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## Teaching Technical Writing Through Snowpack Study

by Richard M. Chisholm

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### Abstract

In the section I teach of Technical Writing at Plymouth State College, students learn to handle the content, form, and style of scientific reports by writing about a snowpack (accumulated snow on the ground). 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 trip, 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 changes that have occurred in the snowpack, and they learn to identify types of snow particles in the field. Then they return to the snowpack to make a second set of observations. During the second field trip, they re-examine the snowpack, compare their hypotheses with actual conditions they observe, and account for persistence and change in the snowpack. At each stage in the snowpack study unit, students write up their findings in a series of technical reports, then write essays in which they examine their personal experience in snowpack study and assess the snowpack

study unit. After a final edit to polish their reports, they publish them on the World Wide Web.

**Key words:** snowpack study, school science, snow physics, snow metamorphism, technical communication, science writing, teaching technical writing

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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*

## **The Rationale for Snowpack Study**

Despite wide publicity of blizzards and near-record snowfalls in New Hampshire this past winter, my observation is that the public is poorly informed about snow. They continue to 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. While snow science has advanced rapidly since the 1930s, 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.”

Capitalizing on this neglect of snow science, I have used snowpack study four times in my course in Technical Writing (EN309). Although I limit the study to observation of physical characteristics of snow on flat ground, snowpack study in this course provides students ample opportunity for extensive observation, interpretation, and reporting.

The chief value of snowpack study in my technical writing course is that it provides a common experience in science among students without a technical background. Snowpack study is suitable for these students because meaningful study of snow on the ground requires little prior scientific knowledge and hardly any mathematics. No member of the class is likely to know anything about the subject, so everyone starts off even. I have tried numerous other writing and research topics in this course, including human anatomy and physiology, hypothermia, environmental impact statements, and a variety of case stud-

ies, but none has worked as well as snowpack study as a vehicle for teaching technical writing.

### **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
- Aim 2. Learn and apply scientific knowledge
- Aim 3. Create and participate in a scientific community
- Aim 4. Communicate about science to the wider scientific community
- Aim 5. Develop personal qualities (skills, attitudes, values and goals) appropriate for humanistic science

### **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 applied science or pure science, snowpack study encourages wider understanding of one of nature's most interesting materials.

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 both professional and lay audiences who are not acquainted with their project. They also learn to work cooperatively in the field, 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 fundamental principles. Student assessments of the course indicate that they value all of these aspects of snowpack study.

### **Snow as a Source of Interest**

Much of the interest of snowpack study derives from the special nature of snow itself. Snow probably changes its structure more than any other substance in the world. 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**

At the level of knowledge required in my course, the scientific concepts of snowpack study are simple and few, and students can master them in a few weeks. Despite its technical simplicity at this level, snowpack study is not mere play or casual observation, but real science. 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. My *Field Guide to Snowpack Study* 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 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 and verify or correct their hypotheses. At the end of each phase of the study, they report their findings. In making their investigations and writing reports, students use the procedures snow

scientists use. They actually engage in original research.

## **Activities of Snowpack Study**

### **The lessons of snowpack study**

Snowpack study is laid out in a sequence of ten lessons described in detail in the *Teachers Guide to Snowpack Study*. 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.

### **Arousing and focusing interest**

I prepare students for snowpack study by explaining the aims of the unit, then having them freewrite about their 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 weather history and hypothesize present conditions in the snowpack. After an hour or so of instruction and demonstration of techniques for conducting field tests, we go out for the first field trip. I get them out to observe and test the snow as soon as I feel they can conduct the tests.

### **Conducting the first field trip: guided observation of a snowpack**

During the initial field trip, students gain primary 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. This first field trip is an eye-opener; it is exciting for students to actually find that the snowpack is made up of layers of snow that differ in observable physical characteristics.

### **Writing Report 1: Initial observations of a snowpack**

Throughout the sequence of ten lessons, students are guided by a series of research questions. During the initial field trip, students focus on answering Research Question one:

*What are the physical characteristics of the snowpack observed in Field Trip One?*

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 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 as well as 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*, supplemented by specifications for the *Proceedings of the Eastern Snow Conference*, an annual publication of reports by leading snow scientists. I provide a system of paragraph num-

bers to help the students follow the form.

Specifications for Report 1 are as follows:

### **Physical Characteristics of a Snowpack Observed During Field Trip One**

This report answers Research Question One: *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, sci-

ence 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 One [In a chronological timetable or log of activities during the actual 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 in Field Trip One]

3.1 Snow Pit Data Sheet [Filled out during Field Trip One]

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]
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**Specifications for Report No 1.** After completing Field Trip One, students report the conditions of the snowpack in the form specified above. Each of the seven reports follows similar specifications as well as general specifications based on standard formats used by snow scientists.

#### **Learning the fundamentals of snow science**

After the first field trip, 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 (See the Glossary at the end

of this paper). 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 particles, 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 the snowpack accumulation and changing snowpack depths throughout recent weeks. Then they describe significant recent weather events in ordinary prose.

## Report 2: Hypothesizing persistence and change 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 Field Trip One, a) What characteristics would remain unchanged? b) What changes would you expect to find?*

They present their hypotheses in Report 2—which sets them up for a 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.

