Learning Food Safety and Other STEM Topics: A Review

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Abstract
Scholars have long used problem-based learning along with other pedagogical approaches that immerse learners in the content to foster an understanding of Science, Technology, Engineering, and, Mathematics (STEM) subjects. However, little has been written about learning food safety as a food science topic. This paper uses a narrative review to understand the ways in which food safety has been taught and how effective these methods have been. The main questions that this review sought to answer are (a) What pedagogical approaches have been used in teaching food safety in college and professional settings, and (b) How effective have these methods been in increasing knowledge retention? Special attention was paid to journals of food science education and more specifically food safety education worldwide, along with searches in institutional databases and other authoritative texts. The focus of the search was on article titles and abstracts with teaching methodology, learning, and effectiveness of these practices. Food safety as a STEM subject is very relevant to the agricultural sector and society at large. Learning food safety is important as it maintains a sustainable food system that provides safe and nutritious food to consumers, whilst ensuring that students and professionals are literate in STEM. Most of the literature on learning food safety suggests that immersing students in experiential, active learning, and problem-based learning significantly increases their knowledge retention.

Keywords: Food Safety, STEM, Learning Food Safety, STEM Education

Introduction

Science has always been seen as dealing with abstractions (McCormick, 2004). With initiatives like Project 2061, there has been a need to improve the pedagogical approaches to scientific conceptual understanding through the integration of science, technology, and mathematics to produce scientifically literate citizens in the United States. Project 2061 was introduced by the American Association for the Advancement of Science (AAAS) to aid in the scientific literacy of the American public. Project 2061 specifically sought to bring about literacy in Science, Engineering, and Mathematics by reforming curricula (Campbell-Phillips, 2020). Following the introduction of Project 2061, some scholars have made suggestions on how to best produce scientifically literate citizens.

In order to address learning approaches, it is imperative to discuss pedagogical approaches and how they can aid in producing STEM-literate citizens. Technology or Engineering Design (T/E design) and other forms of experiential learning can act as facilitators of understanding the abstraction of science. McCormick (2004), for example, states that "science concepts deal with generalities (abstractions), whereas technology with how these concepts are manifest in particular contexts" (McCormick, 2004, p. 24). McCormick's view of science education and knowledge has major implications for the role of pedagogical approaches such as T/E design in science. He shows that design plays a fundamental role in contextualizing the otherwise abstract concepts of science. If science deals in abstractions, then T/E design is an important facilitator in making sense of these abstractions.

Cajas (2001) in discussing what it means to be science literate points out how the American Association for the Advancement of Science (AAAS) outlines how mathematics, technology, and science (STEM) depend on each other and how design is at the core of science literacy (Cajas, 2001). This shows how associations like the AAAS have seen the need to emphasize the role that T/E design plays in science education, namely making it more understandable to learners. Cajas (2001) also points out how T/E design goes beyond the application of science and is concerned about literacy. T/E design is not merely about what people are doing but the ideas and skills that are relevant to literacy. Becoming literate in STEM is important as science helps in naming the world.

Significance of Learning Food Safety as a STEM Topic

Food safety is a public health issue that is relevant to every human being. The United States Department of Agriculture (USDA) defines food safety as "the conditions and practices that preserve the quality of food to prevent contamination and food-borne illnesses" (USDA, n.d.). Safe food benefits a host of infrastructural issues in that it "improves economic growth of the region where food safety is practiced and enhanced. Safe food supply depends on both sound science and equitable law enforcement. With technological advances, new regulations must be enacted to protect a continuing supply of food products that are safe and wholesome for the health and wellness of people" (Fung et al, 2018, p. 89). Scholars like Fung et al. (2018) emphasize how important STEM literacy is when it comes to improving any nation's food safety system. Topics like food safety are learned within professional and academic environments, therefore prompting a need to look into how to best improve these learning approaches.

This paper takes a deliberate aim to understand the ways in which food science or more specifically, food safety has been learned and taught. It also briefly covers how other STEM

topics have been addressed in the literature. The paper covers food safety in professional and academic spaces. This paper answers the following questions: (a) What pedagogical approaches have been used in teaching food safety in college and professional settings, and (b) How effective have these methods been in increasing knowledge retention?

Methods

The main questions that this review sought to answer are (a) What pedagogical approaches have been used in teaching food safety in college and professional settings, and (b) How effective have these methods been in increasing knowledge retention? Special attention was paid to journals of food science education and more specifically food safety education worldwide, along with searches in institutional databases and other authoritative texts. The focus of the search was on article titles and abstracts with teaching methodology, learning, and effectiveness of these practices. Studies that discuss learners in K-12 settings were not included.

