

Food Practices and Professional Development Needs in Food Science Among Tennessee Preservice Agriculture Teachers

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Abstract

Teacher beliefs and practices shape instruction; therefore, this study analyzed Tennessee agriculture preservice teachers' (PSTs) food practices and perceptions of food science topics to identify professional development needs. A researcher-developed survey aligned to Tennessee AFNR Food Science standards was distributed to PSTs across five AFNR teacher-preparation programs. Participants reported food practices and rated topic importance and perceived teaching ability. PD needs were estimated using Borich's mean weighted discrepancy score (MWDS). Over half reported at least one allergy/intolerance, with dairy the most common; nearly half reported avoiding milk. Overall, those without restrictive food practices indicated a greater need for professional development, but when differentiated by dairy restrictions, those reporting dairy restrictions indicated greater need for professional development. Further research is needed to determine the reasoning behind food practices of PSTs and any specific links between food practices and addressing related food science topics in the secondary classroom.

Introduction/Literature Review

Food science is a key area of study as the food products processing industry evolves and expands. As the next generation of leaders in this industry are prepared, food science teachers at the secondary level should also be prepared to address a variety of food products and processing topics in detail, and with confidence. Because secondary food science teachers may be the only expert in their field in the secondary environment, teacher preparation at the undergraduate level should address the variety of food products and processing content knowledge, to support preservice teacher (PST) self-efficacy for teaching food science topics.

Though food science is addressed in other disciplines (i.e., family and consumer sciences and dietetics), secondary agricultural education coursework may include a direct path to food science career preparation through Agriculture, Food, & Natural Resources (AFNR) career clusters. Within Tennessee's AFNR career cluster, Food Science is a relatively new program that includes four levels of coursework: (1) Agriscience, (2) Principles of Food Production, (3) Food Science and Safety, and (4) Advanced Food Science (Tennessee Department of Education, n.d.). Each course is accompanied by content standards; level 3 and 4 courses address more advanced technical knowledge and skills.

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When customers are pleased with their experience, they are more likely to share positive feedback with others. As a result, organizations invest considerable effort in evaluating customer satisfaction levels to foster loyalty and build a positive reputation (Ganpat et al., 2014).

Effectively teaching food science standards involves content knowledge, pedagogical knowledge, and self-efficacy regarding instructional practice. In-service teachers have expressed concerns about the ability to teach food science (Snider et al., 2021). In a statewide study of Tennessee agriscience teachers, Duncan et al. (2021) reported sizable gaps between perceived

importance and perceived competence for food science standards. Across 19 items tied to educational programming, 42%–92% of teachers rated items as important/very important, yet only 17%–69% felt competent/very competent performing them; for example, 83% endorsed the importance of procedures related to equipment, safety, sanitation, and quality control, while just 50%–69% reported competence. These in-service gaps underscore the need to understand professional development priorities earlier in the AFNR teacher pipeline (i.e. among PSTs). The study of self-efficacy among PSTs in various fields is well-documented (e.g., Clark & Newberry, 2019; Ma & Cavanaugh, 2018; van Rooij et al., 2019; Yurekli et al., 2020). More specifically, the relationship between self-efficacy and teaching practices has been examined in terms of how self-efficacy affects performance (Whitley et al., 2019) or student achievement (Jerrim et al., 2023). Alternatively, there are studies that consider how self-efficacy is affected by teacher preparation programs (Ma et al., 2021) and other factors (Kazu & Pullu, 2023). In general, self-efficacy has been established as a positive predictor of commitment to the teaching profession (Chesnut & Burley, 2015), which is important for teacher retention, especially as outcomes of teacher preparation programs. It is also an important consideration for designing professional development (Seneviratne et al., 2019). However, personal food practices may affect food-related education and recommendations (Clark et al., 2022).

