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SERVSAFE® EXAM: STUDENT'S MEMORY RETENTION TWO YEARS LATER

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SERVSAFE® EXAM:
STUDENT'S MEMORY RETENTION TWO YEARS LATER

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in
the College of Agriculture, Food and Environment
at the University of Kentucky

By
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Lexington, KY

2015

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ABSTRACT OF THESIS

SERVSAFE® EXAM: STUDENT'S MEMORY RETENTION TWO YEARS LATER

This study analyzed the memory retention of University of Kentucky Dietetic and Hospitality students as it relates to food safety and sanitation knowledge originally presented on the ServSafe® certification exam. Dietetic and hospitality students take the ServSafe® certification course during the sophomore year of their degree program, but they are responsible for the sanitation and food safety information throughout their entire program of undergraduate study. The final sample consisted of 25 participants, with 84% (n=21) in the Dietetics program and 16% (n=4) in the Hospitality, Management and Tourism program. The mean difference in total score, domain one, domain two, domain three, domain four and domain five were statistically significant with a p-value <0.05. Domain three was the domain students recalled the most with a difference of 16.52%. Domains four and five were recalled least by students with a difference of 35.8% and 35.65%. The information found in this study can be used in the Department of Dietetic and Human Nutrition (DHN) and the Department of Hospitality, Management and Tourism (HMT) to enhance the food sanitation knowledge of students throughout their courses.

KEYWORDS: Foodborne Illness, Food Safety and Sanitation, Domain, Food Code, ServSafe®

Laura Elizabeth Tincher
April 10, 2015

SERVSAFE® EXAM:
STUDENT'S MEMORY RETENTION TWO YEARS LATER

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Chapter One

Introduction

The ServSafe® Food Safety Program for Managers offers food safety training, exams and educational materials to foodservice managers. Successful completion of the exam results in Food Protection Manager Certification, accredited by the American National Standards Institute (ANSI)-Conference for Food Protection (CFP). This certification is recognized by more federal, state and local jurisdictions than any other food safety certification and nationally recognized in industry as the gold standard in training managers how to protect customer health.

There are five domains to the ServSafe® course. The domains include: implement food safety Standard Operating Procedures (SOPs); employee hygiene and health; receipt, storage and transport; food preparation, display and service; and compliance with regulations. At the University of Kentucky in the Departments of Dietetics and Human Nutrition (DHN) and Hospitality, Management and Tourism (HMT), students require knowledge of the five domains in order to ensure food safety in all nutrition food laboratory courses. It is especially important during the Quantity Food Production (Lemon Tree Café) course, where dietetic and hospitality students prepare a three-course meal for 50 individuals dining at the café every Tuesday and Thursday throughout both the fall and spring semesters. Students prepare a quality meal, serve the food, provide leadership and manage the operation with guidance from faculty and staff. Students rotate through various predetermined stations to perform the duties of back of the house manager, preparation staff, front of the house manager, service staff, and sanitary service

staff. In this process, students experience the real life hand-on industry operations that are imperative to managing a restaurant or foodservice operation.

Problem Statement

Dietetic and hospitality students take the ServSafe® certification course during the sophomore year of their degree program, but they are responsible for the sanitation and food safety information throughout their entire program of undergraduate study. Most students who take the Quantity Food Production class their senior year need constant reminders about general food safety issues.

Purpose Statement

The purpose of this study is to test students in the Quantity Food Production course on their current knowledge of food safety sanitation based on the five domains from the ServSafe® Certification Exam.

Research Objectives

There is limited research on the ServSafe® exam and memory retention of the knowledge from the DHN 241 Food Safety Sanitation course. This study intends to determine if students are able to recall specific food safety knowledge from the ServSafe® exam taken two years prior. The specific objectives of this study are:

1. To determine student's recall of knowledge from the original sanitation and food safety exam the students took as sophomores.
2. To determine which knowledge domains of the exam had the highest and lowest retention rate.

Research Questions

The questions that support this research are:

1. How much knowledge from the five domains of the ServSafe® exam do students retain two years later?
2. Which domain has the lowest retention rate?
3. Which domain has the highest retention rate?

Justification

Food safety knowledge is very important when working in a restaurant or any other establishments that prepares food for the public. Food can become contaminated in several ways. It only takes a simple mistake when handling food to cause a foodborne illness.

Food can also become contaminated by food handlers. The food handler can transfer microbes by using the same knife, cutting board, or other utensils for all food being prepared, causing cross contamination. Fully cooked foods can become contaminated if the food comes in contact with raw products. If food handlers leave products sitting out overnight instead of placing it in the refrigerator, one bacterium can reproduce by dividing itself every half hour and can produce 17 million bacteria in 12 hours (CDC, 2012). Since students will be handling food in several capstone courses, it is important for them to handle food safely.

Dietetic and Hospitality students take the ServSafe® exam course sophomore year of their coursework. An introductory food laboratory course introduces food science principles and cooking techniques. Food safety is emphasized, but sampling occurs among students and no food is served to outside customers. The next food laboratory course, Quantity Food Production, is usually taken during a student's senior year. In the Quantity Food Production class, students prepare quality food in quantity, preparing a

three-course meal for 50 people, two days a week for one semester. Students learn what it takes to implement cost control measures and how to manage a restaurant, while practicing hospitable treatment towards the paying guests.

In order to assure food safety is emphasized during this course; students must take the prerequisite ServSafe® course and successfully complete the certification exam before enrolling. However, the students are taking Quantity Food Production two years after completing the certification exam. This study will test students enrolled in Quantity Food Production of their current knowledge of the five ServSafe® domains to determine which domain knowledge students recall the best and to determine areas of improvement in the course work to ensure all students stay knowledgeable on food safety.

Assumptions and Limitations

Throughout this study it is assumed that all students in Quantity Food Production have successfully completed the ServSafe® exam course as it is a prerequisite for all food laboratory courses. It is also assumed when students in Quantity Food Production are tested on their knowledge of the five domains they answer to the best of their ability. Since the wordings of the follow-up questions are not exactly what ServSafe® has written, not all information may be accurately reflected. A limitation of this study is the mindset of the student when being tested on the five domains. Another limitation is the small sample size. This study has no intent to sully the ServSafe® name.

Chapter 2

Literature Review

There has been limited research in memory retention in regards to food safety and sanitation practices. This study is meant to add to the literature by comparing correct food safety question answers of dietetic and hospitality students from Food Service Sanitation (DHN 241) to Quantity Food Production (DHN 342) at the University of Kentucky. This review of literature is meant to give a clearer understanding of foodborne illness, food safety, restaurants and foodborne illness, the ServSafe® program, and learning and memory retention.

Foodborne Illnesses

Definition. A foodborne illness is any illness that results from the consumption of food containing a pathogenic bacteria, virus, contaminated food, parasites, as well as chemical and natural toxins (ex. Poisonous mushrooms). A foodborne illness outbreak can occur when a group of people consume the same contaminated food and more than one person is diagnosed with the same illness around the same time. The main contributor to a foodborne illness outbreak is when contaminated food is left at room temperature for many hours which allows the bacteria to multiply and then be insufficiently cooked to kill the bacteria (Centers for Disease Control (CDC), 2012).

There are many different symptoms that occur with foodborne illnesses. The most common symptoms include: nausea, vomiting, abdominal cramps and diarrhea. The most common foodborne infections occur from *Campylobacter*, *Clostridium perfringens*, Norovirus, and *Salmonella* (CDC, 2012). *Campylobacter* is a bacterial pathogen and when ingested causes fever, diarrhea, and abdominal cramps. Eating undercooked

chicken, or other food that has been contaminated with the juices from raw chicken, is the most common source of *Campylobacter*. *Clostridium perfringens* is a spore-forming gram-positive bacterium and is found in environmental sources and the intestines of animals and humans and can produce a toxin that causes illness. It is present on raw meat and poultry and survives with little or no oxygen. Norovirus causes an acute gastrointestinal illness causing more vomiting over diarrhea and generally resolves after three days. Norovirus spreads primarily from human to human. It spreads through contaminated food, water, and environmental surfaces. An infected kitchen worker can contaminate food they are preparing. Also, sewage discharge into coastal growing waters can contaminate oysters before they are harvested. *Salmonella* is a bacterium found in the intestines of reptiles, birds and mammals. The common symptoms include fever, diarrhea and abdominal cramps. In individuals with poor health or weakened immune systems, the bacterium can enter the bloodstream and cause life-threatening infections (CDC, 2012).

The following is a list of foods that are most associated with foodborne illness:

- Raw foods of animal origin (raw meats, poultry, raw eggs, unpasteurized milk, and raw shellfish)
- Fruits and vegetables consumed raw. Washing can decrease the risk but not completely eliminate the contamination (CDC, 2012).

Prevalence. The CDC estimates that foodborne illnesses affect one in six (16.67%) Americans each year. There are known pathogens (31) and unspecified agents that cause foodborne illness. The known pathogens accounted for 20% (9.4 million) of foodborne illness, 44% (55,961) of hospitalizations, and 44% (1,351) of deaths due to foodborne illness. The unspecified agents accounted for 80% (38.4 million) foodborne

illness, 56% (71,878) hospitalizations, and 56% (1,686) deaths due to foodborne illness. According to the Center for Disease Control (CDC), the top five pathogens causing foodborne illnesses are Norovirus (58%), *Salmonella*, nontyphoidal (11%), *Clostridium perfringens* (10%), *Campylobacter spp.* (9%), and *Staphylococcus aureus* (3%). *Salmonella*, nontyphoidal was also the top pathogen responsible for hospitalization (35%) and deaths (28%), while Norovirus accounted for 26% of hospitalizations and 11% of deaths from foodborne illness. The CDC indicates that if the occurrence of foodborne illness was decreased by 10%, it would keep 5 million Americans from getting sick each year (CDC, 2011). According to the Food Safety Progress Report for 2012, *Campylobacter* cases increased by 14%, and *Vibrio* increased by 43% while *Escherichia coli* (*E. coli*), *Listeria*, *Salmonella*, and *Yersinia* had no change in occurrence (CDC, 2012).

