Snowpack Study in Technical Communication

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ABSTRACT

In the section I teach of Technical Writing at Plymouth State College in New Hampshire, students learn to handle the content, form, and style of scientific reports by writing about a snowpack. In this context, snowpack study requires students to learn and apply only elementary concepts of snow physics, but it establishes common experiences in science for students with non-scientific backgrounds. During an initial field trip, students examine the layers in a snowpack and observe the various characteristics of snow. For two weeks after the first field observations, students study local weather history and learn basic concepts of snow science, snow stratigraphy, and snow metamorphism. Based on their new understanding of snow, they hypothesize what changes have probably occurred in the snowpack, and they learn to identify types of snow particles in the field. During a second field trip, students re-examine the snowpack, compare their hypotheses with actual conditions they observe, and account for persistence and change in the snowpack during the two week interval. At each stage in the snowpack study unit, students keep a log of their observations and write up their findings in a series of technical reports. They also keep a journal of their experiences and write essays in which they examine their personal experience in snowpack study and assess the snowpack study unit. Finally, they compile their reports, then edit and polish them.

THE RATIONALE FOR SNOWPACK STUDY

Consider winter as a classroom, limited not by walls, but only the imaginations of those who venture forth.
Halfpenny and Ozanne - Winter, an Ecological Handbook

Informal surveys among my students at Plymouth State College in New Hampshire suggest that many people are poorly informed about snow. They ignore it, deplore it, or see it only as an adjunct to a sport or play.

A student of mine told me he had never thought much about snow: "I knew it was white and fluffy and sometimes it was compactible (good for snowball fights, and snowmen)." His only thoughts about snow were "how beautiful it was, how great it was to ski and snowmobile on, how much I enjoyed playing in the snow, and how much of a pain it was to shovel the driveway." Beauty, play, sport, nuisance—that summarizes the experience of most people with snow. Snow has lain all around them, but people have never examined its structure or the agents that change it.

This indifference to snow permeates our educational system as well. My survey of dozens of school science texts and science projects described in print and on the Internet show that teaching about snow in the schools has been neglected. Typical school science projects have students merely draw and cut out snowflakes or determine the water content of snowflakes by melting a can of snow. Many school science textbooks fail to mention snow altogether. The motto seems to be, "When the crickets die, bring the science indoors." I want to help change that view.

Capitalizing on this neglect of snow science, I have used snowpack study four times in my course in Technical Writing (EN309) at Plymouth State College. This is a junior-level course designed to introduce students from various academic departments to technical and scientific writing. Although I limit the study to the physical characteristics of snow on flat ground, snowpack study in this course provides students ample opportunity for extensive observation, interpretation, and reporting.

THE AIMS OF SNOWPACK STUDY

At the beginning of the course, I state the aims of the snowpack study unit as follows:

Aim 1. Learn and use scientific procedures. Students conduct scientific investigation through a series of field tests.

Aim 2. Learn and apply scientific knowledge. Students quickly learn the fundamentals of a new science.

Aim 3. Learn to interpret data. Students integrate their knowledge and experience.

Aim 4. Create and participate in a scientific community. Students work individually and collaboratively.

Aim 5 Communicate about science to the wider scientific community. Students create written texts and visuals in various modes for varied audiences.

Aim 6. Develop personal qualities . Students develop skills, attitudes, values, and goals appropriate for a scientist.

THE BENEFITS OF SNOWPACK STUDY

Snowpack study makes students more aware of their environment. Because our students live on the third of the earth's surface where snow falls, they can study a snowpack on their own college lawn with a minimum of equipment; they can study it individually or in a group. And because snowpack study has not been widely used in our schools, it is a fresh topic. Students discover things they had little suspected. Although snowpack study is presented in this course as pure science and as a subject for writing, it also prepares students to understand applications of snow science in glaciology, avalanche studies, ecology, or hydrology, as well as to participate more safely in winter sports. Whether viewed as pure science or applied science, snowpack study encourages wider understanding of one of nature's most interesting materials.

