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/
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| 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.
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| 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
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| 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.
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| 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.
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| 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 |