HOW THE TEACHING AND PRACTICE OF SCIENTIFIC SKETCHING AFFECTS THE QUALITY OF SCIENTIFIC OBSERVATIONS BY HIGH SCHOOL STUDENTS

by

Willow Georgette Affleck

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of

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in

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DEDICATION

For my students, whose curiosity motivates me every day to be a better teacher.

For my family, who have happily endured oh so many impromptu biology lessons.

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ABSTRACT

Could the teaching and practice of scientific sketching affect the quality of observational data collected by high school students in biology class? This question was investigated by comparing two groups of students. One group was taught about why scientific sketching is important and how to make a complete sketch. They were given time to practice their skills and direct teacher feedback after each session on how to improve their sketches. The other group of students did not receive any teacher instruction nor time to practice sketching. Through qualitative interviews and quantitative worksheets, both groups of students were evaluated on their attitudes about sketching and biology, as well as on their abilities to make qualitative observations. The data collected both before and after the scientific sketching lessons showed that not only did the treatment group's attitudes and qualitative observation skills improve post-instruction, but that attitudes and skills of the nontreatment group decreased. The conclusion was reached that scientific sketching is a useful tool in increasing student enjoyment in biology and in developing their abilities to make robust qualitative observations.

CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

Hellgate High School is a four-year, urban school located in Missoula, Montana. With just over 1,200 students attending, the culture of this school is quite diverse. The population of minority students is small but the economic diversity is quite large. Students enroll from six disparate middle schools and many different localities, including ranching communities, suburban areas, and downtown neighborhoods. There is also a diversity in academic abilities within the school. Students range in ability from reading at an elementary level to taking undergraduate classes at the nearby university (Missoula County Public Schools, 2020).

Biology class is the last required science course for students at our school. Some of the students are keen to take more science classes after biology but most are interested in moving on to pursue other academic avenues. However, there is one commonality to both groups, they both struggle with making robust qualitative observations. Rarely are younger students taught the value of qualitative observations or even how to make such observations. The ability to make high caliber qualitative observations is a skill that will not only benefit the students who choose to continue studying science but all students by increasing their environmental perception.

To improve students' abilities to make astute qualitative observations, I have begun to teach a unit on scientific sketching, which is defined by the California Academy of Sciences (2015) as a sketch to record information, not necessarily to make art, that includes labels, notes, diagrams, questions, and explanations. To record their observations, students may use pencils, pencil crayons, rulers, and magnifying glasses. Many students feel intimidated by sketching and

are concerned that a perceived lack of artistic ability will negatively affect their grade in biology class. However, with detailed lectures on how to go about sketching in science and with much time dedicated to its practice, students begin to enjoy the process. They are often surprised with how engaging the activity is and by how much more detail they then observe.

Focus Question

To gain a deeper understanding of whether scientific sketching affects a student's ability to make higher caliber qualitative observations, a research protocol of mixed methods, including both qualitative interviews and quantitative surveys and worksheets was designed.

My focus question was, Does the teaching and practice of scientific sketching affect the quality of scientific observations by high school students?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

The Importance of Sketching

In the past twenty years, the importance of sketching in biology class has gained increasing recognition. As Dempsey and Betz (2001) stated, "Biology, the study of life, requires careful observation and description. One excellent way to describe an object is to draw it" (p. 271). Recent studies have suggested that drawing should be included as a foundational component of science education because it helps students to build the perceptive skills necessary to become stronger learners through observing (Ainsworth et al., 2011; Baldwin & Crawford, 2010). Sketching improves a student's ability to concentrate and helps them become better observers (Ainsworth et al., 2011; Bensusen, 2020; Dempsey & Betz, 2001).

Scientific Observations are Not Intuitive

Observing is often thought to be an intuitive skill and so students are rarely taught how to make high quality scientific observations (Eberbach & Crowley, 2009). As Gainer and Child (1986) noted, "Scientific illustration is a broad area that has been neglected, particularly in the secondary schools" (p. 19). Students struggle in making high caliber observations because they have not been taught how to make complete and accurate sketches (Arias & Davis, 2016). They often record inferences instead of observations, and they sometimes neglect to note details they think of as obvious to their audience (Arias & Davis, 2016; Eberbach & Crowley, 2009). Biology teachers need to spend more time instructing students in how to observe and record nature through sketching (Dempsey & Betz, 2001).

Sketching Their Observations

When students are sketching, they are more engaged with their specimen and start to see the small details within the larger picture (Baxter & Banko, 2018). As the California Academy of Sciences (2015) counsels, "You don't have to be an artist to create a successful scientific sketch. You simply have to take time, observe closely, and record what you see." The color, shape, form, and texture all need to be studied carefully and then committed to paper (Gainer & Child, 1986). The California Academy of Sciences recommends to think of the pneumonic ABCDE while sketching. It reminds students to keep their sketches as (a) accurate as possible, to make the sketching (b) big to include all of the attributes, to use (c) color as a way of recording information, to pay careful attention to the (d) details, and to record word thoughts as a supplementary way to (e) explain some of their difficult-to-sketch observations.

High Quality Observations

It has long been recognized that sketching is an excellent strategy for teaching observational skills (Dempsey & Betz, 2001). As Baldwin and Crawford (2010) stated, "Good observations are often fundamental to good science, and drawing has long been recognized as a tool to develop students' observation skills" (p. 26). The practice of scientific sketching teaches students how to make high caliber qualitative observations (Arias & Davis, 2016). Gagnier et al. (2017) noted that scientists often record their data through sketching and that this act invariably leads to better qualitative observational skills because of the need to record a detailed representation.

Observational Skills are Integral to Science

Sketching has been shown to clarify thinking and to help build the ability to make high quality observations (Baxter & Banko, 2018). Those observations are a critical component of scientific inquiry (Baldwin & Crawford, 2010). Ainsworth et al. (2011) advocated for challenging science learners to sketch because those observational skills are integral to scientific thinking. As Eberbach and Crowley (2009) noted, "Reliable data—whether collected in the field or laboratory—depend upon skilled observation to ensure the collection and accurate documentation of critical evidence" (p. 39). Students who are taught how to sketch, develop higher-level thinking skills and develop a sense of relationship with the natural world (Eberbach & Crowley, 2009; Gainer & Child, 1986).

CHAPTER THREE

METHODOLOGY

Demographics

The purpose of this study was to evaluate if the teaching of scientific sketching in a sophomore level biology class would result in more robust qualitative data collected by students. Specifically, the research question investigated was "Does the teaching and practice of scientific sketching affect the quality of scientific observations by high school students?" To this end, two comparable groups of students were studied. One was taught about scientific sketching and was given time to practice with direct teacher feedback. The other group did not receive any teacher instruction nor time to sketch. The ability to make qualitative observations was assessed before and after the sketching instruction, or lack thereof, through qualitative interviews and quantitative surveys and worksheets to see if any improvement was made over time.

For this study, two similar groups of students were selected. The first group included 23 students with a class grade average of 86%. Only one of the students required learning accommodations, as specified by their Individualized Education Plan (IEP). The second group included 25 students with a class grade average of 84%. Three students within that group required learning accommodations, as specified by their IEPs. Motivation of the students to participate in class seemed quite high, as the homework completion rate for the first group was 93% and for the second group was 95%. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained (Appendix A).

Treatment

To test if the practice of scientific sketching improved the robustness of qualitative observations, the two groups of students received different treatments. The sketching group followed a five-step research plan, whereas the non-sketching group participated only in steps one and five (Figure 1). After the pre-treatment assessments, the sketching group started with direct teacher instruction on how to scientifically sketch. They received a 20-minute lecture that discussed why scientific sketching is important, including how it is an important tool for collecting qualitative data and how, with practice, it increases a person's ability to make high quality, detailed observations. The lecture also featured the aspects that are included in a high-quality scientific sketch, based on the Introduction to Scientific Sketching slideshow by the California Academy of Sciences (2015) (Figure 2).

