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Making sense of photographs

Lilian Leivas Pozzer & Wolff-Michael Roth

University of Victoria

All correspondence concerning this paper should be addressed to Lilian Leivas Pozzer
c/o Wolff-Michael Roth, Lansdowne Professor, Applied Cognitive Science, MacLaurin Building
A548, University of Victoria, PO Box 3100 STN CSC, Victoria, BC, Canada V8W 3N4.

E-mail: llpozzer@uvic.ca. FAX: 1-250-721-7767.

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Abstract

In some contexts, a photograph may be worth a thousand words; on its own, however, a photograph means little because it underdetermines its interpretation giving rise to many different ways of seeing and understanding it. The purpose of this study was to understand how high school students understand photographs that were accompanied by different amounts and types of co-text (caption, main text). The data for this study consists of video-recorded interviews with twelve Brazilian high school students. What students perceived was in part a function of the presence of caption and main text, which therefore not only described what could be seen but also constituted a pedagogy for looking at photographs. We conclude that high schools not only develop subject matter literacy but also a literacy concerning photographs.
Every image embodies a way of seeing. Even a photograph. For photographs are not, as is often assumed, a mechanical record. Every time we look at a photograph, we are aware, however slightly, of the photographer selecting that sight from an infinity of other possible sights. This is true even in the most casual family snapshot. The photographer’s way of seeing is reflected in his choice of subject. … Yet, although every image embodies a way of seeing, our perception or appreciation of an image depends also upon our own way of seeing. (Berger, 1972, p. 10)

We live in a visual world. Television, movies, and photographs are pervasive, constantly overwhelming us with images of reality in places other than where we are finding ourselves. It is therefore not surprising that photographs are also the most frequent type of inscription (representations other than language) in high school biology textbooks (Roth, Bowen, & McGinn, 1999). Existing research suggests that pictures have the potential to make significant contributions to textbooks, particularly because retention of text appears to be improved by such illustrations (Peeck, 1993). Yet there is very little research investigating the pedagogical role of photographs in school science: neither the psychology of cognition and learning nor science education research have paid much attention to this topic (Schnotz, Picard, & Hron, 1993; Pozzer & Roth, in press). What complicates the issue is that photographs may be worth a thousand words, but on their own, they mean very little (Wittgenstein, 1994/58). They give rise to innumerable, different interpretations because, as our introductory quote articulates, their meaning emerges from a transaction of the photographer’s way of seeing and the perception of the reader. It is the reader’s work of reading, the viewer’s perception of the narrative and perceptual order of the photographic image and the surrounding text, and the meaning-making resources available to the reader that allows a specific interpretation of a photograph to arise (Bjelic, 1992; Morrison, 1989). The question therefore arises what high school students will perceive when they look at photographic images in biology textbooks and how they use other meaning-making resources that the text makes available to come to an understanding of the things that the photograph is about. The purpose of this study was therefore to find out how high school students understand photographs that are accompanied by different amounts and types of co-text (caption, main text).
Background

Traditionally, textbooks have been important resources in students’ learning because most science classes are oriented toward these resources. In fact, school science is dominated by textbooks-oriented approaches to teaching and learning (NAS, 1997). Because these textbooks predominantly use photographs and naturalistic drawings (Roth et al., 1999), photographs therefore ought to attract science educators’ attention so that their potential as meaning-making resource can be more fully developed.

An increasing number of studies document the important role of representation practices in science (e.g., Knorr-Cetina & Amann, 1990; Latour, 1999; Lynch & Woolgar, 1990). However, despite the centrality of representation practices in science and despite the many open questions as to the role of inscriptions such as photographs in instruction, relatively little research has been conducted in science education (Roth & McGinn, 1998). Outside science education, a small number of studies considered the role of photographs in communication (Bastide, 1990; Livingston, 1995). These studies confirm the statement in the introductory quote that photographs are often taken as mechanical records of reality; they are thought of being automatically produced, “a recording furnished by an apparatus that offers the reader a guarantee against the intervention of the author” (Bastide, 1990, p. 206). Photographs are therefore taken to be prima-facie evidence, that is, as guarantor of truthful representation (Myers, 1990). All of these underlying assumptions are based on the similitude of photographs with the objects they represented. But even such similitude is a cultural and individual achievement and cannot be taken a priori (Eco, 1984). The photographs can only achieve their powerful role as representations of the real world through the reader’s work of interpretation, the viewer’s perception of the narrative and perceptual order of the document (Bjelic, 1992; Morrison, 1989).

The purpose of this study was to understand this work when the readers are high school students and the photographs and associated text are from high school textbooks that are widely used by schools in Brazil.

How inscriptions are deployed in textbooks plays an important role in the lived experience of students and in their associated appropriation of image-reading practices in the course of
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schooling. But there is a double ambivalence concerning images in textbooks (Schnotz, 1993). On the one hand, teachers and curriculum designers believe that images have a lot of potential as meaning-making resources, captured in the popular adage that a picture is worth ten-thousand words; yet in use, images are used as adjuncts that serve decorative purposes. On the other hand, students prefer textbooks that contain illustrations; yet in learning, they pay only little attention to pictorial information. We therefore need a better understanding how students use photographs, how they can use them in their meaning-making efforts, and, ultimately, how teachers can assist students in learning by drawing support from images.

Most students are indeed familiar with photographs in general; however, appropriate instructions for how to read and analyze photographs are currently not provided to them (Roth, 2002). To understand the effect of photographs in learning, we must consider not only the way they are produced, but also the way they are received by the reader. This study is therefore concerned with the way in which students interpret and make sense of photographs and their associated texts in the context of a scientific concept presented in a textbook. We analyze the meaning-making resources that students discover and draw on while looking at images and associated texts, and how the students make use of these resources to achieve understanding.

