STEM-ENHANCED FOOD AND NUTRITION CURRICULUM: TEACHER PROFESSIONAL DEVELOPMENT NEEDS

ABSTRACT

In 2014 Family & Consumer Sciences teachers in Utah rewrote the Food and Nutrition Sciences curriculum to bolster STEM-related content. This study is a needs assessment of the state implementation of the STEM-enhanced curriculum in 2015-2016. A Borich needs assessment model was used to analyze mean weighted discrepancy scores between teacher-perceived levels of importance and teacher-perceived teaching competence for each objective in the new curriculum. It was found although teachers felt moderately competent to teach the new curriculum, the highest ranked need for professional development was in STEM-related topics. Professional development in STEM-related objectives is recommended.

Key words: Professional Development; STEM; Food and Nutrition curriculum; Career and Technical Educationt; secondary teachers; needs assessment

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Introduction and Purpose

Career and Technical Education (CTE), has been impacted by the increasing demand for more rigorous education and accountability. In 1990, the Commission on the Skills of the American Workforce published *America's Choice: High Skills or Low Wages*, a report warning that technology was changing the needs of the entry-level workforce, requiring "more judgment and responsibility on the part of front-line workers…[necessitating] changes to the constellation of knowledge, skills, and attitudes that entry-level workers needed" (Castellano, Harrison, &

Schneider, 2008, p. 26). With the passage of Perkins IV, Career and Technical Education teachers were also charged with integrating higher level academic skills into their applied teaching coursework (Threeton, 2007). President Obama's 2009 Educate to Innovate initiative ("President Obama Launches 'Educate to Innovate' Campaign for Excellence in STEM Education," 2009) gave specific academic areas of concentration: science, technology, engineering and math (STEM). As one of the many responses to this campaign, in 2014 a Division of Workforce Services Inschool grant was written to revamp the Foods and Nutrition 1 curriculum with the intent to increase the science and math rigor in this course.

The goal of the new curriculum was to cross disciplie boundaries and bolster the academic rigor of the Food and Nutrition 1 course with science and math, while contextualizing the abstract concepts in science and math with food applications. The Utah STEM enhanced Food and Nutrition 1 curriculum was developed and pilot tested with 19 Family and Consumer Sciences (FCS) teachers and implemented statewide at the beginning of the 2015-2016 school year in Utah. The new curriculum was introduced at the Nutrition and Food Science Conference in June 2015. Four 1-hour-long workshops taught by members of the pilot group were offered twice at the Nutrition conference concerning some of the changes to the coursework and how to deal with them. Continuing with the "train the trainers" teaching model, three other workshops were presented surrounding the new standards at the 2015 CTE and Family and Consumer Sciences Summer Conference that followed the 2015 Nutrition Conference (S. Barnum, M. Milburn, & L. Schiers, personal communications, November 14 and 15, 2016).

A preliminary evaluation of the enhanced curriculum of Food and Nutrition Sciences was conducted during the Family and Consumer Science (FACS or FCS) Summer Conference in June of 2015 by Utah State University's (USU) STE2M Center (Maahs-Fladung & Feldon,

2015). However, due to the limited opportunity to implement the curriculum in the classroom during the pilot study, minimal change was found in the initial evaluation. A deeper assessment was warranted after teachers had opportunity to implement the curriculum in their classrooms.

The purpose of this study was to identify the self-efficacy of Food and Nutrition 1 teachers with the STEM-enhanced Food and Nutrition 1 curriculum after a year of classroom implementation. The specific objectives that guided this study were (1) describe Family and Consumer Sciences (FCS) teachers' perceived level of importance and perceived ability to teach the objectives in the enhanced Food and Nutrition Sciences Curriculum, (2) identify and prioritize the inservice needs of FCS teachers by curriculum objectives in the enhanced Food and Nutrition Sciences curriculum, (3) describe the demographic characteristics of FCSE teachers who responded to the survey.

