean scores for their formulation trials and sensory evaluation plans. The student's cake prototypes received the lowest overall mean score. Mean scores assigned by the Instructor, ACH chef, and ACH Technical Coordinator suggest that students could improve their ability to critically think and answer questions using reasoning and scientific knowledge as well as oral communication.

The UT SAIS evaluation form was completed by only 4 students. Because the UT SAIS evaluation form was completed by such few students, limited conclusions and inferences could be made from student responses.

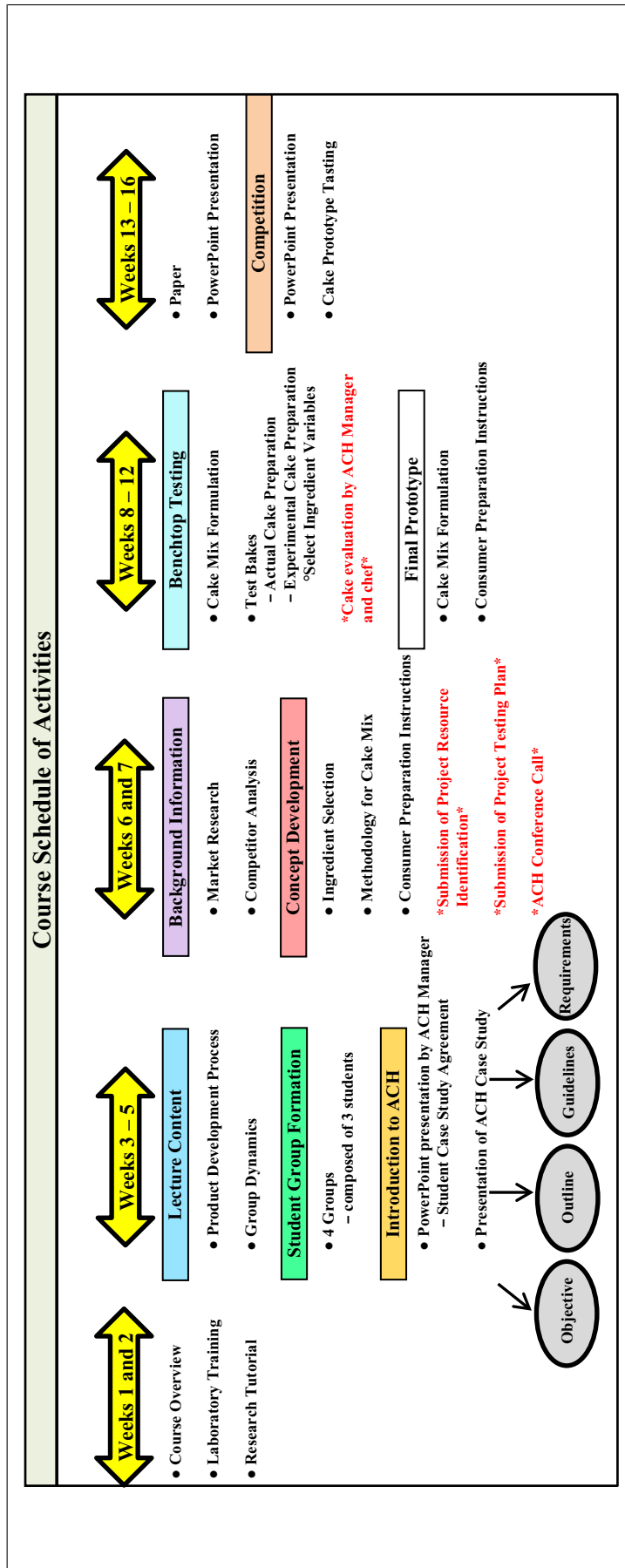


Figure 1—Weekly course schedule for students.

