

THE EFFECTS OF TEACHER COLLABORATION ON STUDENTS'
UNDERSTANDING OF HIGH SCHOOL EARTH SCIENCE CONCEPTS

by

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TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND	1
CONCEPTUAL FRAMEWORK.....	3
METHODOLOGY	8
DATA AND ANALYSIS	19
INTERPRETATION AND CONCLUSION	33
VALUE.....	35
REFERENCES CITED.....	37
APPENDICES	39
APPENDIX A: Nontreatment Activities	40
APPENDIX B: Pre and Postunit Assessment: Nontreatment	46
APPENDIX C: Nontreatment Pre and Postunit Student Concept Interview	48
APPENDIX D: CHS Collaborative Model.....	50
APPENDIX E: Student Questionnaire.....	52
APPENDIX F: Pre and Postunit Assessment: Treatment 1	54
APPENDIX G: Treatment 1: Pre and Post Unit Student Concept Interview	56
APPENDIX H: Treatment 1: Mineral Lab Procedures	58
APPENDIX I: Treatment 1: Mineral Lab Format.....	62
APPENDIX J: Treatment 1: Mineral Lab Rubric	64
APPENDIX K: Pre/Post Assessment: Treatment 2.....	66
APPENDIX L: Treatment 2: Pre and Postunit Student Concept Interview	68
APPENDIX M: Treatment 2: Rock Lab Procedures.....	70
APPENDIX N: Treatment 2: Rock Lab Format	79
APPENDIX O: Rock Lab Rubric	81
APPENDIX P: Timeline	83
APPENDIX Q: Teacher Journal Prompts.....	85
APPENDIX R: Student Survey.....	87
APPENDIX S: Teacher Interview	89
APPENDIX T: Teacher Questionnaire.....	91
APPENDIX U: Administrator Interview	93

LIST OF TABLES

1. Triangulation Matrix.....	16
2. Average Scores of Preassessments and Postassessments	20
3. Average Scores of Preassessments and Postassessments for all units	21
4. Average Scores of Pre and Postunit Concept Interviews.....	21
5. Student Responses to Open-ended Survey Questions	25

LIST OF FIGURES

1. Treatment 1 Survey.....	24
2. Treatment 2 Survey.....	25
3. Student Questionnaire.....	27
4. Teacher Recorded Values of Student Motivation.....	28
5. Teacher Questionnaire	29
6. Average Response to Teacher Reflection Prompts for Self-motivation.....	32

ABSTRACT

Teacher collaboration has been widely implemented in the secondary school setting as an integral component within a professional learning community in an effort to increase student achievement and to foster a better working environment for teachers. The effects of teacher collaboration on both students and teachers of Earth science in a high school environment were investigated in this project. Particularly, the project examined the effects of collaboration of Earth science teachers on student understanding, student motivation, and teacher motivation. Earth science teachers collaborated on instructional strategies that included student labs and subsequent formal reports. The materials that were evaluated by a collaborative team were then used to measure how collaboration impacts students and teachers in the classroom. A comparison of a unit that was taught without guidance from collaborative members was made with two units of instruction that implemented materials that were evaluated by a collaborative team. Pre and postunit assessments, concept interviews, and surveys were used to evaluate student understanding. Additional data was collected through teacher interviews and teacher journals to assess student motivation. My own level of motivation and that of my cohorts was evaluated through my journal and observations made by my administrator. Results indicated that student understanding and teacher motivation increased, while the results on student motivation were mixed. The data showed a large gain in student understanding as a result of collaboration on instruction, whereas the level of student motivation was deemed negligible. Teachers in the collaborative group were observed to have increased levels of motivation as a result of the group's collaborative efforts. The project was an enhancement of my own level of motivation as well.

INTRODUCTION AND BACKGROUND

Until this academic year (2010-2011), I viewed the implementation of teacher collaboration within professional learning communities (PLCs) as the latest fad in a series of district initiatives to improve student achievement. My isolationist view was common among high school teachers at my workplace. I did not recognize or understand the value of collaboration for teachers and students until engagement of the process began. The act of collaborating with others inherently requires constant self-reflection and shared reflection with colleagues. As a result, I felt a strong drive to examine the effects of teacher collaboration on student understanding and motivation. The act of collaborating with my fellow teachers led me to explore the student effects of teacher collaboration as a topic.