Study Design

This study is part of the principal author’s master’s thesis, concerned with understanding the pedagogical function of photographs in Brazilian high school biology textbooks. Two previous studies provided analyses of the meaning-making resources that texts and lectures provide in support of the pedagogical function of photographs in school science (Pozzer & Roth, 2003, in press). These previous studies did not address how students understand photographs and which meaning-making resources they actually would draw on in their interpretative efforts. In this study we therefore interviewed students from different grade levels, showing them photographs from biology textbooks and asking them to articulate what the photographs meant to them. We extracted the photographs from the ecology-related chapters of Brazilian high school biology textbooks that had been analyzed and categorized in a previous study.
Selecting the Students

To investigate photographs and their relation to captions and main text during interpretation, students from two distinct groups were interviewed: (a) students who did not have an ecology course at the high school level and (b) students who already studied ecology as part of their compulsory high school biology course. This choice should allow us to determine the role of prior knowledge on the interpretation and comprehension of photographs and associated texts. In most of Brazilian schools, primary education includes grades K through 8, and high school includes grades 9 through 11. Basic notions of ecology are usually thought in the general sciences courses that students attend in fifth and sixth grade. An expanded ecology curriculum is taught as part of the biology curriculum while students attend tenth or eleventh grade, depending on the school.

A total of twelve students, six from each of the two groups were interviewed. The principal investigator invited students during one of their courses and students were selected on a first-come-first serve basis. In this way, the first participant group included five ninth-grade students, three females and two males, and one eighth-grade male student. The group of students who have had prior instruction in ecology consisted of five eleventh-grade students, four males and one female, and one tenth-grade female student. Pseudonyms are used throughout this study. All interviews were video-taped.

Selecting the Photographs

Among the various photographs displayed in the ecology-related chapters of high school biology textbooks, four photographs were selected. Based on the results of our previous study, we concluded that the four photographs were representative of different categories of photographs (Pozzer & Roth, in press). The following aspects were addressed in the selection of the photographs: (a) the opposition between single and multiple photographs; (b) the four major categories (based on their function) of photographs were included (decorative, illustrative,
explanatory, and complementary); and (c) the presence or absence of the indexical reference to the photograph in the text (i.e., incidence and placement of a sign such as “Fig. 30.3” in the text). We began by selecting a variety of photographs that could address one or more of these aspects; we then discussed each photograph, which led us to further refine this selection until we agreed upon four photographs as meeting the three aspects.

The first photograph we choose, which we will from now on refer to as the photograph of the orchid, represents a single photograph, categorized as *illustrative*, with caption and text accompanying it and an indexical reference appropriately placed in the main text (Figure 1). In the previous study, we had identified some issues related to this photograph that could generate doubts and misinterpretations, due to the enormous amount of details present in the photograph, and the lack of information in the caption as well as in the photograph itself that could otherwise have helped the readers in the work of interpreting this photograph.

The second photograph exemplifies the category of *decorative* illustration; it lacks caption and indexical reference in the text, which makes it difficult to relate it to any specific text. For the interview, we reproduced the entire page where this photograph appears, leaving it to the participants to decide whether the text pertains to the photograph. Decorative photographs primarily enhance the aesthetic aspects of the textbook and may attract the reader’s attention. The chosen photograph shows a caterpillar (Figure 2). The third item consists of a series of three photographs, previously categorized as complementary, dealing with the concept of camouflage (Figure 3). These multiple photographs have a caption and a main text associated to it, although they lack an indexical reference in the text. The fourth and final photograph is another single photograph, presenting a caption that is appropriately associated with the main text by means of an indexical reference. The topic of the text is mutualism, and the photograph presents lichens as examples of mutualistic associations. This photograph has an *explanatory* function.

**Developing Strategies to Conduct the Interviews**

Our major interest is related to the role of photographs, captions and texts in the actual process of reading. We therefore decided to make use of two different strategies that allowed us
to better investigate these roles. We initially presented the orchid (Figure 1) and camouflage photographs (Figure 3) apart from their captions and main texts. After the students had talked about what they were seeing in the photograph, we presented them with the respective caption that originally accompanied the photograph in the textbook. Finally, we presented the main text associated with each photograph. We expected to be able to follow the reasoning that takes place when students are faced with different kinds of information, different kinds of texts that complements each other, in this case, photograph, caption and text.

Our second strategy was to show entire assemblages of photograph, caption and text at once. We proceed in this way with the caterpillar (Figure 2) and lichen photographs (Figure 4). However, as there was no text directly associated with the caterpillar, an example of a decorative photograph, we presented the entire page where the photograph originally appears in the textbook.

We developed an interview guide, containing central questions that should be asked. We were careful to avoid questions that could direct the interviewees towards particular features in the photograph. Nevertheless, the nature of the interview and any word that the interviewer says has to be considered as a potential meaning-making resource to the participants. If students used some such aspect in their reasoning, we would expect that it directly or indirectly shaped the answers given. We address this particular issue and provide some examples of it throughout this article.

Analyzing the Data

The twelve interviews were transcribed and subsequently translated from Portuguese to English. Once the transcripts in English of the twelve interviews were completed, we began our analysis following the principles of Interaction Analysis (Jordan and Henderson, 1995). We read the transcripts individually, identifying relevant issues. Then we met and discussed them together. After our first meeting, we decided to focus our analysis at one photograph at time, proceeding to the analysis of the segment of the interview related to each photograph in each one of the twelve interviews. We met again for a collective analysis after the analysis of each photograph was
finished. Each interview segment was analyzed following this procedure. An overall analysis of the entire interview was conducted at the end of the segmented analysis.

Findings

Illustrative Photograph

"The picture helps to understand the text as much as the text helps to understand the picture." (Faith, grade 10 student)

The first photograph we showed to the students was the photograph of the orchid (Figure 1). We presented the photograph without caption and text, and asked them to tell what they were seeing in this photograph. Students’ response to this request was to point out details identified in the photograph and qualitative characteristics of the photograph itself or of some of the objects that they identified in the photograph. The terms they used to identify each object in the photograph varied, but we grouped them according to what they referred to in the photograph.