Literature Review and Theoretical Framework

Career and Technical Education (CTE) professionals have responded to the STEM education crisis in U.S. high schools by increasing the STEM rigor of their project-based, applied learning courses. Currently there is a gap in the literature regarding STEM integration in the area of CTE food and nutrition courses. In examining degree graduation requirements at two major universities in northern Utah, it was found that an FCS degree had not included rigorous STEM classes (i.e., science, technology, engineering or math classes beyond a freshman or sophomore level). At Brigham Young University, 16 credit hours of course content are required that directly relate to STEM education ("Family & Consumer Sciences Education | Undergraduate Catalog," n.d.). At Utah State University, 32% of degree-specific credit hours (30 credits) of STEM-related content is required for graduation ("Program: Family and Consumer

Sciences Education - BA, BS - Utah State University - Acalog ACMSTM," n.d.). This presents new FCS teachers with a possible knowledge gap between preservice training and inservice requirements.

The STEM enhanced Food and Nutrition 1 curriculum standards are meant to cross discipline boundaries to bolster learning in food and nutrition by adding science or math to the lessons. This gives a context to support learning in science or math by applying it to food and nutrition. The new curriculum includes science labs developed by Utah State University and from the Institute of Food Technologists website. These labs include specific content on the science concepts behind each food lab. In addition, the food safety and sanitation unit in the curriculum was expanded to include information needed to pass the State Food Handlers Examination, which is used as the final summative assessment of the unit. This gives the students a commercial certification.

It is expected by Career and Technical Education professionals that family and consumer sciences (FCS) courses reinforce science, technology, engineering, and math (STEM) principles while engaging students in hands-on and relevant learning activities (Shirley & Kohler, 2012). The application of STEM concepts in food and nutrition content may provide a foundation for greater experiential learning and analysis of STEM concepts. According to the National Standards for FCS students should be able to demonstrate the use of science and technology advancements in food product development and marketing and demonstrate the principles of food biology and chemistry (NASAFACS, 2018).

The theoretical framework for this study is based on Albert Bandura's (1986) social cognitive theory. Bandura (1986) defined self-efficacy as, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of

performances" (p. 391). Bandura suggested self-efficacy plays a significant role in whether or not individuals will attempt a given task as they judge their capabilities to cope with the challenges. For example, if an individual's self-efficacy is high they are more likely to perceive the challenges as attainable given the perception of their abilities and more likely to attempt a given task. Similarly, if an individual's self-efficacy is low, they will perceive the challenges as a deterrent based on their perceived abilities and be less likely to attempt a given task (Bandura, 1977, 1986). Further, the social cognitive theory of Albert Bandura (1986, as cited in Smith, Rayfield, & McKim, 2015) posited that people, in this case teachers, who perceive they can teach a concept effectively will likely be successful in teaching that concept to students.

Using Bandura's social cognitive theory also gives a rationale for measuring the implementation of new curricula. The Borich Needs Assessment model (Borich, 1980) has teachers rate their perceived level of importance for concepts taught in the classroom, then has them rate their perceived self-efficacy in teaching the concept. These scores are compared and a mean weighted discrepancy score (MWDS) is generated. The highest discrepancy score is the area most needed for professional development and training. Any needs assessment is, practically speaking, based on Bandura's social cognitive theory that humans are agents unto themselves: they can change. Therefore, needs assessments are done to discern where needed areas of change exist so that teachers can progress in their abilities.

Methodology

The purpose of this study was to identify the self-efficacy of Food and Nutrition 1 teachers on the STEM-enhanced Food and Nutrition 1 curriculum. The specific objectives that guided this study were (1) describe the FCSE teachers' perceived level of importance and ability

to teach the objectives in the enhanced Food and Nutrition Sciences Curriculum, (2) identify and prioritize the inservice needs of FCS teachers by objective in the enhanced Food and Nutrition Sciences curriculum, (3) describe the demographic characteristics of FCS teachers.

This research study was a nonexperimental, quantitative assessment of Food and Nutrition 1 teachers in Utah. The population for this study included all Food and Nutrition 1 teachers in the state of Utah who taught the Food and Nutrition 1 class in the 2015-2016 school year and was obtained from the Utah State Office of Education (N = 206). Additionally, 12 emails bounced and 4 new FCS teachers who had taught Food and Nutrition in 2015-2016 were identified. Of that, a total of N = 198 FCS teachers received the invitation to participate in the study.