One value of snowpack study in a technical writing course is that it provides a common experience in science among students with limited technical backgrounds. No member of the class is likely to know anything about the subject, so everyone starts off even. Snowpack study is suitable for these students because meaningful study of snow on the ground requires little prior scientific knowledge and hardly any mathematics. Students can master the concepts and procedures in a few weeks. I have tried numerous other writing and research topics in this course,

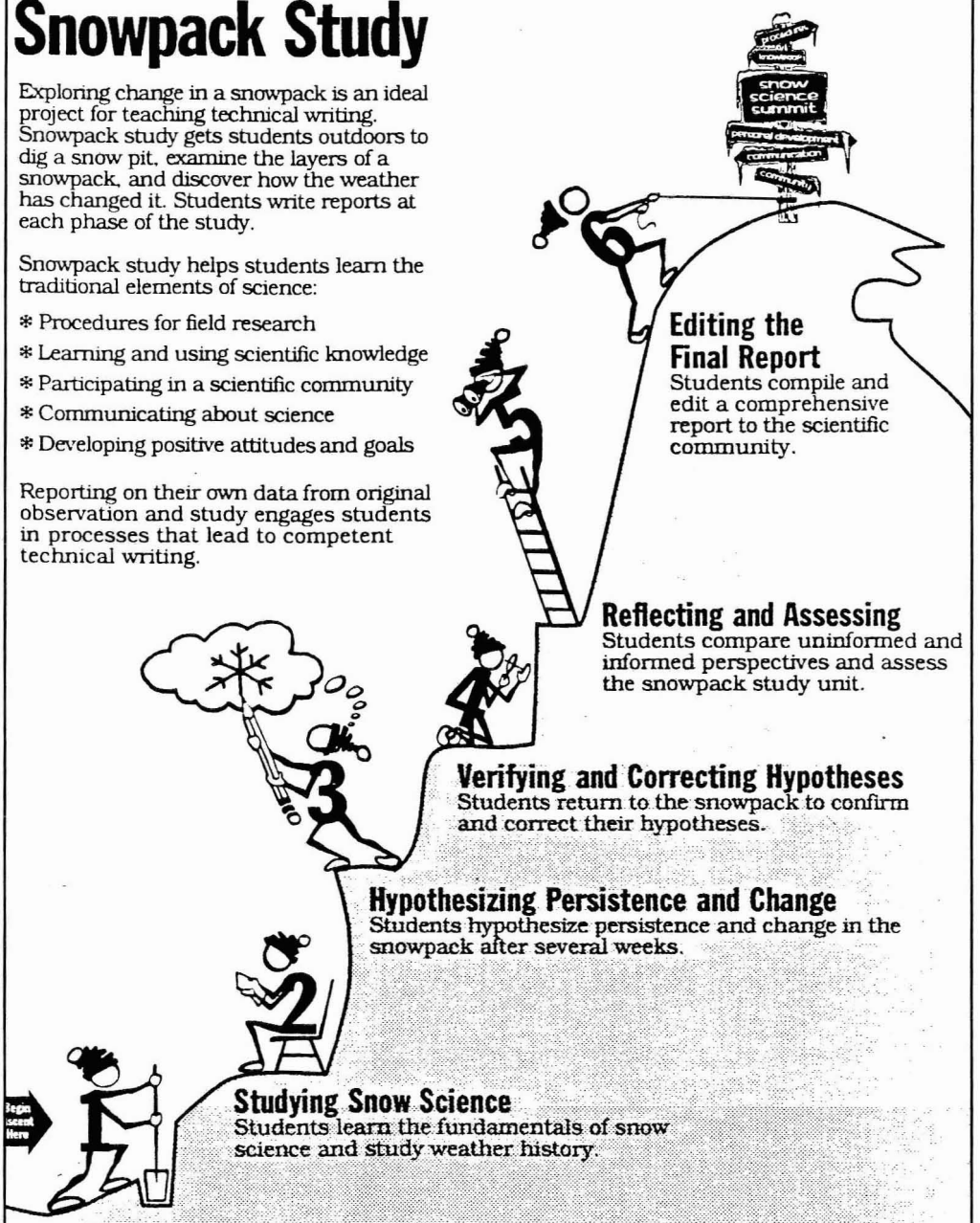
Teaching Technical Writing Through Snowpack Study