![Illustrative Photograph](image)

Figure 1. Photograph, caption and text about epiphyte plants that were presented to the students during the interview

The majority of the students (ten out of twelve students) pointed out the presence of many trees in the picture. This was also the detail with most variation in the term used by the students to refer to it, for example, vegetation, forest, garden, park, and so on. The next most cited object
was the central tree in the photograph (nine students). Six students pointed out a plant, which we infer as being the orchid in the picture, and six students actually pointed out the existence of an orchid in the photograph. Five students identified the lichens in the trunk of the central tree; and four students identified the yellow flowers on the right side of the photograph. Two students pointed out the grass on the ground in the photograph, and only one student identified the sunlight in the top of the photograph. One student referred to the presence of a parasite plant in the photograph, what later in the interview became evident as being the orchid, and another student pointed out the presence of a fern, again in reference to the orchid in the photograph (refer to Table 3).

For three students, the very first thing identified in the photograph was the presence of many trees. Four students immediately identified the central tree, and five students immediately pointed out the orchid.

Six students talked about the orchid, identifying it by “orchid” (four students) or by "the plant", and referring to it as attached to the central tree, or growing on it, or yet hanging on its trunk. They also talked about the orchid as a plant that depends on other plants to survive (one student), or as being a parasite plant (one student).

The students were concerned about providing an appropriate answer to the request “tell me what you are seeing in this photograph” by means of finding focal points in the photograph. Their responses were constrained by the interviewer’s way of phrasing the activity, insofar as asking “what are you seeing in this photograph?” implies a different context than if the question had been, for example, “what is this?”. Through our analysis, we will persistently refer to the influence of the context in the responses that constitute our data in this research.

After reading the caption, which only stated “Fig. 83.1 Epiphyte plant”, all the twelve students tried to find the epiphyte plant in the photograph. The majority of the students (nine) correctly identified the epiphyte plant in the photograph. Three of these students actually referred to the orchid as being the epiphyte plant, and six students, although they could not say that the plant was an orchid, pointed it out as being the epiphyte plant in the photograph. Besides two students who already knew orchids from nature, the other seven students believed the orchid
was the epiphyte plant in the photograph because it was the most focused or centralized object in the photograph.

Two students were confused about which plant was the epiphyte plant, either the central tree or the orchid, and they could not decide about it. One student believed the epiphyte plant was the fungus on the branches of the central tree in the photograph.

As the caption do not provide the readers with any resource that could help them to efficiently identify the epiphyte plant it refers to, the students proceeded to a general activity of separating, and at the same time evaluating, every detail in the photograph, in order to identify the “gratuitous details” that belong to the background and consequently should not be considered as relevant, and also, in doing so, to highlight the relevant details in the foreground. As Myers (1990) says, gratuitous details in the photograph carry no relevant information (although they help to make the photograph a document of a particular piece of nature), and the relevant patterns must be picked out from the irrelevant details present in the photograph.

The majority of the students opted for the criteria “focus” as relevant means to identify the important objects in the photograph, in this case distinguishing “background” and “foreground” in the photograph.

Andy (grade 9) gives a good example of this procedure. He identified the photograph as being of a plantation. When asked about what was the topic of the photograph, he said it referred to “the part of the trunk of the tree” while pointing to the central tree. He justified this saying “it’s more concentrated here”, and outlined the trunk of the central tree in the photograph. Then he further explained that if the photograph was about the plantation, it should have focused also in all the other plants in the background. After reading the caption, the student identified the leaves (orchid) on the side of the trunk of the central tree as being the epiphyte plant, and then he proceeded analyzing the photograph to explain his opinion: “if you analyze really there is only the trunk of the tree like there isn’t its top, but then there is here this more focused.” In this example, the student actually engaged in the process of analyzing the photograph to separate background and foreground, and to distinguish between gratuitous details and the actual topic of the photograph. He concentrated in the objects centralized and more focused in the photograph, that is, the central tree and the leaves attached on it. Then he
further refined his analysis, by pointing out the absence of the top of the tree in the photograph, what led him to believe the tree was not the most important object to be regarded in the photograph; rather, the leaves attached on it would more likely be the topic of it. The fact that the student regarded the orchid as something alien to the tree and not as “the leaves of the tree” was relevant in his work of interpretation of this photograph. He could separate “tree” and “leaves” and then decided about which one was more likely to be the topic of the photograph, making use of other visual information displayed in the photograph to do just that.

Whether the relevant details were in the background or not is completely up to the reader in the present situation. Although common sense suggests that a photograph as a depiction of something will primarily focus in the very object that it is trying to depict, the same photograph can be used for very different purposes, and the attention can be drawn to any detail, other than the one that seems to be the focal point in the photograph. This latter argument can be used to justify the answers of three students, who were confused about what was the epiphyte plant in the photograph. For instance, the student who believed the epiphyte plant was the fungi on the branches of the central tree could be right in his reasoning, insofar as the photographs tends itself as an illustration of lichens as much as an illustration of epiphyte plant. Of course the presence of the caption referring to “epiphyte plants” excludes the possibility of the topic of this photograph being the lichens. However, considering that the student did not know what an epiphyte plant was, anything recognized as a plant in the photograph could be the object that this caption was referring to, including the lichens.

From our analysis of the student’s responses so far, we could identify one of the functions of the caption, that is, the caption names something that should be more carefully regarded, and that has the potential to be the topic of the photograph. Consequently, paying attention to whatever the caption is referring to might be the reason why the photograph had been used in the first place. Whenever the caption fails to help the readers to unmistakably identify the “right detail” in the photograph, this very function of the caption, even if still assumed by the reader, will not nevertheless be properly accomplished. In this case, we can argue that the presence of the caption will no longer be essential to readers’ work of interpretation of the photograph, insofar as they would have to draw on resources other than the caption to identify the topic of the
photograph. This is certainly not the only function of a caption to a photograph, and other functions will be discussed later in this article.

After the students have read the main text that originally accompanied this figure, all the twelve students recognized the topic of the figure as being related to the orchid, and they all were able then to identify the leaves on the central tree as being the orchid, although this identification still was based on an assumption and not a certainty about what was really the epiphyte plant or the orchid in the photograph.

