Method of mastery, evaluation method, and student responses.

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| **Lesson Objectives Evaluation Matrix** | | | | | | |
| **Objective** | **Method of mastery** | **Evaluation** | | **Timeline** | **Anonymous student response** | |
| 1. Develop an understanding of the principles of ice nucleation and recognize the diversity of ice nucleating particles, including identifying specific organic and inorganic ice nucleators. | Story of the discovery of ice nucleation (IN) and following lecture. Guided and open inquiry ice nucleation test. | Student questionnaire | | Pre- and post lesson | * Not all strains of *P. syringae* express IN protein. * Not sure what IN is in the mixture of outdoor sample/ * Large diversity of organic and inorganic IN/ | |
| 2. Recognize how interdisciplinary research can address complex problems across multiple fields of study using ice nucleation and its relationship to atmospheric processes as examples. | Discussion of multiple approaches to studying ice nucleation and possible applications. | Student questionnaire | | Pre-and post lesson | * Species diversity impacts should be considered if ice nucleation was manipulated. | |
| 3. Discuss potential societal and ethical implications of human manipulations of the ice nucleation phenomenon. | Class discussion of factors to consider in regards to possible human manipulations of ice nucleation. | Student questionnaire | | Pre and post lesson | * Increasing rain in one area could change weather patterns and negatively impact a nearby area. * Manipulations could be used purposely for negative impact | |
| 4. Consider principles of experimental design, including the formulation of testable hypotheses and the inclusion of appropriate positive and negative controls in developing an ice nucleation test. | Discussion of experiment design, followed by students designing an ice nucleation experiment. | Student worksheets | | Before, during, and after lesson | * The ability to draw conclusions is limited by the control freezing. * Spacing droplets farther apart would reduce frost contamination. * Dye could alter freezing temperature. | |
| 5. Design and conduct an ice nucleation experiment with known and unknown samples of undetermined ice nucleation activity. | Students perform ice nucleation test with known and unknown samples. | Student worksheets | | During lesson | * Outdoor samples froze at highest temperature. | |
| 6. Understand connections between microbiology (ice nucleation) and the global water cycle (bioprecipitation) | Presentation of bioprecipitation hypothesis and discussion of its implications. | Student questionnaire | | Post lesson | * Weather patterns could be manipulated by controlling ice nucleators. * If ice nucleators were manipulated, changes in precipitation could change soil salinity. | |
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| **Summative Evaluation** | | | | | | |
| **Evaluation Questions** | | | **Data Collection** | | | **Timeline** |
| Has the unit changed teacher and student perceptions about the importance of ice nucleation? | | | Teacher and student follow-up surveys | | | Post lesson |
| To what extent does student motivation to participate in STEM careers increase as a result of participating in this project? | | | Student follow-up surveys | | | Post lesson |
| Do students demonstrate an increase in practicing noncognitive skills (i.e., communication, critical thinking, collaboration, and creativity)? | | | Student pre- and follow-up surveys | | | Pre- and post lesson |
| Do students and their teacher(s) demonstrate an increase in understanding integration of disciplines in an interdisciplinary system? | | | Student and teacher pre- and follow-up surveys | | | Pre- and post lesson |