There have been many steps taken to reduce the incidence of foodborne illness in the United States, the most recent being the Food Safety Modernization Act (FSMA) of 2011. This act was the first major national legislation on food protection in more than 70 years. FSMA recognizes the need for training foodservice employees and calls for training for state and local regulatory officials. This act also directs the Food and Drug Administration (FDA) to invest in food safety programs for its state and local partners. This supports the Integrated Food Safety System (IFSS) strategy of joining food safety efforts at all levels of government into one unified system (Kaml et al., 2013).

Food Safety

“A food safety culture goes beyond the fundamentals of a food safety management system- compromised of regulatory compliances, standard operating

procedures, policies, training and auditing- and incorporates communication efforts, awareness of responsibilities, commitment by management and consideration of the entire organization as an integrated system that can affect food safety”(Powell, D., Jacob,C., & Chapman, B., 2011).

Food can become contaminated in several ways. Healthy animals may have foodborne microbes present in their intestines. Fresh fruits and vegetables can become contaminated when washed or irrigated in water that is contaminated with animal manure or human sewage. Eggs can become infected with *Salmonella* before the shell is formed from a hen having infected ovaries. Food can also become contaminated by food handlers. The food handler could transfer microbes by using the same knife, cutting board, or other utensils for all food being prepared. Fully cooked foods can become contaminated if the food comes in contact with raw products. If food handlers leave products sitting out overnight instead of placing it in the refrigerator, one bacterium can reproduce by dividing itself every half hour and can produce 17 million bacteria in 12 hours. When food is left in the temperature danger zone (40°F - 140°F), food becomes contaminated and should be discarded (CDC, 2012).

Foods high in salt, sugar, or acid level keep bacteria from reproducing. Also, heat kills microbes. When food is heated to an internal temperature above 160°F, it kills parasites, viruses and bacteria, except for *Clostridium* toxin. *Clostridium* toxin is only killed at boiling temperatures (CDC, 2012).

Food safety in college students. Within the limited research focusing on college students and food safety practices, it has been concluded that college students use unsafe practices and risky food handling when it comes to preparing food (Yarrow, L., Remig,

V., & Higgins, M., 2009). The purpose of Yarrow et al. study was to look at college student's self-reported practices, knowledge, beliefs and attitudes among health and non-health majors to determine if an educational intervention could improve these variables. The results from this study showed that fifty eight (58%) percent of health majors were certified compared to just twenty-nine (29%) of non-health majors and the only reason health majors were certified was due to a requirement of certification through coursework. After the educational intervention, students' mean rating of "If I follow safe food handling practices, my chances of sickness would decrease" went from strongly disagree to strongly agree. Also, students' belief that they would get sick if they did not wash their hands prior to preparing food and if they left cooked food out of the refrigerator for more than two hours could result in sickness increased. The results also indicated that students became more aware that they should not prepare food for others if they are experiencing diarrhea (correct response went from 49% to 88%) , that the internal cooking temperature of hamburger meat should be 160 degrees Fahrenheit (correct response went from 39% to 64%) and that egg yolks and whites should be cooked until firm to kill harmful bacteria (correct response went from 61% to 81%) This study showed that even though knowledge was increased, 5 weeks after the intervention the non-health majors showed no improvement in behavior. This showed that even though the attitudes of the students were changed for a short amount of time, it did not mean that the new attitude will replace the old attitude (Yarrow et al., 2009).

Another study by Lazou et al. also found that young adults have an insufficient level of food safety awareness. The majority of the young adults tested knew about proper food safety procedures but did not comply with cross contamination being the

lowest in compliance. The results showed that seventy two percent (72%) use visual indicators instead of a thermometer to determine when food was ready to eat. Seventy eight percent (78%) stated they ate left overs without properly reheating and that seventy percent (70%) were unaware of what the correct temperature should be for different food items. In this particular study, they compared non-health related fields to health related fields and found that even though health related fields scored higher on the assessment than non-health related fields, they still showed poor knowledge of correct food safety practices (Lazou et al., 2012).

Restaurants and Foodborne Illness

Fifty-nine percent (59%) of foodborne illnesses are traced to restaurants. With the restaurant industry growing every year since 1991, an increasing number of meals are eaten away from home (York et al., 2009). The restaurant industry generates \$537 billion in sales annually which makes up five percent (5%) of gross domestic products. On average, an individual purchases meals away from home five times per week, spending \$1054 annually (Howells et al., 2008). The restaurant industry employs 13.1 million employees and many of these employees do not consistently perform food safety procedures. Foodborne illnesses are usually a result of a food handler employee practicing poor personal hygiene, time/temperature abuse and cross-contamination (York et al., 2009). When employees receive training, knowledge about food safety improves, but not necessarily compliance (York et al., 2009).

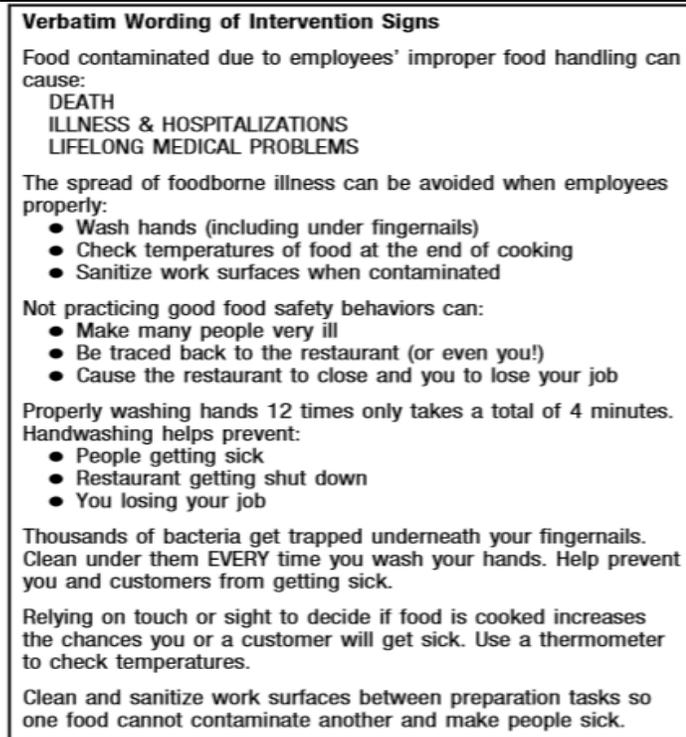
Prevention. The Food Code is used as a model “for safeguarding public health and ensuring food is unadulterated and honestly presented when offered to the consumer” (U.S. Food and Drug Administration). The Food Code “represents the FDA’s best advice

for a uniform system of provisions and address the safety and protection of food offered at retail and in food service” (U.S. Food and Drug Administration). The Food Code 2013 is the newest edition (8th) and marks the 20th anniversary of The Food Code which reflects the continued commitment to maintaining cooperative programs with state, local, tribal, and territorial properties (U.S. Food and Drug Administration). The FDA states that compliance with the 2013 Food Code has the following benefits:

- Reduction of the risk of foodborne illness within a food organization which in turn protects consumers and the food industry from potential health consequences and severe money loss.
- Having uniform standards reduces complexity and ensures standard compliance.
- It establishes a more standardized approach to inspections and audits of food service establishments.
- Reduces redundant procedures in establishing food safety guidelines.

Some restaurants have taken prevention measures to avoid foodborne illnesses occurring in their establishments. One way of prevention has been to hang signs up around the restaurants. An example of a sign is figure 2.1:

Figure 2.1: Example of Prevention Sign (York et al., 2009)



After hanging signs like figure 2.1, York et al. (2009) found knowledge of hand washing was significantly higher at post-training.

Managers completing a 15-hour food safety training and certification program showed a decrease of critical violations and improved restaurant inspection scores. Foodservice employees who completed a 4-hour ServSafe® training showed improved knowledge and higher compliance with food-safety guidelines when compared to a control group (York et al., 2009).

Barriers. Increased knowledge of food safety did not always lead to changes in behavior due to perceived barriers (Howells et al., 2008). Studies have explored the barriers associated with foodservice employees not following proper food safety procedures. Some barriers include lack of time, lack of equipment and resources, lack of education, management and coworkers disinterest in food safety, and lack of consequences for not complying with guidelines (York et al., 2009). According to York

et al., the perceived barriers of food safety compliance by employees should be identified by asking employees what makes it difficult to comply with food safety guidelines. Negative attitudes should also be identified by asking employees to describe unfavorable outcomes from complying with food safety guidelines. Once these barriers are identified the manager can talk with employees to come up with solutions to these perceived barriers (York et al., 2009).

In a study by Howells et al., the top three barriers to performing food safety practices were inadequate training, time constraints, inadequate resources, and inconvenience to perform proper food safety techniques. If managers were to go over the consequences of not performing proper food safety practices, employees may be less likely to think of proper procedures as inconveniences. Signs could be placed around the kitchen area with persuasive messages about the consequences of not performing proper food safety procedures. Managers could also incorporate the proper food safety procedures into the employees' daily routing in order to eliminate the barrier of time constraint. If the proper food safety techniques were already planned into the employees' day, they would be more likely to follow the proper food safety procedures (Howells et al., 2008).

Another way to reduce barriers to food safety practices is to lead by example. Managers should take the time to practice proper food handling procedures in order for the employees to see how important these procedures are to ensuring safety to the consumer (Powell, D., Jacob, C., and Chapman, B., 2011).

ServSafe® Program

Since 1919, The National Restaurant Association's ServSafe® Food Safety program has provided food safety training, exams and educational materials to

foodservice managers. The goal of ServSafe® is “to lead America’s restaurant industry into a new era of prosperity, prominence and participation, enhancing the quality of life for we all serve” (www.servsafe.com). The ServSafe® Food Protection Manager Certification, accredited by American National Standards Institute (ANSI)- Conference for Food Protection (CFP), has awarded more than four million foodservice professionals certification in food safety (www.servsafe.com). This certification is recognized by more federal, state and legal jurisdictions than any other food safety certification (www.servsafe.com).