Teacher beliefs affect science teaching in general (Alt, 2018; Lotter et al., 2018) and may affect food science teaching specifically because beliefs surrounding food manifest in daily practices and food choices. Since university students tend to restrict their dietary practices as evidenced by the increase prevalence of vegetarian diet choices (Olfert et al., 2022), it is reasonable to consider this personal characteristic of PSTs, especially where their food practices might intersect with curricular food science topics. Specifically, food practices that involve omission of food groups (i.e., dairy) may affect the PST's perceived importance of related food science topics and the perceived ability to teach those topics. Currently, regarding AFNR PSTs, no studies have simultaneously investigated food practices, self-efficacy, and perceived importance regarding various food science topics. While prior work with in-service teachers in Tennessee has documented importance–competence discrepancies in food science instruction (Duncan et al., 2021), no studies have simultaneously examined PSTs' food practices alongside perceived importance and perceived ability, which is an omission this study addresses.

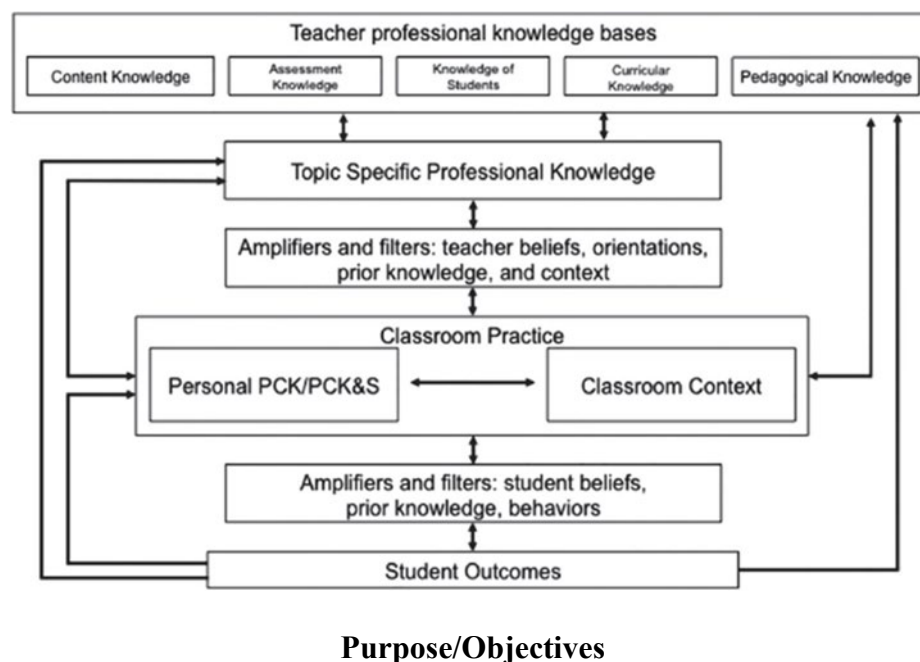
In the conceptual framework of this study, we posit that teacher beliefs and practices are pivotal in shaping classroom practices, as explained by Gess-Newsome (2015). This framework adopts Gess-Newsome's (2015) model, shown in Figure 1, of teacher professional knowledge and skill, inclusive of pedagogical content knowledge (PCK), to explain the processes through which teacher beliefs and practices influence classroom instruction. Central to this model is the notion of amplifiers and filters – person attributes unique to each teacher – that mediate the impact of professional development on classroom practices. The researchers characterize perceived importance of food science topics, perceived ability to teach those food science topics, and food practices as potential amplifiers or filters that might influence classroom instruction.

Because food practices tend to elicit defensive behaviors (Hinrichs et al., 2022), the inclusion of food practices as an amplifier or filter is based on the understanding that these practices represent the unique beliefs and values of an individual teacher of food science. This recognition underscores the nuanced manner in which individual beliefs and values, particularly

those related to food, can serve as significant determinants of the extent to which professional development influences classroom practices. Similarly, both perceived importance of food science topics and perceived ability to teach those topics would serve as an amplifier or filter. Gess-Newsome's (2015) model provides a comprehensive understanding of the interplay between teacher professional knowledge, individual amplifiers and filters, and their collective influence on classroom practices thereby offering insights into the personalized nature of teacher development and its implementation in educational settings.

