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Journaling and Botany: Documenting Learning with Words and Pictures

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In most university curricula, science and art are separate endeavors. However, the work of scientist-artist such as Leonardo DaVinci illustrate that science and art were once used as interchangeable modes of investigation. Recently, several initiatives have attempted to reconnect art and science. Ainsworth et al. (2011) found that drawing increased the students' engagement, reasoning abilities, and communication skills. Baldwin and Crawford (2010) found an illustrated botany journal had a positive impact on the student learning and appreciation of plants. In this workshop we will examine the use of illustrated journals in botany class. Participants will be asked to draw a little too! This invaluable approach can be adapted for other science classes.

Keywords: botany, drawing, engagement

Introduction

Science and Art – Polar Opposites?

In the past it was common for science and art to go hand in hand as demonstrated by Darwin, Leonardo DaVinci, and Galileo (Bredekamp 2000, Whiteley 2008).Today, however, science and art are often considered very separate endeavors, viewing and interpreting the world from different perspectives (Snow 1993, Stange 2010). Recently the role of art in science education has been examined. Ainsworth *et al*. (2011) found that drawing increased the students' engagement, reasoning abilities, and communication skills. Baldwin and Crawford (2010) examined the role of journaling which included drawing in a science lab and the student's perception of their learning. Overall, students reported that the use of illustrated journals had a positive impact on their learning. In particular, the drawing process taught the students to "see" and in doing so, they became more aware of variation in individual plant's morphology. In addition, students also reported becoming more aware of their own learning process. Drawing plants in particular helps overcome "Plant Blindness" (Wandersee and Schussler 1999).

Notes for the Instructor

Students and Drawing

We have used drawing in botany laboratories focused on surveys of different plant groups. In these courses, labs provide time for students to inspect attributes of different plant groups—either for comparison of evolutionary important features or to become familiar with unknown groups and their uses in society. The purpose of the illustrated learning journals, including drawing, is to provide a place for students to document their learning. By "document" we ask students to capture what they are seeing in the various classes through illustration and writing. Students draw from live plants (whole or cut), dried specimens, as well as from microscopic inspection of prepared slides. The goal of the drawing assignment is not to have the students document the totality of each specimen, but to identify the overall shape and important features of the plant being studied. We emphasize the most important aspect of the assignment is to be observant—to look at the mass of different colors, shapes and details in order to find underlying patterns. Students are expected to use available references to identify and label the important features of each drawing. Asking students to annotate their illustrations helps place individual drawings into the overall context of the course material.

Based on our experience, we believe that drawing is important step in encouraging students to slow down and focus on the spatial relationships observed in each specimen. Anecdotally, many students report that drawing specimens allows them to learn the material better than "just looking" and the drawings serve as important review material for lab exams. We hope to encourage this function further by allowing part of each lab exam to be open book using their illustrated field journals as a reference. Finally, by making the student engage in "active observation and inquiry" through the illustrated journals they are modelling the scientific approach (Baldwin and Crawford 2011).

We do caution that early in each course, students often voice frustration with the drawing process itself. They do not feel very equipped to deal with the blank paper and have trouble transferring 3D images into a 2D sketch on paper. We have found providing examples of how they might document particular sections helps ease student anxiety and tension (Fig. 1). We also encourage them to use color – grab the pencil crayons! A common complaint is that "There is too much material to draw." Drawing specimens requires time and we have found it helpful to limit the number of required drawings per lab so that students do not feel overwhelmed. We have also found it very helpful to provide written feedback on each journal at midterm. Separate drawing tutorials are also offered to students who would like further assistance.

In order to promote students' understanding their own process of learning, students are asked to write a metacognitive paragraph after every lab. A metacognitive paragraph is a chance for the student to reflect on their own learning process (Paris and Winograd 1990). Here they describe what they felt was easy or difficult about the material and how they dealt with it.