Dietetic and Human Nutrition (DHN) and Hospitality Management and Tourism (HMT) students at the University of Kentucky go through the ServSafe® program through Food Service Sanitation (DHN 241) during their sophomore year into the program. The ServSafe® program consists of the up-to-date FDA Food Code, food safety research and food sanitation training. Students learn how to practice food safety and create a culture of food safety. The content in the ServSafe® program is based on actual job tasks that have been identified by foodservice industry experts as important food safety issues. The ServSafe® training is offered in two different formats (online and classroom) and is offered in six languages (English, Spanish, Chinese, Korean, Japanese and Canadian French) (www.servsafe.com).

ServSafe® is the most popular food safety training program in the United States because it (www.servsafe.com):

- Uses materials and exams created by foodservice and regulatory experts,
- Reinvests proceeds back into the food service industry,

- Benefits from more than 30 years of proven experience in food safety and training in the foodservice industry,
- Has awarded more than 4.8 million ServSafe® certifications,
- Is accepted in all 50 states,
- Is a single source for both food safety training and the certification examination,
- Delivers current regulatory information
- Provides support from foodservice subject matter experts available to answer questions,
- And offers flexible online, classroom, in-unit and one-on-one training and exam options.

ServSafe® training covers five different domains (www.servsafe.com):

- D1: Implement Food Safety Standard Operating Procedures (SOPs)
- D2: Employee Hygiene and Health
- D3: Receipt, Storage, Transport
- D4: Food Preparation, Display and Service
- D5: Compliance with Regulations

York, et al. (2009), found food safety training improves knowledge on food safety but does not necessarily result in improved behavior. Refresher courses and continual training by managers results in long-term safe food handling behaviors and may also sustain good hand washing practices (Soon et al., 2012). How food safety knowledge is learned can affect how well an individual remembers the knowledge.

Learning and Memory Retention

A systematic review of “Psychological Correlates of University Students’ Academic Performance” by Richardson M., Bond, R. and Abraham, C. investigated individual differences associated with better academic performance and how strong these associations are. Some personality traits associated with academic performance are conscientiousness, procrastination, openness, neuroticism, agreeableness, extraversion, need for cognition, and emotional intelligence. The measures of conscientiousness shows how dependable and achievement oriented an individual can be. Individuals with high levels of conscientiousness are more motivated to perform well and continue to be persistent when faced with an obstacle. Procrastination is a behavioral tendency to delay or postpone tasks and decision making. Individuals high in procrastination tend to achieve less and tend to be low in conscientiousness so they tend to give up when facing challenging work. Individuals who demonstrate openness tend to be more imaginative, and open to new experiences. Individuals demonstrating agreeableness tend to be more trustworthy, empathetic, and compliant to social situations. Students who are high in openness and agreeableness are more likely to attend classes and have greater levels of cooperation with instructors which can have a positive influence on academic success. Individuals who experience neuroticism have anxiety and depression. This impacts how well a student learns in the academic environment. Neuroticism can compromise performance on tests and not necessarily reflect what the student’s actual knowledge of the material is. Individuals who demonstrate extraversion have higher sociability and tend to be more distracted in their studies. When compared to the introvert counterpart, extroverts tend to have lower grades because they spend more time with their social lives

than with their studies. Individuals who have a higher need for cognition have intrinsic motivation to learn and tend to do well in the academic setting. Emotional intelligence is described as being able to understand emotions and use emotion to help with the learning process. Students with high emotional intelligence also tend to excel in academic performance (Richardson, M., Bond, R., and Abraham, C., 2012).

Along with personality traits, motivational factors have an impact on the process of learning. The way a student classifies his or her failings can contribute to how well he or she adapts to a situation. For example, students who blame the instructor for insufficient teaching or as bad luck tend to keep failing. Students who explain poor grades in terms of their own failings tend to go back and look at what they did wrong and do better the next time a similar challenge occurs. This is referred to as performance self-efficacy. The students who learn from past mistakes will excel when a similar situation arises where they failed the first time, whereas the students blaming it on an external factor tend to repeat the mistakes and have low performance self-efficacy. When students continue to set goals and meet their goals they are working on self-improvement which can make performance self-efficacy greater and result in more achievement (Richardson, M., Bond, R., and Abraham, C., 2012).

Product goals and process goals are two different kinds of goal setting that can affect self-efficacy and the learning process. Product goals are goals that have a rate for the quantity of work to be completed. For example, 'complete 100 multiplication problems in 5 minutes'. Process goals use techniques and strategies to solve a problem or learn new knowledge or skills. Process goals can help students to focus their attention on learning while promoting self-regulatory skills. The study by Schunk and Ertmer found

that using process goals in college students is an effective way to enhance achievement outcomes and improves self-efficacy (Schunk, D. and Ertmer, P., 1999).

One barrier to learning is overconfidence. Overconfidence leads to premature termination of study and yields a lower level of learning which translates to lower levels of retention (Dunlosky & Rawson, 2012).

Overlearning is a frequent occurrence in educational settings. This may be because this is the strategy of choice when memorizing textbooks or materials for an exam. Overlearning is defined as “a means of ensuring long-term retention” (Rohrer, D., Taylor, K., Pashler, H., Wixted, J.T., & Cepeda, N.J., 2005). Overlearning plays a role in long term retention because when the information is removed from the short-term memory into the long-term memory, the information has been overlearned. If the criterion is reached but further study is delayed until a subsequent session is not overlearning. Overlearning is beneficial when memorizing material for a test, such as the ServSafe® exam, but once the test is finished, overlearning benefits dissipate and after a period of time, the retention of the information is lost. Overlearning retention declines by about 2/3 from 70% at week 1 to 24% at week 9 (Taylor, Pashler, Wixted, & Cepeda, 2005). Rohrer et al found when overlearning is learned throughout a period of time, the long-term retention stage is longer. If overlearning occurs at once, only a small amount of the information will be retained in the long-term memory (Rohrer et al., 2005).

Judgments of Learning (JOL) are “judgments that occur during or after acquisition and are predictions about future test performance on recently studied items” (Sundqvist, Todorov, Kubik, & Jonsson, 2012). The “delayed JOL effect” is memory predictions that have higher predictive validity towards subsequent recall that is made in

delay rather than immediately after studying. The side effect of using the delayed JOL effect is that it does not improve monitoring, but may improve memory long term. The US Department of Education advises the use of delay JOLs in order to improve monitoring. When students study for an exam, such as the ServSafe® exam, two consecutive study sessions leads to worse retention of the information being studied when compared to a study session followed by being tested on what was studied. By retrieving the information from memory, the probability of successfully retrieving it again in the future is increased. Typical findings in studies where delayed JOLs were performed, an interaction between a learning condition and retention interval and after a longer retention interval, the participants in the testing condition out performed those in the restudy condition. This study also found that performing delayed JOLs attributes to better retention over time. A 1-wk study group only remembered 39% of what their 5 minute counterparts could recall whereas the 1-wk JOL group remembered 61% when compared to 5-minute counterparts. This supports the use of JOL (Sundqvist et al., 2012).

Theories

The Theory of Planned Behavior (TPB) is a framework for understanding, predicting, and changing human social behavior. The perceived barriers, attitudes and subjective norms influence intentions to perform a particular behavior. If an individual sees barriers or has an unfavorable attitude about a behavior, it is unlikely the individual will perform the behavior. TPB takes an individual's attitude about a particular behavior and educates the individual on the consequences of their behavior in order to change the individual's attitude to result in a new positive behavior (York et al., 2009). York et al. used a TPB intervention to measure changes in employees' knowledge to compliance

with food-safety practices. The results showed that food safety training improves knowledge of food-safety practices but that training alone does not improve behavior (York et al., 2009).

The Constructivism Theory states that a learner builds new ideas and concepts from past knowledge and experience. In the study by Yarrow et. al. (2009) the health majors reported decreased consumption of high-risk foods and increased food safety practices while the non-health majors showed no improvement, meaning they did not retain the new information five weeks after the educational intervention. Another theory used in the study by Yarrow et al. (2009), the Behaviorism Theory, states that behaviors will change based positive or negative reinforcements. In the study by Yarrow et al. the non-health majors did not recognize positive reinforcement (good health) or negative reinforcement (illness) associated with using proper food safety techniques so they were not motivated to change behavior (Yarrow et al., 2009).

Conclusion

In conclusion, this literature review gives a greater understanding of memory retention and how it applies to food safety and sanitation in regards to the ServSafe® exam. This literature reviewed covered information on foodborne illnesses, food safety, restaurants and foodborne illness, ServSafe® program, learning and memory retention and theories. From the review of literature, there is a lack of memory retention regarding the knowledge of food safety in college students. For HMT and dietetic students, retention on the knowledge of food safety and sanitation is crucial for their future careers. This study intends to fill this gap by comparing results of food safety and sanitation questions from DHN 342 to the original ServSafe® exam in DHN 241. From these

results, the lacking of memory retention in certain domains will be analyzed and recommendations on how to improve memory retention on food safety sanitation knowledge will be made.

Chapter Three

Methodology

There is limited research on the memory retention related to food safety and sanitation knowledge. It is important that students in the dietetics and hospitality programs retain their knowledge of food safety for use in the DHN 342 (Quantity Food Production) course. The purpose of this study is to test senior students in Quantity Food Production on their current knowledge of the five domains from the ServSafe® exam taken two years prior.

Research Design

There is limited research on the retention of sanitation and food safety among students during sequential food laboratory experiences throughout their undergraduate career. Sanitation and food safety exam questions, divided into five domains, were developed and presented to students to assess the food safety knowledge of students during DHN 241 Foodservice Sanitation and two years later during DHN 342 Quantity Food Production. By comparing the original answers to the answers of the students in Quantity Food Production, the retention of knowledge was determined. Data was collected in the fall of 2014.

Subjects

The subjects were recruited via in-class collection for students who had completed DHN 241 and were currently enrolled in DHN 342. The population included 25 dietetic and hospitality management and tourism majors. These students took the ServSafe® certification exam for DHN 241 and repeated a food safety and sanitation questionnaire during an in-class assessment for DHN 342. Student classification and

demographic were collected beyond the specific test questions within the five domains. No private information was collected.

