WILSON "SNOWFLAKE" BENTLEY: A LIFE STORY

From Primary and Secondary Documents

Objectives: Students will learn the difference between primary and secondary sources, and the values and challenges of working with both. They will learn about the life and work of pioneering snowflake photographer Wilson A. Bentley by analyzing, reading, and evaluating primary and secondary sources.

Time: 55 minutes (Adjust Time As Needed)
- introduction, (suggested: 15 minutes)
- small groups, (suggested: 20 minutes)
- large group discussion, (suggested: 20 minutes)

Skills: Reading, Critical Thinking, Document Based Questions and Answers

Content Area: Social Studies, Science

Materials: (contained below)
- Wilson A. Bentley letter and transcript
- Wilson A. Bentley article
- Obituary of Wilson A. Bentley
- Group worksheets

Grade Level: Grades 4 – 6

Historical Overview:

For over forty years, Wilson “Snowflake” Bentley (1865-1931) photographed thousands of individual snowflakes and perfected the innovative photomicrographic technique. His photographs and publications provide valuable scientific records of snow crystals and their many types. Five hundred of his snowflake photos now reside in the Smithsonian Institution Archives, donated by Bentley in 1903 to protect against “all possibility of loss and destruction, through fire or accident.”

Wilson A. Bentley was born in 1865 in Jericho, Vermont. Taught by his mother, he lived and worked on the family farm. Growing up in the “snowbelt,” where the annual snow fall is about 120 inches, Bentley developed an interest in snow crystals after he received a microscope for his fifteenth birthday. Four years
later, in 1885, then equipped with both his microscope and a camera, Bentley made the first successful photograph of a snowflake.

Bentley pioneered "photomicrography," the photographing of very small objects, especially of snowflakes. Snowflakes or snow crystals are difficult to photograph because they melt so quickly, but Bentley developed the equipment and technique that allowed him to take thousands of photographs of individual snowflakes. He connected his camera to a microscope in order to create photos that showed intricate details of each snow crystal and stood in the winter cold for hours at a time. Patiently, he caught falling flakes and carefully handled them with a feather to place them under the lens. The apparatus was set up outside so that the delicate specimens would not melt, and a minute and a half exposure captured the snowflakes.

From that first photograph in 1885, Bentley photographed more than 5000 snow crystals until his death in 1931. Within his massive collection, he noticed every single snowflake was unique, and in the year of his death he, along with William J. Humphreys, a physicist with the U.S. Weather Bureau, published Snow Crystals, a volume containing 2,300 of his photographs for all to study and enjoy. Throughout his life he also published sixty articles in various scientific and popular journals. While most of his articles discussed snow crystals, he also photographed and wrote about frost, dew, and other atmospheric phenomena.

In 1903, he donated a collection of 500 of his snowflake photographs to the Smithsonian Institution to ensure their safety. In his correspondence with third Smithsonian Institution Secretary Samuel Pierpont Langley, Bentley offered positives and slides of his photos, writing that he was "deeply grateful for your [the Smithsonian's] kindly help in thus placing my collection of snow photographs beyond all possibility of loss and destruction, through fire or accident." At that time he also sent a copy of a previous publication on the snow crystal photographs. Later, he sent a lecture he had given at the Brooklyn Institute of Arts and Sciences in 1905, intending that it would be edited and published by the Smithsonian, though it never was. Each item sent to the Smithsonian was stamped and numbered to help
keep track of the images. His photographs remain in the Smithsonian Institution Archives to this day, safeguarded from any misfortune.

Bentley remained in Jericho, Vermont throughout his life. Ever dedicated to his work, he died there in 1931 after having caught pneumonia walking through a blizzard.

**Primary and Secondary Sources:**

A *primary source* is any original source of information that provides a direct or first-person connection to a historical event. Examples may include: documents such as letters, diaries, birth certificates, receipts, and notebooks; photographs and drawings; objects, such as clothing or furnishings; oral history interviews, and home movies. Primary sources were created by a person who witnessed an event first-hand.

*Secondary sources* are summaries, second-hand accounts, and analyses of events. They were created by someone who did not witness the event, but may have read or heard about it. Examples may include: books or articles written on a topic, artworks depicting an event, letters or diaries recounting a version of events told to the author by another source.