Exploring change in a snowpack is an ideal project for teaching technical writing. Snowpack study gets students outdoors to dig a snow pit, examine the layers of a snowpack, and discover how the weather has changed it. Students write reports at each phase of the study.

Snowpack study helps students learn the traditional elements of science:

* Procedures for field research
* Learning and using scientific knowledge
* Participating in a scientific community
* Communicating about science
* Developing positive attitudes and goals

Reporting on their own data from original observation and study engages students in processes that lead to competent technical writing.



Editing the Final Report
Students compile and edit a comprehensive report to the scientific community.

Reflecting and Assessing
Students compare uninformed and informed perspectives and assess the snowpack study unit.

Verifying and Correcting Hypotheses
Students return to the snowpack to confirm and correct their hypotheses.

Hypothesizing Persistence and Change
Students hypothesize persistence and change in the snowpack after several weeks.

Studying Snow Science
Students learn the fundamentals of snow science and study weather history.

Observing and Reporting
Students conduct tests of snowpack conditions and write up their observations.

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An Annotated Flow Chart of Snowpack Study. The six phases of snowpack study help students learn technical writing through field investigation of snow on the ground

including human anatomy and physiology, hypothermia, environmental impact statements, and a variety of case studies, but none has worked as well as snowpack study as a vehicle for teaching technical writing.

Students find snowpack study rich and demanding. Through field work, study, and writing reports, they get the feel for scientific investigation and scientific writing. They not only gain specific knowledge about the physics of snow stratigraphy and metamorphism but learn to observe, record, and interpret data. They learn to write concisely and precisely. Further, they learn to present information in several forms for a variety of readers who are not acquainted with their project. They also learn to work cooperatively, to review each other's reports, to accept criticism from their peers, and to rewrite their reports on the basis of feedback. Perhaps most importantly, students learn how to approach a new area of knowledge and quickly master its concepts. Unlike many technical writing projects, snowpack study has students do original research and write up the results of their own investigation. Student assessments of the course indicate that they value all of these aspects of snowpack study.

SNOW AS AN OBJECT OF INTEREST

Much of the interest of snowpack study derives from the special nature of snow itself. In studying a snowpack, students can observe the cycle that begins with new snow and, after many intermediary stages, ends in meltwater. This means that they can observe several processes of change over the course of one winter. Other crystal metamorphic processes, such as those that occur in rocks, take hundreds of thousands of years. Although students do not see the processes of metamorphism directly, they come to understand how the changes in the snowpack create structures that vary daily. For promoting the study of science and science writing, this benefit of snowpack study can hardly be overestimated.

THE GENERAL PLAN OF SNOWPACK STUDY

Despite its technical simplicity at this level, snowpack study is not mere play or casual observation, but disciplined scientific investigation. Students get out onto the snow, dig a snow pit, observe a snowpack under guidance, and report their observations.

After this introduction to field methods and report writing, students study snow science. The *Field Guide to Snowpack Study* (Chisholm, 1996) introduces snowpack study, explains all of the technical information, and gives detailed specifications for each report. This information, supplemented with lecture material derived from the sources listed in the Selected Bibliography, helps students learn the fundamentals of snow physics, identify particles, classify them into standard categories, and hypothesize persistence and change in the snowpack. After learning about snow science, the students return to re-examine the snowpack to observe the effects of the forces of change. They re-examine their hypotheses to determine how close their predictions came to actual conditions. At the end of each phase of the study, they report their findings. Thus, students collect, interpret, and report their own data from original observation. This primary research engages students in a process that leads to competent technical writing.