From recent experience I can attest to the value of collaboration as an enhancement of communication at the workplace; however, the effects of teacher collaboration on students' understanding is a link that needs verification and my project aimed to make that link. For this project, I have selected labs and lab reports as a strategy to evaluate and target the effects of teacher collaboration. The focus question for the project is: what are the effects of teacher collaboration on lab exercises and subsequently lab report writing on students' understanding of Earth science concepts? My project considers the following subquestions: what are the effects of teacher collaboration on Earth science on students' motivation in Earth science classes and what are the effects of teacher collaboration on instructional strategies for Earth science classes on teacher motivation? For this study, motivation refers to engagement for students and participation for teachers, respectively.

The purpose of this project was to examine the benefits of teacher collaboration for students in the classroom. After all, the primary intent of collaboration is to increase student achievement, but understanding of concepts precedes any measure of achievement. The level of student understanding was evaluated by implementing labs and scientific reports in Earth science classes that were developed for students by Earth science teachers in a collaborative setting. Additionally, the project delved into the perceptions of student and teacher value on the process of collaboration.

The project examined the focus using one of my three freshmen Earth science classes that I currently instruct. The project took place where I teach, at Centennial High School (CHS) in the western suburbs of Boise, Idaho. CHS is a traditional high school (Grades 9 through 12) that has a student body of approximately 1,900. CHS uses an eight period 90-minute A/B block schedule, where students are in each class every other school day for 90 minutes and there are four classes per day.

The advisement for this capstone project was done through a Capstone Graduate Committee, which consisted of two faculty members of the Masters of Science in Science Education (MSSE) program at Montana State University. Jewel Reuter, Ph.D., served as the principal advisor throughout the development of this project through the completion of the capstone presentation in June of 2011. In addition, Joe Bradshaw, of the Ecology department, served as project reader and advisor.

The project was supported by a team of four professionals that are all colleagues at CHS and will be referenced as advisors within the Validation Team. Dave Moser, the principal at CHS, was an administrative advisor to the project. He possesses a high level of expertise in regards to school collaboration and professional learning communities.

Marilyn Kennings, the AP Literature and Composition teacher at CHS, provided assistance with the writing component of the project. Sam Goff and Charlie Bidondo, both Earth science teachers, provided insight to project data and project development.

CONCEPTUAL FRAMEWORK

Recent research suggests that the practice of teacher collaboration in school systems improves student understanding, thus, enabling gains in student achievement. A fundamental shift from the traditional organizational structure of schools to PLCs, where teachers actively collaborate fosters an environment conducive to student learning. When professional communities are properly implemented, teachers engage on learning outcomes and student learning becomes the focus of a school by clarifying what students are to learn and by monitoring each student's progress (DuFour, DuFour, Eaker, & Many, 2006).

According to DuFour and Eaker (1998), the most recent education reform efforts in American public schools, such as the Excellence movement and the Restructuring movement, are viewed as disappointments in terms of student achievement. Fullan (2006) supports the assessment of Dufour and Eaker and affirms that structural and curricular reform initiatives have failed to positively affect student performance. DuFour and Eaker (1998) state that "the factory-based organizational structure within schools has lost relevance and needs to be transformed into a PLC to meet the needs of learners in post-industrial society" (p.20). Honawar (2008) states in an evaluation of Adlai E. Stevenson High School that "in a professional learning community, each teacher has access to the ideas, materials, strategies, and talents of the entire team" (p.25). Fullan

(2006) agrees and observes that to achieve desired results in the classroom teachers need to be actively engaged in continuous professional learning that is embedded in the school culture, where collaboration is the avenue for which the best practices are shared.