Figure 1

Model of Teacher Professional Knowledge and Skill (Gess-Newsome, 2015)



The purpose of this study was to describe Tennessee agriculture PST food practices, perceived importance of teaching food science topics, and perceived ability of teaching food science topics. Concepts of competence, self-efficacy, and perceived ability are sometimes conflated and can overlap (Baraka's, 2011; Lauermann & ten Hagan, 2021). For this study, the researchers operationalize perceived ability as a reflection of self-efficacy to teach specific topics and the subsequent expectation of success in student performance.

Many studies have examined associations between personal practices among future professionals with the idea that personal practices may act as a bias or filter in professional practice. Examples include prevalence of eating disorders among nutrition students (Mahn & Lordly, 2015), health practices among nursing students (Bryer et al., 2013), and exercise habits of physical therapy professionals (Chevan & Haskvitz, 2010). In practice, these professionals have the potential to influence food and health practices of the populations they serve. Future agriculture teachers, especially those teaching food science, will not be exempt from this potential influence on their students in the food science classroom. Therefore, the research questions were:

1. What dietary practices and food preferences are reported by Tennessee AFNR PSTs?
2. What are the professional development needs of Tennessee AFNR PSTs?
3. What differences exist, if any, in the professional development needs of Tennessee AFNR PSTs based on dietary restrictions, in general?
4. What differences exist, if any, in the professional development needs of Tennessee AFNR PSTs regarding dairy-specific food science topics based on dairy-related dietary restrictions?

Methods/Procedures

This study employed a researcher developed survey aligned with two Tennessee AFNR Food Science courses: (a) Food Science and Safety and (b) Advanced Food Science (Tennessee Department of Education, 2021). The instrument comprised three sections: (a) food practices, (b) perceived importance, and (c) perceived teaching ability for standards aligned topics. Food practice items were derived from typical dietary behaviors, such as avoidance or consumption of gluten, eggs, dairy, and meat, as related to AFNR Food Science topics. To ensure comparability with prior work, items measuring perceived importance and perceived teaching ability were adapted from Duncan et al. (2021), originally developed for in service Tennessee agriscience teachers. Participants rated the perceived importance of each topic on a 5-point Likert-type scale (1 = not important, 5 = very important) and their perceived teaching ability on a 5-point Likert-type scale (1 = strongly disagree, 5 = strongly agree), following Garton and Chung (1997).

Face and content validity were evaluated by an expert panel of individuals comprised of university faculty in food science and agriculture ($N = 13$), similar to the approach used by Duncan et al. (2006). Cronbach's alpha reliability coefficients were calculated to measure internal consistency as described by Taber (2018). Cronbach's α was .85 for perceived importance and .79 for perceived ability.

The target population for the study was undergraduate students (PSTs) enrolled in agricultural education coursework at the time of data collection across all five universities offering agriculture teacher preparation programs in Tennessee ($N = 92$). Census sampling, where researchers attempt to survey all members of a population (Lodico et al., 2006) was used. University faculty distributed the survey to their students by providing a Qualtrics link. A total of 29 respondents (32%) completed the survey. Most respondents were upperclassmen (72%) between the ages of 18 and 21 (93%). Most identified as White (93%) and female (79%). In addition, 86% reported taking agricultural courses in high school, and among those students, 88% had taken these courses for all four years.

Results

Food Practices of AFNR PSTs

Research question one sought to identify the dietary practices and food preferences of Tennessee AFNR PSTs. To answer this question, descriptive statistics (frequencies and percentages) were calculated for participant-reported dietary patterns, allergies or intolerances,

and specific food preferences. Table 1 summarizes the reported dietary practices and preferences. Of the 29 participants, 93% ($n = 27$) reported following a typical American diet. Of all participants, 55% ($n = 16$) reported at least one allergy (or intolerance) to specific foods, with dairy accounting for 50% ($n = 8$) of all reported allergies. Table 1 shows all allergies reported by participants. Whether due to preference or allergy, 48% ($n = 14$) of students reported avoidance of milk. Regarding protein sources, 20% ($n = 6$) of students reported avoidance of whole eggs, but no students reported avoidance of red meat. Regarding produce, 24% ($n = 7$) preferred purchasing organic produce instead of conventionally grown produce.