The information presented in the text proved to be extremely necessary in this case for the readers to be actually able to interpret the photograph and relate it to its caption. Although the caption helped to guide the readers towards what could be the topic of the photograph- that of the photograph being about an epiphyte plant-, it was not enough to constrain the endless possibilities of interpretations that this photograph could give rise to. That was primarily a consequence of the absence of further information that could clarify the readers about what an epiphyte plant was or even to help them to identify it in the photograph. This information was provided by the main text, and only through reading the main text the readers were able to make sense of the photograph in the context of the concept introduced by the text. In this case, not only was significant the fact that the text explained what an epiphyte plant was, even providing examples of epiphyte plants, but also the presence of the indexical reference to the figure in the main text played an important role in guiding the reader towards the interpretation of the photograph, which emerged from the association of this photograph with its caption and text. The indexical reference helps the readers to select the specific topic of the photograph in relation to the main text. In this case, for instance, the presence of the indexical reference just after the phrase “It is the case of the interaction between orchids or bromeliads and the trees in which trunk they install themselves”, leads the readers to regard the photograph as providing an example of the interaction referred to in this phrase. The readers, then, were expected to look for a plant like an orchid or bromeliad and the trunk where they should be installed.

Although not every student read the indexical reference in the main text aloud while they were reading the text, the majority of the students (nine students) recognized the presence of an indexical reference that linked figure and text. Three students either did not mention the indexical
reference or they stated that there was no indexical reference to the photograph in the main text (one student even read the indexical reference aloud when reading the main text, but he failed to recollect its existence when asked about it by the interviewer).

Nevertheless, reading the main text and associating it to the figure does not assure that the students will actually interpret the photograph in the way they were expected to do it. Two cases of misinterpretation of the photograph are related to misreading of the text itself. The first case is of a student that, after reading the main text, engaged in an effort of identifying both orchid and bromeliad in the photograph. She could not decide whether the leaves on the side of the trunk of the central tree in the photograph were an orchid or a bromeliad. The student was also confused when she attempted to identify a second plant in the photograph that could be also an epiphyte plant, thus pointing to many different trees and flowers in the photograph.

The other case is of a student that identified the epiphyte plant as being the orchid and the host tree as being a bromeliad. In this case, the misreading of the text is easily identified, as the student read “orchids and bromeliads”, instead of “orchids or bromeliads” when the text reads, “It is the case of the interaction between orchids or bromeliads and the trees in which trunk they install themselves”. This misreading of the text (and instead of or) accounts for a misinterpretation of the photograph and even of the entire concept presented in the text, insofar as the student believed bromeliads as being host trees instead of being another example of epiphyte plants, therefore in the same category as orchids. This is clear in his statement: “the orchid is in a bromeliad, without causing any damage to it”.

Both cases involve the same aspect of text and photograph, namely the fact that the photograph was showing the interaction between orchids or bromeliads and the host trees. Nevertheless, this interaction is not visually available in the photograph, but how an orchid looks like in the trunk of a host tree in a natural setting. The way in which this information was provided in the main text, as well as the way in which the indexical reference was used, accounts for the possibility of different interpretations of the photograph, as for example, in the two cases mentioned above. The text actually does not make explicit if the photograph presents an orchid or a bromeliad, only that these are examples of epiphyte plants. Therefore, the reader is able to connect figure and text through the indexical reference placed at the end of the phrase where
the text refers to orchids and bromeliads. When reading the caption, however, the reader cannot find any further information that could help him/her to decide if the photograph was showing an orchid or a bromeliad in the trunk of the tree.

Nevertheless, in this situation, the information necessary for the reader to decide if the photograph is showing an orchid or a bromeliad is available in the photograph itself. At the bottom right of the photograph it is written “orchid”. This information by itself is useless; although it could still function to focus the readers’ interest in something specific in the photograph, without however help them to actually identify this specific object or phenomena in the photograph. But in the context of the entire assemblage of photograph, caption and main text with indexical reference, this information becomes essential for the reader to make sense of the photograph in relation to the text. Just by looking at the photograph, the students could identify the most centralized and focused objects as being the probable topic of the photograph; by reading the caption, they focused their attention to a plant in the photograph, and later, by reading the text, they associated the figure with the text, going as far as realizing that the photograph was showing an epiphyte plant and its host tree. However, they still were not sure about which one of the examples of epiphyte plants given by the text- orchid and bromeliad- was represented in the photograph. The word “orchid” written in the photograph is the ultimate information needed to properly interpret this photograph in relation to the text. The work of interpretation of photograph and text is essentially dialect; the text helps to understand the photograph as much as the photograph helps to understand the text, and both text and photograph need each other in order to be properly interpreted.

About this photograph, a student’s answers provide a very good example of the importance of the context influencing an interview. When asked about what would be the topic of the photograph, Adam, a grade 12th student, immediately answered that it would be the orchid, and he pointed out the orchid in the photograph. Adam had identified the orchid as soon as he first looked at the picture, and he had admitted to already know orchids from nature (his mother uses to grow orchids at home, and also his grandmother’s garden has many orchids growing attached on trees). He knew how an orchid looks like and he was familiar with it. He also pointed out the word “orchid” written in the bottom right of the photograph.
After reading the caption, however, Adam suddenly changed his mind. He said the plant he earlier had identified as an orchid no longer looked like an orchid, and he added that there are many kinds of orchids and the ones he knew were different from the plant in the photograph. He said he was confused and that the caption only makes everything worse. Only after reading the main text Adam was able to recognize the plant in the photograph as being an orchid and an epiphyte plant. He realized then that both denominations could be used to address the plant in the photograph.

Later, during the debriefing part of the interview, Adam admitted that he knew the plant was an orchid from the beginning, he had recognized it in the photograph because he was very familiar with orchids. However, when he read the caption, although he did not know what an epiphyte plant was, he believed the word “orchid” in the bottom right of the photograph was deceptive and did not have anything to do with the photograph itself, and he considered the plant he had just identified as an orchid in the photograph as being the epiphyte plant referred to by the caption. The reason why he thought so, he explained, was because he knew the interview was part of a research and he expected some kind of trick in the interview.