	Group #: Group Members: Jane Doe Joe Doe Date:
<b>Project Testing Plan</b>	
<b>Competitor Analysis:</b> <ul style="list-style-type: none"> <li>○ Who are top competitors that produce similar products?</li> <li>○ How many of the similar products do they produce?</li> <li>○ What is the cost of the products?</li> <li>○ What flavors are produced by the competitors?</li> <li>○ What are the key ingredients used in similar products?</li> <li>○ What is the purpose/functionality of key ingredients?</li> <li>○ What is the quantity of product in one unit?</li> <li>○ What is the serving size and weight?</li> <li>○ What type of packaging is used?</li> </ul>	
<b>Product Description:</b> <ul style="list-style-type: none"> <li>○ Name of product</li> <li>○ Description           <ul style="list-style-type: none"> <li>▪ Definition of product</li> <li>▪ Packaging</li> </ul> </li> <li>○ Selected Variables for Testing           <ul style="list-style-type: none"> <li>▪ Explanation for selection 1               <ul style="list-style-type: none"> <li>□ List of Ingredients                   <ul style="list-style-type: none"> <li>○ Purpose/Functionality</li> </ul> </li> <li>□ Baking Instructions</li> </ul> </li> <li>▪ Explanation for selection 2               <ul style="list-style-type: none"> <li>□ List of Ingredients                   <ul style="list-style-type: none"> <li>○ Purpose/Functionality</li> </ul> </li> <li>□ Baking Instructions</li> </ul> </li> <li>▪ Explanation for selection 3               <ul style="list-style-type: none"> <li>□ List of Ingredients                   <ul style="list-style-type: none"> <li>○ Purpose/Functionality</li> </ul> </li> <li>□ Baking Instructions</li> </ul> </li> </ul> </li> </ul>	

Figure 2—Template for project testing plan.

Based on student responses obtained from the UT SAIS evaluation form, the course as a whole received a mean rating of 4.25. On the scale, this rating was between “Very Good” and “Excellent.” Students felt that they had the opportunity to practice what they learned and develop their own ideas and skills. The high mean scores received for the use of class time (that is, 4.00), the amount of information learned (that is, 4.25), relevance and usefulness of course content (that is, 4.25), and evaluative and grading techniques (that is, 4.25) signify that students felt positively about the structure of the course and use of a food industry case study approach. The intellectual challenge presented by the course received a mean rating of 4.25. On the scale, this rating was between “Average” and “Much Higher.” Students perceived the intellectual challenge in the Food Product Development course as being higher relative to other courses that they had previously taken. The intellectual challenge may, in part, explain why students reported being more involved and putting forth more effort in this course than other courses taken.

More student data will need to be collected using the UT SAIS evaluation form when the course is taught during subsequent semesters to adequately assess the course.

Table 3 shows results from the anonymous survey. The aspect of the course that students liked the most was the hands-on/laboratory experience. Students also liked the structure of the course and having the freedom to be creative. The aspects of the course that students liked the least were assignments and meeting times. Some students did not like having to write a paper and felt like they did not receive merit on assignments in some instances.

All of the students felt that the ACH case study provided a positive experience and was beneficial. In order for a case study to be effective, students must be presented with situations that are similar to those that they would encounter in the “real world” (Gallego and others 2013), specifically the food industry. Students gained a new respect for all of the different aspects involved in the product development process. Students built a relationship and connection with food industry professionals from ACH and gained more insight about ACH in terms of how it functions, the approach it uses to develop new product concepts, and roles/responsibilities of its employees. Having students work in small groups allows collaborative learning to take place because they have to collectively find a solution or answer (Stahl and others 2006; Gallego and others 2013). Students had the opportunity to improve their team work skills.

Some recommendations to improve the course included decreasing restrictions/specifications for the food product concept and increasing the quantity of course/laboratory meetings. Some students indicated that they would have liked to develop their own food product concept or work on a food product other than a cake mix. Given that students really enjoyed the hands-on/laboratory experience, some students wanted to meet more frequently as a collective class to discuss progress and have more time/opportunities to work in the laboratory on their benchtop testing.