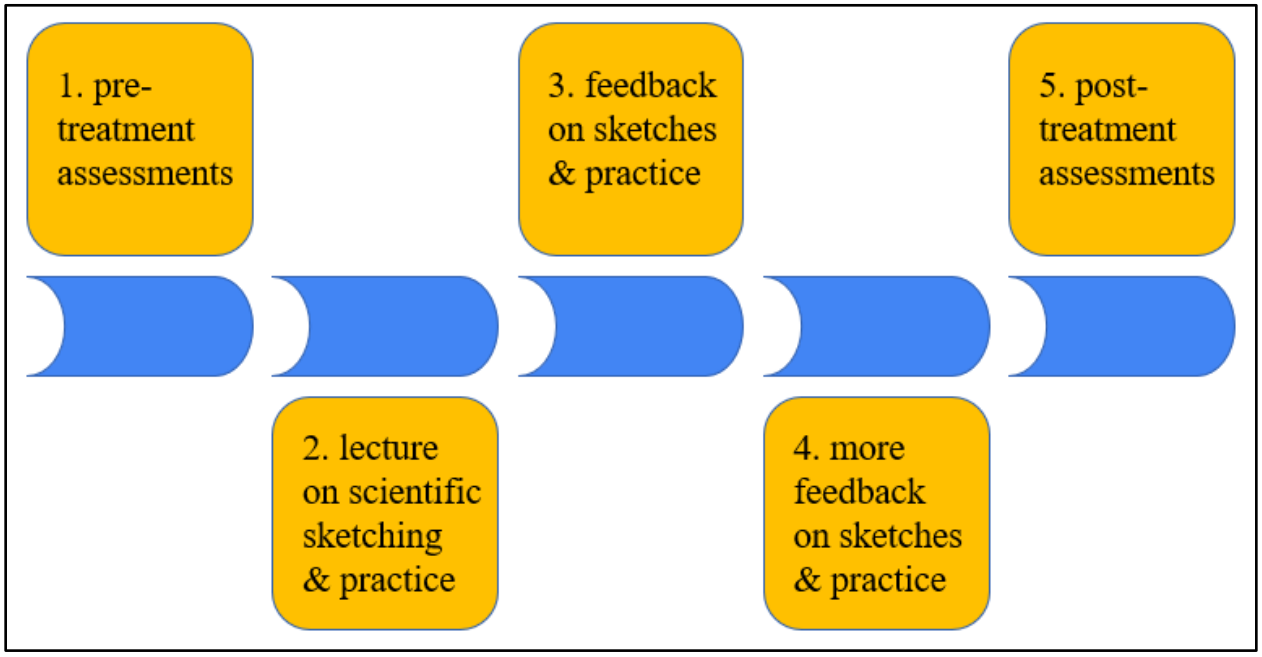


Figure 1. The five-step research plan followed by the sketching group.

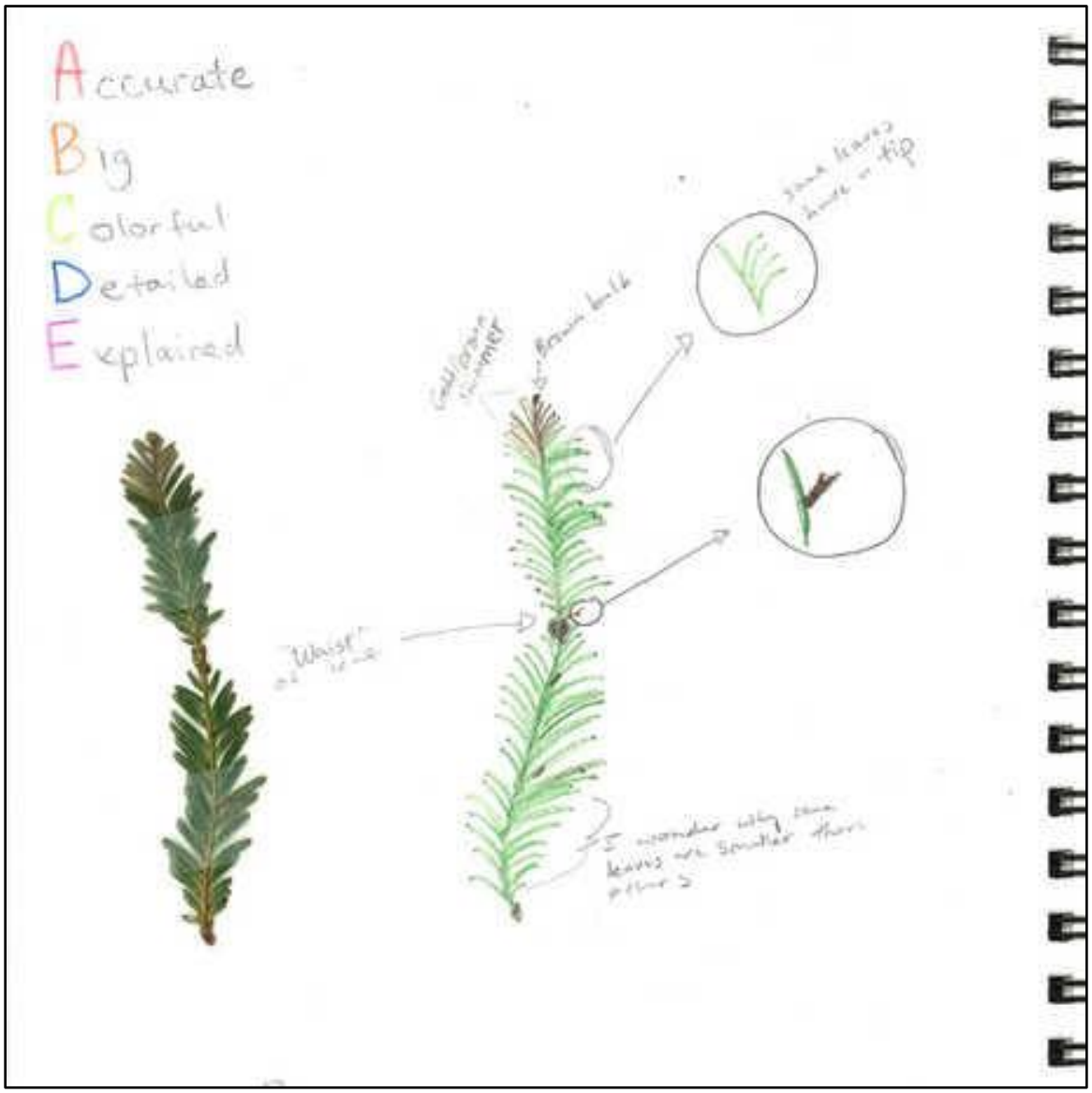


Figure 2. Example of the sketching details in the Introduction to Scientific Sketching slideshow (California Academy of Sciences, 2015).

After the lecture, the students had 30 minutes to complete a sketch of a leaf of one of our classroom plants (*Oxalis regnellii*). The 30-minute time line was given due to the class period being 50 minutes long. The students were instructed to focus on recording identifying details of their leaf, as the teacher would use those details to try to identify their specific leaf (Figure 3).