Instrument of Measurement

The instrument of measurement used in this study was a questionnaire. The purpose of the questionnaire was to collect quantitative data on memory retention of the subjects regarding food safety information divided into five domains. The questionnaire used as well as the instructions for use are attached in appendix A. This questionnaire was used in DHN 342 to gather data on student's current knowledge of food safety and sanitation. The results from this questionnaire were then compared to the student's original ServSafe® exam scores of the five domains.

Procedure

Students were introduced to food safety and sanitation through DHN 241 and concluded the course with a ServSafe® certification exam. Students then progressed through the Dietetic and Human Nutrition and the Hospitality Tourism Management programs before enrolling in DHN 342. Students in DHN 342 were given a questionnaire (see Appendix A) to complete on food safety and sanitation. The results of the ServSafe® certification exam and results from the food safety and sanitation questionnaires in DHN 342 were compared to determine memory retention on food safety and sanitation practices. Raw data collected was quantified and analyzed using the data analysis tool in excel. The test questions are available in Appendix A along with the instructions for use.

Data Analysis

The data collected from Blackboard and paper exams were entered into excel. Descriptive statistics and paired t-tests were used in the analysis.

Chapter Four

Results

The final sample consisted of 25 participants out of 43 enrolled in DHN 342 Quantity Food Production Fall 2014.

Demographics

The final sample consisted of 8% (n=2) males and 92% (n=23) females. Participants were primarily the age of 21, with 48% (n=12) being 21, 24% (n=6) being 22, 8% (n=2) being 23, and 20% (n=5) being 24 or older. The mean age of participants was 23.4 years. The minimum age was 21 and the maximum age was 46. Dietetics majors accounted for 84% (n=21) of participants while Hospitality majors accounted for 16% (n=4) of participants. The percentage of participants categorized as *in state* was 76% (n=19). The percentage of participants categorized as *out of state* was 24% (n=6). The mean GPA of participants was 3.34 with the minimum GPA at 2.5 and the maximum GPA at 3.98. Table 4.1 summarizes demographic information gathered.

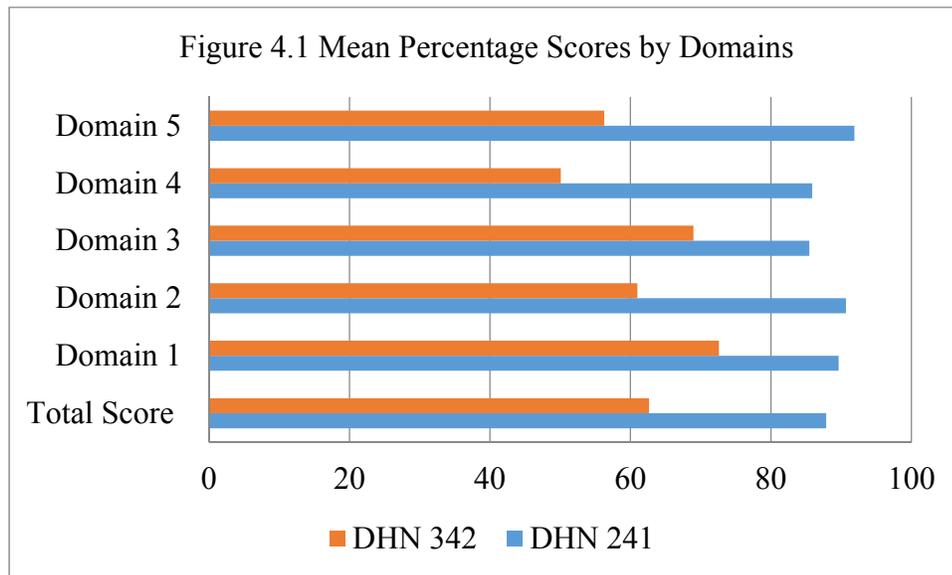
Table 4.1 Demographics		
	N	%
Gender		
Male	2	8
Female	23	92
Age		
21	12	48
22	6	24
23	2	8
24 and over	5	20
Classification		
Senior	24	96
Grad	1	4
Status		
In state	19	76
Out of state	6	24
Major		
Dietetics	21	84
Hospitality	4	16
GPA		
2.50-2.99	4	16
3.00-3.49	8	32
3.50-3.98	13	52
Race		
Caucasian	21	84
African American	2	8
Asian	1	4
Multiracial	1	4

Average Percentage Score by Domains

The mean percentage score of participants on their exam in DHN 241 (Food Service Sanitation) was 87.88% while the mean percentage score of participants on their exam in DHN 342 (Quantity Food Production) was 62.64%. This change in score is statistically significant with a p-value < 0.05. The mean percentage score of domain one (Implement Food Safety Standard Operating Procedures (SOPs)) on the original exam in DHN 241 was 89.64% while the mean percentage score of domain one in DHN 342 was 72.6%. This change in domain one scores is statistically significant with a p-value <0.05.

The mean percentage score of domain two (Employee Health and Hygiene) on the original exam in DHN 241 was 90.68% while the mean percentage score in DHN 342 was 61%. This change in score is statistically significant with a p-value <0.05 . The mean percentage score of domain three (Receipt, Storage, Transport) in DHN 241 was 85.88% while in DHN 342 the average percentage score of domain three was 68.96%. This change of scores in domain three is significantly significant with a p-value <0.05 . The mean percentage score of domain four (Food preparation, Display and Service) in DHN 241 was 85.88% while in DHN 342 the average percentage score of domain four was 50.08%. This change in scores is statistically significant with a p-value <0.05 . The mean percentage score of domain five (Compliance with Regulations) in DHN 241 was 91.88% while in DHN 342 the average percentage score of domain five was 56.28%. This change in scores is statistically significant with a p-value <0.05 . The following table and figure, Table 4.2 and Figure 4.1, summarize the mean percentage scores by domains. Table 4.3 summarizes the topics in each domain as well as which question from the exam given in DHN 342 fit into each domain.

	Total Score	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5
DHN 241	87.88	89.64	90.68	85.48	85.88	91.88
DHN 342	62.64	72.6	61	68.96	50.08	56.28
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001



	Topic	DHN 342 Questions
Domain 1	Implement food safety Standard Operating Procedures (SOPs)	2,4,5,6,7,8,9,10,15,30,31,38
Domain 2	Employee hygiene and health	12,13,14,32
Domain 3	Receipt, storage, transport	16,17,18,19,20,39
Domain 4	Food preparation, display and service	3,11,21,22,23,24,25,26,27,28,29
Domain 5	Compliance with regulations	1,33,34,35,36,37,40

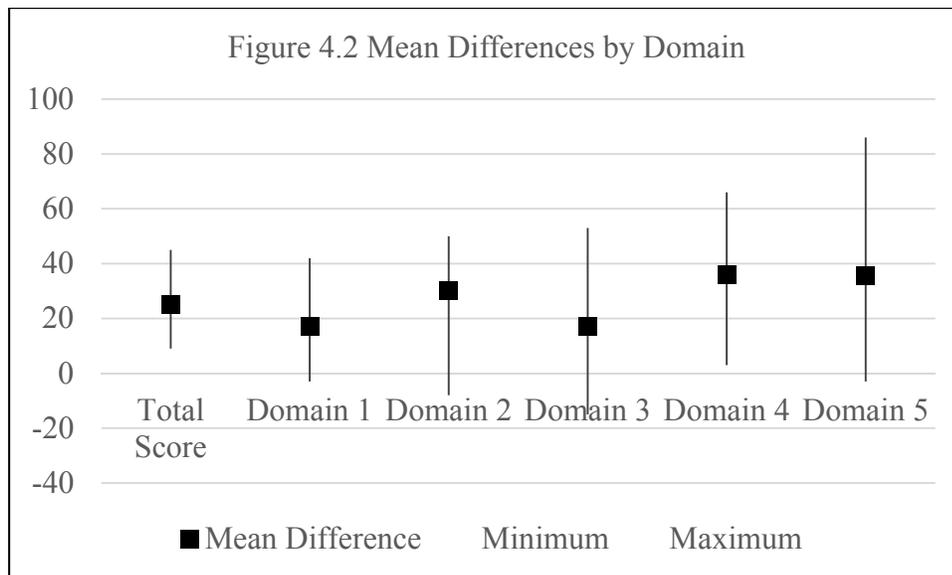
Differences in Scores from DHN 241 to DHN 342

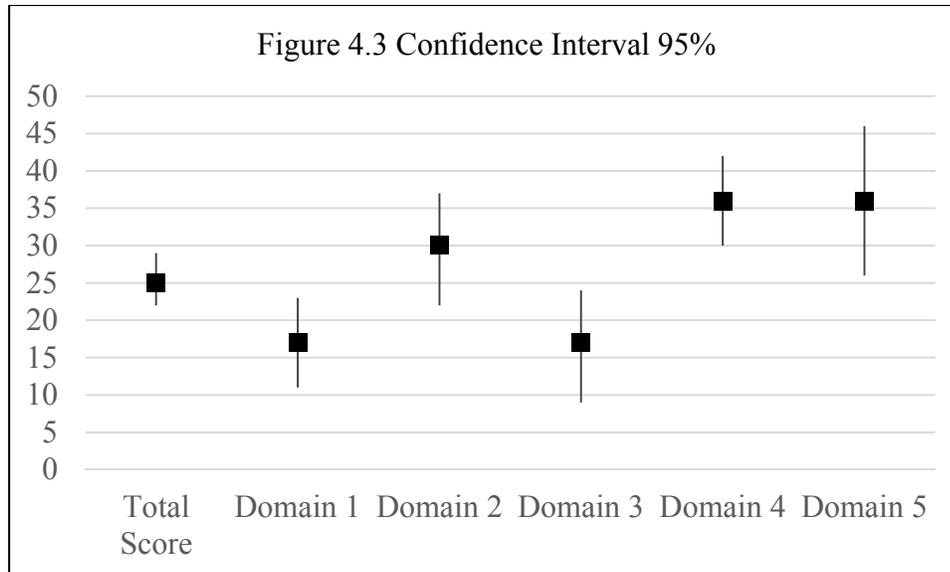
The mean difference in total score from DHN 241 to DHN 342 was 25.24%. The mean difference from DHN 241 to DHN 342 was 17.04% for domain one, 29.68% for domain 2, 16.52% for domain 3, 35.8% for domain 4, and 35.6% for domain five. Table

4.4 summarizes the score difference from DHN 241 to DHN 342. Figure 4.2 summarizes the mean difference by domains including the minimum and maximum differences.