One source can contain both primary and secondary information. For example, a diary entry that contains a version of events the author read in the newspaper (*secondary*) and the author's feelings about the event (*primary*). Whether a source is primary or secondary can depend on the question you ask. If you are looking for information on how an event occurred, the diary entry written from a newspaper article would be a secondary source (the newspaper article may be a primary source). But if you are asking how the author learned about an event, the diary entry written from a newspaper article would be a primary source.

Primary sources provide valuable information that we cannot find elsewhere. They speak to us in a first-person voice and bring history alive. They provide an individual's view of historic events and times, and they tell stories about how people lived and coped in the past. These letters, diaries, and photographs create engaging stories for students to learn about and relate to. By comparing conflicting primary sources, students learn to carefully examine actual documents,
as well as the words they contain, evaluate evidence and point of view, and develop critical thinking skills about the past and also about their world today.
Instructions for Teachers:

Explain the differences between a primary and secondary source to your students. Ask them to think of examples of both primary and secondary sources. Ask why they think primary sources are a valuable way to study history.

Read the historical context section to your students to introduce them to Wilson A. Bentley and his work.

Divide students into small groups. Print copies of the original documents and worksheets for each student in each group. Give each group one of the sources: the Wilson A. Bentley letter, the Wilson A. Bentley article, or the obituary of Wilson A. Bentley, alternating from group to group.

Before sending the groups to look at and read their respective original documents, describe the historical context of Solomon Brown’s letters and life in Civil War Washington.

First have students examine the original documents carefully in their individual groups. Students should use the original documents and complete an analysis of the documents before they turn to the transcripts, which can be used for reading.

After students have looked at, read, and analyzed their sources and answered their questions in the small groups, bring the class back together for a large discussion. Have each group share a summary of their sources and the answers they found. Ask these questions to begin a discussion:

- What do these documents tell you about Wilson A. Bentley's life?
- Does one source help you to evaluate or better understand the information in other sources?
- When you combine these sources, is the whole greater than the sum of its parts?

Please note that all Smithsonian Institution primary and secondary source materials can be used and reproduced for educational purposes without further permission.
Instructions for Students:

In your assigned groups, carefully examine, read, and analyze your source documents or images carefully. Answer the questions listed on your worksheet, using evidence from the documents or images to support your answers.
Wilson A. Bentley Letter

Names: ____________________________________________

Questions:

1. Who wrote this letter?

2. When and where was this letter written?

3. What is this letter about?

4. Why was this letter written?

5. Who was the intended audience?

6. What was the point of view of the letter writer?

7. What does this letter tell you about Wilson Bentley's work?

8. What does this letter tell you about Wilson Bentley's personality?

9. How does the grammar/spelling and word use differ from today's writing style?

10. Is this letter a primary or secondary source, or both?

11. Are any/all parts of it a primary source, explain why or why not?

12. How could you check the accuracy of the information in the letter?
Wilson A. Bentley Article

Names: ____________________________

Questions:

1. Who wrote this article?

2. When and where was this article written/published?

3. What is this article about?

4. Why was this article written?

5. Who was the intended audience?

6. What was the point of view of the article writer?

7. What does this article tell you about Wilson Bentley’s work?

8. What does this article tell you about Wilson Bentley’s personality?

9. What does the article tell you about the public’s view of Wilson Bentley?

10. Is this article a primary or secondary source, or both?

11. Are any/all parts of the article a primary source, explain why or why not?

12. How could you check the accuracy of the information in the article?
Obituary of Wilson A. Bentley

Names: ____________________________________________________________

Questions:

1. Who wrote this obituary?

2. When and where was this obituary written/published?

3. What is this obituary about?

4. Why was this obituary written?

5. Who was the intended audience?

6. What was the point of view of the obituary writer?

7. What does this letter tell you about Wilson Bentley's work?

8. What does this letter tell you about Wilson Bentley's personality?

9. What does this obituary tell you about the public's view of Wilson A. Bentley?

10. Is this obituary a primary or secondary source, or both?

11. Are any/all parts of the article a primary source, explain why or why not?

12. How could you check the accuracy of the information in the article?
Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 1, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm
for superior in both numbers 1.

beauty. I might add interest to that of any other collection in the world.