The researcher-designed instrument was developed and tested for face and content validity by a panel of experts consisting of three university faculty with expertise in research design and Family and Consumer Sciences Education. Reliability of the instrument was determined by conducting a pilot test of 19 high school Family and Consumer Science teachers who were the pilot group for the development of the curriculum and who had taught the Food and Nutrition 1 course in 2015-2016. Cronbach's alpha coefficients ranged from .50 - .96.

The first section of the Qualtrics® survey was designed in a Borich needs assessment (Borich, 1980) double matrix format containing the curriculum's six standards outlined into 23 unit objectives. The Borich needs assessment model (Borich, 1980), has been shown to be a reliable method of evaluation (Garton & Chung, 1997). The instrument listed the objectives of each of the six standards for Food and Nutrition Sciences for importance and, separately, for ability to teach. A 1-to-5 Likert-type scale was used, 1 = not important or not competent, and 5 =

very important or very competent. The next section asked demographic information including educational background, age, gender, and years teaching.

Respondents were emailed using Dillman's (2000) tailored design method (as cited in "*Summing It Up 2012*," University of New England, 2012). Data were collected using a secure online survey provider, Qualtrics®. An anonymous link to the instrument was distributed to all 198 FCS teachers. Two reminder emails were sent for a 25% (N = 50) response rate.

Findings

Objective one sought to describe the Family and Consumer Sciences teachers' perceived level of importance and their ability to teach the objectives in the enhanced Food and Nutrition Sciences Curriculum. The teachers were asked to rank on a 1 to 5 Likert scale the importance of teaching each objective and then ranked their perception of their own ability to teach that same objective.

The Likert scale for both importance and perceived ability had a range of 1 to 5, with 1 as lowest, "not important" or "not competent," and 5 as the highest, "very important" and "very competent," respectively. As shown in Table 1, the high average means in importance and ability would seem to indicate the teachers on average perceive all of the objectives in the new curriculum to be important to be taught, and also that they perceive they have the ability to teach them. The highest mean rankings for unit importance were hygiene for food handling (M = 4.89; SD = .583); sanitation (M = 4.84; SD = .367); and kitchen safety rules and guidelines (M = 4.84; SD = .424). Surprisingly, the lowest rankings in perceived ability were not in these areas. It was the ability to teach vitamins (M = 4.12; SD = 1.00) and minerals (M = 4.15; SD = .949). These

two units also had the largest standard deviations in perceived ability, indicating a wider variability in feelings of competency within the survey group.

Table 1

Importance and Ability Statistics Per Objective

Importance					Ability			
Mean	*SD*	Range	*N*	Standards and objectives	Mean	*SD*	Range	*N*
4.84	.424	2	45	St. 1, Objective 1: Kitchen Safety Rules and Guidelines	4.53	.735	3	43
4.58	.583	2	45	St. 1, Objective 2: First Aid	4.45	.739	3	42
4.89	.318	1	45	St. 1, Objective 3: Hygiene for Food Handling	4.57	.737	3	42
4.84	.367	1	45	St. 1, Objective 4: Sanitation	4.52	.804	3	42
4.69	.514	2	45	St. 1, Objective 5: Food-borne Pathogens	4.36	.850	3	42
4.38	.716	2	45	St. 2, Objective 6: Kitchen Equipment	4.60	.767	4	42
4.53	.726	3	45	St. 2, Objective 7: Abbreviations and Measurements	4.67	.570	2	42
4.53	.661	2	45	St. 2, Objective 8: Kitchen Mathematics	4.40	.857	3	42
4.67	.564	2	45	St. 2, Objective 9: Food Preparation Terminology	4.62	.697	3	42
4.47	.625	2	45	St. 3, Objective 10: Grains/Carbs	4.45	.772	3	42
4.47	.661	3	45	St. 3, Objective 11: Fiber	4.46	.897	4	41
4.31	.763	3	45	St. 3, Objective 12: Quickbreads, Pasta, Rice	4.52	.707	3	42
4.36	.712	3	45	St. 4, Objective 13: Proteins, Complete/Incomplete	4.26	.912	3	42
4.22	.795	3	45	St. 4, Objective 14: Eggs	4.48	.740	3	42
4.22	.823	3	45	St. 4, Objective 15: Milk	4.48	.804	3	42
4.47	.726	3	45	St. 4, Objective 16: Lipids	4.43	.737	3	42
4.32	.800	3	44	St. 5, Objective 17: Vitamins	4.12	1.005	4	41
4.27	.817	3	44	St. 5, Objective 18: Minerals	4.15	.949	3	40
4.57	.587	2	44	St. 5, Objective 19: Water	4.41	.805	3	41
4.49	.668	2	43	St. 5, Objective 20: Produce, Fruits and Vegetables	4.49	.711	2	41
4.22	.850	3	45	St. 6, Objective 21: Dietary Guidelines (DGA)	4.33	.846	4	42
4.27	.899	3	44	St. 6, Objective 22: ChooseMyPlate	4.52	.804	3	42
4.60	.720	3	45	St. 6, Objective 23: Healthy Eating Patterns	4.48	.862	4	42