Figure 4.3 shows the 95% confidence level for each domain in score differences.

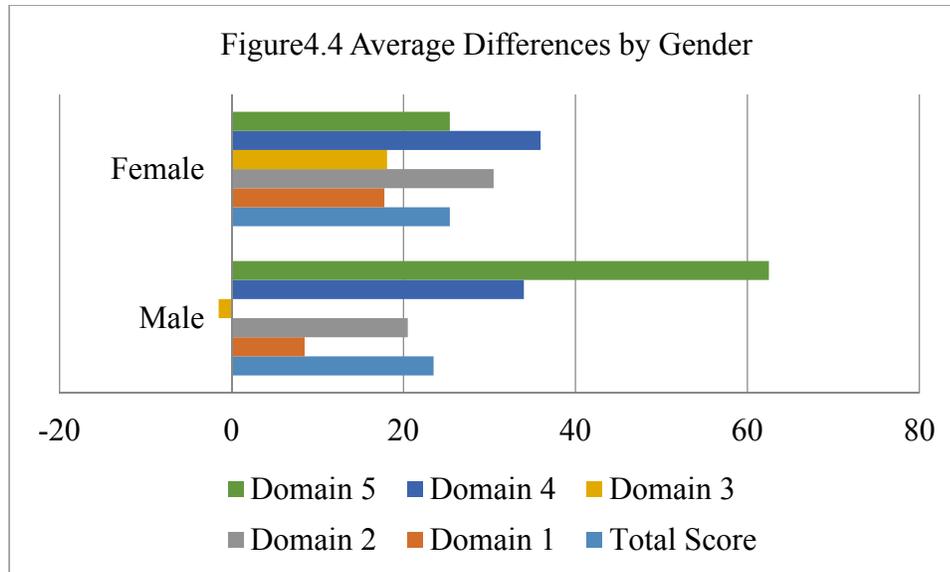
	Total Score	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5
Mean Difference	25.24	17.04	29.68	16.52	35.8	35.6
Median	25	17	30	18	35	31
Standard Deviation	8.76085	13.62742	18.22479	17.87950	14.64581	23.97568
Minimum	9	-3	-8	-15	3	-3
Maximum	45	42	50	53	66	86
Confidence Level (95%)	3.61630	5.62512	7.52282	7.38029	6.04549	9.89667
Confidence Interval (95%)	(21.62, 28.86)	(11.42, 22.67)	(22.16, 37.20)	(9.14, 23.90)	(29.76, 41.85)	(25.70, 45.50)



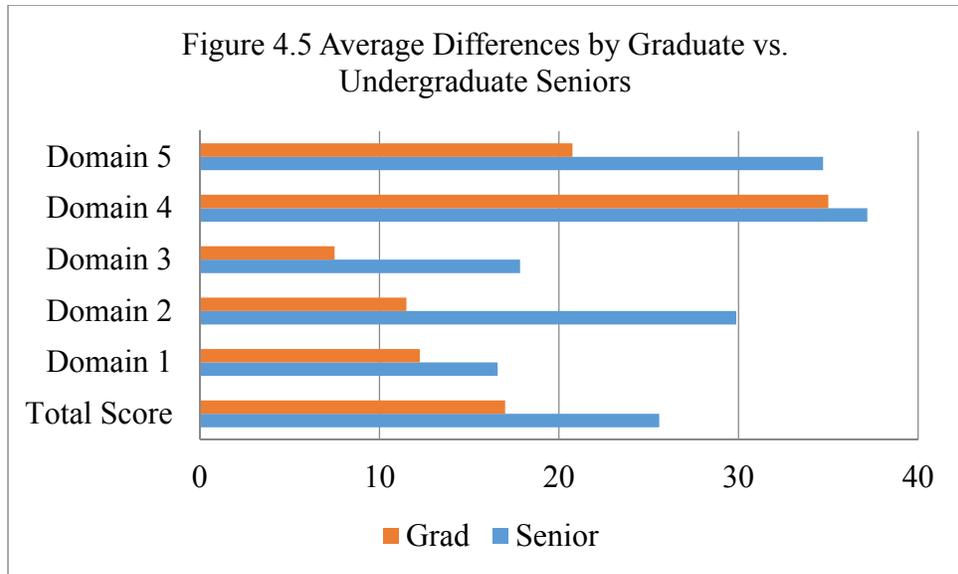


Differences by Demographics

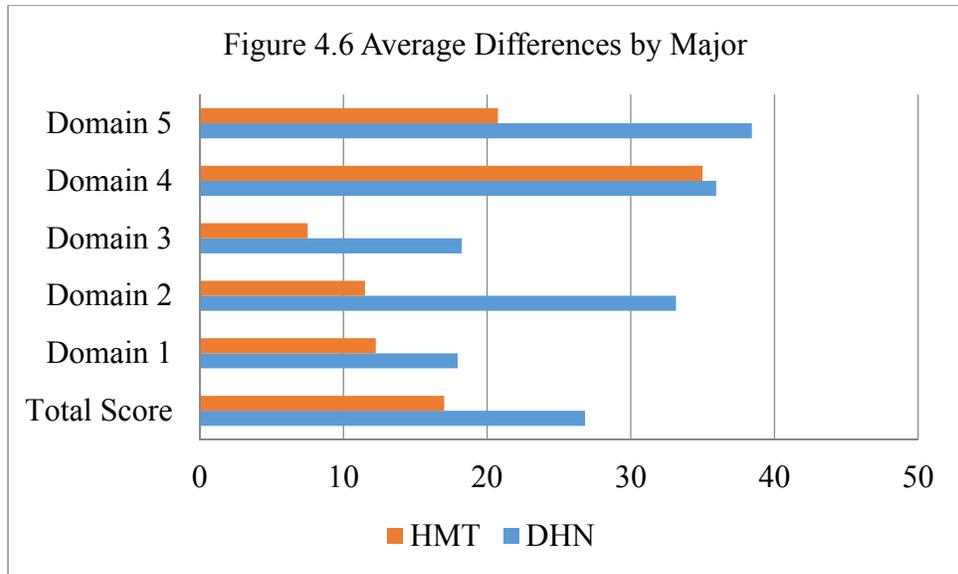
In regards to demographics, the differences between domains for gender, graduate vs. undergraduate status, major, age, GPA, and age were found. There were no statistically significant findings between genders. For total score the average difference between the original exam in DHN 241 and the recall exam in DHN 342 was 23.50% for males and 25.39% for females. For domain one, the average difference between DHN 241 and DHN 342 was 8.50% for males and 17.78% for females. For domain two, the average difference between DHN 241 and DHN 342 was 20.50% for males and 30.48% for females. For domain three, the average difference between DHN 241 and DHN 342 was -1.50% for males and 18.09% for females. For domain four, the average difference between DHN 241 and DHN 342 was 34.00% for males and 35.96% for females. For domain five, the average difference between DHN 241 and DHN 342 was 62.5% for males and 25.39% for females. Table 4.5 and Figure 4.4 summarize these findings.



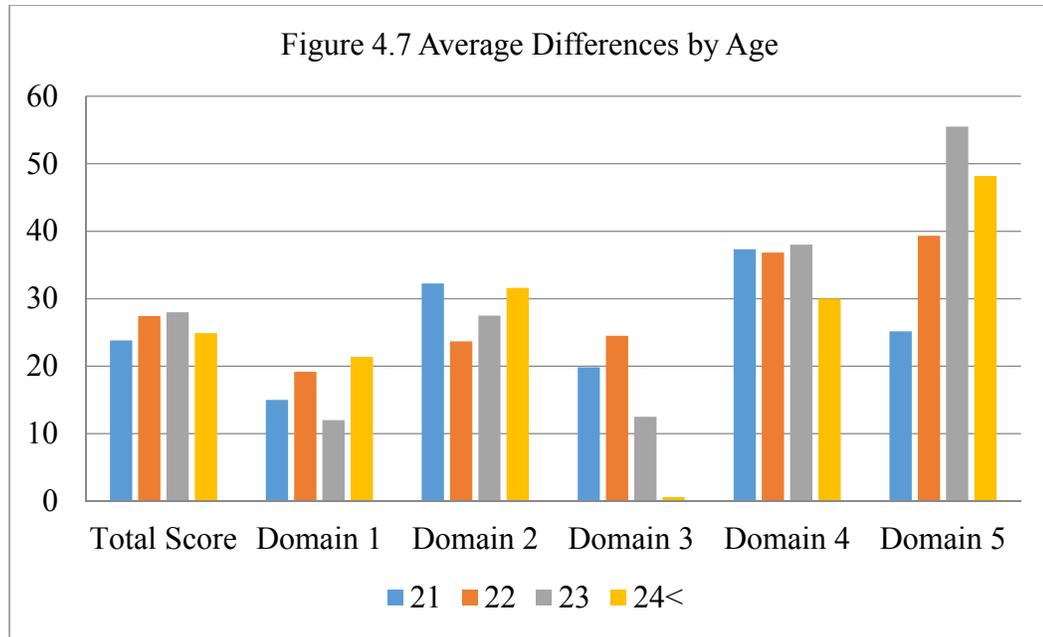
In regards to graduate vs undergraduate status, the mean difference between total score, domain one, domain three, domain four, and domain five were statistically significant (p -value < 0.05). The average difference between classifications for domain two was not statistically significant with a p -value of 0.21. For total score, the average difference between DHN 241 and DHN 342 for seniors was 25.58% and for graduate students was 17.00%. For domain one, the average difference between DHN 241 and DHN 342 for seniors was 16.58% and for graduate students was 12.25%. For domain two, the average difference between DHN 241 and DHN 342 for seniors was 29.88% and for graduate students was 11.50%. For domain three, the average difference between DHN 241 and DHN 342 for seniors was 17.83% and for graduate students was 7.50%. For domain four, the average difference between DHN 241 and DHN 342 for seniors was 37.17% and for graduate students was 35.00%. For domain five, the average difference between DHN 241 and DHN 342 for seniors was 34.71% and for graduate students was 20.75%. Table 4.5 and Figure 4.5 summarize these findings.