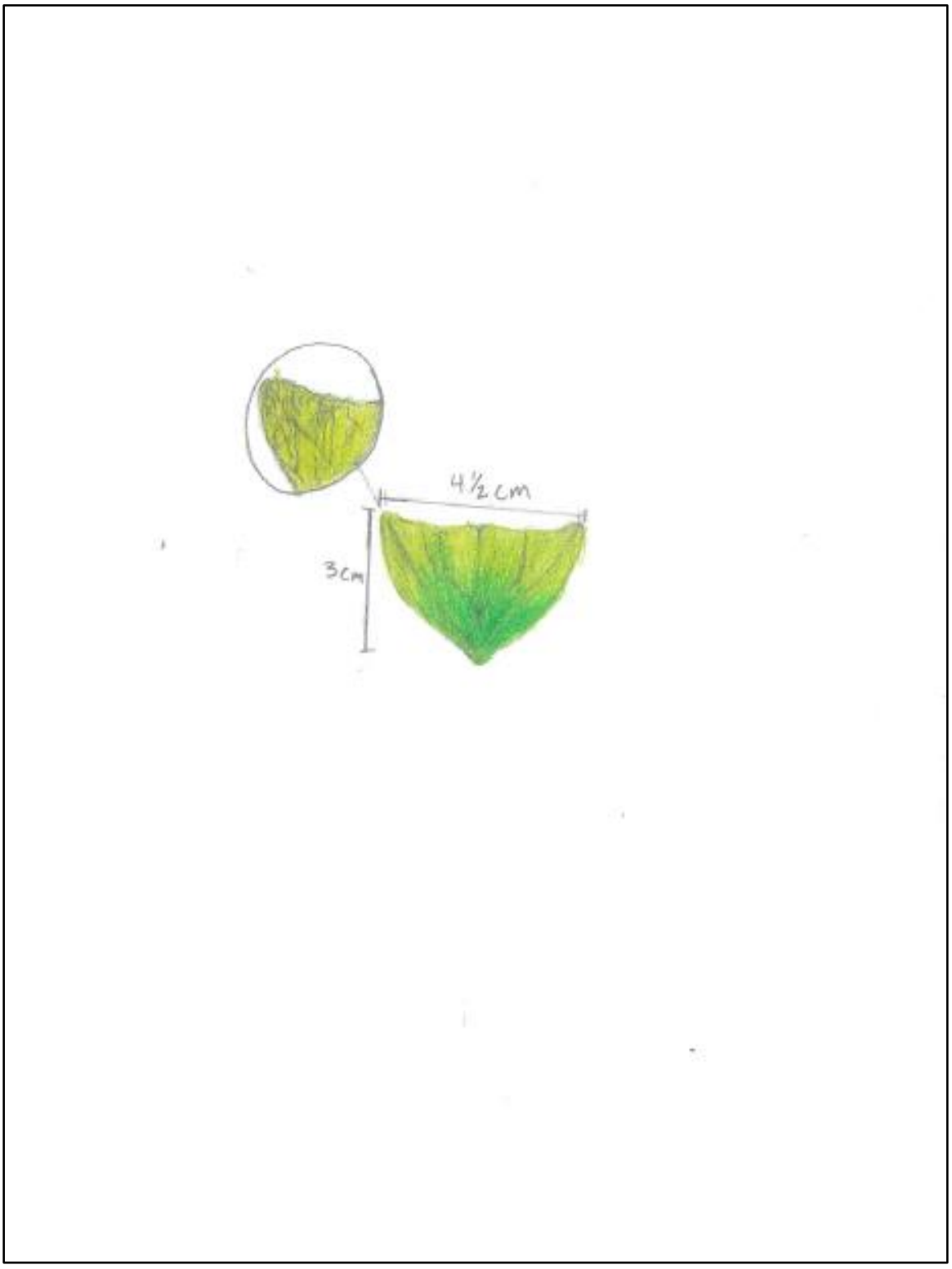


Figure 3. An example of an *Oxalis regnellii* leaf sketched by a student in the treatment group.

The next day, the students were given direct teacher feedback about what was done well and what could be improved for collecting qualitative data within their sketches. The students were then given 40-minutes to incorporate that feedback into another scientific sketch. This time they were presented with cones of eight different species of local conifers from which to choose (*Pinus ponderosa*, *Pinus contorta*, *Pinus aristata*, *Pinus strobus*, *Thuja plicata*, *Larix occidentalis*, *Pseudotsuga menziesii*, and *Picea abies*). The students were instructed to record as many identifying details as possible about their cone so that their teacher could identify which species they had chosen (Figure 4).

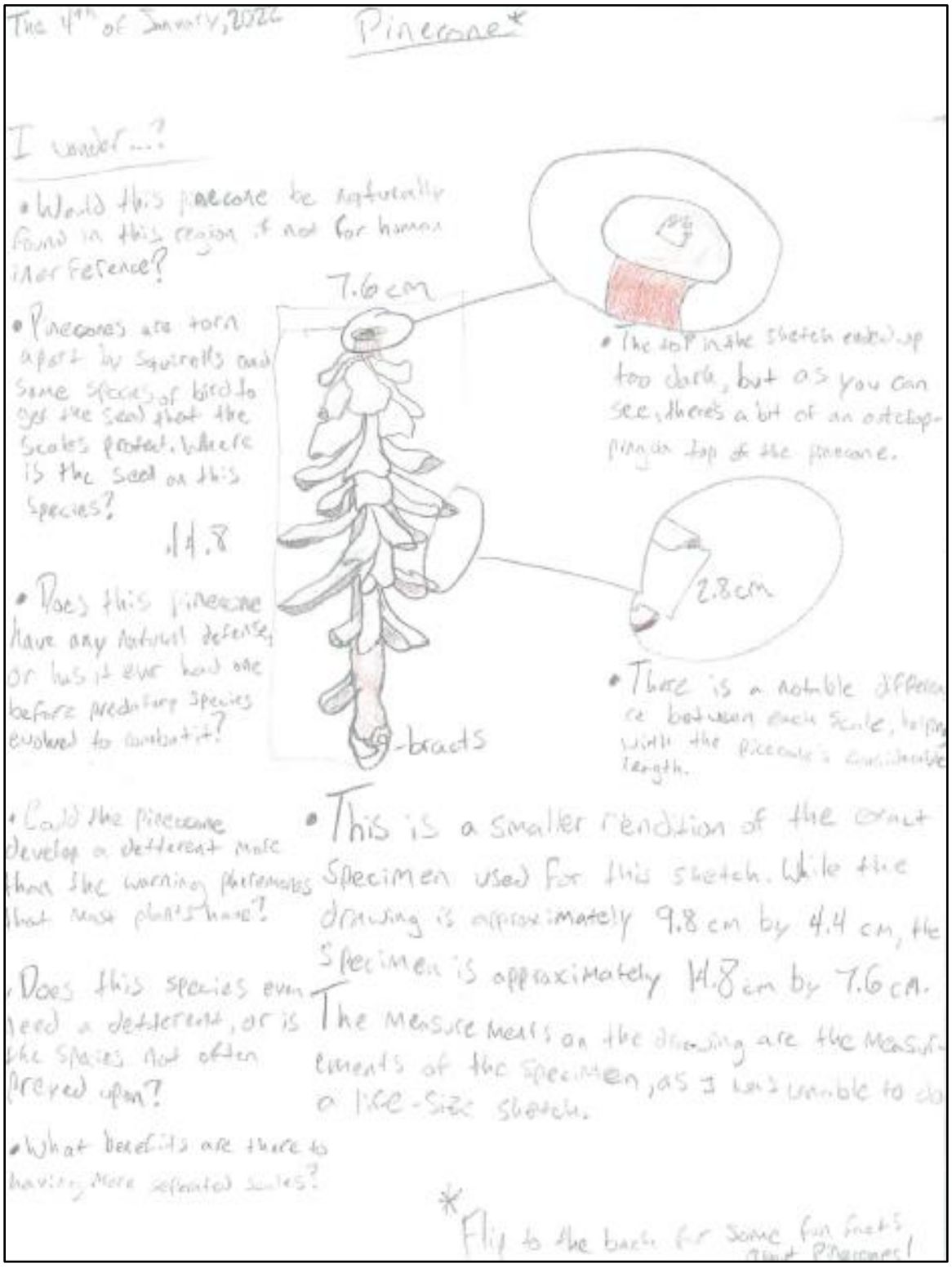


Figure 4. An example of a cone sketched by the same student in the treatment group.

The following day, they were given direct teacher feedback about what was done well in their sketches and what could be improved. The students were then given 50 minutes to sketch a cone from *Pinus strobus*. They were instructed to record enough identifying details so that the teacher could identify their specific cone (Figure 5).

As a non-treatment group, the other class of students were given no instruction about scientific sketching and no time to practice sketching, either. To ensure fairness, it was decided that if the treatment was observed to have a positive effect, then it would be later applied to the non-treatment group.

