

Teaching Apple Preservation and Packaging with Integrated STEM through AFNR

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Introduction

Every learner interacts with and depends on agriculture everyday (The National Council For Agricultural Education, 2015). The comprehensive topics within the Agriculture, Food and Natural Resources (AFNR) national standards offer a multitude of different contextualization opportunities. Knobloch et al. (2007) reported that teachers believed an authentic learning experience occurred through an agricultural context. Apples provide not only an agricultural context, but a local, cultural context for students in Lafayette, Indiana. Van Ingen et al. (2018) reported that culturally responsive teaching can support an integrated science, technology, engineering, and mathematics (iSTEM) approach and engage learners. Integrated STEM is “The approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning” (Kelley & Knowles, 2016, p. 3). Vasquez et al. (2013) identified three approaches to iSTEM: multidisciplinary, interdisciplinary, and transdisciplinary. The different approaches vary in the degree to which the learning experience weaves the subject domains together, provides real-world application, and gives ownership to the learners. The purpose of this unit was to create an opportunity for late elementary learners to explore apple preservation and packaging within a community context through iSTEM within an AFNR context. Learners explored the science and reasoning behind the choices food scientists and packaging engineers make in their careers to address real-world concerns such as food waste and overproduction.

How it Works

This unit was developed by Purdue graduate students enrolled in *Integrated STEM Through AFNR*. The unit was informed by Standards for Technology and Engineering Literacy, Indiana Science and Engineering Process Standards, and The AFNR Career Cluster Content Standards.

The unit began by activating prior knowledge of food science and technology. It then allowed students to explore and simulate the science behind apple browning, and through inquiry learning, design their own experiment to prevent apple browning. Continuing to apply inquiry learning, lesson 3 presented students with additional variables that food scientists and packaging engineers must consider and allowed them to explore packaging materials. Transitioning to a project-based learning approach through the engineering design process, lesson 4 and 5 assigned students the role of a packaging engineer. The lesson set the context for the problem within a local orchard. Students co-created constraints and criteria for their projects as well as tests to evaluate their criteria. Students designed their apple slice packages and after testing, made revisions based on their conducted tests. The unit was designed to be implemented over a week with additional time needed for completion of the summative assessment. The 45-minute lessons could also stand-alone but best support the learner as a unit.

Within the unit, students began by developing STEM skills and developed an understanding within a multidisciplinary approach (Vasquez et al.). As the unit progressed, it transitioned to an interdisciplinary approach that required students to use the skills they learned to solve problems in an authentic context. Multidisciplinary integration was present in lesson 1 and 2, advanced to interdisciplinary integration in lessons 3, 4, and 5, and through the summative assessment, reached transdisciplinary iSTEM. The concepts that were taught are distinguishable as science or technology/engineering with mathematics applied to collect evidence and justify decisions. The application of knowledge made this unit valuable as the students applied what they learned to make meaning and transfer it to an authentic problem. Multiple disciplines were consistently

used throughout the lessons to support students' problem solving and decision making. The instructor acted as a facilitator while also providing a fair amount of guidance to assist the learning process. Food production acted as the context for the learning experiences and challenged students to solve an authentic feasible problem within that field. Students built on their existing understandings surrounding the science of apples and used creative thinking to solve a real-world problem. Lessons 2-4, covering scientific inquiry and part of the engineering design process, were co-taught by two facilitators at a local after school program in a non-formal learning environment. "[Non-formal learning] shares the characteristic of being mediated with formal education, but the motivation for learning may be wholly intrinsic to the learner" (Eshach, 2006, p. 173). The lessons are adaptable to non-formal and formal learning environments.

Results to Date

Ten students at a local after school program designed their apple packaging to be airtight and to hold liquid, showing they understood the effect the oxygen in the air had on the apple slices and reflected the inquiry results that a liquid lemon water mixture worked best. Worksheets showed that learners were actively making and recording observations about the effects of the anti-browning agents. The worksheets also showed that learners were defending their conclusions by applying the observational data they recorded. The discussions within the engineering design prototype building time showed that students were thinking about the previous concepts; learners were building prototypes that would hold liquids and keep oxygen out.

Future Plans/Advice to Others

The unit is designed to be taught in sequence over a week. The lessons could also stand-alone but would require the facilitator to provide some context to the learners. In person delivery created opportunities for the facilitators to interact one-on-one with the groups and ask learners higher-order thinking questions to assess and foster their learning (Krathwohl, 2002). In-person lessons allowed for peer collaboration and richer discussions. Collaborative learning encourages students to self-regulate their learning and co-regulate their peers' learning (DiDonato, 2012). Encouraging students to work collaboratively in groups can have social, psychological, and academic benefits (Laal & Ghodsi, 2012). Inviting local apple producers to share and present the problem within the local context as well as field trips to a local orchard would enhance the problem and make it more meaningful to learners (Crompton, 2020). The context of the unit could be adjusted based on the local agricultural industry or learner interests.

Costs/Resources Needed

Each lesson plan in the unit includes a list of resources needed. The lessons were designed to be affordable, so most of the supporting and building materials are accessible household items (i.e. milk, salt, foil, wax paper). The lessons could be adapted to be taught online and the common household materials would support the online delivery. The inquiry and engineering design activities list a variety of suggested materials but do not require them all nor limit learners to only those materials. The approximate cost of all the suggested consumable materials for the unit is \$50. Computer access is highly recommended to support the lessons with the respective videos and visuals. Each lesson includes complimentary worksheets that would incur printing expenses. The online implementation of this unit would be of less cost to the facilitator but may create a financial barrier for learners.

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