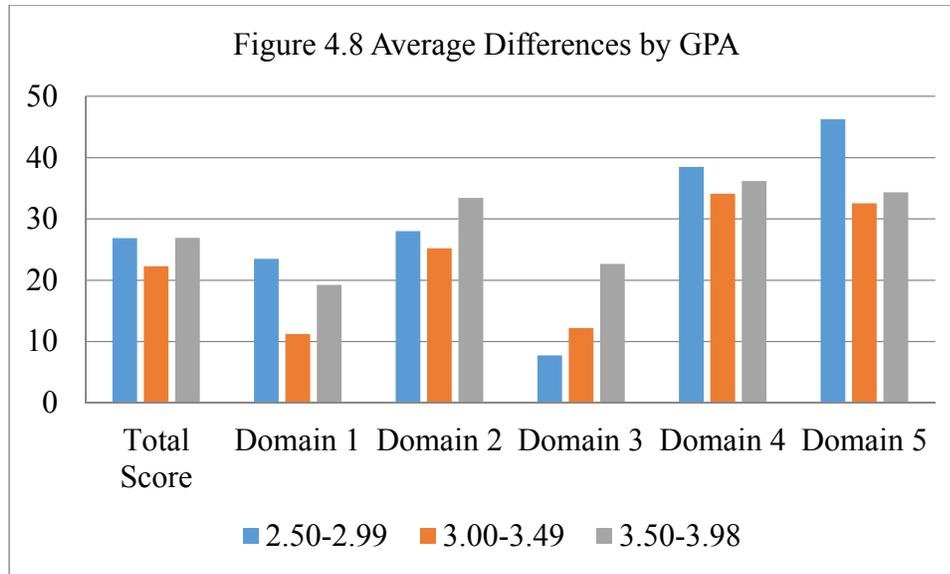
In regards to major, the mean difference for total score was statistically significant (p-value <0.05). While the average differences in domains one, two, three, four, and five were not found to be statistically significant (p-value >0.05). For total score, the average difference between DHN 241 and DHN 342 was 26.81% for DHN students and 17.00% for HMT students. For domain one, the average difference between DHN 241 and DHN 342 was 17.95% for DHN students and 12.25% for HMT students. For domain two, the average difference between DHN 241 and DHN 342 was 33.14% for DHN students and 11.50% for HMT students. For domain three, the average difference between DHN 241 and DHN 342 was 18.24% for DHN students and 7.50% for HMT students. For domain four, the average difference between DHN 241 and DHN 342 was 35.95% for DHN students and 35.00% for HMT students. For domain five, the average difference between DHN 241 and DHN 342 was 38.43% for DHN students and 20.75% for HMT students. Table 4.5 and Figure 4.6 summarize these findings.



The results for age for the average differences between DHN 241 and DHN 342 in total score were 23.83% for 21, 27.42% for 22, 28.00% for 23, and 24.90 for 24 and over. The average difference between DHN 241 and DHN 342 in domain one was 15.00% for 21, 19.17% for 22, 12.00% for 23, and 21.40% for 24 and over. The average difference between DHN 241 and DHN 342 in domain two was 32.25% for 21, 23.67% for 22, 27.50% for 23 and 31.60% for 24 and over. The average difference between DHN 241 and DHN 342 in domain three was 19.83% for 21, 24.50% for 22, 12.50% for 23 and 0.06% for 24 and over. The average difference between DHN 241 and DHN 342 in domain four was 37.33% for 21, 36.83% for 22, 38.00% for 23 and 30.00% for 24 and over. The average difference between DHN 241 and DHN 342 in domain five was 25.17% for 21, 39.33% for 22, 55.50% for 23 and 48.20% for 24 and over. The summary of these results is found in Table 4.5 and Figure 4.7.



The results for GPA on the average difference between DHN 241 and DHN 342 in total score were 26.88% for GPA 2.50-2.99, 22.28% for GPA 3.00-3.49 and 26.92% for GPA 3.50-3.98. The average difference between DHN 241 and DHN 342 in domain one was 23.50% for GPA 2.50-2.99, 11.22% for GPA 3.00-3.49 and 19.25% for GPA 3.50-3.98. The average difference between DHN 241 and DHN 342 in domain two was 28.00% for GPA 2.50-2.99, 25.22% for GPA 3.00-3.49 and 33.42% for GPA 3.50-3.98. The average difference between DHN 241 and DHN 342 in domain three was 7.75% for GPA 2.50-3.00, 12.22% for GPA 3.00-3.49 and 22.67% for GPA 3.50-3.98. The average difference between DHN 241 and DHN 342 in domain four was 38.50% for GPA 2.50-2.99, 34.11% for GPA 3.00-3.49 and 36.17% for GPA 3.50-3.98. The average difference between DHN 241 and DHN 342 in domain five was 46.25% for GPA 2.50-2.99, 32.56% for GPA 3.00-3.49 and 34.33% for GPA 3.50-3.98. Table 4.5 and Figure 4.8 summarize these results.



The results for race for the average difference between DHN 241 and DHN 342 in total score was 25.56% for Caucasian, 28.75% for African American, 28.00% for Asian and 9.00% for Multiracial. The average difference between DHN 241 and DHN 342 in domain one was 17.33% for Caucasian, 31.50% for African American, 2.00% for Asian, and -3.00% for Multiracial. The average difference between DHN 241 and DHN 342 in domain two was 32.33% for Caucasian, 33.00% for African American, 5.00% for Asian and -8.00% for Multiracial. The average difference between DHN 241 and DHN 342 in domain three was 17.24% for Caucasian, 1.50% for African American, 6.00% for Asian, and 42.00% for Multiracial. The average difference between DHN 241 and DHN 342 in domain four was 36.38% for Caucasian, 26.00% for African American, 44.00% for Asian and 35.00% for Multiracial. The average difference between DHN 241 and DHN 342 in domain five was 33.86% for Caucasian, 64.50% for African American, 53.00% for Asian and -3.00% for Multiracial. Table 4.5 and Figure 4.10 summarize these results.

Figure 4.9 Average Differences by Race

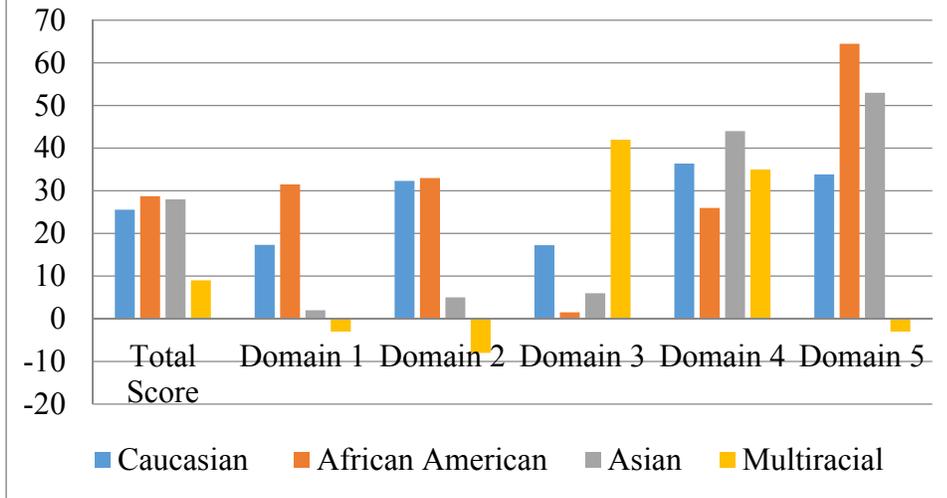


Table 4.5 Differences by Demographics						
	Total Score	Domain 1	Domain 2	Domain 3	Domain 4	Domain 5
Gender						
Male	23.50	8.50	20.50	-1.50	34.00	62.50
Female	25.39	17.78	30.48	18.09	35.96	25.39
p-value	0.8471	0.0602	0.1929	0.3734	0.5640	0.4371
Classification						
Senior	25.58	16.58	29.88	17.83	37.17	34.71
Grad	17.00	12.25	11.50	7.50	35.00	20.75
p-value	<0.001	0.0005	0.2114	2.12E-9	7.67E-12	0.0001
Major						
DHN	26.81	17.95	33.14	18.24	35.95	38.43
HMT	17.00	12.25	11.50	7.50	35.00	20.75
p-value	0.03926	0.5071	0.0829	0.4513	0.8100	0.1576
Age						
21	23.83	15.00	32.25	19.83	37.33	25.17
22	27.42	19.17	23.67	24.50	36.83	39.53
23	28.00	12.00	27.50	12.50	38.00	55.50
24<	24.90	21.40	31.60	0.60	30.00	48.20
GPA						
2.50-2.99	26.88	23.50	28.00	7.75	38.50	46.25
3.00-3.49	22.28	11.22	25.22	12.22	34.11	32.56
3.50-3.98	26.92	19.25	34.42	22.67	36.17	34.33
Race						
Caucasian	25.56	17.33	32.33	17.24	36.38	33.86
African American	28.75	31.50	33.00	1.50	26.00	64.50
Asian	28.00	2.00	5.00	6.00	44.00	53.00
Multiracial	9.00	-3.00	-8.00	42.00	35	-3.00

Summary

Table 4.6 provides a summary of the statistically significant findings from this study.