From the Instructor’s point of view, students’ ability to systematically and methodically think and solve problems improved. The 1st laboratory meeting was very chaotic because students were not

<b>Product Development Paper Guidelines</b>	
<b>Specifications</b>	
Font Style: Times New Roman	
Font Size: 12pt	
Line Spacing: Double-spaced (except reference list)	
Page Numbers: Page Numbers should be centered at the bottom of the page (exclude cover page)	
Quantity of Pages: (exclude cover page, tables, figures, and references) at least 10 pages for undergraduate students	
Tables and Figures: use provided formatting guidelines and samples	
Quantity of References: at least 15 references for undergraduate students	
<b>Components of Paper</b>	
Cover Page:	<ul style="list-style-type: none"> <li>▪ Group Member Names and Date should be in upper right-hand corner of cover page</li> <li>▪ Product Name/Title</li> </ul>
Paper:	<ul style="list-style-type: none"> <li>▪ Introduction <ul style="list-style-type: none"> <li>○ Statement of Problem</li> <li>○ Market Research</li> <li>○ Who are top competitors that produce similar products?</li> <li>○ How many of the similar products do they produce?</li> <li>○ What is the cost of the products?</li> <li>○ What flavors are produced by the competitors?</li> <li>○ What are the key ingredients used in similar products?</li> <li>○ What is the purpose/functionality of key ingredients?</li> <li>○ What is the quantity of product in one unit?</li> <li>○ What is the serving size and weight?</li> <li>○ What type of packaging is used?</li> </ul> </li> <li>▪ Product Description <ul style="list-style-type: none"> <li>○ Name of product</li> <li>○ Description <ul style="list-style-type: none"> <li>▪ Definition of product</li> <li>▪ Ingredients</li> <li>▪ Packaging</li> </ul> </li> <li>○ Selected Variables for Testing <ul style="list-style-type: none"> <li>▪ Explanation for selection</li> </ul> </li> <li>○ Ingredients <ul style="list-style-type: none"> <li>▪ Purpose/Functionality</li> <li>▪ Explanation for selection</li> </ul> </li> </ul> </li> <li>▪ Competition <ul style="list-style-type: none"> <li>○ Who are the top 3 competitors? Why?</li> </ul> </li> </ul>
	<ul style="list-style-type: none"> <li>▪ Marketing <ul style="list-style-type: none"> <li>○ Determine the target group/consumer for product <ul style="list-style-type: none"> <li>▪ Age group</li> <li>▪ Gender</li> <li>▪ Ethnicity</li> </ul> </li> <li>○ Location where product would be sold</li> </ul> </li> <li>▪ Processing <ul style="list-style-type: none"> <li>○ Ingredients</li> <li>○ Equipment/Utensils</li> <li>○ Detailed steps for product preparation</li> </ul> </li> <li>▪ Costs <ul style="list-style-type: none"> <li>○ Costs of ingredients</li> <li>○ Cost of equipment</li> </ul> </li> <li>▪ Benefits <ul style="list-style-type: none"> <li>○ Company</li> <li>○ Consumers</li> </ul> </li> <li>▪ Food Safety <ul style="list-style-type: none"> <li>○ Food Allergens</li> <li>○ Likelihood of Microbial Growth <ul style="list-style-type: none"> <li>▪ pH</li> <li>▪ Water</li> <li>▪ Oxygen</li> <li>▪ Nutrients</li> <li>▪ Temperature</li> </ul> </li> <li>○ Shelf-life</li> <li>○ HACCP Plan</li> </ul> </li> <li>▪ Sensory Evaluation <ul style="list-style-type: none"> <li>○ Sensory technique that would be used for evaluation of product</li> <li>○ Sensory characteristics that would be evaluated</li> <li>○ Number of panelists that would be used</li> <li>○ Preliminary sensory feedback if available</li> </ul> </li> <li>▪ Packaging <ul style="list-style-type: none"> <li>○ Type of material that would be used</li> </ul> </li> <li>▪ Conclusion <ul style="list-style-type: none"> <li>○ Attitude and opinion about case study experience</li> <li>○ Lessons learned</li> </ul> </li> <li>▪ References <ul style="list-style-type: none"> <li>○ Use provided format</li> </ul> </li> </ul> <p><b>*Tables and figures should be used when possible.</b></p>

Figure 3—Guidelines for food product development paper.