Table 1*Food Practices*

Type of Food Practice	Number (N = 29)	Percentage
Diet		
Typical American Diet	27	93%
Keto	2	7%
Allergies/Intolerances		
None	15	53%
Dairy	8	28%
Gluten	1	3%
Eggs	1	3%
Red meat	1	3%
Soy	1	3%
Nuts	1	3%
Shellfish/seafood	1	3%
Apples	1	3%
Dairy		
Consume all dairy	14	48%
Avoid all dairy	1	3%
Consume dairy but not milk	14	48%
Prefer raw milk	2	7%
Organic Produce		
Does not prefer to buy organic	22	76%
Prefer to buy organic	7	24%
Egg Consumption		
Consumes eggs in any form	23	79%
Only in baked products	4	14%
Avoid eggs in any form	2	7%

The second research question sought to identify the professional development needs of Tennessee AFNR PSTs. To answer this question, mean weight discrepancy scores (MWDS) as described by McKim and Saucier (2011) were calculated using the Borich (1980) needs assessment model. Discrepancy scores were determined by subtracting the perceived ability

score (Table 2) from the perceived importance score (Table 3) for each participant for each topic. The weighted discrepancy scores were calculated by multiplying the raw discrepancy score for each topic by the mean importance score. The MWDS for each topic was calculated by dividing the sum of the weighted discrepancy scores by the number of participants. The purpose of determining the MWDS for each topic was to identify the highest scores, indicating the greatest need for interventions (i.e., training through formal education or professional development) as described by Borich (1980).

Teachers perceived their strongest ability in teaching general safety guidelines for meat, poultry, and eggs, with a mean of 3.52 ($SD = 1.18$). Teaching chemical processes and interactions of food components in baked goods was lowest among the topics with a mean of 2.83 ($SD = 1.39$). The grand mean for perceived ability to teach food science topics was 3.29 ($SD = 1.28$) which was relatively neutral (i.e., “neither agree nor disagree”) with only two topics they somewhat agreed (indicated by means greater than 3.5) they could teach: (a) changes in produce from field to table; and, (b) teaching general safety guidelines for meat, poultry, and eggs.

Table 2

Perceived Ability to Teach

Item	<i>M</i>	<i>SD</i>
Explain changes in produce from field to table, including transport and storage.	3.51	1.18
Teach general safety guidelines for fruit and vegetables.	3.17	1.34
Teach procedures for preparation, processing, and quality testing for fruit and vegetable products.	3.17	1.34
Teach general safety guidelines for dairy products.	3.45	1.33
Describe procedures for preparation, processing, and quality testing for milk and dairy products like buttermilk, yogurt, ice cream, and cheeses.	3.45	1.33
Teach general safety guidelines for meat, poultry, and eggs.	3.52	1.18
Describe procedures for preparation, processing, and quality testing for meat, poultry, and eggs.	3.28	1.19
Explain chemical processes and interactions of food components in baked goods.	2.83	1.39
Grand Mean Score	3.29	1.28

As with perceived ability, teachers perceived that understanding general safety guidelines for meat, poultry, and eggs was the most important with a mean of 4.57 ($SD = 0.68$). Also, like perceived ability, the topic perceived to be least important was understanding chemical processes and interactions of food components in baked goods with a mean of 3.90 ($SD = 0.92$). The grand mean for perceived importance of food science topics was 4.33 ($SD = 0.73$) which indicates that PSTs perceived most topics to be important.