In this case the influence of the context in the answers provided by the student is clear. Although the student was answering the questions asked by the interviewer, he was also conscious of the fact that the interview was part of a research, and his particular idea of what kind of research was being conducted influenced his responses as much as to make him disregard his previous knowledge about orchids, actually even doubting it, as he states “it doesn’t look like an orchid (...) the orchid that I know is different”.

Decorative Photograph

In this case, we showed the students a reproduction of the entire page of the textbook where this photograph originally appeared (Figure 2). This photograph was classified in our previous work as decorative, insofar as it does not present a caption or indexical reference associated to
it¹. The students were asked to talk about what they were doing, if looking at the photograph or reading the text. The first thing ten students said was that they were looking at the photograph, while other two students stated that they were reading the title of the text or “looking at the text”. After this, the students were asked to either describe what they were seeing in the photograph or read the text aloud. Independently of the order in which it occurs, all the twelve students read the text and described the photograph.

About the photograph, five students said the photograph presented a caterpillar; three students said it was a centipede, and two students referred to the animal just as “a bug”. One student said it was a worm, and another one identified it as an insect. Eleven students said the animal in the photograph was eating, feeding, or gnawing a plant or a leaf (refer to Table 4). The idea that the animal in the photograph is eating is related to the fact that our interpretation of photographs is influenced by conventions of perspective, as well as by our previous knowledge. It is not possible to visualize in this photograph the caterpillar “eating” the leaves, however, we can see evidences of it in the photograph. As Amann and Knorr-Cetina (1990) says, the evidence is built upon the difference between what one can see and what one may think, or have heard, or believe. Therefore, the shape of the leaves is assumed to be bite marks, and the caterpillar is assumed to be responsible for these bites. A lot of previous knowledge and common sense, as well as conventions of perspective, go into the work of interpreting this photograph. We assume, for instance, that caterpillars eats plants, or at least, leaves; therefore, these animals should have a mouth, and this mouth should be able to imprint a particular kind of mark in the leaves. All these details cannot be visualize in the photograph and yet they are very important in the work of interpretation of photographs.

Two students made references to where or when this photograph was took, “in a closed space” or “at night”, because the background was dark. These two students also inferred other aspects of the photograph; one of them said, “this is a small bug”, and the other stated that, “it

¹ The photographs classified as decorative appeared in the introductory page of each chapter of one of the textbook analysed in our previous study (Pozzer & Roth, 2002). They did not have a caption or a main text associated to it in the page where they appear, although in the last page of the book one can read “captions of the photographs of the introductory pages of the chapters”, where one can find a statement about each one of these photographs following the chapter number, e.g., in this case “Chapter two: caterpillar of moth eating leaves”. We do not considered this as being a caption because there are no evidence whatsoever of
must stop to be able to eat”. We can notice again in these cases the influence of previous knowledge and conventions of perspective in the interpretation of photographs.

About the text, four students identified the text as a summary or an introduction of what would be presented in the following chapter. That was indeed what the text was about, and this structure was a pattern in the textbook from where this page was extracted: the first page of each new chapter presents a decorative photograph and an introductory text, as well as some highlights of the topics that would be presented in the chapter. However, eight students did not identify this characteristic of the text.

When asked about if there was any relation between the text and the photograph, two students said the photograph did not have anything to do with the text. Six students said they could not understand the photograph (students also said that the text did not help to understand the photograph, or that they could not know what the text was about, or yet that the photograph diverted from the text). Seven students said the photograph could be substituted by another photograph without altering its relation with the text.

the presence of these “captions” anywhere in the textbook, what makes the reading of these phrases and its association to the photographs an almost “accidental discovery”.
All the twelve students believed the photograph and the text were associated by means of establishing a relation between living beings and environment (students also mentioned ecosystem and biosphere). This relation, however, is very general, and when asked about a more specific relation, there were as many different answers as there were students interviewed. That is, the students said the photograph was illustrating or exemplifying something referred to in the text, and each student believed this was a different thing: the natural cycles; the distinction between autotrophs and heterotrophs; the food chains; the particular environment (or ecosystem) where the caterpillar lives; the relation between the plant and the caterpillar; the importance of eating to surviving; the relation of human beings and the animals (and the fact that we should respect the animals); and metamorphosis. These were all cited as possible topics of both photograph and text, and these topics supposedly explained to the students the relation between photograph and text.

It was noticeable that the students were trying to authenticate (Bjelic, 1992) the photograph, searching for a segment on the text that could be related to the photograph. In relating the text and the photograph, the students were trying to find a specific function to the photograph, that of illustrating something referred to in the text. They assumed the photograph was helpful in some
way to understand the text, and they struggled to justify this assumption by directly connecting text and photograph, even if this connection was actually not explicit.

The general character of this photograph in relation to the text, that is, the lack of resources that definitely and directly linked photograph and text, allows a wide range of different interpretations, what accounts for the great variety of subjects mentioned by the students as possible topics of the photograph.

As much as we could actually relate the photograph to the text, the fact that the text is an introductory text, together with the fact that there is not a direct association between text and photograph, emphasizes the decorative character of the photograph in this page. This photograph’s basic function is to catch the attention of the reader, and it also improves aesthetic aspects of the textbook.

**Complementary Photograph**

The multiple photographs about camouflage (Figure 3) were showed to the students according to the same strategy used to present the students with the photograph of the orchid, that is, we showed the students first the series of the photographs without the accompanying caption and main text, then we showed them the caption, and finally, the main text. This time, however, the details identified in the photographs did not vary as much as they did in the first case, and the students’ answers were overall very similar (refer to Table 5).