Note. Scale: 1 = not important; 2 = of little importance; 3 = somewhat important; 4 = important; 5 = very important--- 1 = not competent; 2 = little competence; 3 = somewhat competent; 4 = competent; 5 = very competent; mode for all objectives was 5 in both importance and ability, with the exception of importance for eggs and milk, which was 4.

Objective two sought to identify and prioritize the inservice needs of FCS teachers by objective in the enhanced Food and Nutrition Sciences curriculum. The Borich needs assessment (Borich, 1980) is used to determine areas of professional development by taking the Importance scores and subtracting the Ability scores to determine the discrepancy between the two for each respondent. Each discrepancy score is weighted by multiplying it by the mean of the Importance scores. The weighted discrepancy scores are then averaged, giving the MWDS for each of the objectives (See Table 2). The highest MWDS indicates the most needed area(s) for professional development. The units on food-borne pathogens, kitchen safety rules and guidelines, hygiene for food handling and sanitation indicate a larger discrepancy in teachers' perceived importance of these curriculum standards and their perceived ability to teach them.

Table 2

STEM Enhanced Food and Nutrition 1 Mean Weighted Discrepancy Scores

Standards and Objectives	MWDS
St. 1, Objective 5: Food-borne Pathogens	1.80
St. 1, Objective 1: Kitchen Safety Rules and Guidelines	1.70
St. 1, Objective 3: Hygiene for Food Handling	1.63
St. 1, Objective 4: Sanitation	1.62
St. 5, Objective 17: Vitamins	0.84
St. 5, Objective 19: Water	0.78
St. 1, Objective 2: First Aid	0.77
St. 2, Objective 8: Kitchen Mathematics	0.76
St. 6, Objective 23: Healthy Eating Patterns	0.55
St. 5, Objective 18: Minerals	0.43
St. 3, Objective 11: Fiber	0.42
St. 4, Objective 13: Proteins, Complete/Incomplete	0.31
St. 2, Objective 9: Food Preparation Terminology	0.22
St. 4, Objective 16: Lipids	0.21
St. 5, Objective 20: Produce, Fruits and Vegetables	0.11
St. 3, Objective 10: Grains/Carbs	0

St. 6, Objective 21: Dietary Guidelines (DGA)	-0.40
St. 2, Objective 7: Abbreviations and Measurements	-0.54
St. 2, Objective 6: Kitchen Equipment	-0.84
St. 6, Objective 22: ChooseMyPlate	-0.85
St. 3, Objective 12: Quickbreads, Pasta, Rice	-0.92
St. 4, Objective 14: Eggs	-1.20
St. 4, Objective 15: Milk	-1.20

Objective three sought to describe the demographic characteristics of the FSC teachers. Two percent of the respondents were male, 98% percent of the respondents were female, and the median age was 49 with the average age of 46.5 years. The age range was 38 years, with modes at 27, 50, and 58. The median years teaching was 10 years, and the average years teaching was 12 years with a range of 33 years and a mode of 5 years. In terms of length of time teaching, gender, and age, we are looking at a majority of female, mid-career, middle-aged teachers.

Twenty-eight of 56 respondents (50%) had a Level 2 teaching license, 30% received their degree at Utah State University, and 27% received their degree from Brigham Young University, also located in Utah. Of those who responded to the question, 64% have a BS or BA, and 34% have an MS or MA. Over the years, names of degrees have changed, but assuming that “Home Ec Education” is the forerunner of Family and Consumer Sciences Education (FACSE or FCSE), then 56% of those who responded to the question are trained specifically in what we now call FCSE, with an additional 28% trained in “Home Ec” or FCS/FCS Composite degrees (81% overall in FCSE-related fields).