ACTIVITIES OF SNOWPACK STUDY

Snowpack study is laid out in a sequence of ten lessons described in detail in the *Teacher's Guide to Snowpack Study* (Chisholm, 1996). The lessons are segmented and articulated so that each phase of the unit builds upon the work done in the previous phases and lays the groundwork for the following ones. The lessons are arranged in six phases, as follows:

PHASE 1. OBSERVING AND REPORTING

Arousing and focusing interest

I prepare students for snowpack study by explaining the aims of the unit, then having them write about their earlier experiences with snow. Colored transparencies of students using equipment, making observations, and collecting data on field trips arouse and channel their interest in snowpack study. Then students recollect recent weather history and hypothesize present conditions in the snowpack. After an hour or so of instruction and demonstration of techniques for conducting field tests and another hour of preliminary field tests, we go outdoors to observe and test the snow and conduct the tests.

Field Trip 1: guided observation of a snowpack

During an initial hour of orientation to field work, students gain first-hand experience with snow. They dig a pit in the snow, expose and measure the layers of the snowpack, test the layers for hardness and wetness, observe particle type, width, and color, and record their observations on a Snow Pit Data Sheet. Having learned the procedures, students then conduct Field Trip 1 to collect good data. These first two field experiences are eye-openers; it is exciting for students to discover that the snowpack is actually made up of layers of snow that differ in observable physical characteristics.

Report 1: Initial observations of a snowpack

Throughout the sequence of ten lessons, students are guided by a series of research questions. During Field Trip 1, students focus on answering Research Question 1:

What are the physical characteristics of the snowpack observed during Field Trip 1?

Students write up their initial field observations in Report 1, where they present information in tabular, visual, and narrative form. The specifications for the first report require students to face and resolve all of the writing problems early in the unit: what information to include, how to say it, and how to format it. They learn to write only relevant information in the concise and highly-structured form required for technical communication. Drafts of these reports undergo repeated review by both other students and by me and repeated revision by the writers.

For this and all subsequent reports, I require students to follow specifications exactly. The specifications are modified from Robert Day's *How to Write and Publish a Scientific Paper* (1994), supplemented by specifications for the *Proceedings of the Eastern Snow Conference* (1996), an annual publication of reports by leading snow scientists. I provide a system of paragraph numbers to help the students follow the form.

Specifications for Report 1

PHYSICAL CHARACTERISTICS OF A SNOWPACK

Observed During Field Trip 1

This report answers Research Question 1: *What are the physical characteristics of the snowpack?* Follow the General Specifications and the outline below. Information in brackets [ ] is for your guidance only; do not include these words in your headings.

Front Material

- Title page [Include the title, your name, the course place, date, and occasion for writing.]
- Abstract [An informative summary, giving as much detail as possible in <250 words]
- Key words [Four or five words or phrases helpful for persons searching in a data base]
- Contents [Include the headings from these specifications—but not the bracketed material.]

1. Introduction
   - 1.1 Background of the Study [Tell who, what, when, and where.]
   - 1.2 The Research Question [The nature and scope of the problem]
   - 1.3 Rationale for the Study [Why it is significant or important]
   - 1.4 Review of the Literature [Summary of the *Tests* and other sources of information]
   - 1.5 Personnel [A list of colleagues, their background and experience, college major, science courses, technical courses, writing courses, writing experience, and special knowledge]
   - 1.6 Study Site
   - 1.6.1 Map of the Study Area
   - 1.6.2 Plan of the Study Site
   - 1.6.3 Description of the Study Site [Include the reasons for choosing this site.]

2. Materials and Methods [How you went about it]
   - 2.1. Equipment [Tools and supplies]
   - 2.2. Methods of Investigation in Field Trip 1

   In a chronological timetable or log of activities during the field trip, briefly list and describe the tests you used [from *Tests of Snowpack Conditions*]; tell why you used them, and how you used them. Tell who did what and describe the way you interacted during the field trip. Give enough detail that a reader can understand the procedures you used, judge the quality of your work, and replicate your procedure. Reserve assessment of these matters for 5.1 in the Appendix. Use past tense to describe the procedures; do not give directions.]