When asked about what they were seeing in the photographs, the twelve students mentioned the birds (three birds, three animals, eagle, falcon). Five students identified the environment around the animals in the photographs, and four students noticed the difference in the plumage of the birds in the three photographs (different feathers, different colors). Three students referred to a difference in seasons in the photographs (also referred as difference in temperature or climates). Ten students out of the twelve interviewed attempted to describe each photograph separately, emphasizing differences between the birds, the environments and/or the seasons represented in the three photographs.
About the first photograph of the series, on the left, the students identified a white bird and they referred to the environment as snow, ice or cold. The third photograph of the series, on the right, was said of representing a brown bird in a field or mountain (students also mentioned grass and rocks, and hot climate). The second photograph, in the middle, was the one that generated a greater variety of answers from the students. About the bird in this photograph, one student said it was black-and-white, another said it was more-or less white, and yet another student said the bird was tiger-like, but the majority of the students did not refer to the bird, describing only the environment on this photograph. The environment was identified as a river or running water, and also as intermediate temperature; only one student said it was melted ice. One student said about this second photograph that it was changing with the heat, although it is not clear if the student was referring to the bird or to the environment, or even to both. Three students also said that they could not understand this second photograph in the series. The difficulty the students have to identify the environment on this photograph as the transition between winter and summer may be due to the fact that in Brazil the winter is very mild, and none of the students interviewed had ever seen snow or frozen lakes and rivers other than on television or books and magazines. Therefore, their life experiences influenced their interpretation of the photographs; thus the aspects a Canadian student might easily identify in this photograph was not so easily identified by Brazilian students.
When asked about the birds in the three photographs, seven students believed it was the same bird with different plumage on each photograph; five students answered the three birds were different species of birds.

For ten students the three photographs represented a sequence of season, climate, or temperature. Other two students believed the photographs did not represent a sequence.

The topic of these photographs, for six students, was the environment. Two students believed the topic of the photographs were the birds, and other two students said it was the birds in relation to their environments. Only two students said the topic of the photographs was camouflage, and they were the only ones to point out the fact that the birds in the first and in the third photographs were similar to the environment, and that this would make it more difficult for predators to find the birds.
In this case, the differences in environment and in the bird itself were the most salient details that were identified through comparison of the three photographs. Other details, as for example the fact that a white bird was in a white environment, or a black-and-white bird was in a similar environment- specifically what constitutes the phenomenon of camouflage-, did not catch the attention of the readers. The students concentrated their attention to the changes in the photographs, the differences in the environment and the differences in the plumage of the bird. A series of photographs characteristically invites the readers to pay attention to the differences between each photograph, by means of comparison. As Bastide (1990) points out, in a series of photographs the isolated figure takes on a meaning only in an external system of comparison; the internal comparison of the object with its background is scarcely informative. Through comparison, the reader can distinguish the details that are different in each photograph and the ones that are repetitive in all the photographs, therefore, regarding everything that does not change as irrelevant details and concentrating in the details that actually vary among photographs.

Although the students concentrated in the “changes” they could visualize in the three photographs, they did not identify the three photographs as being a series of photographs in sequence. Here, neither the phenomenon of camouflage nor the phenomenon of adaptation was salient to the majority of the students yet. This situation changed dramatically after they read the caption.

After reading the caption, all the twelve students believed the three photographs were a sequence of seasons or climates and the bird represented in each photograph was the same animal. The most salient difference in the students’ answers after they have read the caption, however, was related to the phenomenon of camouflage itself.

Once the students have read the caption, they pointed out the fact that the white bird in the first photograph of the series was camouflaged, and it was almost impossible to see the bird in the photograph except for its beak and eyes. The same occurred with the last photograph of the series. About the photograph in the middle however, the students were not sure about what it was representing; some students even said that the bird in this second photograph was not well camouflaged. Few students pointed out that this second photograph was in fact representing the
change the animal goes through from how it is in the first photograph to how it presents itself in the third photograph, what makes us infer that these students actually were able to identify at least the phenomenon of adaptation in this series of photographs.

Nevertheless, the students could not make sense of the second photograph in the series in the context of the concept of camouflage presented by the caption. The students demonstrated they understood the phenomenon of camouflage (two students even mentioned military strategies during a war and how the soldiers camouflaged themselves as examples of camouflage), and they identified the phenomenon of camouflage in the first and in the third photographs of the series, where the bird was very well camouflaged in its environment. The phenomenon of camouflage was very well illustrated in these two photographs, and the photograph in the middle was not at all necessary; as a matter of fact, this particular photograph was only pertinent in the context of the visualization of the phenomenon of adaptation.

Furthermore, the second photograph in the series accounts for misinterpretations of the concept of camouflage. The caption also contributes to further confuse both phenomena-camouflage and adaptation-, insofar as, in describing the photographs, it emphasizes the phenomenon of adaptation, but it ends this description stating that it is a good example of camouflage. The caption refers at the same time to both phenomena of camouflage and adaptation, without however helping the reader to identify the two different phenomena represented in these photographs.

Therefore, the students could neither identify the phenomenon of camouflage in the second photograph, nor could they distinguish the phenomenon of adaptation represented in the sequence of photographs and described in the caption. In the second photograph of the series, the bird is not camouflaged at all; it is easily distinguished from its environment. This photograph is not representing camouflage, but the process of changing of plumage and environment that occurs between the two stages represented in the first and the third photographs. Although the caption explains that the animal changes its plumage according to the season in order to be camouflaged during the winter and during the summer, this particular process of changing is not an example of camouflage, rather it is an example of adaptation, a concept that was not
introduced to the students neither by the caption nor by the text presented to them during the interviews.

The presence of two different phenomena in the three photographs and the way the caption explained the photographs account for the confusion many students did, “mixing up” the two concepts, camouflage and adaptation. When asked if the three photographs were necessary to represent the phenomenon of camouflage, the twelve students said they would need at least the first and the third photographs, in order to visualize the “changes” in the animal and in the environment. The students incorporate the phenomenon of adaptation as an intrinsic characteristic of the phenomenon of camouflage.