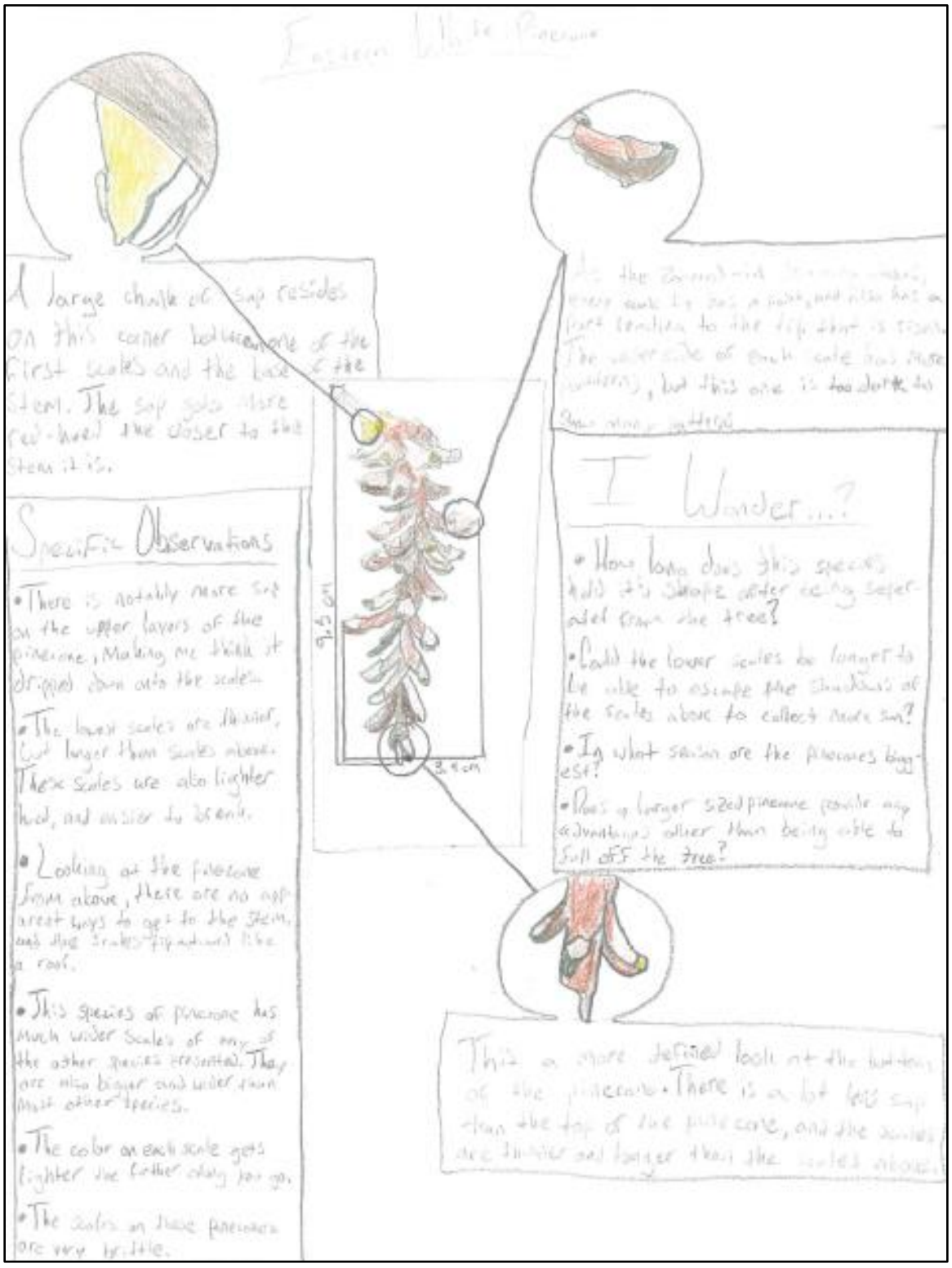


Figure 5. An example of a sketch of *Pinus strobus* by the same student in the treatment group.

Data Collection and Analysis Strategies

Before and after the sketching classes, the students from both groups were asked to complete the Qualitative Data Collection Survey to assess if they had any awareness of the concepts of qualitative observations and scientific sketching (Appendix B). The survey was looking to evaluate students' cognizance of the utility of qualitative observations, the role of art in science, and the value of scientific sketching. The questions were posed as open-ended inquiries and included, Is there any utility in qualitative observations? Explain; Is there any role for art in science? Explain; and Can anything be gained by scientific sketching? Explain. The proportion of how many students responded I Don't Know, No, and Yes to each question was calculated and compared for pre- and post-treatment, or lack thereof, for both the sketching and the non-sketching group.

Before and after the sketching classes, the students from both groups were also asked about their opinions on sketching and biology. The Student Opinion Regarding Sketching and Biology Questionnaire asked students to rate several statements on a scale of Strongly Disagree, Disagree, Agree, and Strongly Agree (Appendix C). The questionnaire was looking to assess student thoughts on their appreciation of art and biology, and to see if there was awareness of the overlap of similar skill sets that are necessary in both subjects. Those questions included I like to draw; I am good at capturing detail in sketches; I like biology; I am good at observing details; and I have been taught how to make scientifically accurate sketches. The proportion of how many students responded Strongly Disagree, Disagree, Agree, and Strongly Agree to each question was calculated and compared for pre- and post-treatment, or lack thereof, for both the sketching and the non-sketching group.

Before the sketching lessons began, it was also important to assess the innate ability of the students to make qualitative observations. The Oak Leaf Qualitative Observations Worksheet was looking to assess how many descriptors students would record about the different parts of a leaf (Appendix D). The students were asked to Describe the leaf edge; Describe the leaf veins; Describe the leaf stem; and Describe the leaf color. After the final sketching lesson, the ability of the students to make qualitative observations was again assessed, this time with the Linden Leaf Qualitative Observations Worksheet (Appendix F). To assess change in the ability of the students to make qualitative observations, the change in number of descriptors recorded for each leaf part was compared between pre- and post-treatment, or lack thereof, for both the sketching and the non-sketching group.

During the last sketching lesson, students were engaged in a formative style interview. While they were working on their last sketch, they were asked to participate in the Thoughts on Science and Sketching interview (Appendix E). This interview was conversational in nature and gathered unguarded thoughts from students in the class about scientific sketching. The interview followed their train of thought and all of their ideas were recorded.

All three sketches from each student were collected and studied to look for general improvement in scientific sketching skills. The amount of identifying details recorded in each of the three sketches was noted to look for an increase in qualitative observations from the first sketch to the last. The mean and median of identifying details was calculated.

A triangulation matrix table was completed to show how each data collection instrument contributed to answering the research question, “Does the teaching and practice of scientific sketching affect the quality of scientific observations by high school students?” (Table 1).

Table 1. Data Triangulation Matrix.

Research Question	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5
Does the teaching and practice of scientific sketching affect the quality of scientific observations by high school students?	Qualitative Data Collection Survey	Student Opinion Regarding Sketching and Biology Questionnaire	Oak Leaf Qualitative Observations Worksheet	Thoughts on Science and Sketching	Linden Leaf Qualitative Observations Worksheet

CHAPTER FOUR

DATA ANALYSIS

Change in Qualitative Data Collection Survey

The results of the Qualitative Data Collection Survey pre- and post-treatment show that the treatment group had a greater appreciation for the role of art and scientific sketching in science. As to whether there was utility in qualitative observations, the number of students agreeing in the sketching group increased from 59% to 89%. One student said, “Yes. Attention to detail is a vital skill when making scientific observations.” The non-sketching group had the same number of students agreeing (79%) pre- and post-treatment. As for the role of art in science, the sketching and non-sketching groups had similar levels of agreement post-treatment, with the sketching group increasing from 88% to 94% and the non-sketching group decreasing from 100% to 93%. One student from the sketching group said, “Yes, it can help one study what they are drawing and notice more about it.” In the post-treatment evaluation, 100% of the sketching group agreed (an increase of 12%) that something can be gained by scientific sketching in science, whereas only 93% (a decrease of 7%) of the non-sketching group agreed with this statement. One student from the sketching group said, “Yes, details in color, shape, size and more can be noticed and then drawn. More observation skills are gained.” Finally, none of the students answered No for any of the survey questions (Figure 6).

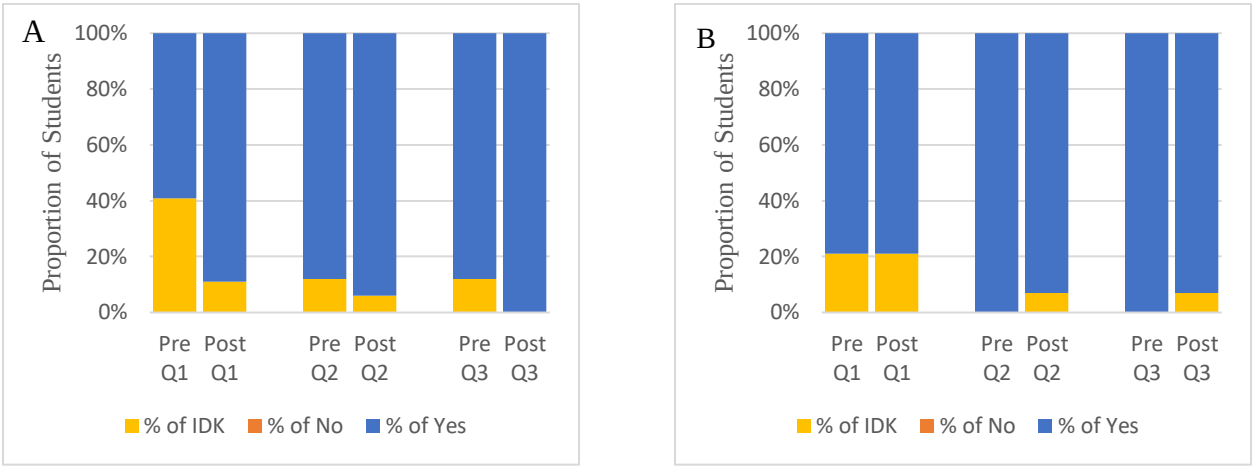


Figure 6. Change in Qualitative Data Collection Survey results for the sketching group (A), (*N*=18), and for the non-sketching group (B), (*N*=14). *Note*. Q1=Is there any utility in qualitative observations; Q2=Is there any role for art in science; Q3=Can anything be gained by scientific sketching in science.