3. Results [Characteristics of the snowpack observed during Field Trip 1]
   - 3.1 Snow Pit Data Sheet [Filled out during Field Trip 1]
   - 3.2 Profile of the Snowpack [A cutaway view, including date of deposit and age of the layer]
   - 3.3 Snowpack Characteristics [Describe each layer of the snowpack in connected prose.]

4. Discussion
   - 4.1 Interpretation [Interpret the results of your field observations.]
   - 4.2 Limitations of the Study [List and explain constraints on the study.]

5. Appendices
   - 5.1 Assessment of the Project [What you knew about a snowpack and writing scientific reports before the project; what you learned; how you learned it; how you worked to write and revise this report; how you felt about the project; its value to you.]
   - 5.2 Acknowledgments [Acknowledge the help you received from classmates.]
   - 5.3 References [Lecture, handouts, conferences in standard bibliographic form and style]

Figure 1. Specifications for Report 1. After completing Field Trip 1, students report the conditions of the snowpack in the form specified here. Each of the seven reports follows similar specifications as well as general specifications based on standard formats used by snow scientists.

Specifications for Report 1 are given in Figure 1.

PHASE 2: STUDYING SNOW SCIENCE

Learning the fundamentals of snow science

After the first field observations and the first report, students spend about a week learning about snow science through lectures, visuals, and reading the *Field Guide to Snowpack Study*. They learn basic concepts of snow physics such as temperature gradients, sublimation and condensation, sintering, and latent heat. For many students, these are new concepts, but when presented appropriately, they find most of them easy to learn and apply. This instruction is followed by a brief explanation of snow formation and deposition and the characteristics of newly-deposited snow.

Students next learn how a snowpack is affected by various agents of change: mechanical change through gravity and compaction, wind, solar radiation, warm air, and liquid water; and metamorphic change through angular-grain metamorphism, round-grain metamorphism, and melt–freeze metamorphism. Both the agents and the processes of change are explained in detail and kept in focus throughout the remainder of the study unit.

Armed with knowledge of basic concepts of snow physics and snow metamorphism, and aided by a guide to types of snow, students learn how to identify various snow particles such as settled snow, wind crust, sun crust, sintered snow, ice lenses, melt–freeze particles, angulated particles, and rounded particles.

Learning about weather history

After learning about the forces and processes of change and their various products, students work in small groups to study local weather history in detail. Using data supplied by Charles Durgin of Plymouth, a New Hampshire weather observer, they convert the information from British units to metric units. From the data, they design a graph that shows snow accumulation and changing snowpack depths throughout recent weeks. Then they describe significant recent weather events in ordinary prose.

These exercises help students become aware of scientific usage, become familiar with the data, and learn to express data in several forms (numerical, graphic, and narrative description).

PHASE 3: HYPOTHESIZING PERSISTENCE AND CHANGE

Report 2: Hypothesizing conditions in the snowpack

Drawing on their newly-acquired knowledge of snow science and understanding of weather history, students then hypothesize how recent weather has affected the snowpack. Research Question 2 guides their hypothesizing:

Considering the influences on the snowpack since your first field observations, a) What characteristics would remain unchanged? b) What changes would you expect to find?

Students present their hypotheses in Report 2—which prepares them for the second field trip.

Students become aware of the fact that although they will not be tested on this material—there are no examinations about snow science in this course—when they conduct a second round of field tests, they will need to apply what they have learned. In this way they come to understand what a *working knowledge* of a topic entails.