Table 3

Perceived Importance of Teaching

Item	<i>M</i>	<i>SD</i>
Understanding changes in produce from field to table, including transport and storage	4.37	0.61
Understanding general safety guidelines for fruit and vegetables.	4.37	0.76
Understanding procedures for preparation, processing, and quality testing for fruit and vegetable products.	4.27	0.78
Understanding general safety guidelines for dairy products.	4.4	0.67
Understanding procedures for preparation, processing, and quality testing for milk and dairy products like buttermilk, yogurt, ice cream, and cheeses.	4.30	0.75
Understanding general safety guidelines for meat, poultry, and eggs.	4.57	0.68
Understanding procedures for preparation, processing, and quality testing for meat, poultry, and eggs.	4.43	0.72
Understanding chemical processes and interactions of food components in baked goods.	3.90	0.92
Grand Mean Score	4.33	0.73

On a 5-point Likert-type scale, the MWDS can range from -4 to 20, with positive scores indicating varying needs for further educational intervention since self-efficacy falls short of perceived importance (Narine & Harder, 2021). Higher numbers indicate larger discrepancy between the perceived importance and perceived ability and therefore indicate greater needs for professional development. Table 4 shows the MWDS for food science topics in order of highest to lowest needs. Procedures for preparation and safety guidelines for fruits and vegetables showed the highest scores, while transport and storage for fruit and vegetables showed the lowest scores.

Table 4

Professional development needs of Tennessee AFNR PSTs

Item	MWDS
Teaching procedures for preparation, processing, and quality testing for fruit and vegetable products.	5.26
Teaching general safety guidelines for fruits and vegetables	5.09
Teaching procedures for preparation, processing, and quality testing for meat, poultry, and eggs.	5.02
Teaching procedures for preparation, processing, and quality testing for milk and dairy products like buttermilk, yogurt, ice cream, and cheeses.	5.02
Teaching general safety guidelines for meat, poultry, and eggs.	4.55
Teaching general safety guidelines for dairy products.	4.08
Teaching chemical processes and interactions of food components in baked goods.	3.99
Explain changes in produce from field to table, including transport and storage	3.59

Research question three sought to identify differences in the professional development needs of Tennessee AFNR PSTs based on dietary restrictions. To contextualize perceived

importance and perceived ability in terms of food practices, Table 5 shows the mean scores for those reporting restrictive diets (i.e. keto diets or restrictions due to one or more food allergies) and for non-restrictive diets (i.e. a typical American diet and no allergies/intolerances). More PSTs reported restrictive practices ($n = 22$) than those with no restrictions ($n = 7$). These data show that those with restrictive food practices showed lower perceived importance of all topics (grand mean = 4.19, $SD = 0.21$) than those with no restrictions (grand mean = 4.61, $SD = 0.23$). Conversely, those with restrictive food practices showed higher perceived ability to teach all topics (grand mean = 3.31, $SD = 0.30$) compared to those with no restrictions (grand mean = 3.06, $SD = 0.31$) except the topic regarding baked goods.

Table 5*Mean Perceived Importance and Perceived Ability*

Perceived Importance	Mean score for Restrictive Diets (n=22)	Mean score for Non-Restrictive Diets (n=7)
Produce from field to table	4.27 (<i>SD</i> 0.63)	4.57 (<i>SD</i> 0.53)
Produce safety	4.27 (<i>SD</i> 0.77)	4.57 (<i>SD</i> 0.79)
Produce processing	4.05 (<i>SD</i> 0.90)	4.57 (<i>SD</i> 0.53)
Meat processing	4.32 (<i>SD</i> 0.78)	4.71 (<i>SD</i> 0.49)
Meat safety	4.45 (<i>SD</i> 0.74)	4.86 (<i>SD</i> 0.38)
Baked goods	3.77 (<i>SD</i> 0.92)	4.14 (<i>SD</i> 0.90)
Dairy safety	4.23 (<i>SD</i> 0.69)	4.86 (<i>SD</i> 0.38)
Dairy processing	4.18 (<i>SD</i> 0.80)	4.57 (<i>SD</i> 0.53)
Grand Mean	4.19 (<i>SD</i> 0.21)	4.61 (<i>SD</i> 0.23)
Perceived Ability	Mean score for Restrictive Diets (n=22)	Mean score for Non-Restrictive Diets (n=7)
Produce from field to table	3.55 (<i>SD</i> 1.26)	3.43 (<i>SD</i> 0.98)
Produce safety	3.41 (<i>SD</i> 1.30)	2.43 (<i>SD</i> 1.27)
Produce processing	3.05 (<i>SD</i> 1.21)	2.86 (<i>SD</i> 1.21)
Meat processing	3.32 (<i>SD</i> 1.21)	3.14 (<i>SD</i> 1.21)
Meat safety	3.64 (<i>SD</i> 1.18)	3.29 (<i>SD</i> 1.38)
Baked goods	2.77 (<i>SD</i> 1.45)	3.00 (<i>SD</i> 1.29)
Dairy safety	3.50 (<i>SD</i> 1.26)	3.29 (<i>SD</i> 1.60)
Dairy processing	3.14 (<i>SD</i> 1.28)	3.00 (<i>SD</i> 1.29)
Grand Mean	3.29 (<i>SD</i> 0.29)	3.06 (<i>SD</i> 0.31)