A marking rubric (Table 1) is given to the students at the beginning of the course which outlines what is expected of their journals. Within the overall course, students have multiple ways to demonstrate their engagement and learning of the course material including the journal. Within the learning journal assignment, we do allocate a minor portion of the grade for overall aesthetics as many students invest large amount of time into developing intricate and detailed learning journals.

Table 1. Learning Journal Grading Rubric.

Category	Marks Possible
Completeness • All lab and reading material discussed/ diagrammed • Observations "truthful" • Titles & overall organization • Table of Content • Page Numbers • Metacognitive paragraphs	6

Level of Engagement
• Independent observations/questions
• Synthesis (compare/contrast)
• Value as reference
  • Integration with lecture material
  • Use of references other than lab/ lecture/textbook
	3

Aesthetics • Is it appealing, interesting, or captivating?	1

Student Work

Examples of student drawings and their metacognitive paragraphs were presented at the mini-workshop, as well as summaries about their experiences and opinions from a questionnaire:

Did the lab journals contribute to your learning as a botany student?

"Yes…. more interesting because I was able to really see the structures I was studying. Instead of just memorizing, I was retaining the material."

"It became easier and really solidified in my brain the concepts we were learning."

"Through art I found a way to better understand the science I was studying. I didn't realize how much I actually thought in pictures, and translated it into words in order to memorize concepts for exams. The journals helped put the two together and I re-

ally felt they helped my quality of learning."

"I began using this method of learning for my other classes."

"I found that more difficult concepts become easier to understand when I could draw it out as a pictured storyline."

"Yes. I really enjoyed making the lab journal. It made it fun to learn in the lab."

"This journal is probably the longest assignment I have worked on all semester. It has been very time consuming, but I'm proud of the results."

Excerpt from BIOL 2280 Lab Manual 2012 Lab 1 (Baldwin 2012)

A learning journal is a collection of writings and/or drawings that you as a student will make in a book. Learning journals have been increasingly used to help students become self-aware and focused on how they learn, as well as what it is they are learning. This type of metacognition (knowledge of your own thoughts and the factors that influence your thinking) is one of the characteristics of expert learners—students who know how to use self-knowledge to select the strategies to need to achieve their learning goals.

We expect the learning journal to be a place where you will document what it is you learn about plants in laboratory, but also a place for you to reflect upon how it is you learned the material. We expect at least one "metacognitive paragraph" at the end of each laboratory entry in your journal. Questions to reflect upon may include (among others):

a. *Was there some material that was easier? More interesting to learn?*
b. *What factors made it easier for you to learn?*
c. *Are there "outside" influences (noise, talking, position in room) that affect how you learn?*
d. *What did you like best about this lab? What was the most difficult?*

Beyond increasing your awareness of your own learning, your learning journal will fulfill two primary objectives. First it is an exercise book in which you must practice looking at plants and recording what it is you see. Leonardo da Vinci called drawing "the father of all the arts" and drawing, when good, is truth-telling in lines (Brooks 1920). Even in this day of image proliferation where a Google Image Search will likely deliver any desired image, the simple act of recording the lines of an object is a learning experience.

In order to draw an organism (a fern, a butterfly, or a mountain), you must truly SEE that entity. Translating a 3-dimensional object into 2-dimensions requires clarity of observation and we believe that those observations are the key to succeeding in the study of plant biology (really, all of science). The successful completion of this lab requires drawing, but does it require fine, artistic drawing? No. Although we concur with Thomas Huxley who wrote "everybody, or almost everybody, can learn to write and writing is a kind of drawing," your lab journal grade does not depend on the artistic quality of your drawings. What it does depend upon, however, is the quality of observations that you make in your journal. Are you drawing what you see? Are you taking the time to decipher the intricacy of the plant or are you drawing lines that have no meaning, but are instead visual mistruths? Most of us are committed to the use of language as our primary means of communication—we are verbal animals. We realize this and we encourage you take a risk here—to commit to the language of the line. Realize also that drawing is a skill, just like speaking and writing and will take time to develop. Here are some things to think about as you work.