Change in Student Opinion Regarding Sketching and Biology Questionnaire

Change was also reflected in the pre- and post-treatment Student Opinion Regarding Sketching and Biology Questionnaire. For the first statement, I like to draw, the sketching group increased 5%, from 80% to 85%, in the agree/strongly agree categories, whereas the non-sketching group decreased 5%, from 82% to 77%. For the second statement, I am good at capturing details in sketches, the sketching group increased 22% in the agree/strongly agree categories, from 40% to 62%, while the non-sketching group only increased 12%, from 66% to 78%. The third statement, I like biology, saw a similar increase in the agree/strongly agree categories for both groups; the sketching group increased 11%, from 60% to 71%, and the non-sketching group increased 14%, from 70% to 84%. For the fourth statement, I am good at observing details, the sketching group increased 5% in the agree/strongly agree categories, while the non-sketching group decreased 7%, from 91% to 84%. For the last statement, I have been taught how to make scientifically accurate sketches, the sketching group increased 25% in the

agree/strongly agree categories, from 75% to 100%, while the non-sketching group increased 33%, from 61% to 94% (Figure 7).

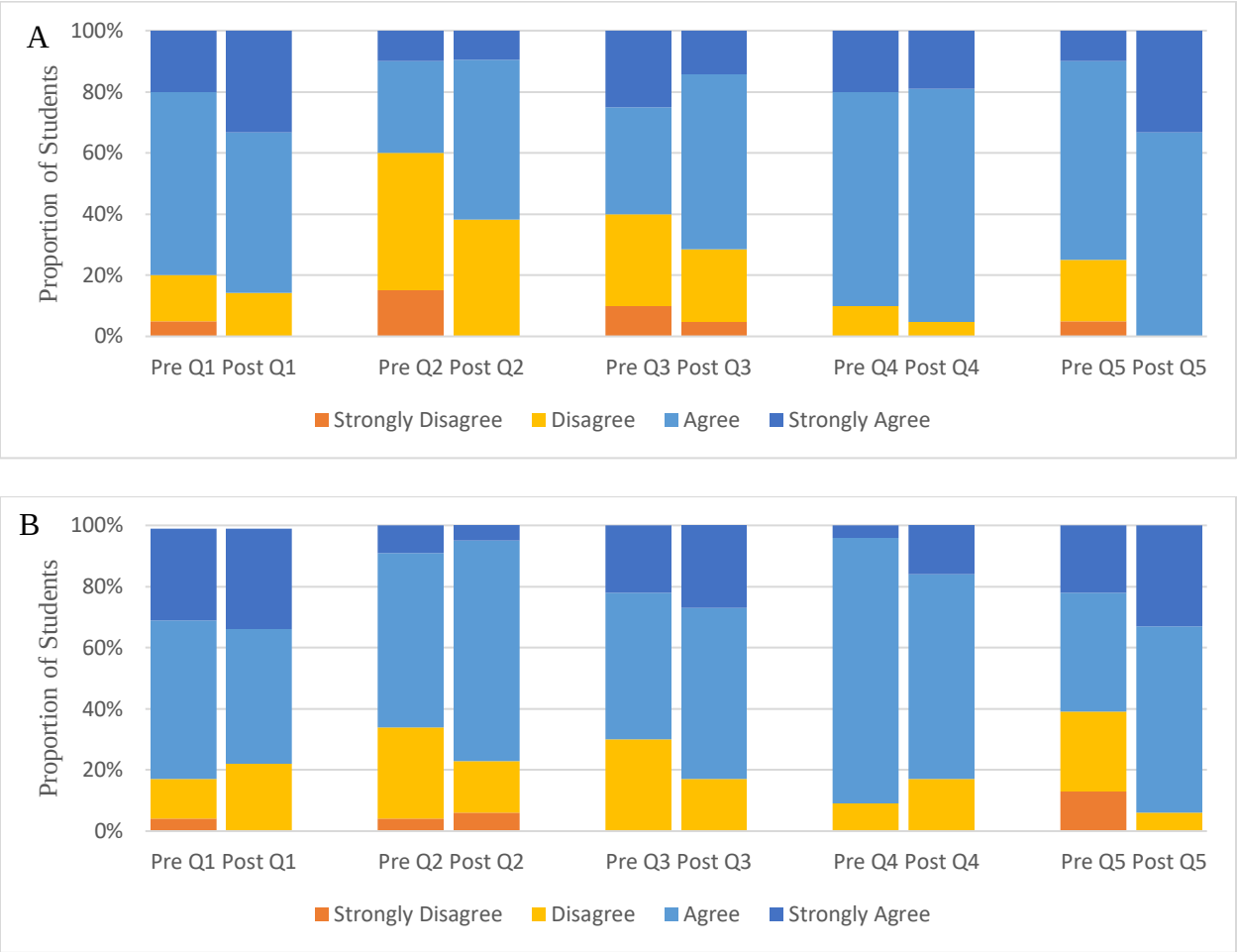


Figure 7. Change in Student Opinion Regarding Sketching and Biology Questionnaire for the sketching group (A), (*N*=21), and the non-sketching group (B), (*N*=18). Note. Q1=I like to draw; Q2=I am good at capturing detail in sketches; Q3=I like biology; Q4=I am good at observing details; Q5=I have been taught how to make scientifically accurate sketches.

Scientific Sketching Data Collection

The results of the three scientific sketches completed by the sketching group participants indicated that the number of identifying details increased with each successive sketching session. The first sketch had a mean of 10 identifying details recorded about their specimens, while the

second sketch had 11, and the third sketch had 14. One student said, “It’s important to know how to capture details. It’s a singular focus that helps you pick up on details. It makes you more in-tune with your subject. It helps in developing of the skill of capturing details but not just in drawing.” The median of identifying details also showed an overall increasing trend. The first sketch had a median of 11, the second sketch dipped slightly to 10 but then increased to 14 for the third sketch. Another student said, “It requires me to practice a skill that I don’t. It requires me to look at an object I normally wouldn’t and really understand it” (Figure 8).

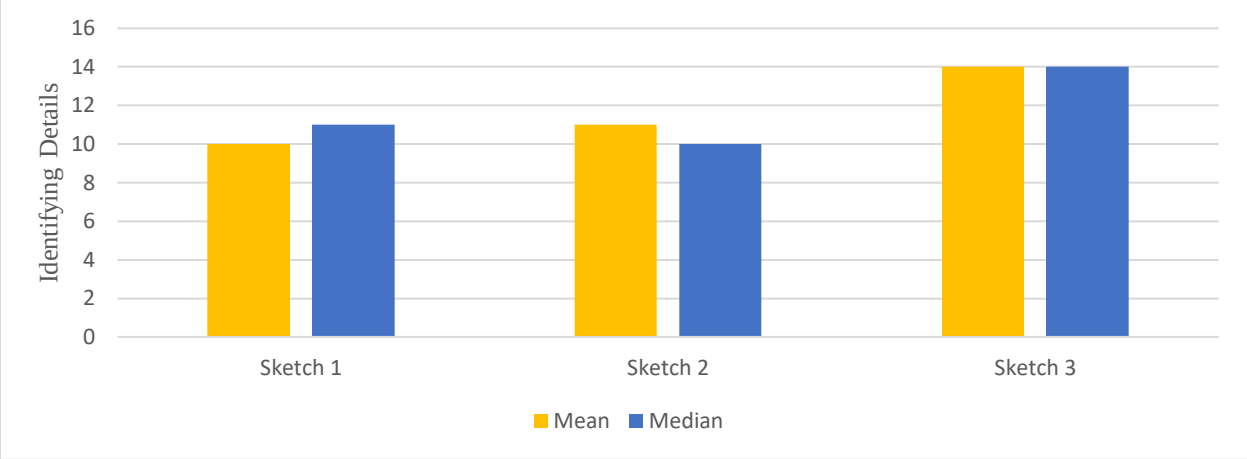


Figure 8. The number of identifying details recorded in the three scientific sketches, (*N*=12).

An example of the first scientific sketch, of an *Oxalis regnellii* leaf, completed by a student in the treatment group can be seen in Figure 9. An example of the second scientific sketch, of a *Pinus ponderosa* cone, completed by the same student in the treatment group can be seen in Figure 10. An example of the third scientific sketch, of a *Pinus strobus* cone, completed by the same student in the treatment group can be seen in Figure 11.