CRITERIA	9 – 10	7 – 8	5 - 6	1 - 4	SCORE
Product Name and Description	Product name is original, descriptive, and marketable. Product description provides a clear and detailed explanation of what the product is, how it is unique, and how it meets a specific consumer need.	Product name is descriptive. Product description provides a clear explanation of what the product is but an unclear or incomplete explanation of how the product is unique, and how it meets a specific consumer need.	Product name is not descriptive. Product description provides an unclear explanation of what the product is.	Product name or product description is missing or shows little effort.	_____ Comments:
Originality of Product	Product is completely original. There is no other product like it on the market	Product is mostly original but based on modifications of an existing product.	Product represents only minor modifications of an existing product.	Product is a copy of an existing product.	_____ Comments:
Product Recipe	Product recipe clearly lists, in order of use, all ingredients used in the product, accurate explanations of the specific functions (based on physical, chemical, or functional properties) of all product ingredients, and detailed procedures for preparation.	Product recipe clearly lists all ingredients used in the product, reasonable, but general, explanations of the functions (based on physical, chemical, or functional properties) of all ingredients, and procedures for preparation.	Product recipe provides an incomplete list of the ingredients used in the product, incomplete or incorrect explanations of the ingredient functions, or incomplete or unclear procedures for preparation.	The list of ingredients, explanations of ingredient functions, or instructions for preparation are missing or show little effort.	_____ Comments:
Formulation Trials	Formulation Trials provide explanations of ingredients, instructions for preparations, and observations/results . Explains cause of formulation problems and how results were used to change formulations.	Formulation Trials provide explanations of ingredients, instructions for preparations, and observations/result.	Formulation Trials provide incomplete explanations of ingredients, instructions for preparations, and observations/result.	Formulation Trials are missing or show little effort.	_____ Comments:
Market Research	Marketing research provides detailed analysis of top competitors, existing products, product preparation instructions, and packaging. Explains how market research was used to develop product concept.	Marketing research provides an analysis of top competitors, existing products, product preparation instructions, and packaging.	Marketing research provides an incomplete analysis of top competitors, existing products, product preparation instructions, and packaging.	Marketing research is missing or shows little effort.	_____ Comments:
Sensory Evaluation Plan	Sensory evaluation plan provides detailed explanation of test(s) to be used and purpose.	Sensory evaluation plan provides explanation of test(s) to be used and purpose.	Sensory evaluation plan provides an incomplete explanation of test(s) to be used and purpose.	Sensory evaluation plan is missing or shows little effort.	_____ Comments:
Prototype	Prototype is representative of the product description, and has good flavor, texture, and appearance.	Prototype is representative of the product description, but needs improvement of the flavor, texture, or appearance.	Prototype is representative of the product description, but needs improvement of the flavor, texture, and appearance.	Prototype is not representative of the product description.	_____ Comments:
Oral Communication	Presentation is clear convincing, interesting, and well-organized. Graphics are used to enhance presentation.	Presentation is clear convincing, interesting, and well-organized.	Presentation is clear.	Presentation is not clear.	
Questioning	Answers provided to questions with ease using reasoning and scientific knowledge.	Answers provided to questions using reasoning and scientific knowledge.	Answers provided to questions but no reasoning and scientific knowledge used.	No answers provided to questions.	_____ Comments:
Total Score (out of 90)					_____
Additional Comments:					

Figure 4–Rubric for food product development competition.

Table 1—UT SAIS evaluation form questions.

