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CONTENT KNOWLEDGE RETENTION BY UNDERGRADUATE STUDENTS IN SURVEY COURSES IN METEOROLOGY

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1. INTRODUCTION

In recent years, considerable effort has been taken to address the quality of Geoscience education at the K-12 level, however, instruction at the university level remains relatively unexamined, especially for non-majors.

The majority of students enrolled in introductory meteorology courses at the University of Illinois at Urbana-Champaign (UIUC) do so to fulfill their university general education science requirement (DAS 1998). It is imperative that these students, upon completion of the course, obtain a solid foundation of elementary atmospheric science and an appreciation of science, in general, as it may be their only exposure to scientific processes.

Current curricula and pedagogy in the atmospheric sciences are such that undergraduate students are presented a large amount of scientific material within a 16-week semester or 10-week quarter period. Traditional instructional methods in atmospheric science include lecture format presentations and in some cases optional laboratory meetings. However, this format is not necessarily the most effective way to present information to students, especially to students not majoring in the topic.

The volume of material presented, coupled with the method of presentation, plays a primary role in not only the student's comprehension of material, but their ability to integrate it with concepts previously acquired either earlier in the course, in other science courses, or with pre-existing knowledge. This problem is compounded in the atmospheric sciences where new concepts are often immediately applied to existing and developing weather events, the result often being the inability for students to fully comprehend class/course material.

Alternative instructional methods for large classes in undergraduate courses have been investigated and are in current use across disciplines. These alternative methods of instruction have yielded positive results in terms of student learning outcomes (Knox and Croft 1997; Heinze-Fry and Novak 1990; Poole and Kidder 1996; Grove et al. 1996; Carr, K. 1997).

In this investigation, the authors investigated the long-term content knowledge retention of students enrolled in a general education atmospheric sciences survey course at UIUC. The results of this study will be used to restructure curricula of the introductory meteorology course such that the emphasis will be placed on understanding of physical processes and retention of that material. Pedagogy will be reevaluated and incorporation of the most current and effective instructional methods for achieving long-term content knowledge retention will be adopted.

The primary focus of the first portion of the investigation was determining what knowledge acquired throughout the semester course was accurately retained several months later. The two goals of the study were to determine if students, (1) understood the physics driving atmospheric processes and (2) could apply the physical principles to the interpretation of weather maps and charts. The second portion of study determined alternative instructional methods, and the final phase of the study focused on the incorporation of the recommended changes based on student outcomes. An overview of the student interviews (first portion of the study) is outlined below.

2. COURSE BACKGROUND

Introduction to Meteorology (ATMOS 100) is a general education course fulfilling 3-credit hour science requirements for students enrolled at UIUC. The majority of students who enroll in ATMOS 100 do so to either fulfill at general education requirement for the university or out of a personal curiosity about the weather (DAS 1998).
Standard instructional methods included presenting material in straight lecture format, no discussion sections or laboratory meetings, and closely following the textbook (Ahrens 1994). Attempts were made to include weather discussions into lecture via the use of current weather maps and charts. For the semester under investigation, the course structure consisted of six homework assignments, two in-class tests, random quizzes and a (limited comprehensive) final exam.

Upon completion of the course, students are, at a minimum, expected to be able to read a newspaper weather map and identify basic weather patterns and conditions, and more importantly, should understand at a basic level, the physical concepts involved in atmospheric processes.

3. INTERVIEW METHOD

In December, 1997, ATMOS 100 students were asked to voluntarily participate in the study. Of the 75 students invited to participate, 32 responded positively, of which 22 agreed to be interviewed; 20 interviews were conducted. Semi-structured clinical interviews were held in April, 1998. Interviews were approximately one hour fifteen minutes long and were took place in a private room where only the interviewer and interviewee were present. All interviews were audio and video taped.

From an educational research perspective, clinical interviews are superior to survey-based questionnaires in that the interviewee can be probed to explain exactly what it is they are trying to say, and can be asked to clarify the usage of technical terms (Finley 1986, 1984; Saigh 1992). For example, in discussing cloud formation, the student may use terms such as: “condensation,” "lifted condensation level," and "stability." When asked to clarify what is meant by "condensation" or "stability" they may or may not be able to correctly define the terminology.

Interview topics were selected based on two primary questions (see list below), (1) Does the student understand the physical processes governing the atmosphere? (2) Can the student apply scientific principles to “real-life” situations? e.g., can the student correctly interpret current weather conditions and read basic weather maps and chart? The interview was designed to be comprehensive and have continuity.

Color maps and diagrams were used as a tool to extract knowledge of map reading as well as trigger explanations of physical processes of the atmosphere which contribute to various weather conditions.

Interview Topics
- Definitions
  - weather, climate, latent heat
- Sea level pressure map
  - pressure balance/imbalance; wind information
- Upper air map
  - upper air winds, connection to surface features
- Clouds
  - vapor content, cloud formation, dissipation, composition; reasons for cloud shapes
- Thunderstorm diagram
  - identify thunderstorm features; explain physical dynamics of thunderstorm
- Precipitation
  - causes of precipitation; seasonal differences in type; formation processes
- Surface analysis map
  - reading station model data; identifying and explaining surface features

Due to limited time and the nature of the interview, several key meteorological topics were omitted from the interview including radiation balance, greenhouse effect, global warming and climate change. If interview subjects brought up these or other topics during the interview, they were asked to briefly expand on the topic. (See Morgan and Moran (1997) for university students’ knowledge on greenhouse effect and ozone hole.)

4. ANALYSIS

To analyze the data, the “Finding patterns and developing category systems” approach (Patton 1990) was used. Common themes in the interviews were elicited and a coding scheme was developed for each of the topics studied. Using the system described by Patton, the authors worked "back and forth between the data and the classification system to verify the meaningfulness and accuracy of the categories and the placement of data in categories.” Following the creation of the categorical schemes each interview was coded. The NU*DIST qualitative research computer program (Sage Publications, 1997) was used to enter codes and then to search for coded segments that corresponded to each construct.
Data were grouped and analyzed to test for differences between students of different majors, age, gender, previous science classes, etc.

5. RESULTS AND CONCLUSIONS

Preliminary analysis shows that, overall, students had difficulty explaining or identifying the traditionally difficult topics in introductory atmospheric science (latent heat, precipitation formation processes, stability and its application). For example, more than two-thirds of the students said they recalled the term “latent heat,” but had no idea what it referred to. Conversely, almost all subjects had a strong knowledge base in more common weather topics such as identifying various structural features of a thunderstorm, reading surface maps with station data and discussing cloud formation, structure and composition.

Additional results from further analysis will be used to determine what other instructional methods should be employed to enhance student understanding and long-term knowledge retention.

6. ACKNOWLEDGEMENTS

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7. REFERENCES


DAS. Department of Atmospheric Sciences, 1998, University of Illinois at Urbana-Champaign.