In order to gauge STEM education background, the respondents were asked to mark the most advanced classes they took in various STEM-related disciplines. The percentages with their course levels are mentioned in each discipline (see Table 3). As Table 3 shows, the highest percentages of STEM-related classes were in Food Science and Nutrition/Dietetics, as well as the most advanced classes. The highest level of "Did Not Take" was in the Engineering fields. As far as upper division classes (Junior and Senior level), Nutrition /Dietetics had been taken by 46% of the respondents, but only 22% took a senior level class. Food Science was slightly better overall: 39% at the junior level, and 34% at the senior level.

Table 3

Highest Level STEM-Related Classes Taken

STEM Class	Fresh. (%)	Soph. (%)	Junior (%)	Senior (%)	Grad. (%)	Did not take (%)
Biology	41.5	24.4	4.9	4.9	2.4	22.0
Biochemistry	9.8	7.3	19.5	2.4	--	61.0
Chemistry	24.4	36.6	24.4	7.3	--	7.3
Chemical Eng.	--	--	--	--	--	100.0
Engineering	5.4	--	--	--	--	94.6
Food Science	2.4	14.6	39.0	34.1	--	9.8
Mathematics	28.9	34.2	7.9	5.3	2.6	21.1
Nutrition/dietetics	4.9	17.1	46.3	22.0	--	9.8
Physics	15.4	2.6	--	--	--	82.1
Statistics	7.7	5.1	10.3	2.6	5.1	69.2

Note. Classes could be preservice or graduate degree.

Implications

Research Objectives 1, 2 and 3 specifically dealt with the FCS teachers' perceptions of the individual curriculum standards. The teachers were asked to describe their perceived level of importance and their perceived level of ability for each of the objectives within the six curriculum standards. Given these two parameters, the Mean Weighted Discrepancy Score (MWDS) between those numbers was calculated using an Excel-based Mean Weighted Discrepancy Score Calculator developed by McKim and Saucier (2011).

The range of means for the Importance scores was 4.19 to 4.9 on a 5-point Likert scale. This relatively high score for Importance seemed to indicate that, on average, the teachers felt strongly the concepts represented by the curriculum were important to very important to be taught to their students. The range of means for the perceived ability scores was 4.12 to 4.67 on a similar 5-point Likert scale. This only slightly lower score seemed to point to the conclusion that the teachers felt competent to teach the new curriculum, but not Very Competent which was the definition for a 5 rating.

The MWDS for the individual objectives ranged from -1.2 to 1.8, with an average of 42 respondents. The areas with the largest MWDS fall into Standard 1 Kitchen Safety Procedures and Sanitation Techniques: food handling safety rules and guidelines, First Aid, food handler health and hygiene, sanitation guidelines, and the identification and prevention of food-borne illnesses and contamination.

Standard 1 is foundational knowledge to have a safe food environment in the classroom, as well as important knowledge for their homes or culinary employment. The perceived efficacy scores are not particularly low, but the gap between importance and feeling competent in getting the point across to the students causes the high MWDS. There may be several reasons for

Standard 1 to be problematic: First, Standard 1 is setting up the laboratory management protocol for the classroom, so must be done at the beginning of the coursework before students understand why they must do things a particular way. Second, it is the least cooking-related unit, so students who have come for the food have the least interest in this unit, which makes it hard to teach. Third, it is arguably the most academic of the units, with the study of food-borne illness pathogens, science experiments to show sanitation or the lack thereof, and memorization of food handling rules and regulations for the Food Handler Examination, the summative assessment for this unit.

Standard 1 objective areas have frequently been requested topics of workshops at the summer conferences. In an article about - high discrepancy scores with laboratory management safety competencies in an agricultural mechanics course (Saucier, McKim, Terry, & Schumacher, 2014), it was recommended that "…pertinent and continuous inservice education should be facilitated each year and focused on one agricultural mechanics laboratory management competency at a time, beginning with the highest priority construct…" (Saucier et al., 2014, p. 40). It was also suggested the Missouri Board of Education offer graduate level credit for this inservice as an incentive to take the courses.