## 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 trips?*

This re-examination of the snowpack reveals how the layers of snow particles have persisted or changed

during the weeks since the initial field trip.

#### **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?*

Report 4 completes the series of technical reports.

#### **Increasing complexity in the four technical reports**

Each of the technical reports (Reports 1–4) 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 the first field trip, they now interpret the data by reference to processes of snow science 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. 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 will so severely test the students' abilities—nor so greatly enlarge and enrich 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. Report 4 brings to a close the technical portion of the snowpack study unit.

#### **Learning to handle complexities**

Although the students in this course are untrained in science, they must quickly learn to use scientific procedure and scientific knowledge (the concepts, the techniques, the terminology, the observational skills).

And 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 all make it over the hump.

### **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. For many of them, learning to be objective, concise, and direct entails a radical change of style. They have become so accustomed to writing for student peers or professors in their own field that they have difficulty fulfilling the expectations of professional readers in a different field.

For many students, writing a scientific report means not only learning a new style but a new concept of writing. This is probably the first time they have ever written from the point of view of a person who knows something that few others know. This especially means learning a new point of view about readers and how to meet their needs. I try to help students develop a technique appropriate for technical and scientific writing by giving them both general principles and specific instances, such as the following.

In the Methods section of their reports, for example, I find that students often tell *what they had to do* or *what they were instructed to do*:

We were told to recollect the weather.

Or

The instructor had us recollect weather history.

Or

We had to study the *Field Guide to Snowpack Study*.

The students who wrote these sentences are apparently trying to describe the teaching and learning processes or the context they took place in, while they ought instead to describe the intellectual steps they took. The phrases “told to” and “had to” no doubt derive from a dozen or more years of thinking about classroom experiences as teacher-imposed tasks. Although these phrases might reflect the actual conditions of college writing (or even of writing on the job), students need to know that professionals do not write that way. I encourage students to write more objectively and pointedly:

We used concepts in the *Field Guide* as the basis for hypothesizing characteristics of the snowpack.

Or

We examined weather history to determine its probable effect on the snowpack.

Again, I often find students telling *what they learned*:

During this time, we learned the basic concepts of snow science.

I urge them instead to tell *how they used information*:

We synthesized concepts of snow science with data from the winter's weather history to hypothesize change in the snowpack.

Or

To make accurate predictions of change in the snowpack, we prepared tables and graphs of winter temperatures, precipitation, and snow accumulation based on standard weather reports.

Students sometimes merely tell *how they spent their time*; their writing may sound like a report of classroom observation:

In class as a large group we looked over the questions that we would be referring to in our assessment. We then looked up the aims of the snowpack study. We used these guidelines in conjunction with questions I will be answering. In class we had an open discussion and opportunity to address some of these questions.

I point out that they need to give only relevant detail:

We evaluated the snowpack study unit by assessing the degree to which we had met the objectives.

These small differences in style reflect great differences in point of view and status. Changing "We had to study weather history" to "We used weather history to hypothesize change in the snowpack" not only explains how the writer used the information but

changes the student–teacher relation to a professional–peer level. In these ways, students are encouraged to substitute professional style for 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 5: Contrasting naive and informed observation**

With the work entailed by the second field trip now completed and Reports 1–4 neatly salted away, students have completed the technical portion of the snowpack study unit. They now begin to reflect on their own 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 have asked them to 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 second field trip? Were you more interested or less?” Re-worked into an essay toward the end of the unit, these freewrites help students recapitulate the unit from their individual point of view. Each time I assign a topic for a journal entry, I urge them to write fully, reminding them that they will use their journal entries in a final report.

The journal entries are but the raw material for the

report. To help students convert their freewrites 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 One*

*Stage 4: Reporting initial observations of a snowpack [writing, reviewing, and rewriting Report No 1; include peer review of others' reports]*

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

*Stage 6: Hypothesizing persistence and change in the snowpack*

*Stage 7: Confirming and correcting the hypothesis by additional observation*

*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 five 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.

### **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 applying the concepts in Robin Williams' *The Mac [or PC] is Not a Typewriter* and submitting them to peer review and repeated revision. Students create individual home pages on the World Wide Web, then publish selected reports for a variety of readers on the Web.

Publishing on the World Wide Web creates a new dimension of technical writing: world-wide overnight publication—something few students have experienced. Publication on the Web is a heady tonic that maintains interest for the final big push. Many students realize that this publication opens for them a new method of communication, and provides another sheaf for their professional portfolio and an important new line in their résumés. The fact that publication of their report reflects well or ill upon their college provides additional incentive to perfect their reports. Publication on the Web rounds out the snowpack study unit.

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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## **Glossary**

- Snowpack.* The accumulation of snow on the ground.
- Sintering.* The process of compaction. When you squeeze snow into a snowball, you are sintering it. Sintering causes the particles to bond; that's why they stick together.
- Sublimation.* The process of changing from solid to gas without having melted. It is a kind of evaporation.
- Latent heat.* The heat given off or taken up by water when it freezes or melts. The amount is 80 calories per cubic centimeter. Water gives up or absorbs this amount of heat without changing temperature.

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