Meteorology Misconceptions Held by Students in an Earth Science Course for Preservice K-5 Teachers

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Background

Students hold misconceptions when they confidently believe certain information, but that information differs from the commonly accepted scientific consensus.[1] Misconceptions accumulate over time due to a combination of incorrect perceptions of everyday experiences, over-simplifications and over-generalizations found in textbooks and the media, and incorrect or incomplete diagrams and analogies.[2-7]

Clausen described misconceptions held by teachers, and how they affected student learning.[8] After observing several teachers teaching about weather and climate change, he concluded that personal beliefs and values impacted what parts of science they emphasized in the classroom, resulting in students learning the content differently and inconsistently.

This study is important because the participants will be teaching shortly; it is imperative for these teachers to fully understand the content that they are educating their students on. If they have weather misconceptions, it could be damaging to their future students' understanding of this foundational content that they will need throughout their lives.

Purpose & Research Questions

This study identified to what extent weather misconceptions persisted after 19 pre-service teachers completed ESS 112 (Inquiry Earth Systems Sciences for Teachers), as measured by their performance on a recently created Survey of Meteorology Concepts (SMC), completed as a pre- and post-test. By examining participant data using psychometric statistics, survey data will also be used to validate the SMC. The research questions are:

- ***What weather concepts do participants have limited or no knowledge of?***
- ***What weather misconceptions are prevalent among the participants?***
- ***To what extent completing ESS 112 increases content knowledge and decreases weather misconceptions?***

Methods

A literature review was completed to identify common weather misconceptions and similar surveys. Two of the researchers wrote the items and a panel of geoscience and meteorology experts provided content validation. The best 45 of 90 items were added to this version of the SMC. A Certainty of Response Index question was added to classify responses in four categories:

- Lucky Guess – **Correct** answer, **low** confidence that it was correct.
- Knowledge – **Correct** answer, **high** confidence that it was correct.
- Unlucky Guess - **Wrong** answer, **low** confidence that it was correct.
- Misconception - **Wrong** answer, **high** confidence that it was correct.

13. In what month is the Sun the closest to Earth?
A. January
B. March
C. April
D. June
E. July
F. September
G. October

Please indicate whether you answered the previous question using knowledge learned in classes/ books, or not.

A. Totally guessed the answer.
B. Almost a guess.
C. Not sure.
D. Sure.
E. Almost certain.
F. Certain.

The 19 pre-service teachers optionally completed the SMC as a pre- and post-survey, to study if there was any significant change in performance. We then tabulated this data in Excel to produce graphs and run statistical analysis. Calculated Item Response Theory parameters were the item difficulty, discrimination, and distractor analysis to identify non- and over-distracting incorrect alternatives.

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Findings

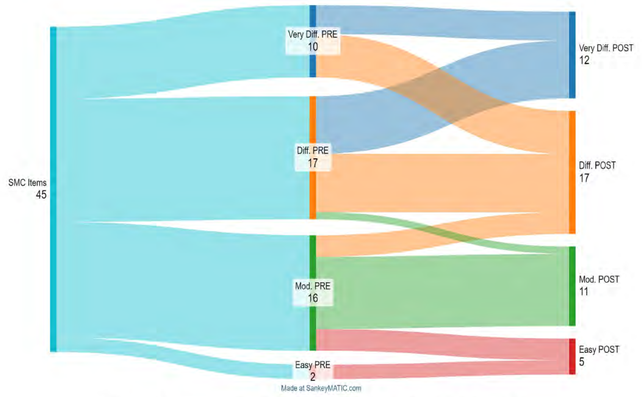

Fig 1. Changes in item difficulty after ESS 112.

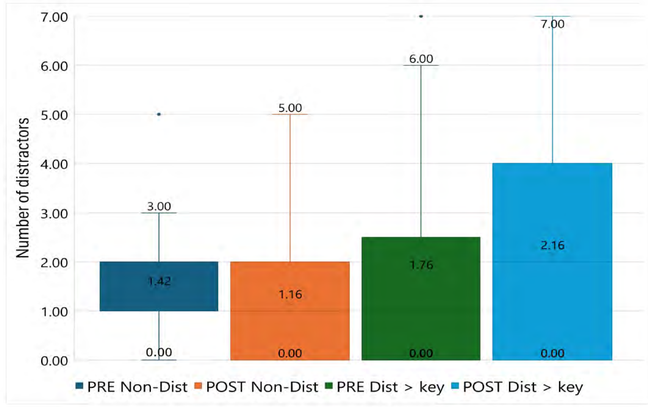

Fig. 2. Changes in over- and non-distractors after ESS 112.

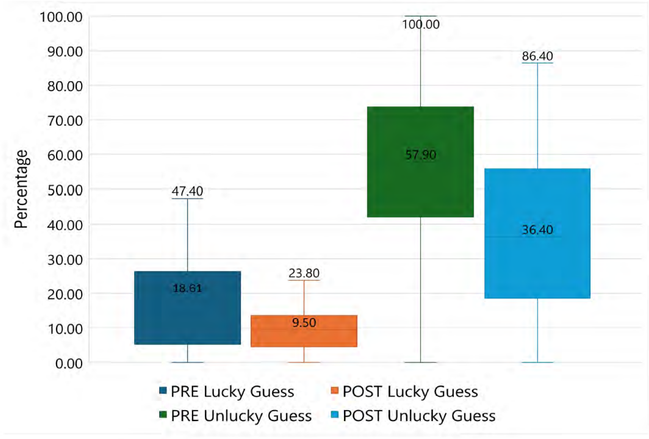

Fig. 3. Changes in guessing after ESS 112.

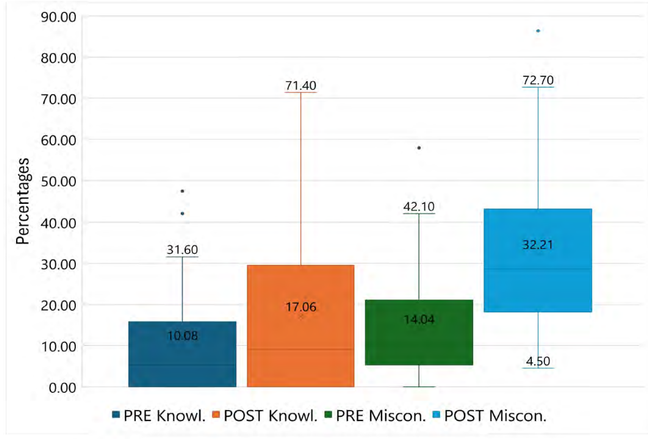

Fig 4. Knowledge & misconceptions after ESS 112.

Most Common Misconceptions

- Identify what atmospheric features are water vapor (#37).
- State the causes of sea level rise associated with global warming (#45)
- State how frequently lightning strikes the same place (#41).
- Graphically identify the daily variation in air temperature during a sunny, calm spring day (#5).
- State in what month the Sun is at perihelion (#13).
- Identify under what temperature conditions water freezes, melts (#42).

Conclusions

The group of pre-service teachers in ESS 112 students showed very little weather content knowledge initially (10% to 14%) and a concerningly low knowledge gain post-survey (17% to 25%). Their performance contributed to a low Cronbach coefficient of 0.18 for the SMC.

Additionally, ESS 112 students had more misconceptions post-survey, at a misconception rate of 32%. This suggests that the class made students feel more confident of their weather knowledge, including their incorrect ideas (misconceptions). Future work includes replicating the study with more students and revising curricula to better challenge weather misconceptions.

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