The idea of concentrated inservice, throughout the year, at an advanced level, for one objective at a time might also be the best way to approach Food and Nutrition Science' Standard 1. If these objectives were routinely taught in rotation throughout the year on webcasts or other online resources, as well as having hands-on labs at the summer conferences, the teachers could deepen their understanding in this content area, leading to higher competency ratings to match the higher levels of importance. It would also encourage state-wide adherence to a high level of kitchen lab safety in the high schools.

The educational background, age, gender, years teaching, licensure levels, educational degrees, and STEM-related classes taken also lend support to targeted, advanced level professional development coursework. Over one-third of the teachers who responded to the survey have already earned a master's degree in a family and consumer sciences-related field, and yet still feel less confident in teaching components of Standard 1.

As mentioned above, in asking about STEM education background, food science and nutrition were the most frequently taken STEM-related college classes, and the ones where the students went on to the more advanced Junior and Senior level classes, which would typically be outside of general education requirements. Even in food science and nutrition courses, no more than 34% of the respondents took four years of educational scaffolding in STEM-related classes. Since in the objectives portion of the survey instrument the teachers indicated they felt comfortable teaching the new curriculum in spite of the increased science rigor, the lack of a more rigorous personal STEM education background may not negatively impact teaching Foods and Nutrition at the high school level. It does, however, give academic areas of focus for more advanced professional development.

Based on Bandura's concepts of self-efficacy, more professional development training in STEM-related fields would deepen the understanding of the majority of the teachers, leading not only to a higher feeling of competency for them, but hopefully the ability to create a better learning environment for the students, giving the *students* a higher level of self-efficacy in STEM education.

A specific Nutrition, Dietetics, and Food Science endorsement, especially with higher level or graduate courses, would target specific concepts needed for Food and Nutrition 1, as

well as preparing the teacher to connect more STEM-related concepts in the advanced food classes. This, translated to further educational scaffolding for the students as they take the advanced food classes, further contextualizes advanced science and math classes for the student as well. Incentives by the school districts or the state Board of Education to gain this endorsement would encourage the teachers to continue their own learning. Collaboration with individual high schools' science, math or biology departments would also be beneficial for the teacher to see the science point-of-view on a lesson plan.

Immediate professional development target areas need to address Standard 1: Kitchen Safety and Sanitation. In particular, the food-borne illness prevention and contamination objective had the highest mean weighted discrepancy score between its importance and the teachers' perception of their ability to teach its concepts. Research could be done to investigate the possibility of university faculty partnering with the Board of Education to develop a web-based series of lectures and lab demonstrations to help the teachers understand the science behind the Standard 1 objectives. Further, Standard 1 research could be done to ascertain what exactly makes Standard 1 more problematic than the other standards. The recommendation from the agricultural mechanics laboratory management article (Saucier et al., 2014) for pertinent, ongoing inservice training on one objective (competency) at a time would work well dealing with Standard 1 topics.

Future research could also be done among the Administration of the high schools to evaluate whether the teachers' perceived competence is the same as the Administration's perception of the competence of the teachers, their curriculum and their performance.

Future research areas involving students could address how the STEM-enhanced curriculum has impacted student outcomes. Is student enrollment dropping as the Food and Nutrition 1 class becomes more STEM education-oriented and less cooking-oriented?
Are the FCS end-of-year test scores rising? Have other STEM education end-of-year scores risen in response to STEM concepts in the FCS courses? A Borich Needs Assessment could be done evaluating student self-efficacy in STEM education because of the STEM in the Food and Nutrition 1 class. If the teachers feel themselves "Competent," but not "Very Competent," what level of STEM concepts are the *students* absorbing in Food and Nutrition 1?

Conclusions

Family and Consumer Sciences educators do just that: They educate. They feel education is important, they are confident in their abilities to teach what they are asked to teach. This does not mean they should remain unsupported in teaching new curricula, particularly curricula they have not studied personally. Professional development, continuous professional development, in STEM-related disciplines needs to be developed and offered to FSC educators. It will enhance their abilities to bring abstract STEM concepts into real-world scenarios, allowing the students to move forward in a STEM-based world.

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