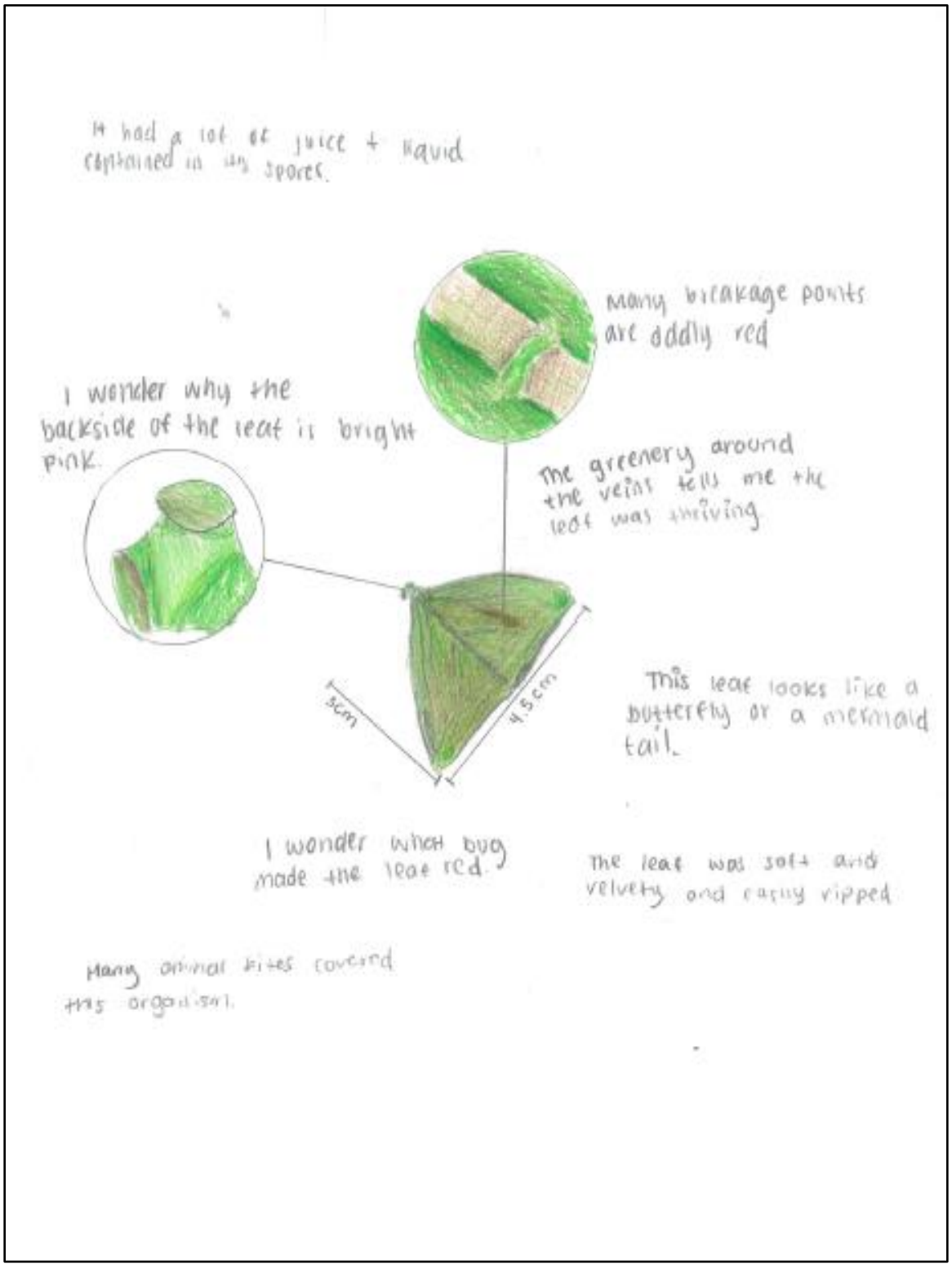


Figure 9. The first scientific sketch of a student in the treatment group.

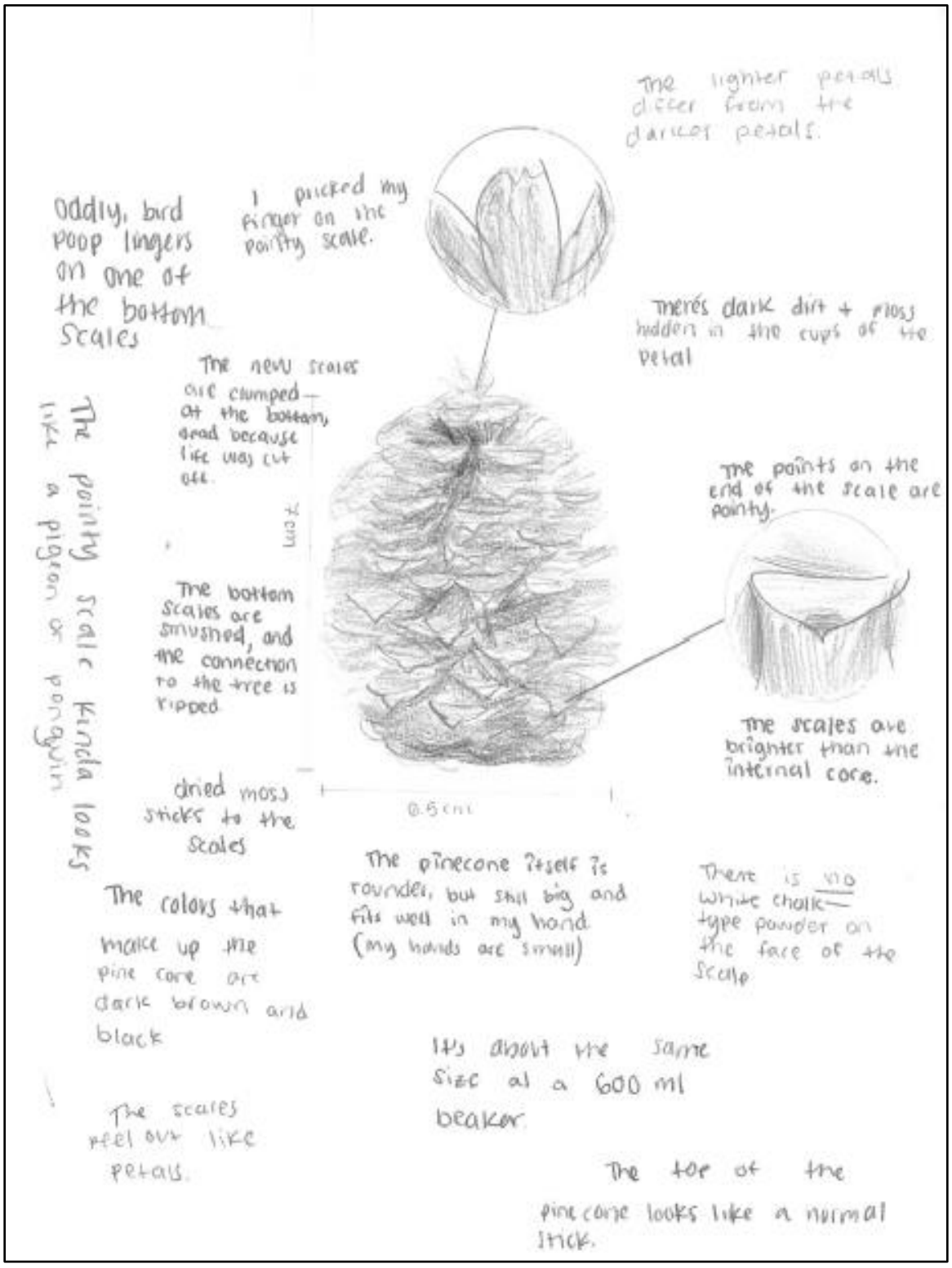


Figure 10. The second scientific sketch from the same student of the treatment group showing more identifying details recorded.