picture quite completely the crystalline

form of water. The great majority

of these negative are in my possession,

no copies of them, except on paper,

(2 some lantern slides at various

institutions) are preserved anywhere

in fire proof building. I hope

felt strongly for some years, that

same institution, like I especially

the Smithsonian Institution, should

possess copies, indestuctible permanent

copies, as plan, of the choice photographs

of my collection. The danger from

fire, lighthouse, or accident here at

my home is not to be ignored, I have

caused me much anxiety. It seems to

me that such a collection as mine

should be placed beyond the possibility
Wilson A. Bentley to Samuel P. Langley, December 15, 1904, page 3, Smithsonian Institution Archives.
http://siarchives.si.edu/history/exhibits/documents/bentley.htm
position, I think the expense would not exceed 15 ct. each, or the negatives, but 25 ct. each, or possibly 30 ct. If about 500 of my best examples were copied in this manner, it would be a great relief to me, I would cast but about $80. for the position, I about $150. for the negatives (if the latter were desired, instead of the former). Should you, through your great influence, bring about the desire I have so long cherished, I shall be deeply grateful. I should you wish to publish a monograph, or article regarding the snow and frost crystals, in the quarterly issue of the Smithsonian publication, I will gladly write or furnish data for it. (I think you mentioned having such an article in a letter to Prof. Alt.)

Sincerely,

W. A. Bentley
Dear Sir,

I have collected photographs of snow crystals during the past 20 years, & now have a collection numbering over 1100 no two alike. It has been almost a life work with me, & conducted entirely at my own expense. In addition to the photos of the snow crystals, I have secured some 150 more photographs of frost & ice crystallization, of great beauty & interest. My collection of both frost & snow crystal photographs are each in their class — [Start Page 2] far superior in both number & beauty & I might add interest, to that of any other collection in the world, & picture quite completely the crystalline forms of water. The great majority of these negatives are in my possession, & no copies of them, except on paper; (& some lantern slides, at various Institutions,) are preserved anywhere in fire proof buildings. I have felt strongly for some years, that some institution, & especially the Smithsonian Institution, should, possess indestructible permanent copies on glass, of at least the choice photographs of my collection. The danger from fire, & lightning, or accident here at my home is not to be ignored, & has caused me much anxiety. It seems to me that such a collection as mine should be placed beyond the possibility [Start Page 3] of destruction by fire or accident. This is my excuse for troubling you in the matter, & I write to ask if there is not some fund available from the Smithsonian Institution, or elsewhere, that can be drawn upon to defray the expense of making copies of these on glass, to be stored, & kept for study, at the Smithsonian Institution. I have been to so much expense making my collection; far more than I could well afford; that I do not feel as though I could even do the photographic work, developing, exchanging etc, free gratis, but I would willingly do it at very low wages, indeed. The expense of making the negatives would depend upon whether the copy desired was to be a positive, (first copy), or a negative, (second copy), & in the case of the [Start Page 4] positive, I think the expense would not exceed 15 cts each, & if the negatives but 25 cts each, or possibly 30 cts. If but 500 of my best examples were copied in this manner, it would be a great relief to me, I would cast but about $80.00 for the positives, & about $150.00 for the negatives, (if the latter were desired, instead of the former.) Should you, through your great influence, bring about the desire I have so long cherished, I shall be deeply grateful, & I should you wish to publish a monograph, or article regarding the snow
or frost crystals, in the quarterly issue of the Smithsonian publications, I will gladly write, or furnish data for it. (I think you mentioned desiring such an article, in a letter to Prof. [Cleveland] Abbe.)

Yours sincerely,

W. A. Bentley
“Photographing Snowflakes” article by Wilson A. Bentley:

EVERY snowflake has an infinity of beauty which is enhanced by the knowledge that the investigator will, in all probability, never find another exactly like it. Consequently, photographing these transient forms of Nature gives to the worker something of the spirit of a discoverer. Besides combining her greatest skill and artistry in the production of snowflakes, Nature generously fashions the most beautiful specimens on a very thin plane so that they are specially adapted for photomicrographical study.

The photographing of snowflakes, although quite delicate work, can hardly be called difficult, although some hardships attend it, because the work must all be done in a temperature below freezing, and under conditions of much physical exposure. The temperature at which photography is possible depends somewhat upon the thickness of the crystals; this varies greatly from time to time, and depends upon whether the temperature is rising from an intense degree of cold or falling from a point above freezing. If rising after a cold snap, photographing can often be continued until actual thawing commences.

Of course, location is everything in this work, and no one except those living in arctic climates or in regions having long and severe winters, can accomplish very much. Generally speaking, the western quadrants of widespread storms or blizzards furnish the most beautiful and perfect forms. At such times the wind is usually westerly or northerly, with the barometer standing at 29.6 to 29.9 in. and slowing rising. The percentage of perfect crystals is likely to be larger when the snowfall is not too thick and heavy, with the crystals medium to small in size rather than large. The character of the snowfall often undergoes quite abrupt changes as a storm progresses.