1. *Don't be afraid of the page. This is an exercise book, a practice book and your drawings will improve if you commit to them. One way to think about this is to use left-hand page as your sketching/drawing page and the right-page for more formal integration of the material. Use the journal in the "Landscape" position rather than the "Portrait" position.*
2. *Make your drawings large (4-5 cm minimum). No dime size drawings—while these illustrations may take less time to complete, it will be difficult to interpret them later.*
3. *Use guideposts. You usually decide how big you want the sketch to be and mark out guideposts on the paper, before you start to draw. You then mentally identify where these guideposts fall on the plant. If you draw structures (size/shape/orientation) relative to one another, your sketch will have more coherence.*
4. *What to draw? First, accept that you can't draw everything. The best rule of thumb is to "Only draw what you can count." While much of the lab will be spent looking at whole plants, we will also dive into the anatomy of plants and look at cross-sections of stems, leaves, roots. Each cross section may contain 1000's of cells. Part of our task will be to decipher the diversity of these cells and record them. If you attempt to draw each cell, you will never finish. Learn to draw the outline of a specimen and then record merely a cross section of the cell types (see example below).*
5. *For some specimens, it may be necessary to provide two views.*
6. *Make your choice of tools. It is recommended to start your drawings with a mechanical pencil with HB lead. Note that HB lead can smudge leading to messy journal drawings. Overdraw the HB pencil lines with a coloured pencil crayon or a thin black ink pen to prevent this. Many scientific illustrators will only work with pencil lead that is 2H or harder, but they will complete the drawing in ink. Choose the tool with which you are comfortable, but ensure that your journal pages are dark enough to be legible.*

7. *Make sure to organize your drawings by each lab with clear titles and headings. Also include relevant labels for each drawing done. Think about why you drew it – what are you trying to learn about it?*

Mini-workshop Participant's Drawing and Metacognitive Paragraph

Journal Drawing of a Conifer Branch

Take a small piece of your plant and view under x4 and x10 power objectives. Get a sense of how the needles or "leaves" are arranged around the stem itself. These can be important clues for identifying the species. Draw this branch showing the needles in their relative positions – are they single or in bundles (fascicles)? If the needles are in bundles – note how many. Are the needles attached to the stem by small stalks or directly to the stem itself? Are the needles pointed at the tip? Are they curved or flat along their length? Draw a single needle. Are needles flat or four angled in cross section? You may use a dissection microscope to determine these smaller features. Look for these details and include in your drawings. Use the available references and add labels to your drawings.

Now take a moment and reflect on the drawing process itself. Was it hard? Did it get easier? Do you feel you really "looked" at the conifer branch and understand more about it than you did at the beginning of this exercise? Write your metacognitive paragraph.

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Literature Cited

Ainsworth, S., V. Prain,and R. Tytler. 2011.Drawing to learn in science. *Science*. 333(6046):1096–1097.

Baldwin, L., and I. Crawford. 2010. Art instruction in the botany lab: a collaborative approach. *Journal of College Science Teaching*. 40(2): 26-31.

Baldwin, L. [Internet]: Illustrated Field Journals – Lyn Baldwin [cited 2013 January 24]. Available from: **http://faculty.tru.ca/lbaldwin/Field%20Journal/Journals_Home.htm**