The main text that accompanied this figure in the textbook reads about camouflage, explains the concept and also provides some other examples of camouflage. However, neither the main text nor the caption referred to adaptation, no further than stating that camouflage is a kind of adaptation. After reading the main text, ten students believed the topic of the photographs was camouflage; only two students said the topic of the photographs was adaptation to the environment. Nevertheless, the students were still confused about the phenomenon represented in the photographs. According to the caption, the photographs represented a good example of camouflage; also the main text further explains about the concept of camouflage, but what the students saw in the photographs was more than only camouflage; they also saw adaptation to the environment in different seasons. The phenomenon of adaptation was not present in the main text, but it was described in the caption, although the students could not find an explicit reference to adaptation neither in the caption, nor in the main text. What happened then was that the students tried to make sense of the series of photographs, and its sequential nature, in the context of camouflage, incorporating the process of changing that actually illustrates the phenomenon of adaptation, as part of the phenomenon of camouflage.

For the sole purpose of illustrating the phenomenon of camouflage, either the first or the third photographs could have been used; the multiple photographs representing the changes the animal goes through during different seasons is not relevant in the context of camouflage. For the concept of adaptation, however, the three photographs are necessary, so the readers are able to visualize the changing process. Therefore, these multiple photographs would be more
useful as an illustration of the phenomenon of adaptation, rather than the phenomenon of camouflage.

If this series of photographs were to be efficiently used as an illustration of camouflage, the caption should emphasize the phenomenon of camouflage in the first and in the third photographs, at the same time making explicit the existence of another phenomenon—adaptation, that in this case is related to the phenomenon of camouflage but it is not intrinsic to this phenomenon. The caption should guide the readers through the interpretation of the photographs, helping them to identify and to distinguish both phenomena of camouflage and adaptation in this series of photographs.

We identify here a second major function of the caption: it describes the photograph, emphasizing the important details to be regarded, and connecting what can be seen in the photograph with the concept referred in the main text. In order to fully accomplish this function, a caption should clearly guide the reader towards the interpretation of the photograph in the specific context introduced by the main text.

**Explanatory Photograph**

This photograph had been previously identified as explanatory (Pozzer & Roth, 2002). There is an indexical reference to this photograph in the text, appropriately placed just after the subject of the photograph was mentioned. However, although the lichens are satisfactorily visible in this photograph, they appear out of context, as the background of this photograph is not easily identified, and neither the caption nor the main text presents any information about the background of this photograph, nor for that matter any other information that could help the readers to identify where lichens can be found (Figure 4).

This photograph was showed to the students together with the caption and main text associated to it. The entire assemblage was showed to the students all at once, and the students were asked to tell what they were doing, if reading the text or looking at the photograph. Five students said they were looking at the photograph before reading the text, and seven students started reading the text before referring to the photograph (refer to Table 6).
We can easily notice from the videotapes that all the twelve students looked at the photograph before either talking about it or starting reading the text. However, only three students said what they were seeing in the photograph, while other two students who did not start reading immediately only said they were looking at the picture, without any further comment about it. The other seven students, although they certainly looked at the photograph, did not make any comment whatsoever about the photograph, and decided to start reading the text instead. What we can argue here is that the students, with the exception of those three who actually tried to describe the photograph, were not able to identify anything in the photograph, and therefore they turned their attention to the text, searching for information that could help them to figure it out what the photograph was all about.

![Figure 4. Reproduction of the page of the textbook, presented to the students during the interview.](image)

If we compare this situation with the one presented by the Photograph of the caterpillar, we can realize that in the latter situation, the students were immediately drawn to the photograph,
and although they all read the text, they only did so after commenting about the photograph. This comparison further lead us to believe that the reason why the students did not immediately make any comments about this photograph of the lichens, is because they did not know what the photograph was about. The visual information provided by this photograph proved to be not enough to help the students interpret the photograph, and the texts associated to this photograph not only were important for directing the readers towards a specific interpretation, but actually these texts were essential to the reader to achieve any understanding about this photograph.

When reading the text aloud, seven students read the caption; six students read the indexical reference, and only four students read the note at the bottom of the page. Four students read the caption aloud only after the interviewer had referred to the caption and asked them about it, and the same happened with the indexical reference to the photograph, with four students reading it aloud only when asked about it.

While reading the text, six students referred to the figure at the exact point in the text where the indexical reference was placed. Not all of them read the indexical reference aloud at this point, but they either looked at the photograph, or pointed to it, or yet said something about the figure.

The descriptions of the photograph were similar in that the students were aware that the photograph represented lichens. Both the caption and the main text read that the photograph was about lichens, and some students even stated that they already knew how a lichen looks like, and that they were able to identify it in the photograph before reading the caption and the main text. When asked to point out the lichens in the photograph, however, eight students were able to do it properly, that is, identifying what were lichens and what was background in the photograph.

Two students said they could not identify which was which in the photograph- lichen, algae and fungus. One student believed the background of the photograph (darker color) was the fungus, and the lichen (lighter color) was the algae, and these two together formed a lichen, which in this student’s opinion was represented by the entire photograph. Another student identified the lichen as such in the photograph, but believed algae and fungus constituted the
Making Sense of Photographs

background. In these cases, the confusion was not only due to the decontextualized nature of the photograph, but also because of the misunderstanding of the texts that accompanied the photograph. These two students did not understand what forms a lichen, they were not able to correctly associate the terms algae, fungus and lichens in order to give meaning to them. Not knowing what a lichen was, the difficulty in interpreting the photograph was enormously increased. The dialectic relation between photograph and text proved to be also complex and indispensable to the comprehension of this concept, that is, the text failed to introduce the readers to the concept of lichens, and it did not help the reader to interpret the photograph either, while the photograph did not help to understand the text.

Only four students were able to identify the background either as a tree or a rock. Insofar as this information is not be found in the texts, the students relied on previous knowledge to identify the background of the photograph. The identification of the background is important because it allows the reader to distinguish the relevant details in the photographs. When this identification is not possible, the interpretation of the photograph is jeopardized.

The students were also confused about the term “macro” used in the caption: “Macroscopic aspect of lichens.” After reading this caption, two students said the lichens could not be seen without a microscope, and two other students referred to lichens as having something to do with bacteria. One of these students said, “this here (pointing to the photograph) is a bacteria because macromolecule is like magnified”. Of course, in this case, the confusion could not be attribute to the lack of information in the photograph or in the texts. However, some terms used in textbooks, especially in Biology, should be more carefully and thoroughly explained, so to minimize the possibilities of misinterpretations and confusion as happened in this case.