Table 4.6 Summary of Statistically Significant Results		
Variables		<i>p</i>
Mean Percentage Scores by Domains DHN 241 to DHN 342	Total score	<0.001
	Domain 1	<0.001
	Domain 2	<0.001
	Domain 3	<0.001
	Domain 4	<0.001
	Domain 5	<0.001
Differences by Demographics		
Graduate vs. Undergraduate Seniors	Total Score	<0.001
	Domain 1	<0.001
	Domain 3	<0.001
	Domain 4	<0.001
	Domain 5	0.0001
Major	Total Score	0.03926

Chapter Five

Discussion

This study was designed to gather new and valuable information from dietetics and hospitality students at the University of Kentucky regarding memory recall of food service sanitation knowledge. Specifically this study aimed to assess the current knowledge of food safety sanitation for Quantity Food Production (DHN 342) students two years after taking Food Service Sanitation (DHN 241) to receive ServSafe® certification.

Demographics and Food Service Sanitation Recall

The context in which the results must be interpreted includes the background details obtained, such as gender, age, status, classification, race, major and GPA. A majority of participants were female, age of 21, status of *in-state*, seniors, Caucasian, DHN with a GPA between 3.50-3.98. There was significant difference in memory recall between DHN and HMT students in total score. This suggests that HMT students have better recall in regards to food service safety and sanitation. Hospitality students may have more job experience in the foodservice industry or have more interest in foodservice than dietetic students which could account for these results. There was also a low number of HMT students (n=4) when compared to DHN students (n=21) which could interfere with the significance of these results.

Objective 1: Student Recall

In regards to objective one, determining student's recall knowledge in Quantity Food Production (DHN 342) from the original sanitation and food safety exam as sophomores in Food Service Sanitation (DHN 241), the mean difference in total score,

domain one, domain two, domain three, domain four and domain five were statistically significant (p -value <0.05). This result suggests there is a significant difference in how well students performed in DHN 342 when compared to DHN 241. This result could be from students using overlearning when studying for the certification exam. Taylor et al. stated that overlearning retention declines by two-thirds from 70% at week 1 to 24% at week 9. DHN 241 lasts 8 weeks in a 16 week semester. If students are using overlearning to study for the food sanitation exam, by the end of the semester, they are only remembering 24% of the information they learned. . It is easy for students to use overlearning in DHN 241 because of the way the class is set up. The class is taught online and has several different modules for the students to complete throughout the semester to prepare them for the certification exam. The successful completion of the ServSafe® certification exam is required for students to continue their course work in the nutrition food labs. Many students tend to memorize the information just for the exam and then it is later forgotten which was suggested by these results. This suggests that more knowledge on food service sanitation should be implemented throughout the course of study. According to the theory of overlearning, students only remember 24% of what was learned by the 9th week. This means it is the department's responsibility to introduce food safety and sanitation practices in all of its food science courses. Instructors should not assume since the student has certification in food safety sanitation that they remember all the information learned. Instead, instructors in the nutrition food labs should be constantly refreshing the students on food safety and sanitation practices. If instructors in DHN 302 (Principles of Food Preparation) and DHN 304 (Experimental Foods) were to implement food safety sanitation practices more, DHN 342 students may be able to recall

more food safety and sanitation questions correctly from obtaining increased knowledge in these nutrition food lab courses. Not only is food sanitation important for Dietetic and HMT majors in the nutrition food labs at the university, but it is important for their future careers. Dietetic students go on to complete an internship and obtain Registered Dietitian (RD) credentials. Once the credentials are obtained, they are eligible to work in medical nutrition therapy, food service systems management, or community as the nutrition expert. Since these students are eligible to work in food service systems management, they need to be able to know the proper food safety sanitation procedures that should occur in order to keep the food safe for individuals consuming the food. Dietitians tend to work in hospital and school food systems management where there are populations at high risk for a food borne illness (children, elderly, and the ill). Having the knowledge on food safety can help them be successful when working with these populations and keeping them safe. HMT students go on to do many different things. Some go on to be wedding planners, others work in hotels, and others in the restaurant industry. No matter where these students end up they need proper food safety sanitation knowledge to effectively do their job.

Objective 2: Recall by Domains

Each domain represents different areas of knowledge in food safety sanitation. Domain 1 focuses on implementing food safety Standard Operating Procedures (SOPs). It explains the importance of SOPs and why they need to be followed. Domain 2 focuses on employee hygiene and health. This section goes over the proper hand washing techniques and proper hygiene for working in a food service establishment. Domain 2 also emphasizes the times that employees should not come to work when they have diarrhea

or a fever. Domain 3 focuses on receipt, storage, and transport of food. This section goes into detail about the proper procedures for receiving different food items, how these items should be stored and how they should be transported in order to keep the food safe.

Domain 4 focuses on food preparation, display and service. This section goes over the importance of using thermometers to check temperatures and cross contamination. It goes over the importance of using clean cutting boards when preparing different food items and what the proper temperatures for different food items should be. Domain 5 focuses on compliance with regulations. It goes over why it is important to follow food safety procedures and the consequences that can occur when proper food safety procedures are not followed.

Based on the results, students remembered the most from domain 3 with a difference of 16.52%. This could reflect the knowledge students learn in other classes regarding receiving, transport and storage of foods. In DHN 342, students learn this process again which could reflect why students were able to remember this domain over the other domains.

Domain 4 and domain 5 were the domains the students remembered the least. Domain 4 had a difference of 35.8% while domain 5 had a difference of 35.6%. This suggests students need more education in these two areas. They need to be able to know the correct temperatures of foods and be able to prevent cross contamination in order to keep the food prepared in the Lemon Tree Café safe for patrons. With the low retention in domain 5, this suggests students do not know all the consequences that can occur by not using proper food safety and sanitation procedures. According to Yarrow et al. (2009), college students practice unsafe and risky food handling when preparing food.

Lazou et al. (2012) suggests young adults have an insufficient level of knowledge on food safety awareness and consequences of unsafe food handling procedures. If the students remained more aware of the consequences of practicing unsafe food handling procedures, they may be able to remember more of the food safety practices they learn in their classes because it would become more important to them. If students do not see food safety practices as important, they are less likely to remember the proper procedures.

Differences by Demographics

The results were also divided between gender, classification, major, age, GPA and race. There were no significant findings in the differences of gender. The females were able to recall more from domain 4 and domain 5, while males were able to recall more from domain 1, domain 2 and domain 3. This suggests that in this case, males were able to recall procedures better than females, but females understood the consequences of not following procedures more than males. The results between genders differences also needs to take into account that there were only 2 males in the study while there were 23 females. With a more even distribution of males and females, this result may have been different.

In determining the differences by status, there was a significant difference (p-value <0.05) for total score between *in state* and *out of state* students with *out of state* students remembering more than *in state* students. There was no significant difference for domains one, two, three, four, and five between *in state* and *out of state* students. Because of the low sample number, there was not enough evidence to predict a valid reason as to why *out of state* students were able to recall more food safety sanitation knowledge than *in state* students.

The results based on age showed no significant difference between age and domain retention. This suggests that the age of the individual does not necessarily reflect how much food safety knowledge is known. It suggests that course work and personal experiences through working in the food service industry have more of an impact on food safety knowledge than age.

When examining the results for GPA, the individuals with a GPA 3.00-3.49 had the best retention rate followed by GPA 3.50-3.98 then GPA 2.50-2.99. The individuals with a GPA 3.00-3.49 may have better retention of food safety sanitation knowledge because they may be better test takers, study more efficiently and care about preserving the knowledge they have gained. Individuals with GPA 3.00-3.49 are typically the students with jobs while going to school. It can be assumed that having jobs makes these students less able to focus on their studies as much as those with a GPA 3.49-3.98. However, job experience may help to reinforce the food safety practices they learned from DHN 241.

Multiracial and Asian students had better memory retention for total score, domain one and domain two than Caucasians and African Americans. This better retention could be a cultural difference. Multiracial and Asian students may have several life factors that account for the difference.

Limitations and Opportunities for Future Research

This study was constrained by several limitations. First, the final sample only consisted of 25 students' responses. The reason for this small sample was that NRAEF was unable to supply the researcher with the student's original test results. The results are limited to those students who were able to look up their original test results and share

those results with the researcher. Also, the wording of the food safety sanitation questions was different than the wording of the original ServSafe® exam. This makes it hard to compare the answers of the original with those in DHN 342. Another limitation is that this study is limited to Dietetic and Hospitality students at the University of Kentucky in the departments of Dietetics and Human Nutrition (DHN) and Hospitality Management and Tourism (HMT).

Future studies could not only test the students' knowledge of food sanitation but could also observe the food safety sanitation practices being used while preparing food. It could compare if food safety knowledge improves food safety behavior. Future studies could also look at the method of learning students in DHN 241 are using to study for the ServSafe® certification exam and compare that to their results in DHN 342. A larger sample size would be beneficial to the results of this study and would have provided a clearer picture for the results.

Conclusion

Food service sanitation practices are an important part of any food service industry. For dietetic and hospitality students at the University of Kentucky, it is an important asset for their future careers. Learning and practicing proper food sanitation procedures is an important part of their course work to prepare them for their futures.

The results of this study can be used to assist in the planning of nutrition food laboratories (DHN 302, DHN 304 and DHN 342) at the University of Kentucky in order to promote food safety sanitation practices in dietetic and hospitality students. The main finding of this study was that students recalled the least from domain four and domain five. The topics covered in domain four are food preparation, display and service while

domain five covers compliance with regulations. This shows that more knowledge on correct food preparation procedures as well as compliance with these regulations should be implemented more in the other nutrition food lab experiences before students enroll in DHN 342. In the future, the Dietetics and Human Nutrition (DHN) department at the University of Kentucky can use this information to maximize nutrition food laboratory experiences and improve the knowledge of food sanitation procedures in all dietetic and hospitality students.

Appendix A

Food Safety and Sanitation Questionnaire

Please answer the questions to the best of your ability by circling the one best answer. Thanks.

1. Evidence of a foodborne-illness outbreak is confirmed when:
 - A. Five or more people return to an establishment sick.
 - B. A customer makes a formal foodborne-illness complaint.
 - C. Two employees call in sick.
 - D. Laboratory analysis shows that a specific food is the source of the illness.