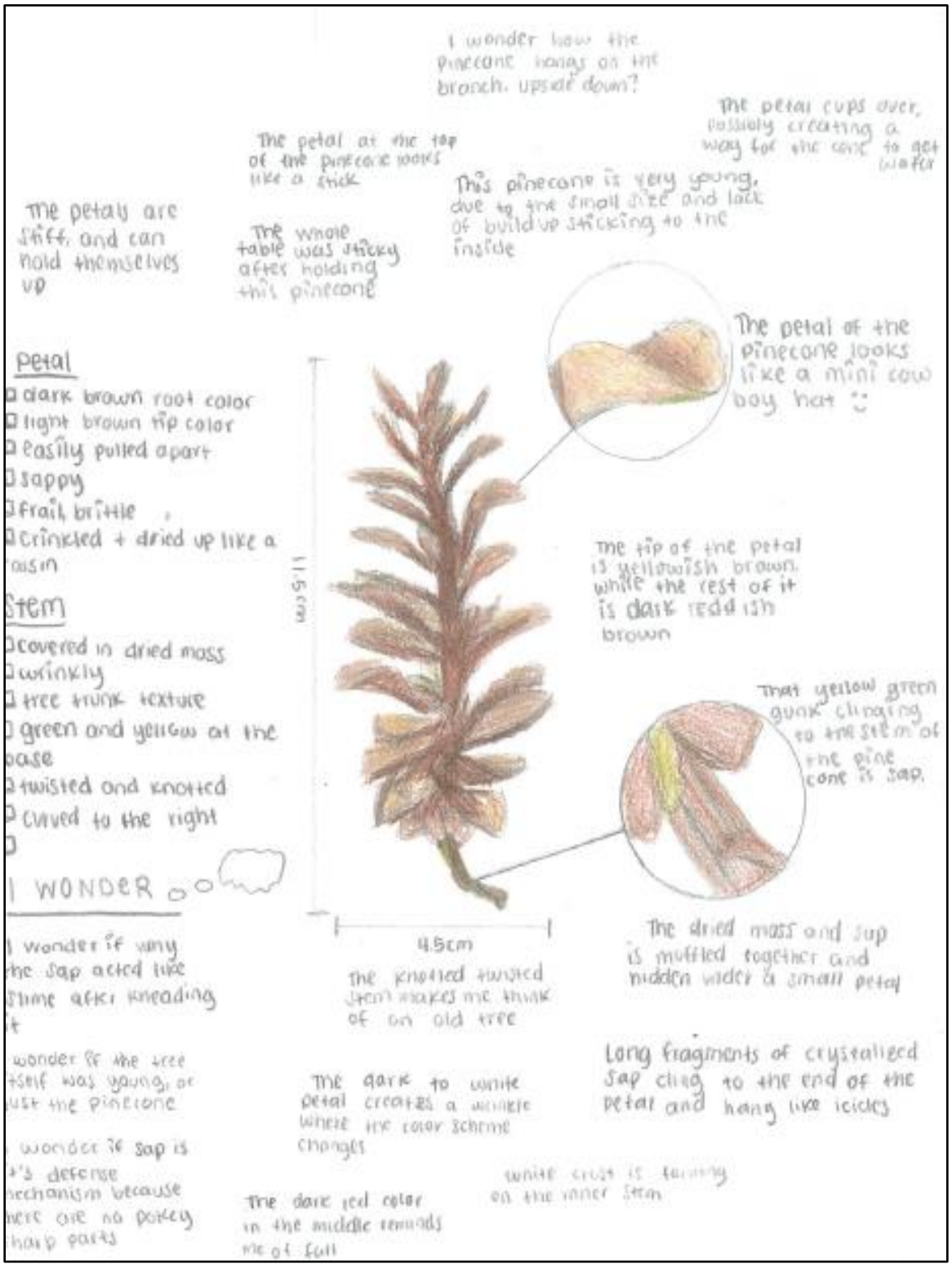


Figure 11. The third scientific sketch from the same student of the treatment group showing even more identifying details recorded.

Change in Qualitative Observations Worksheet (Oak Leaf vs. Linden Leaf)

There were some interesting differences between the pre-treatment Oak Leaf Qualitative Observations Worksheet and the post-treatment Linden Leaf Qualitative Observations Worksheet. They indicated that the sketching group increased one descriptor per question on average, whereas the non-sketching group had an average decrease of 0.4 descriptors per question (Figure 12).

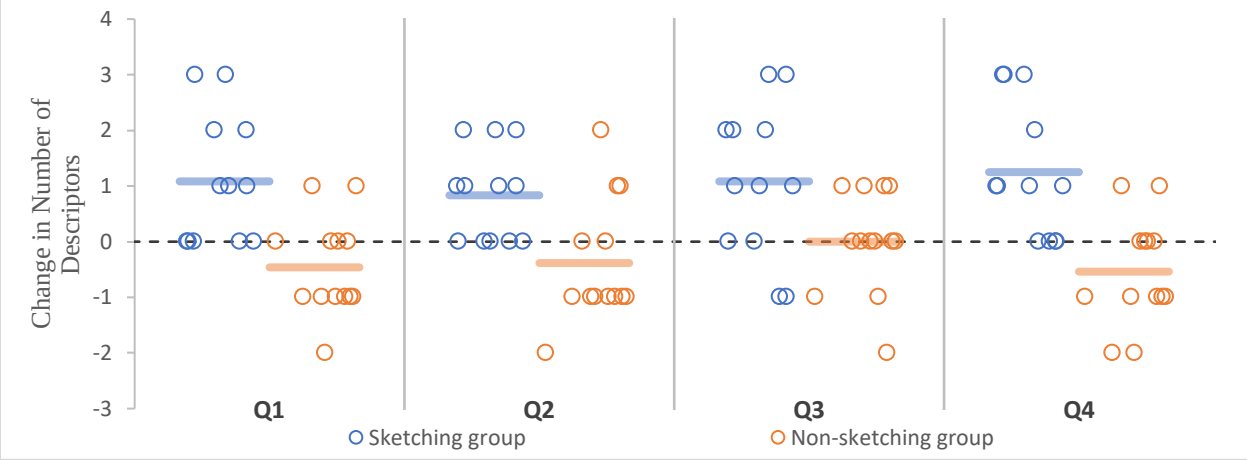


Figure 12. Change in number of descriptors between the Oak Leaf Qualitative Observations Worksheet and the Linden Leaf Qualitative Observations Worksheet, (*N*=12). Note. 1=Describe the leaf edge; 2=Describe the leaf veins; 3=Describe the leaf stem; 4=Describe the leaf color.

An example of the observations recorded on the Oak Leaf Qualitative Observations Worksheet by a student in the treatment group can be seen in Figure 13. An example of the observations later recorded on the Linden Leaf Qualitative Observations Worksheet by the same student in the treatment group can be seen in Figure 14.

OAK LEAF QUALITATIVE OBSERVATIONS WORKSHEET

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with detailed responses.

(© Domnitsky, 2021)

1. Describe the leaf edge.

It looks like a scribble

2. Describe the leaf veins.

they are brigth & yellow & run throughout everywhere

3. Describe the leaf stem.

It is short & green and has possibly been picked from a tree

4. Describe the leaf color.

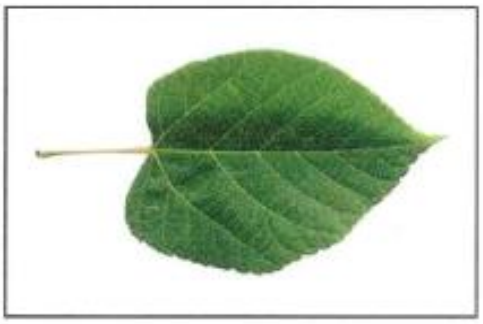
bright green

Figure 13. An Oak Leaf Qualitative Observations Worksheet from a student within the treatment group.

LINDEN LEAF QUALITATIVE OBSERVATIONS WORKSHEET

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with detailed responses.



(© Stieber, 2021)

1. Describe the leaf edge.

It is ragged, rounded at some areas & pointy at others
it's not bitten by any bugs or animals, not ripped

2. Describe the leaf veins.

light green color
carefully, symmetrically placed, until the tiny veins come in

3. Describe the leaf stem.

half an inch maybe
yellow black/brown at the end
has a ladie type shape at the end

4. Describe the leaf color.

Dark green on the outer and lighter green towards the middle
yellow on the rip

CHAPTER FIVE

EVIDENCE, CLAIMS, REASONING

Claims From the Study

Unfortunately, this data collection occurred during the height of the COVID-19 Omicron infection in our community. Our school district was committed to continuing in-person instruction, which was highly valued by our families but led to a high student absentee rate. This affected the data collected for this research project, such as sample sizes being lower than class sizes.

Looking closely at the change in how the students thought about sketching and biology revealed an interesting trend. The treatment group recorded a greater appreciation post-treatment for the role of scientific sketching in science. The results indicated that those students developed a better understanding that qualitative observations are important data, lending to a fuller picture of an event or system. They also observed that scientific sketching helped to build their observational skills, just like Dempsey and Betz (2001) observed.