PHASE 4. VERIFYING AND CORRECTING HYPOTHESES

Report 3 on the second field trip: Observing persistence and change

Students then return to the snowpack to make a second set of observations. They again dig a snow pit, examine and measure the layers, and record the physical characteristics of snow. This time they are guided by Research Question 3:

Which characteristics of the snowpack have persisted and which have changed during the interval between your first and your second field observations?

This re-examination of the snowpack reveals how the layers of snow particles have persisted or changed during the weeks since the initial field observations.

Report 4: Accounting for persistence and change in the snowpack

In Report 4, students explain how the changes they have observed correspond to the weather history at the site, and they correlate their hypotheses about persistence and change with the actual conditions they observe. This report requires students to apply the principles of snow physics to field observations. In writing this report, they are guided by Research Question 4:

How does the snowpack reflect the influences of mechanical change and metamorphism?

Increasing complexity in the four technical reports

Each of the first four reports requires students to apply appropriate techniques to gather and record information about various aspects of the snowpack, then to synthesize and interpret this information for a variety of audiences. The complexity of the synthesis increases with each report, so that by the time they write Report 4, students have to synthesize five bodies of information:

1. Initial observations as described in Report 1
2. *Snow science as described in Chapters 3–5 of the* Field Guide
3. Weather information from the local weather station
4. Their hypotheses about persistence and change
5. Observations of the snowpack during the second field trip

Report 4 thus calls for a good bit of integration. Having begun with the concrete experience of the snowpack in Field Trip 1, they now interpret the data collected in Field Trip 2 by reference to processes of change in the snowpack they have recently learned. Students incorporate scientific concepts into a theoretical understanding of physical forces and their effects and infer the causes of present conditions based on their understanding of these forces. Then they re-examine the changes they have documented and interpret the changes on the basis of snow physics and weather history. At each stage, the tasks become more complex and demanding and the intellectual skills move to a higher level. No other part of snowpack study so se-

verely tests the students' abilities—nor so greatly enlarges and enriches their concepts.

Report 4 as a culminating activity

Each of the first four reports presents a stage in the investigation of the snowpack, and each will remain as an integral part of the final report. Report 4 builds on information in the earlier reports. Although it is not a cumulative report and it does not replace the earlier reports, it corrects errors in them and synthesizes some information in them.

Learning to handle complexities

Although the students in this course are not trained in science, they must quickly learn to use scientific procedures and scientific knowledge (the concepts, the techniques, the terminology, and the observational skills). After a minimum of instruction, they must learn to handle the new writing problems that technical reports present: selecting appropriate scientific material, organizing it according to a specified form, developing their ideas fully, writing clearly and correctly. It is a big order.

At this point, some students begin to feel overwhelmed by the complexity of this assignment and the demands of science writing. I help them deal with getting stuck by sharing techniques for coping: recognizing the problem, writing it out, considering parallel problems, and so on. With this help, they learn how to deal effectively with difficulties.

Style in the technical reports

One of the greatest challenges for students is making the transition from student-based and classroom-based writing to professional writing. Learning to be objective, concise, and direct entails a radical change of style. I help students develop a technique appropriate for technical and scientific writing by giving them both general principles and specific instances, as well as detailed specifications for each report. In these ways, students are encouraged to learn a professional style to replace their habitual mode of classroom writing.

Noting limitations of the technical reports

In each of the technical reports, I encourage students to acknowledge the limitations of their study, such as those imposed by time and cold weather as well as by their lack of knowledge and experience. An essential element in their learning is stating these limitations directly and specifically, but without apology, as shown in this excerpt from a student report:

This study was limited by the brief time available for the first field trip (30 minutes), by the cold weather and inadequate clothing of the observers, and by our lack of knowledge and experience.

In writing this way, students practice the humility and honesty essential in science writing.

Report 4 brings to a close the technical portion of the snowpack study unit.

PHASE 5. REFLECTING AND ASSESSING

Report 5: Contrasting naive and informed observation

With the work entailed by the second set of field observations now completed and Reports 1 through 4 revised and edited, students have completed the technical portion of the snowpack study unit. They now begin to reflect on their personal development during this unit. They consider their role as members of the scientific community, such as developing the habits of inquiring and observing, searching for objective data, and reporting to professional peers. They also contemplate their attitudes, values, and goals, and their skill at handling interpersonal relationships as well as their own feelings.

