



Teaching Tips for the Development of a Virtual Food Microbiology Laboratory for Online Teaching During the COVID-19 Pandemic

Introduction

The food science and technology field consists of three main areas: food microbiology, food chemistry and food processing. All three areas require laboratory exercises and demonstrations. However, with the ongoing COVID-19 pandemic, food science programs are facing decisions about how to best continue teaching and learning while keeping faculty, staff, and students safe (Hodges, Moore, Lockee, Trust, & Bond, 2020). As a result, most institutions have opted to cancel all face-to-face classes, including laboratory sections and have moved all courses' sessions online in order to help prevent the spread of COVID-19 (Hodges et al., 2020). With this change in the style of teaching, common questions have been raised, such as "How will food science laboratories be conducted"? There is also a concern about the quality of learning outcomes from online experiences if learning objectives are being met. With remote teaching and learning, it is necessary to ensure that learning objectives, expectations and outcomes are on par with those of traditional classroom education .

With remote teaching, the instructors deliver the course content online via lectures, and students are required to complete assignments, projects, and other tasks as they would do in face-to-face classes. However, shifting the laboratory experience online as remote learning presents unique challenges as students must be able to complete the laboratory exercises in a way that meets learning objectives (Flaherty, 2020).

In 2004, while developing a food microbiology course for junior and senior students (FCS440 Food microbiology and Biotechnology), I decided to try a different teaching approach with more emphasis on active learning, team work and the use of technology. Thus, instead of the classical microbiology lecture approach, I placed more emphasis on discussion, active search for information online, development of learning protocols and other active learning approaches. However, with the emergence of COVID 19, instructors in food microbiology classes need a different approach to address laboratory experiences. One possible approach is the development of a virtual laboratory. The virtual laboratory can consist of text, hypertext, sound, images, animation, video and graphics

and possible digital forms, which can challenge students to be involved in problem solving exercises.

The purpose of this paper was to provide tips for the development of a virtual food microbiology laboratory for online teaching during the COVID-19 pandemic.

Procedure

The development of the virtual food microbiology course requires the following steps:

1. Development of the instructional content for the exercise (including an objective statement of what the student needs to master and how will mastery be defined/measured)
2. Design and build the laboratory exercise
3. Evaluate the steps involved in each exercise
4. Conduct the laboratory exercises
5. Analyze the outcome (results)
6. Evaluate the effectiveness of the virtual experience

In the development of the virtual laboratory, instructors must modify learning objectives and find appropriate sources to deliver (Taft, 2020). It is also important to provide students with clear, concise instructions and expected outcome for each exercise. In addition, adequate planning must be incorporated into assignments in order to allow students to have a thorough understanding of each expected task. Taft (2020) also recommends the use of simulations with the virtual laboratory in order to give students more details about the steps involved in the exercise and to avoid confusion. This is considered as an illustration step for the exercise and should help to eliminate confusion. For example, students could watch a video of yogurt making and observe changes in pH values during fermentation. This might require providing more details and step by step procedures for all elements involved in yogurt making. Students could learn the steps of yogurt making, required ingredients and other necessary steps such as heating and cooling, and how lactic acid bacteria grows in milk, report their observations of how milk changes during fermentation from fluid to solid due to changes in acidity (Zimmerman et al., 2019, 2020). Another virtual laboratory exercise would be learning how to isolate bacteria from food products using an agar plate. This exercise can include steps involved in agar media preparation, the use of sterilizer and techniques to prepare the plates food sample preparation and laboratory skills for measuring food quantity. Student will observe each step, collect the raw data and then analyze the data and write a laboratory report. Another advanced virtual food microbiology exercise would be to develop software that shows the flow chart with simulation for each step involved in the laboratory exercises. This could also be created with software for simulation and web design. At the end of each exercise, summary points will be presented for the expected learning outcomes. For the lab activity assessment, students will be required to answer questions for each step based on a video clip review.

The “microbe game” is another method for active learning. In the microbe game, students work as a team in designed games (i.e.: card games or monopoly (board games)) that teach students about foodborne pathogens or other related topics in food microbiology. The game development guidelines can be set to evaluate the students’ understanding of the subject content. Such student-produced work could then be incorporated into virtual laboratory exercises where students can engage in active learning and record their scores based on the correct answers.

Students can also participate in a virtual conference with food microbiology experts and conduct 10-15 minute interviews and post them for other students to watch and summarize along with critical thinking input.

Overall, it is important to note that in the development of the virtual food microbiology laboratory for online teaching, instructors should rely on different technologies depending on individual comfort levels and the available resources (Beldarrain, 2006). In addition, the educational institution must be aware of the impact of the available resources on student learning outcomes. Therefore, it is important that educators be comfortable with implementing any new technology required for virtual learning and also have an understanding of advantages and disadvantages related to using such technology.

Formative assessment at a distance is challenging but possible (Miller, 2020). Instructors will still need to check for student understanding and provide meaningful and frequent feedback. Remote teaching allows for immediate and multiple assessments at a *click* of a button. Both synchronous and asynchronous assessment are recommended. For example, polling and chat sessions allow for synchronous assessment while students can post work and receive feedback in a longer timeframe in the asynchronous assessment.

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