The MWDS is listed for each topic differentiated by restrictive practices in Table 6. All scores are positive, indicating a need for intervention, but those with no dietary restrictions score consistently higher than those with restrictive practices indicating a higher priority professional development for those with non-restrictive diets. The highest MWDS is 9.80 among those with no dietary restrictions for teaching safety guidelines for fruits and vegetables. The lowest score in this set of data is 3.07 for those with restrictive practices for teaching safety for dairy products.

Table 6*Mean Weight Discrepancy Score per Food Practice Category*

Item	Food Practice Category	MWDS
Teaching procedures for preparation, processing, and quality testing for fruit and vegetable products.	Restrictive	4.05
	Non-restrictive	7.83
Teaching general safety guidelines for fruits and vegetables	Restrictive	3.69
	Non-restrictive	9.80
Explain changes in produce from field to table, including transport and storage	Restrictive	3.11
	Non-restrictive	5.22
Teaching procedures for preparation, processing, and quality testing for meat, poultry, and eggs.	Restrictive	4.32
	Non-restrictive	7.41
Teaching general safety guidelines for meat, poultry, and eggs.	Restrictive	3.64
	Non-restrictive	7.63
Teaching procedures for preparation, processing, and quality testing for milk and dairy products like buttermilk, yogurt, ice cream, and cheeses.	Restrictive	4.37
	Non-restrictive	7.19
Teaching general safety guidelines for dairy products.	Restrictive	3.07
	Non-restrictive	7.63
Teaching chemical processes and interactions of food components in baked goods.	Restrictive	3.77
	Non-restrictive	4.74

The fourth research question sought to identify differences in the professional development needs of Tennessee AFNR PSTs regarding dairy-specific food science topics based on dairy-related dietary restrictions. Since the most common dietary restriction reported was related to dairy, participants were again separated into two groups, this time by dairy restriction ($n = 8$) and no dairy restrictions ($n = 21$) instead of general restrictions. The MWDS is listed for each topic differentiated by dairy-restrictive practices in Table 7. Those with more restrictive diets showed lower perceived importance and higher perceived ability, except that those with a dairy restriction reported lower perceived ability for teaching dairy safety. Regarding both dairy-related topics, the MWDS was higher for those with dairy restrictions, suggested greater need for development for those reporting dairy restrictions than those without restrictions.

Table 7*Dairy Perceived Importance and Ability with MWDS*

	Perceived Importance	Perceived Ability	MWDS
Dairy Restriction (n=8)			

Dairy safety	4.13 (<i>SD</i> 0.35)	3.25 (<i>SD</i> 1.67)	4.26
Dairy processing	4.13(<i>SD</i> 0.64)	3.25 (<i>SD</i> 1.39)	5.57
No Dairy Restriction (n=21)			
Dairy safety	4.48 (<i>SD</i> 0.75)	3.52 (<i>SD</i> 1.21)	3.61
Dairy processing	4.33 (<i>SD</i> 0.79)	3.05 (<i>SD</i> 1.24)	3.61