2. Why are infants and preschool-age children at higher risk for contracting a foodborne illness?
 - A. They have not yet build up adequate immune systems.
 - B. They eat less nutritious meals than everyone else.
 - C. Their immune systems have weakened with age.
 - D. All of the above.

3. Which of the following is considered a potentially hazardous food item?
 - A. Baked potatoes.
 - B. Saltines.
 - C. Bananas.
 - D. Romaine lettuce.

4. Which of the following is an example of a biological hazard?
 - A. Dirt on lettuce.
 - B. Ciguatera toxin in red snapper.
 - C. Tomato juice served in a pewter pitcher.
 - D. Metal shavings in a can of peaches.

5. Which of the following can cause food to become unsafe?
 - A. Time-temperature abuse.
 - B. Cross-contamination.
 - C. Poor personal hygiene.
 - D. All of the above.

6. A foodborne infection occurs when a person eats food containing:
 - A. Pathogens, which then produce illness-causing toxins in the intestines.
 - B. Toxins that cause illness.
 - C. Pathogens, which then grow in the intestines and cause illness.
 - D. Toxic metals that have been leached from their storage containers.

7. Which of the following microorganisms is likely to be found in raw oysters?
 - A. *Salmonella* spp.
 - B. Rotavirus.
 - C. *Vibrio vulnificus*.
 - D. *Giardia duodenalis*.

8. To grow and reproduce, bacteria need:
 - A. Heat, adequate time, the appropriate level of acidity, dry conditions, and human contact.
 - B. A warm, dark, and damp environment.
 - C. Food, the appropriate level of acidity, proper temperature, adequate time, the necessary level of oxygen, and ample moisture.
 - D. Sunlight, nitrogen, oxygen, and sulfur.

9. Which of the following could lead to the contamination of food?
 - A. Storing cleaning chemicals near food in the dry-storage area.
 - B. Putting garbage in plastic waste containers.
 - C. Using color-coded cutting boards.
 - D. Washing dirty pans in a three-compartment sink.

10. Several customers were diagnosed with scombroid poisoning after eating swordfish at a local seafood restaurant. How could this have been prevented?
 - A. By cooking the swordfish to its required minimum internal temperature.
 - B. By purchasing the swordfish from a reputable supplier who practices strict time-temperature control.
 - C. By freezing the swordfish before cooking it.
 - D. By filleting the swordfish on a stainless steel prep table.

11. An employee is preparing sandwiches in a deli. Which step might contaminate food?
 - A. The employee washes his hands and then dries them using a single-use paper towel.
 - B. The employee uses a deli tissue to grab a roll from the bin.
 - C. The employee wipes his fingertips on his apron before taking a slice of deli meat.
 - D. The employee uses a knife to spread mayonnaise on the roll.

12. While chopping vegetables, a foodhandler cuts her finger. She should:
- A. Cover the cut with a bandage and return to work.
 - B. Wash her hands, cover the cut with a clean bandage, put a single-use glove over it and return to work.
 - C. Put a piece of plastic wrap around her cut finger and continue working.
 - D. Put on a single-use glove and continue working.
13. When washing your hands, you should scrub them for at least:
- A. Five to ten seconds.
 - B. Ten to fifteen seconds.
 - C. Fifteen to twenty seconds.
 - D. Twenty to twenty-five seconds.
14. An employee at a fine-dining, Italian restaurant comes to work with a sore throat and fever, but still desires to work. What should the manager have him do?
- A. Work as host
 - B. Slice mozzarella
 - C. Clean pots and pans
 - D. Wash hands repeatedly while handling food.
15. Which of the following behaviors poses a hazard to the safety of food?
- A. Chewing tobacco while preparing food.
 - B. Spraying sanitizer on a clean surface.
 - C. Wearing a baseball cap as a hair restraint.
 - D. Placing ready-to-eat food on the top shelf in the walk-in refrigerator.
16. A shipment of sour cream containers arrives at your establishment. How should you check the temperature of the shipment?
- A. Place the thermometer stem between two containers of sour cream for a reading.
 - B. Remove the lid of one of the containers and insert the thermometer stem into the sour cream for a reading.
 - C. Place the thermometer stem between two boxes of sour cream for a reading.
 - D. Place your hand on a container to see if it is cool to the touch.
17. Which of the following conditions indicates a shipment of whole chicken is acceptable?
- A. The wing tips are dark and there is an overall purplish color.
 - B. The chicken has a firm texture.
 - C. The temperature of the chicken is 55°F.
 - D. There is stickiness under the wings and around the joints.

18. Which food item has been stored properly in the dry-storage area?
- A. Bag of rice stored in direct sunlight.
 - B. Saltines stored at seventy-five percent humidity.
 - C. Sack of flour stored on the floor.
 - D. Canned tomatoes stored at 50°F.
19. Following the first in, first out method of stock rotation, which of the following items are being stored improperly?
- A. Container of spices with an expiration date of 11/3 stored in front of another container dated 11/12.
 - B. Rolled roast with an expiration date of 9/14 stored in front in front of another dated 9/26.
 - C. Container of sour cream with an expiration date of 8/5 stored behind another dated 7/19.
 - D. Box of pasta with an expiration date of 3/7 stored behind another box dated 3/22.
20. Which food item is being stored improperly?
- A. Sliced pineapple stored below raw steaks.
 - B. Butter stored above raw salmon.
 - C. Raw ground pork stored above raw ground poultry.
 - D. Raw poultry stored below a raw pork roast.
21. Which of the following food items is being thawed improperly?
- A. Whole chicken being thawed in a refrigerator.
 - B. Frozen fish being thawed under running potable water at a room temperature of 70°F.
 - C. Frozen turkey being thawed on a prep table at room temperature.
 - D. Frozen hamburger patties being thawed on a grill while they are being cooked.
22. A chef is cooking red snapper fillets. What is the required minimum internal cooking temperature for the fish?
- A. 125°F for fifteen seconds.
 - B. 145°F for fifteen seconds.
 - C. 155°F for fifteen seconds.
 - D. 165°F for fifteen seconds.

23. Cooked food must be cooled from 135°F to 70°F within two hours and from 70°F to 41°F or lower in an additional _____ hour(s).
- A. One.
 - B. Two.
 - C. Three.
 - D. Four.
24. Which of the following is an acceptable method for cooling a stock pot of hot chicken noodle soup?
- A. Place the stockpot of soup into a walk-in refrigerator to cool.
 - B. Divide the soup into smaller containers and place the containers in an ice-water bath to cool.
 - C. Place the stockpot on a prep table at room temperature to cool.
 - D. Place the stockpot of soup into the walk-in freezer to cool.
25. When reheating leftover chili for hot-holding, it should be reheated to:
- A. 135°F for fifteen seconds within two hours.
 - B. 145°F for fifteen seconds within two hours.
 - C. 155°F for fifteen seconds within two hours.
 - D. 165°F for fifteen seconds within two hours.
26. Potentially hazardous food cooked in a microwave must be heated to:
- A. 135°F for fifteen seconds within two hours.
 - B. 145°F for fifteen seconds within two hours.
 - C. 155°F for fifteen seconds within two hours.
 - D. 165°F for fifteen seconds within two hours.
27. To minimize contamination when serving beverages, glassware can be held in all of the following ways except by the:
- A. Rim.
 - B. Stem.
 - C. Middle.
 - D. Bottom.
28. Which of the following food is being held improperly?
- A. Chicken in marinara sauce held at 140°F.
 - B. Seafood pasta salad held at 41°F.
 - C. Steamed asparagus held at 125°F.
 - D. Salad dressing held at 41°F.

29. What hazard is associated with allowing customers to reuse plates or silverware for refills at a self-service bar?
- A. Cross-contamination.
 - B. Poor personal hygiene.
 - C. Time-temperature abuse.
 - D. None of the above.
30. A pan of lasagna that is hot-held at 125°F is reheated to 165°F for fifteen seconds within two hours. This is an example of:
- A. Monitoring.
 - B. Corrective action.
 - C. Hazard analysis.
 - D. Verification.
31. Food-contact surfaces should be cleaned and sanitized at least every:
- A. Seven hours
 - B. Six hours
 - C. Five hours
 - D. Four hours
32. Hand washing stations are required to have all of the following except:
- A. Hot and cold running water.
 - B. Soap.
 - C. A means to dry hands.
 - D. Sanitizer.
33. An establishment should respond to a backup of raw sewage by:
- A. Closing.
 - B. Correcting the cause of the backup.
 - C. Thoroughly cleaning the area.
 - D. All of the above.
34. Which of the following items will not prevent backflow?
- A. Vacuum breaker.
 - B. Air gap.
 - C. Air space between the drain pipe of a sink and the floor drain.
 - D. Cross-connection.

35. Stationary equipment should be sealed to a masonry base or should be mounted on legs at least _____ inches off of the floor.
- A. Two.
 - B. Three.
 - C. Four.
 - D. Six.
36. All of the following will affect the efficiency of a sanitizer except the:
- A. Temperature of the sanitizing solution.
 - B. Concentration of the sanitizer.
 - C. Volume of tableware being sanitized.
 - D. Amount of time the sanitizer stays in contact with the item.
37. Which of the following signs indicates you have a problem with cockroaches?
- A. Tracks.
 - B. Signs of gnawing.
 - C. Shiny gray droppings.
 - D. A strong oily odor.
38. Before cleaning and sanitizing items in a three-compartment sink, you should:
- A. Wash items in the first sink with detergent.
 - B. Immerse items in a sanitizing solution in the third sink.
 - C. Clean and sanitize each sink and work surface.
 - D. Immerse or spray-rinse items in the second sink.
39. Which of the following items has not been stored properly?
- A. Tableware stored six inches off the floor.
 - B. Glasses stored upside down.
 - C. Flatware stored with the handles down.
 - D. Utensils covered for protection.
40. Which of the following is responsible for writing regulations that must be followed by the restaurant and foodservice establishments?
- A. Food and Drug Administration.
 - B. Centers for Disease Control.
 - C. State legislators.
 - D. U.S. Public Health Service.

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