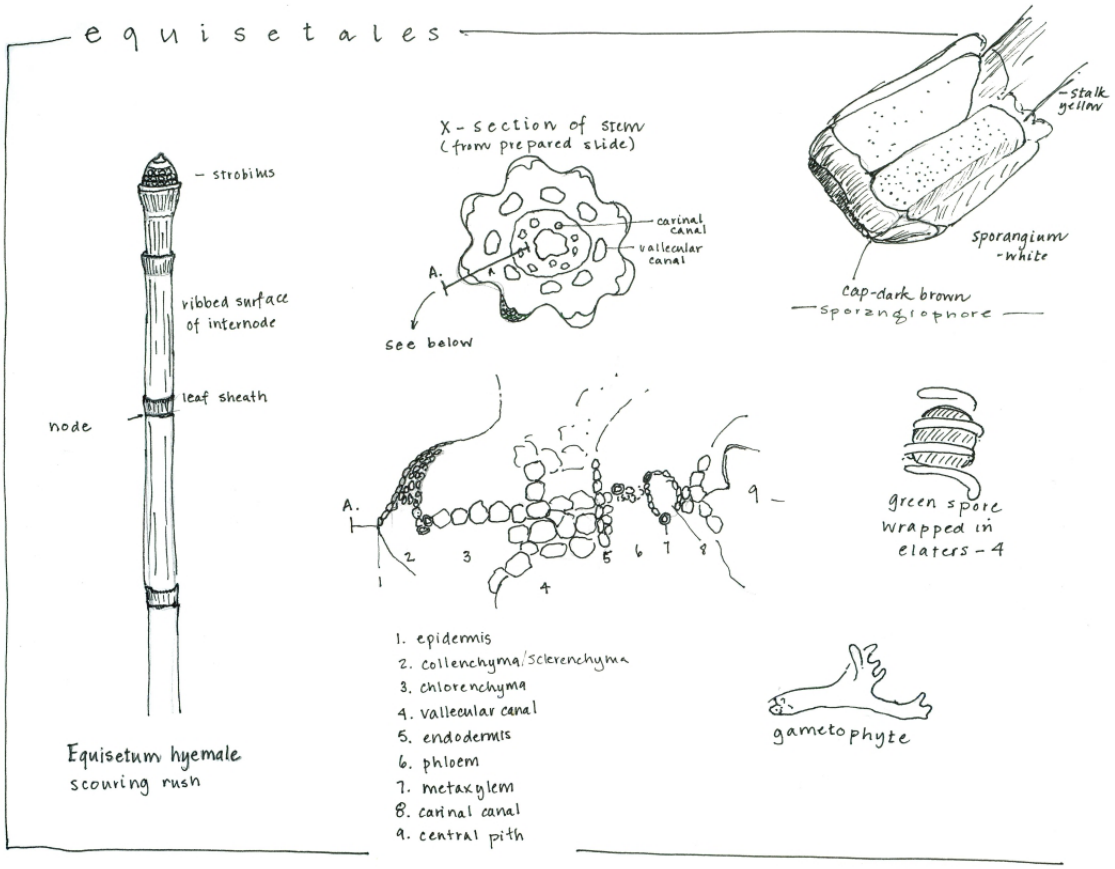

Figure 1. Example illustrated learning journal page provided to students as part of explanation of assignment. Drawn by Lyn Baldwin.

Baldwin, L., and I. Crawford.[Internet].2012. Does the science of botany need art? Does art need the science of botany? *CBA/ABC Bulletin*: 45(1): 10-13. [cited 2013 January 24]. Available from: **http://www.tru.ca/__shared/assets/Botany_and_Art26017.pdf**.

Baldwin, L., 2012 BIOL 2280 *Evolution and Ecology of Land Plants Lab Manual*. Lab 1. Pages 1- 12. Thompson Rivers University.

Bredekamp, H. 2000. Gazing hands and blind spots: Galileo as draftsman. *Science in Context* 13 (3/4): 423–462.

Paris, S.G., and P. Winograd. 1990. How metacognition can promote academic learning and instruction. Pages 15-51, in Jones, B.F. and Idol, L, Editors. *Dimensions of thinking and cognitive instruction*. Lawrence Erlbraum Associates, Inc: New Jersey.

Snow, C.P. 1993. *The Two Cultures (Canto Classics)*. Cambridge University Press. 181 pages.

Stange, K. 2010. The secret agents of art and science in *21st Biennial Congress of International Association of Empirical Aesthetics*. Dresden, Germany.

Wandersee, J.H., and E. E. Schussler. 1999. Preventing plant blindness. *The American Biology Teacher*. 61(2): 82–86.

Whitely, L. 2008. Science sketched out: Q&A with Terry Rosenberg. *Nature*. 455: 468.

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