Question	Scale					
	Excellent	Very good	Good	Fair	Poor	Very poor
The course as a whole was	5	4	3	2	1	0
The course content was	5	4	3	2	1	0
The instructor's contribution to the course was	5	4	3	2	1	0
The instructor's effectiveness in teaching the subject matter was	5	4	3	2	1	0
Opportunity for practicing what was learned was	5	4	3	2	1	0
Sequential development of skills was	5	4	3	2	1	0
Explanations of underlying rationales for new techniques or skills was	5	4	3	2	1	0
Demonstrations of expected skills were	5	4	3	2	1	0
Instructor's confidence in students' ability was	5	4	3	2	1	0
Recognition of student progress by instructor was	5	4	3	2	1	0
Student confidence in instructor's knowledge was	5	4	3	2	1	0
Freedom allowed students to develop own skills and ideas was	5	4	3	2	1	0
Instructor's ability to deal with student difficulties was	5	4	3	2	1	0
Tailoring of instruction to varying student skill levels was	5	4	3	2	1	0
Availability of extra help when needed was	5	4	3	2	1	0
Use of class time was	5	4	3	2	1	0
Instructor's interest in whether students learned was	5	4	3	2	1	0
Amount you learned in the course was	5	4	3	2	1	0
Relevance and usefulness of course content were	5	4	3	2	1	0
Evaluative and grading techniques (tests, papers, projects, and so on) were	5	4	3	2	1	0
Reasonableness of assigned work was	5	4	3	2	1	0
Clarity of student responsibilities and requirements was	5	4	3	2	1	0

Question	Scale						
	Much higher	Average				Much lower	
Do you expect your grade in this course to be	6	5	4	3	2	1	0
The intellectual challenge presented was	6	5	4	3	2	1	0
The amount of effort you put into this course was	6	5	4	3	2	1	0
The amount of effort to succeed in this course was	6	5	4	3	2	1	0
Your involvement in this course (doing assignments, attending classes, and so on) was	6	5	4	3	2	1	0

Table 2—Mean scores<sup>a</sup> for student group PowerPoint presentations during food product development contest.

Criteria <sup>b</sup>	Group				Overall mean score	(SD)
	1	2	3	4		
Product name and description	7.17	6.83	7.67	9.00	7.67	(0.95)
Originality of product	7.33	7.83	6.67	8.67	7.63	(0.84)
Product recipe	7.00	7.00	8.17	6.83	7.25	(0.62)
Formulation trials	7.67	7.67	9.00	8.17	8.13	(0.63)
Market research	7.50	8.50	7.67	7.83	7.88	(0.44)
Sensory evaluation plan	8.33	8.33	8.00	7.50	8.04	(0.39)
Prototype	9.67	6.50	4.00	7.83	7.00	(2.38)
Oral communication	7.50	7.67	7.83	7.33	7.58	(0.22)
Questioning	6.00	7.33	7.33	7.83	7.13	(0.79)

<sup>a</sup> Means based on scores given by 3 judges using a 10-point scale.

<sup>b</sup> Refer to Figure 4 for explanation of score values.

prepared to test their 1st cake mix formulation. Many students had not thought about bringing a copy of their formulation and consumer preparation instructions; checking to make sure that all necessary equipment, materials, and ingredients were available; and designating responsibilities among themselves in their respective groups. As a result, the 1st laboratory meeting took the longest for each group. Students ensured that they had all necessary equipment, materials, and ingredients and developed a testing plan for subsequent laboratory meetings.

Initially, students selected ingredients because they were used in other recipes or cake mix products. But as they began to conduct their test bakes, they began to expand their thought process by thinking about the functionality or impact of ingredients on sensory characteristics of the product. As the students conducted their test bakes, they started thinking about the cause(s) of defects or problems with sensory characteristics such as the texture or appearance and how such defects or problems could be eliminated.

The Instructor also observed improvement in the students' ability to think more critically. Students had to think quickly and

synthesize food science principles and concepts during an ACH conference call. Food scientists asked the students questions regarding processing, ingredient functionality, and potential chemical reactions and interactions based on the ingredients that they selected.

Students improved their communication skills as well. Students were not used to providing detailed descriptions and writing a step-by-step methodology in such a manner that it could be replicated. Student groups observed problems with their initial test bakes because their written methodologies either lacked necessary details or were written in such a manner that students couldn't understand what was exactly done. Students realized the importance of recording measurements, times, temperatures, and the sequence of steps used to create the cake mix and instructions for consumer preparation. So, students wrote more details for subsequent test bakes.