Literature Review

Problem-Based Learning

Problem-based learning is one of the most popular means of learning and teaching STEM subjects. The literature shows the benefits of using problem-based learning to teach STEM courses. Duffrin (2003) explored how using problem-based learning aided in teaching an introductory food science course. The study showed that Integrating problem-based learning aids in students' communication, problem-solving, and self-directed learning along with other desirable skills. Developing these and other skills is necessary for improving the literacy of STEM and other related disciplines knowledge.

Problem-based learning itself is about learning through problem-solving. “In PBL [Problem-Based Learning], student learning centers on a complex problem that does not have a single correct answer. Students work in collaborative groups to identify what they need to learn to solve a problem. They engage in self-directed learning (SDL) and then apply their new knowledge to the problem and reflect on what they learned, and the effectiveness of the strategies employed” (Hmelo-Silver, 2004, p. 235). Having a complex problem to solve engages students' self-learning by encouraging them to investigate various inquiry forms to understand the problem and its solution better. Since the problem does not have a single correct answer, students can find multiple solutions.

Problem-based learning dates to John Dewey (1938) who advocated for learning that is experiential. Dewey reasoned that experience and education go hand in hand even though not every experience is educational. Experiences or experiential learning are beneficial for knowledge retention. This becomes an even greater necessity for complex studies such as food science and other STEM courses. Food science makes a unique course in which problem-based learning can occur as the subject matter is very practical. For example, when it comes to topics such as food safety, instructors can immerse learners in solving problems that are likely to occur during food preparation. It is this kind of learning that Duffrin (2003) probed by presenting an ill-structured problem for first-year food science students.

Ill-structured problems provide students with limited explanations of the problem they have to solve to stimulate interest and learning. One area that made Duffrin’s (2003) study unique

was that students had to consult the literature on how to best go about solving the problems presented. In this way, students provided a variety of solutions and focused on studies that were of interest to them. This kind of learning engages students as they can probe issues that are specific to their interests. Duffrin (2003) also cautioned on how to properly use problem-based learning, explaining how good problems motivate students to begin working on solutions and engage in critical thinking.

Project-Based Learning

Scholars have also looked into project-based learning as a pedagogical approach. In project-based learning, students are assigned a project, much like problem-based learning, and are engaged in inquiry. Students can dialogue not only with new knowledge but also with their past experiences.

Oliveira and Cardoso (2021) combined project and problem-based learning to promote innovation and entrepreneurship among master's students in Food engineering. "The PBL strategy allowed students to mobilize knowledge from several curricular units of food studies for the development of different deliverables to participate in the innovation program and contest. This participation allowed students, supported by business mentors, to demonstrate their products to stakeholders" (Oliveira & Cardoso, 2021, p. 120). By allowing students to have deliverables at the end of the study, students demonstrated mastery of the desired learning outcomes and most importantly, the acquisition skills necessary for their profession.

Design-Based Learning and Other Pedagogical Approaches.

Design-based learning or "Design-Based Science (DBS) is a pedagogy in which the goal of designing an artifact contextualizes all curricular activities. Design is viewed as a vehicle through which scientific knowledge and real-world problem-solving skills can be constructed" (Fortus et al., 2004, p. 1081). Much like the other modes of learning, DBS helps students contextualize scientific material by making connections with real-world examples whilst engaging students in design projects.

By utilizing the analyze-design-develop-implement-evaluate (ADDIE) model, Alberts and Stevenson (2017) redesigned an undergraduate food safety management systems course. The premise of using the ADDIE model was to engage students in learning that was student-centered, engaging, authentic, and inspiring. Following the intervention, there were significant gains in knowledge, which prepared the learners for the workforce.

Discussion

John Dewey (1899) decades ago proposed that the work students do in the classroom should not merely be mindless or utilitarian but should be instrumental in connecting learners to society and social processes. To do this, learners must be shown the connections between what is taught in the science classroom to the world outside the classroom using T/E design as a facilitator. This helps learners develop critical thinking skills and habits of the mind.

Helping students make connections between what is learned, and the real world is essential for topics like food safety as it is a public health issue that affects everyone. For STEM topics to be learned properly, students must be engaged in hands-on projects, as prescribed by the literature to aid in a literate citizenry.

While the literature does not have numerous examples of learning food safety specifically, much can be drawn from how other STEM courses are learned. Similarly, learning STEM topics cannot be discussed without probing pedagogical approaches.

Conclusion

Learning about food safety is important as food safety is a public health issue that affects everyone. This paper sought to ascertain from the literature how to best learn food safety and other STEM topics. The literature prescribed involves learners in hands-on projects and other experiential learning opportunities to achieve scientifically literate citizens. The literature also showed how science is best learned when students can make connections between what is learned in the classroom and what is happening in the real world. It would be beneficial for the literature to use food safety as a model of how to incorporate the various sciences (STEM) to achieve scientifically literate citizens.

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