The apparatus required for snowflake photography consists of a compound microscope, fitted with a joint that permits the instrument to be turned down horizontally, at right angles to its base, so that it can be coupled to a camera bellows by means of a light-tight connection. The microscope objectives are used alone, without the eyepiece. It is best to have several different objectives; ½, ¾, and 3-in. combinations, which give magnifications of from 8 to 60 diameters (4 to 360 times), will serve well.

Ordinary daylight, coming through a window, is used for illuminating the crystal after it has been placed on a micro- scope slide, a tiny beam of light entering through the small aperture in the sub-stage of the instrument. The apparatus is placed indoors, near by and facing a window. The room, the apparatus, and its accessories should always be away from any source of artificial heat, and at a temperature approximately that of the outside air. The necessary accessories are an observation microscope, a pair of thin mitters, microscope slides, a sharp-pointed wooden splint, a feather, and a turkey wing or similar cluster; also, an extra focusing back for the camera.
Frank Thone Obituary of Wilson A. Bentley:

Every Snowflake a Unique Jewel

In Over Forty Years of Photographing “the Faery Daughters Of King Bores”, Wilson Bentley Never Found Two Alike

By FRANK THONE

Up in the mountains of Vermont, where the winters are long and the snow falls frequently, there died a few weeks ago, a quiet, retiring man who was the world’s foremost snow artist. His name was Wilson Bentley. He was a man of simple, inconspicuous tastes. His chief ambition was to create a miniature replica of Michelangelo’s marble statue, whose snow sculptures get into the newspapers and magazine sections. His was a far more difficult art, for it dealt with single flakes rather than great masses of raised snow, yet though it dealt with single flakes, it was a more permanent art than the efforts of those gravers of the earth’s most impermanent plastic.

For Wilson Bentley made photographs of snowflakes; he was Portraitist To Their Highnesses, the Faery Daughters of Old King Bores. For more than forty years, he let the winds of the world bring beauty to his humble den, step on a small town near the village called Jericho, he captured it in its more fragile form and held it for a moment while the chilled kiss of the cloud-hidden sun has graven its beauty in the invisible silver grains of photographic plates. For forty years he accumulated hispatterns of perfection in snowy tales, treasuring them as a less wise man might treasure the jewels they resemble, or fine silver pieces whose worth might be inferred from their incredibly exquisite patterns. For at least a part of the forty years he had recognition from a few scientists who would read the moods of the weather, and others who were artists and were filled with wonder and a desire to see them. But the world outside he did not know nor knew he was a great artist. So far as that goes, even his friends of the outside world who sought him in his home in the hills and once each year he was asked to make a few days’ pilgrimage to the big city—even his friends from outside knew very little about him. He was not a scholar in a great laboratory, for all his magic with the microscope and his camera, nobody knew what he did or where he lived, he was a poor man, and it is true he lived most unobtrusively and plainly, so as it is still possible to do in a New England village community without losing caste. But so also have some of the world’s riches lived. Men like John Burroughs, and his own fellow New Englander, Thoreau, and the turned-out little man, centuries ago, whom his neighbors called “Il Peregrino” when they came in admiring crowds to hear him talk.

A Board of Beauty

His friends of the outside world for years felt considerable concern over the fate of his great collection of plates and photographs. Hundreds upon hundreds they piled up in his little house, a board of beauty almost lost to the world. They felt like everywhere gifts, when they were allowed to see them only a few pairs of appreciative eyes what they knew thousands would be glad to behold. Some of them were about in their minds for ways and means.

To Prof. W. J. Humphreys, physicist of the U.S. Weather Bureau, it seemed that the medium at once the happiest and most grateful would be a book, collecting all of their pictures into a series of fine photographic plates. This would permit the world at large to see in its own house the treasures that had hitherto been visible only at the cost of a pilgrimage to Jericho, and it would at the same time place this treasury of joylessness safely beyond the irrefragable ban that a single fire or other disaster might have caused had it existed. Mr. Bentley’s house and destroyed his collection of plates and photos.