Conclusions, Implications, and Recommendations

This study first described the dietary practices and food preferences of Tennessee AFNR PSTs. A notable finding was the high prevalence (28%) of food allergies in this population compared to less than 2% in the general U.S. population (Gupta et al., 2019). It is possible that allergies in this population were overestimated by participants, as Gupta et al. (2019) found that self-reported allergies were almost double the estimated prevalence. The possible overestimation of allergies especially applies to the high prevalence of dairy allergies (50% of allergies, and 28% of all participants). Interestingly, those Gupta et al. (2019) suggest higher prevalence between ages of 18 and 29 years old (the typical age of the study population), but still only 2.4%. The prevalence or severity of medically confirmed dairy allergies is not diminished by these findings; however, the possibility of unnecessary food restrictions based on beliefs is highlighted. Such restrictions have implications for teaching, as MWDS results showed that those with dairy restrictions reported greater need for educational intervention than those without restrictions. Given the number of Food Science Standards that relate to dairy (Tennessee Department of Education, 2021, *Food Science and Safety*), this may be an important consideration for preparation of PSTs.

Beyond food practices, the needs assessment indicated meaningful discrepancies between perceived importance and perceived ability across topics. All MWDS values are positive, indicating further needs for professional development to address the differences between perceived importance of a topic and perceived ability for teaching. The highest need appears to be around safety guidelines for fruits and vegetables. These MWDS priorities, particularly in produce safety and processing, align with in-service gaps reported by Duncan et al. (2021) in safety, sanitation, processing, and quality-control content, and extend that work by linking dairy-related needs to PSTs' personal food practices. Given the rising popularity of plant-based food practices (Clem & Barthel, 2021), and the development of specific products to meet this demand (Singh et al., 2021), topics in fruit and vegetable processing and safety may also rise in importance. Considering that the top needs for professional development in this study relate to processing and safety of plant-based products, universities may need to evaluate their programs to meet this change in the industry, especially to meet the demand of plant-based meat alternatives (PBMA; Clem & Barthel, 2021). These findings support the framework proposed by Gess-Newsome (2015), where personal practices and beliefs may serve as amplifiers or filters influencing self-efficacy and professional development needs in teaching food science.

The study had several limitations. First, because the population of this study focused on undergraduate PSTs in Tennessee, results cannot be generalized to education programs in other

states. Also, PSTs were in varying stages of their studies, so data collected toward completion of their studies may offer more reliable data as to how they perceive food science topics regarding importance and ability to teach. Another limitation is the reliance on self-reported data in terms of dairy restrictions in that there is no information as to why students restricted dairy, especially to differentiate between restrictions due to preferences or a clinically diagnosed condition. This point would be helpful in future studies. An additional limitation is that there was no measurement of actual competency in the classroom, which would require more in-depth data collection.

Implications of this study are related to awareness of food practices among AFNR PSTs who will guide secondary students toward careers in the food industry. Dairy, the most prevalent restrictive food practice in this study, is an industry that is prone to misconceptions about the relationship of dairy and health which has negative implications for the dairy industry (Redding et al., 2021). Since the prevalence of dairy restrictions is higher in this sample of AFNR PSTs than in the general population, more information is needed to determine if AFNR PSTs hold these misconceptions, and if their food practice preferences affect their attention to this topic in the classroom. Identifying and addressing possible underlying misconceptions and effects of restrictive food practices on actual teaching practices would be important aspects of improving pedagogical content knowledge and self-efficacy in teaching these topics.

Further research is needed to determine the reasoning behind food practices of PSTs, and any specific links between food practices and addressing these food science topics in the secondary classroom. For example, food practices may affect the time spent on certain topics, or the development of experiential learning for those topics. For the development of PSTs, future studies might examine these data only upon completion of the program as our participants were in varying stages of study. Finally, further research is needed to determine if in-service teachers have the same results (needs for professional development in produce processing and safety) based on the Borich model.

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