Discussion

Visual representations pervade our lives. From television, Internet, movies and magazines, to the curriculum materials employed at schools, visual images are widely and constantly used. Photographs, for instance, are the most frequent inscriptions present in high school Biology textbooks (Pozzer & Roth, 2002). Knowing that teaching and learning strategies rely heavily on
textbooks, we should more carefully investigate the pedagogical potential of photographs, and how students and teachers make use of these visual resources to achieve and help others to achieve understanding. This study is part of a series of studies that aim to answer some of the questions related to the use of photographs in school science.

How do students interpret photographs? How do they make use of the semiotic resources present in the textbooks? How do they connect photograph and text? In this study we have tried to answer these questions through careful analysis of data collected from interviews with twelve students from different grade levels.

During the interviews, we presented the students with reproductions of photographs and texts extracted from high school biology textbooks widely adopted in Brazil. We made use of two different strategies to show the photographs and texts to the students: (1) we presented the students with the isolated photograph at first, followed by its associated caption, and finally its associated main text; and (2) we presented them with the entire assemblage of photograph, caption and main text, as these items appeared in the original textbook.

From our analysis, it became clear that one of the major functions of photographs is to capture readers’ attention. Invariably, the students interviewed noticed and commented on the photographs before referring to the texts. Although we were careful as to take into account the influence of the interview setting as well as the influence of the interviewer herself on student’s responses, we do believe the students demonstrated interest in the photographs, even if they did not pursue the investigation of these photographs afterwards.

Some of the arguments we have made in our previous study (Pozzer & Roth, 2002) were validated by the results encountered in this study. For instance, the use of multiple photographs is preferable to the use of single photographs. Multiple photographs greatly reduce the possibilities of diverse interpretations of the topic treated in the photographs. As presented in this article, student’s responses about what would be the topic of the photographs were fairly more similar in the case of the multiple photographs of the camouflage than in the three other cases, where they were presented with single photographs. The possibility of external comparison provided by the use of series of photographs allows the readers to grasp the subject matter treated in the photograph more easily. It is important to highlight, however, that a series of
photographs by itself is not enough to ensure the correct interpretation of the photograph. It is the interaction of other semiotic resources presented in the textbooks, together with the photographs, that made possible to the reader to interpret and understand what he/she is reading.

Another topic mentioned in our previous study is related to the background of the photographs. Photographs with neutral backgrounds are useful to highlight the object of interest, insofar as gratuitous details are almost non-existent. Nevertheless, the lack of these gratuitous details sometimes implies in the decontextualization of the object depicted in the photograph. In the photograph of the lichens, we could notice how the students could not comment about the photograph before reading the text, as they could not easily identify the object in this photograph. The photograph was taken aiming to focus only on the lichens, without any consideration with the background, in this case, the place where the lichens were installed. Furthermore, the information in the texts accompanying this photograph was not enough to help the reader to distinguish what he/she was seeing.

On the other hand, photographs as the one of the orchid also present many problems related to the identification of the important or right detail to the observed in the photograph. The abundance of details in this photograph certainly gives it realism; unfortunately, it also accounts for much confusion. The students were not able to identify the epiphyte plant among so many other plants depicted in the photograph. Some students were not able to decide which plant was the epiphyte plant even after reading the caption and the main text. The students who did identify the epiphyte plant either made use of previous knowledge to do this, or did it after much struggle and reasoning, making use of other semiotic resources available to them, for example, guessing that the epiphyte plant was the one more focused or centralized in the photograph. We again suggest that more specific directions, such as arrows and colored areas, should be used to help the readers to identify the right detail to be observed in the photograph.

The captions are a major aspect to be careful considered when using photographs for pedagogical purposes in textbooks. First of all, every photograph must have its own caption. Secondly, the caption should always refer to whatever the photograph is supposed to be a depiction of. For example, in the case of the photograph of the orchid and the photograph of the
lichens, both captions are referring to what the students should observe in the photographs, that is, an epiphyte plant in the first case, and the lichens in the latter.

In reading the caption there should be no doubts about what the topic of the photograph is. However, this information is not always enough to assure the identification of the important object in the photograph. Depending on the photograph, captions should not only name the object, but also guide the readers through the photograph, helping them to distinguish foreground from background, and all the gratuitous details from the object of interest. In the case of the multiple photographs about camouflage, although the presence of two concepts generated doubts on the students, the description in the caption of what should be observed in the photographs are useful to the readers.

Another important semiotic resource mentioned in our earlier study and again salient in this article is the indexical reference to the figure. It should be placed always in the main text, preferably following the first mention of the phenomenon or object depicted in the photograph. The indexical reference to the photograph of the lichens is a good example of where to place the indexical reference to a photograph. When reading the text, the students immediately connect “lichens” with the photograph, because the index for this photograph is placed just after the word “lichens” on the text. In the case of the photograph of the orchid, however, the indexical reference placed after an entire phrase that identifies a phenomenon and not an object, confuses the reader. The indexical reference is what allows the reader to connect photograph and text, therefore, it is an essential resource to help readers to interpret photographs and texts in the context of learning a scientific concept.

Another aspect, not directly related to photographs, become evident in our study, and should be more carefully regarded as well. Analyzing students’ readings, we noticed that few students have the habit of reading whatever is written between parentheses or in text boxes or side texts. Relevant information is not necessarily available only in the main text. Therefore, reading through the entire page of the textbook, including texts in text boxes and between parentheses, photographs and its captions, should be more emphasized.

Many of the concepts presented in science textbooks are abstract and need an illustration. Photographs seem to be the preferred visual illustration on science textbooks. However, for the
photographs to achieve their full potential as pedagogical resources in teaching and learning science, many aspects of their use in textbooks should be more carefully regarded. When students are reading textbooks, the way in which they interpret photographs greatly influences their understanding of the concept presented by the textbook. Therefore, careful selection of photographs, as well as appropriate captions and indexical references to these photographs constitute ways to ensure that a better understanding is more likely to happen.

References