But such an undertaking would be expensive. There would be no profit in such a book, for it would have to sell at a rather high price to a comparatively limited number of people. A fund would have to be provided to delay a lot of preliminary expenses. A generous donor came forward with the fund, and the American Meteorological Society became its trustee, sponsoring the book. Hours and days of labor would be required, to arrange the thousands of photographs in their most effective order and to write a few pages of carefully thought-out explanatory text. Prof. Humphreys undertook this labor himself. A publisher would have to be found. The McGraw-Hill firm accepted the book gladly, though they knew they would be doing work to break even as it financially. The whole way was not easy, but each was the cause of Wilson Bentley’s pictures that everybody who had anything to do with the book should
Only Wilson Bentley himself hesitated, with characteristic self-confidence and equally characteristic New England understatement:

"Surely nobody's going to want a great big book like the one you are talking about," he said to Prof. Humphreys.

"Haven't we better get out a little one first, and see how it goes?"

But Prof. Humphreys had his way, and the book came out, and Wilson Bentley had the great satisfaction, in his last days, of seeing his work in permanent form. In it he explained the method by which he was able to have his many views done as etchings with salt of sodium with which he snowed his own snow crystals with a common lamp. Then with great care and patience, he reprinted each page of the book, and the first edition was published in 1932. Thus Wilson Bentley, with his snow crystals, has left us a record of the beauty and wonder of nature, which will be treasured by generations to come.

Snow Storms

"Snow-photography" is the right phrase, one for which you should use a snow globe through the microscope you must hold your breath. The warmth of the brightest frost from human fumes melts it at once; even the radiation from one's body will destroy it in a short time.

So the first requisite for a snow-photographer must be a willingness and an ability to work in the cold. A picture of Wilson Bentley at his microscope camera shows him in a thick overcoat and with his hands encased in subzero woolen mittens. How he was able, in this necessary armor against the cold, to perform swiftly and delicate manipulations that would put several to work of a month's time is one of the marvels of his craft. Perhaps that is one of the things that come with practice, and Wilson Bentley had forty years and more of that.

The task of transferring the exact beauty of the snowflakes to the more permanent record of the photomicrograph is well told by Prof. Humphreys in another letter:

"First you catch your snow crystal. This is conveniently done by holding a smooth black board, a foot or so square, a mirror or two, or as long as necessary, and there the snow-covered surface is taken under a low-power microscope. The snow is the glass slide on which the crystal rests, and the stage is covered with a piece of black paper to protect the eye from the light. The crystal is then turned and the photomicrographer must judge whether or not it is worthy of photographic preservation. If it seems to be worth while, it is moved to a second camera, and the picture taken is the record of the day's work.

Wilson Bentley's work was not always as easy as it sounds. He was frequently without a microscope, and when he did have one, it was often a poor one. But he never gave up, and in the end he was able to produce a magnificent collection of snowflakes, which is now in the archives of the Smithsonian Institution.

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The Great Warrior

This map of the southern sky during February should replace the one published last week on page 21 with the article "Astronomy in the Schools." It shows the stars of the southern hemisphere and their relative positions. The constellations are clearly depicted and are marked with their Latin names. The map is a valuable educational tool for students interested in astronomy.

Additional Resources:

**Texts:**


**Reliable websites with documents online:**

SI Stories, Smithsonian Institution Archives, [http://siarchives.si.edu/history/exhibits/documents/index.htm](http://siarchives.si.edu/history/exhibits/documents/index.htm)

Smithsonian Institution Archives History Pages, [http://siarchives.si.edu/history](http://siarchives.si.edu/history)

Smithsonian Institution Archives Home Page, [http://siarchives.si.edu/](http://siarchives.si.edu/)

Historic Pictures of the Smithsonian, Smithsonian Institution Archives, [http://siarchives.si.edu/history/exhibits/historic-pictures-smithsonian](http://siarchives.si.edu/history/exhibits/historic-pictures-smithsonian)

Smithsonian Institution Education site, [http://www.smithsonianeducation.org/educators/](http://www.smithsonianeducation.org/educators/)


SBentley Snow Crystal Collection of the Buffalo Museum of Science, [http://bentley.sciencebuff.org/index.htm](http://bentley.sciencebuff.org/index.htm)

Snow Crystals.com - An online guide to snowflakes, snow crystals, and other ice phenomenon, created by Kenneth Libbrecht, Professor of Physics at Caltech (California Institute of Technology)

Snow Crystals, Our Friends – an online guide by James Provencio, Katie Ohsann, Stephen Barta, and Dave Gosselin, from the University of Arizona