As the students turn their attention to their intellectual journey during the snowpack study unit, they are guided by Research Question 5:

How have you moved from unawareness of snow to informed interpretation and reporting of snowpack characteristics?

This report encourages students to contrast their uninformed and informed observations of a snowpack and thus gain perspective on their learning.

The source for the personal reflections that students present in Report 5 is a series of journal entries they have written. Throughout the semester, I had them write brief notes about their thoughts and feelings and to preserve them for eventual use in a culminating essay. Early in the snowpack study unit, students write in response to questions such as, "What did you know about snow before you came into this course? How did you feel about it?"; "What went right during the first field trip? Why?"; and "What went wrong? What could you do next time to make it go better?" Later, they reflect on their changing perspectives and abilities by answering questions such as "How were things different in your first and second field trips? Were you more interested or less?" These journal entries help students recapitulate the unit from their individual point of view.

The journal entries are the raw material for Report 5. To help students convert their journal writing into a focused essay, I have them answer a set of questions about what they learned during the snowpack study unit:

What have been the differences in your understanding of a snowpack and of technical writing at these stages:

Stage 1: Before instruction or guidance in this course [casual observation, sport, work, indifference, etc.]

Stage 2: Preparation for the field trip [lecture and demonstration]

Stage 3: Guided observation during Field Trip 1

Stage 4: Reporting initial observations of a snowpack [writing, reviewing, and rewriting Report 1; include peer review of others' reports]

Stage 5: Learning the fundamentals of snow science and weather history [reading, lecture, exercises, and discussion]

Stage 6: Hypothesizing persistence and change in the snowpack

Stage 7: Confirming and correcting the hypothesis by additional observation during Field Trip 2

Stage 8: Accounting for persistence and change in the snowpack

Students reflect not only on how much information they have gained and used but also on ways that their learning about snow has improved their ability to make scientific observations and to write them up for specific audiences. Having answered these questions, they are well on their way to thinking scientifically. At the same time, their reflections help them meet the liberal arts and general education goals of the unit.

Report 6: Assessing the snowpack study unit

Toward the end of the snowpack study unit, students assess the unit itself. Their evaluation of teaching and learning in the snowpack study unit is guided by Research Question 6:

What is your assessment of the snowpack study project?

Students explain each of the aims in their own words, state whether they were appropriate aims for the course and for them, evaluate how well the activities of the course contributed to achieving the aims, tell how well they in fact achieved the aims, and explain how they coped with difficulties.

Assessing an educational experience is quite new to most students. For this reason, what they learn in this section is not only how to make honest and straightforward evaluations but to couch them in diplomatic language. They learn to maintain a tone of collegiality that respects the sensibilities of the people and actions they write about; at the same time they learn to avoid both gratuitous compliments and offensive statements.

PHASE 6: EDITING THE FINAL REPORT

Report 7: Preparing the final report for publication

The tangible product of the snowpack study unit is the final cumulative report in which students meld their series of write-ups. They prepare the final reports for publication by submitting them to peer review and repeated revision. They submit a printed report to me.

Eventually, I plan to have students publish their reports on the World Wide Web. Publishing on the Web will create a new dimension for technical writing: world-wide overnight publication—something few students have experienced. Expectation that their report will be published on the Web will be a heady tonic to maintain interest for the final big push. Many students realize that this mode of publication opens for them a new method of communication as well as providing another sheaf for their professional portfolio and an important new line in their résumés. The fact that Web publication of their report reflects well or ill both upon them and upon their college will, I surmise, provide additional incentive to perfect their reports.

Students tell me that in this snowpack study unit they not only learn how to write more concisely and clearly but develop a new appreciation for one of nature's most interesting substances.

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