"Working on case studies requires good organizational and time management skills" (Ryerson 2015). The Instructor and ACH Manager both felt that time-management and student progress



Table 3—Results from case study assessment Survey.<sup>a</sup>

Response	Percentage of responses (number of responses)
<b>What was liked the most about the course<sup>b</sup></b>	
Baking cake structure	3.13% (1)
Eating cake	18.75% (6)
Food company collaboration	3.13% (1)
Freedom to be creative	6.25% (2)
Group work	15.63% (5)
Hands-on/ laboratory experience	6.25% (2)
Learning about ingredient functionality	31.25% (10)
Learning about the product development process	3.13% (1)
Learning measurement techniques	6.25% (2)
Learning to document/ record information	3.13% (1)
3.13% (1)	
<b>What was liked the least about the course<sup>b</sup></b>	
Assignments	17.39% (4)
Documentation/ recordkeeping	4.35% (1)
Duration of course	4.35% (1)
Group work	8.70% (2)
Meeting times	17.39% (4)
No dislikes	8.70% (2)
Quantity of set deadlines	4.35% (1)
Quantity of weekly course meetings	13.04% (3)
Quantity of weekly laboratory meetings	13.04% (3)
Restrictions/ specifications for product concept	8.70% (2)
<b>What recommendations do you have to improve the course</b>	
Change meeting time	7.69% (1)
Decrease restrictions/specifications for product concept	30.77% (4)
Decrease supervision	7.69% (1)
Increase quantity of course/ laboratory meetings	15.38% (2)
Increase quantity of set deadlines	7.69% (1)
No recommendations	23.08% (3)
Offer individual projects	7.69% (1)

<sup>a</sup>N = 12.<sup>b</sup>Students were allowed to provide up to 3 responses.

were hindered by the loose structure of the course. Two obstacles in implementing a food industry approach were an increase in preparation time and the quantity of content that could be covered by the Instructor. The implementation of case studies can be difficult for STEM (Science, Technology, Engineering, and Mathematics) instructors who must cover a lot of content and associate student learning with the quantity of information covered (Herreid and Schiller 2013).

### Limitations

The food industry case study approach was only implemented once. In order to more fully assess its effectiveness, the approach will need to be continually implemented and evaluated using an array of assessment techniques. The course enrollment was small, so findings may not generalize to other instructors who implement a food industry case study approach.

### Conclusions

Food Product Development will be offered as a formalized lecture and laboratory course during spring 2016. Students will have three course meetings per week (2 lectures/discussion meetings and 1 laboratory meeting). The Instructor and ACH will continue to collaborate and present “real-world” case studies to students in the course. Changes will be implemented based on observations and student feedback in an effort to improve the course. The Instructor and ACH will minimize restrictions/specifications for product concepts so that students have more freedom to be creative and innovative. Also, the ACH case study will be more structured to help students manage their time and to ensure that they spend sufficient time addressing different aspects of food science that are

involved in the product development process such as food safety and packaging. Students will have more set deadlines, and specific food science areas for students to focus on will be outlined in the tentative course schedule to facilitate student progress.

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## Appendix

**STUDENT CASE STUDY AGREEMENT**

[TEMPLATE]

This Agreement is made by and between **(Company Name)** and Student, an individual, identified below.

**RECITALS:**

**WHEREAS**, Student is a student at **(University Name)** and **(University Name)** (the "University") has executed an agreement with **(Company Name)** whereby **(Company Name)** will facilitate an optional consumer food product development case study (the "Case Study") for University students (the "University Case Study Agreement"); and

**WHEREAS**, Student is enrolled in the University course that will be offering the Case Study; and

**WHEREAS**, **(Company Name)** has requested that Student acknowledge his/her responsibilities and obligations regarding certain confidential information and ownership of his/her work product in addition to other matters.