Another trend noted was that the treatment also led to a more favorable opinion of drawing and biology. The students recorded an increase in self-confidence in both being able to observe and to capture details, like Baldwin and Crawford (2010) had discovered. The students also noted that after the treatment they felt they were better prepared to capture those details within a scientific sketch.

This all culminated in some revealing pre- and post-test data. The treatment group, on average, increased their qualitative observations by one descriptor per leaf part. This indicates that the students made improvements in their ability to record qualitative observations which is

similar to the observations made by Baxter and Banko (2018) and Gagnier et al. (2017). The non-treatment group, however, had an average decrease of 0.4 descriptors per leaf part, showing a slight decrease in their abilities over time to make qualitative observations. After the data collection was complete, the non-treatment group was taught the scientific sketching lessons that the treatment group received.

Impact of Action Research on the Author

While the treatment group's results were expected, it was not expected that the students in the non-treatment group would decrease in their enjoyment in drawing and in ability to make qualitative observations. In the years to come, I will begin with lessons on scientific sketching as an introduction to the joys of biology and the process of collecting qualitative observations, and will continue these lessons throughout the year. This research has also confirmed that I can trust my professional instincts and adjust curriculum and teaching methods when it seems necessary.

Finally, the past two years have been some of the most difficult in public education. The result of dealing with the deadliest pandemic in the past 100 years has been emotionally crushing. As we begin to return to pre-pandemic educational practices, our students are unprepared for academic rigor and are struggling emotionally. The mental health of our students needs to be a serious consideration for all teachers.

This research project started in pre-pandemic time and was based on a simple observation about a phenomenon in a single classroom. Post-pandemic however, this research has gained more significance. Now, more than ever, it is imperative that teachers find a way to engage our students in the joy of learning and, it appears, scientific sketching may be one such method.

REFERENCES CITED

Ainsworth, S., Prain, V., & Tytler, R. (2011). Drawing to learn in science. *Science (American Association for the Advancement of Science), 333*(6046), 1096-1097.

Arias, A. M. & Davis, E. A. (2016). Making and recording observations: When done well, observations can serve as evidence when engaging in science practices. *Science and Children, 53*(8), 54-60.

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

Baxter, J. & Banko, W. (2018). Drawing for meaning: Students develop three-dimensional skills through scientific drawings. *Science and Children, 55*(6), 80-85.

Bensusen, S. J. (2020). The power of observation. *Science and Children, 57*(5), 60-65.

California Academy of Sciences. (2015). Introduction to scientific sketching. *California Academy of Sciences*. https://www.calacademy.org/educators/lesson-plans/introduction-to-scientific-sketching.

Dempsey, B. C. & Betz, B. J. (2001). Biological drawing a scientific tool for learning. *The American Biology Teacher, 63*(4), 271-281.

Domnitsky, D. (2021). Oak tree leaf isolated on white background. *Dreamstime.com*. https://www.dreamstime.com/oak-tree-leaf-isolated-white-background-image176522199

Eberbach, C. & Crowley, K. (2009). From everyday to scientific observation: How children learn to observe the biologist's world. *Review of Educational Research, 79*(1), 39-68.

Gagnier, K. M., Atit, K., Ormand, C. J., & Shipley, T. F. (2017). Comprehending 3D diagrams: Sketching to support spatial reasoning. *Topics in Cognitive Science, 9*(4), 883-901.

Gainer, R. S. & Child, J. S. (1986). Scientific illustration for the elementary school. *Art Education (Reston), 39*(6), 19-22.

Missoula County Public Schools. (2020). Hellgate High School. *Hellgate High School.* https://www.mcpsmt.org/Page/9.

Stieber, S. (2021). Linden leaf on white background. *Dreamstime.com*. https://www.dreamstime.com/stock-photography-linden-leaf-white-background-image31819582.

APPENDICES

APPENDIX A

EXEMPTION BY MONTANA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD

MONTANA STATE UNIVERSITY
Request for Designation of Research as Exempt
MSSE Research Projects Only
(6/16/14)

****

THIS AREA IS FOR INSTITUTIONAL REVIEW BOARD USE ONLY. DO NOT WRITE IN THIS AREA.
Confirmation Date: 11/12/21 Mark T. Quinn
Application Number:

****

DATE of SUBMISSION: November 5, 2021

Address each section – do not leave any section blank.

-Okay as exempt
-MSSE Classroom assessment
-Little/no risk
-Principal approved
-No concerns
MQ 11/12/21

I. INVESTIGATOR:

Name: **Willow Affleck**
Home or School Mailing Address: **508 North Avenue East**
Telephone Number: **406-813-1747**
E-Mail Address: **waffleck@hotmail.com**
DATE TRAINING COMPLETED: **February 14, 2021** *[Required training: CITI training; see website for link]*

Investigator Signature Willow Affleck

Name of Project Advisor: **(Carl) John Graves**
E-Mail Address of Project Advisor: **carl.graves@ecat1.montana.edu**

II. TITLE OF RESEARCH PROJECT: **Does the teaching and practicing of scientific sketching increase the quality of scientific observations by high school students?**

III. BRIEF DESCRIPTION OF RESEARCH METHODS (If using a survey/questionnaire, provide a copy).
To test if the practice of scientific sketching improves the robustness of qualitative observations, two groups of equivalent students will receive different treatments. One group will have direct teacher instruction on how to scientifically sketch. They will receive a 20-minute lecture that will include why scientific sketching is important, what is included in a high-quality scientific sketch, and how to make one. This first group will have 30 minutes to complete a sketch and will be then given direct teacher feedback about what was done well and what could be improved. The following day the same students will be given a 10-minute lecture that will highlight the exemplary sketches completed by their classmates the day before and then 40 minutes to complete another scientific sketch. Direct teacher feedback about what was done well and what could be improved will be again given when the sketches are complete. The following day, they will be given 50 minutes to complete a sketch and then again direct teacher feedback. The second group of students will be given no instruction about scientific sketching and no time to practice sketching.

Before the sketching lessons, both groups of students will be asked to fill in the Qualitative Data Collection Survey, the Student Opinion Regarding Sketching and Biology Questionnaire, and the Oak Leaf Qualitative Observations Worksheet. After the sketching lessons, or lack thereof, both groups of students will be asked to complete the Linden Leaf Qualitative Observations Worksheet, the Student Opinion Regarding Sketching and Biology Questionnaire, and the Qualitative Data Collection Survey. All of these worksheets are attached at the end of this document.

APPENDIX B

QUALITATIVE DATA COLLECTION SURVEY

QUALITATIVE DATA COLLECTION SURVEY

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with expanded responses.

1. Is there any utility in qualitative observations? Explain.

2. Is there any role for art in science? Explain.

3. Can anything be gained by scientific sketching in science? Explain.

APPENDIX C

STUDENT OPINION REGARDING SKETCHING AND BIOLOGY QUESTIONNAIRE

STUDENT OPINION REGARDING SKETCHING AND BIOLOGY QUESTIONNAIRE

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with honest responses.

1. I like to draw.

Strongly Disagree Disagree Agree Strongly Agree

2. I am good at capturing detail in sketches.

Strongly Disagree Disagree Agree Strongly Agree

3. I like biology.

Strongly Disagree Disagree Agree Strongly Agree

4. I am good at observing details.

Strongly Disagree Disagree Agree Strongly Agree

5. I have been taught how to make scientifically accurate sketches.

Strongly Disagree Disagree Agree Strongly Agree

APPENDIX D

OAK LEAF QUALITATIVE OBSERVATIONS WORKSHEET

OAK LEAF QUALITATIVE OBSERVATIONS WORKSHEET

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with detailed responses.

(© Domnitsky, 2021)

1. Describe the leaf edge.

2. Describe the leaf veins.

3. Describe the leaf stem.

4. Describe the leaf color.

APPENDIX E

THOUGHTS ON SCIENCE AND SKETCHING

THOUGHTS ON SCIENCE AND SKETCHING

Participation in this research is voluntary & will not affect your standing or grade in any manner.

APPENDIX F

LINDEN LEAF QUALITATIVE OBSERVATIONS WORKSHEET

LINDEN LEAF QUALITATIVE OBSERVATIONS WORKSHEET

Participation in this research is voluntary & will not affect your standing or grade in any manner.

Please answer the following questions with detailed responses.

(© Stieber, 2021)

1. Describe the leaf edge.

2. Describe the leaf veins.

3. Describe the leaf stem.

4. Describe the leaf color.