**NOW, THEREFORE**, in consideration of the premises stated above and in return for **(Company Name)** allowing Student to participate in the Case Study pursuant to the University Case Study Agreement, Student agrees as follows:

**1. Confidential Information.** Student acknowledges that in the course of performing pursuant to the Case Study he/she will be given access to information which is confidential and proprietary to **(Company Name)**, which is marked as confidential or proprietary or that, by its nature or the manner disclosed, can reasonably be determined to be confidential or proprietary, and which was developed and created at great expense, time and effort by **(Company Name)**. Such information is deemed "Confidential Information" and consists of any information conveyed to, received by or created or developed by Student and includes, but is not limited to, product formulas and recipes, procedures and processes, whether oral, written or computerized and shall also include the results of Student's performance provided under this Agreement and the University Case Study Agreement. Student agrees that he/she shall not:

**1.1** Use Confidential Information for his/her own benefit or the benefit of others but only for the purpose of performing under the Case Study; or

**1.2** Disclose the Confidential Information to others, except **(Company Name)** personnel, the University, and other Students which require access to the Confidential Information for purposes of the Case Study.

**1.3** The obligations to maintain confidentiality and not to use or disclose Confidential Information does not apply to:

- i. information which is now available in the public domain without the fault or breaches of this Agreement by Student; or
- ii. information that hereafter becomes available to the public generally without the fault of Student; or
- iii. information which is obtained or acquired by Student in good faith from a third party without any restrictions on use and disclosure; or
- iv. information which is already known by Student before its receipt from **(Company Name)**, as shown by prior written records; or
- v. information which is developed by Student independently of the disclosures made by **(Company Name)** hereunder as shown by prior written records; or
- vi. information which, by the prior written consent of **(Company Name)**, is authorized for disclosure.

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Student Case Study Agreement

Figure A1–Continued

**2. Return of Confidential Information.** Student acknowledges that all Confidential Information shall be and at all times remain the sole and exclusive property of (Company Name) and that upon termination of Student's performance under the Case Study that Student shall immediately deliver to (Company Name), in good condition, all Confidential Information in its possession or control except for presentations and materials required for Course work.

**3. Intellectual Property.** Student represents and warrants to (Company Name) that his/her work and work product performed under this Agreement shall be original works of authorship and, to the best of the Student's knowledge, shall not infringe the patents, copyrights, trade secrets or other intellectual property rights of third persons. Student assigns, conveys and transfers to (Company Name) all right, title, interest and ownership which he/she has in the work product, work-in-progress or other materials resulting from Student's performance under the Case Study. Student agrees to execute such additional documents and otherwise assist (Company Name) to more fully or formally reflect (Company Name)'s ownership in Student's work product, work-in-progress or such other materials resulting from Student's performance pursuant to the Case Study.

**4. Injunctive Relief.** Student agrees that its breach of this Agreement may cause substantial and irreparable harm to (Company Name) for which money damages may not provide adequate compensation and Student agrees that (Company Name) shall, in addition to all other rights and remedies available to (Company Name) by law or equity, be entitled to seek equitable relief to prevent a breach or continued breach of this Agreement, without the requirement that (Company Name) post a bond.

**5. Survival Following Termination.** Student agrees that the duties of confidentiality under this Agreement and the other duties of Student shall continue past the last day of the Case Study and shall survive termination of this Agreement and the University Case Study Agreement for a period not longer than two (2) years.

**6. Miscellaneous.**

**6.1.** This Agreement constitutes the complete Agreement between the parties with respect to its stated subject matter and replaces and supersedes all previous agreements, understandings, representations and statements.

**6.2.** This Agreement shall be governed and construed according to the laws of the State of (Location of University).

**6.3.** This Agreement shall not be construed to make Student the agent, employee, partner or joint venturer of (Company Name), or of University.

**6.4.** This Agreement shall be effective as of the date of last signature below, and shall terminate on (Termination Date), unless terminated earlier upon at least 30 days prior written notification by either party; provided, however, that the obligation of confidentiality set forth herein shall survive termination of this Agreement.

**I have read this entire Agreement, understand its content and, by executing it below, signify my intent to be bound by its terms and conditions.**

\_\_\_\_\_  
DATE OF  
SIGNING:  
(Date must be filled in)

BY: \_\_\_\_\_  
PRINT NAME: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
DATE OF  
SIGNING:  
(Date must be filled in)

BY: \_\_\_\_\_  
PRINT NAME: \_\_\_\_\_  
ADDRESS: \_\_\_\_\_  
\_\_\_\_\_

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Student Case Study Agreement

Figure A1–Student case study agreement template.