Collaboration between high school teachers is generally organized by departments and subject matter. Corcoran & Silander (2009) point out that this compartmentalization can isolate teachers if the core focus of collaboration is not on instruction. Feeney (2009) agrees and observes that many department leaders function as managers of an administration protocol that does not focus on student learning. However; studies show that a successful collaboration can exist departmentally, if the group is strong and opportunities for sharing and dissemination of ideas exist (Corcoran & Silander, 2009). What constitutes a functional collaboration within PLC is specific and is furnished by DuFour (2007) in a response to research that questions the benefits of PLCs. He argues that a working collaborative team collectively focuses efforts on answering critical questions that guide teachers to focus on student learning and teacher efforts. In order for student learning to occur, collaborative teams need parameters.

DuFour et al. (2006) propose that a teacher team in collaboration asks the following four corollary questions to make the link between their collaboration and student achievement: 1) What is it we want our students to learn? 2) How will we know if each student has learned it? 3) How will we respond when some students do not learn it? 4) How can we extend and enrich the learning for students who have demonstrated proficiency? If teachers can use the answers to these questions as a guide for their collaboration, student learning will be the outcome. In addition, the relationship between

the team will grow stronger when collaboration is focused on student learning (Friend, 2005).

Nathan (2008) explains how collegial relationships among teachers can foster professional relationships in departments and across curricula. The research conducted by Bradley Ermeling (2010) of four science teachers practicing collaborative teacher inquiry demonstrates how instructional techniques and student understanding improve with joint effort. The research supports how teacher collaboration has a synergistic effect. Shank (2006) concludes in her study that teacher reflection in a collaborative group aids in an understanding of best practices while simultaneously building a bond with each other. Reflection with other teachers about what happens in the classroom breaks the walls of isolation and provides a path to what instruction is effective.

Collaboration requires that teachers have vulnerability when reflecting in order to build trust. If a collaborative team of teachers works in a trusting environment, they have a basis for reflection of practice and are willing to take risks and challenge each other (Berry, Daughtrey, & Weider, 2009). I observe this in my own collaboration when it comes to an agreement on what content curriculum we are to teach and consequently test as a team of Earth science teachers. Sharing results for the greater benefit of students requires teachers to put their preferences aside and share their results (Friend, 2006). In a 10-year collaborative study by Hoban and Hastings (2006), a relationship was built between a science teacher and researcher to learn what measurement strategies of student feedback were effective for collaboration. The research demonstrates how teachers can successfully reflect on valuable measurement strategies of students to adjust instruction for student understanding.

My investigation attempts to connect the reflection that occurs within teacher collaboration to a best instructional practice that is determined by the team as a strategy to enhance student understanding and student engagement in earth science classes. Honawar (2008) paraphrases a teacher and says the “agenda needs to be more about examining, for instance, available data on how students are meeting standards and determining what needs to be done to help them succeed through sound lesson plans and strategies” (p.29). According to Corcoran and Silander (2009), an effective instructional approach is one that results in measurable improvement on tests. Therefore, the connection between an instructional strategy developed in collaboration needs to be seen through a measurable classroom assessment in order for that strategy to be deemed effective at increasing student understanding. Otherwise, the effectiveness is subjective, especially when teachers do not share results and reflect on their practice.

A variety of techniques can be employed to measure the effectiveness of teacher collaboration. Corcoran and Silander (2009) highlight group learning and project-based learning as instructional strategies that teachers can collaborate on to increase students’ conceptual understanding. Additionally, their research examines guided inquiry in the science classroom as a subject specific strategy for teacher collaboration. A review of the research has found that the aforementioned strategies in conjunction with collaboration have improved student results in scientific understanding and motivation. These instructional strategies offer a variety of formative assessments for teachers to work from in collaboration to increase student understanding.

Research indicates that lab studies and subsequent scientific writing as an instructional strategy increases student understanding in the science classroom. To evaluate the

effectiveness of the strategy, McLaren and Webber (2009) employed an intervention involving two science classes, where each class of students constructed a formal lab report based on observations on a selected topic. The two separate classes then unknowingly performed the labs written by the other class. In comparison to previous years, where more traditional teacher-centered delivery was employed, instructors overall observed a higher level of understanding. Results from a qualitative and quantitative analysis of their study yielded an increased level of understanding and a higher level of performance on summative assessments. Writing elevates the level of knowledge of a topic more than just merely recording the information. Allen (1987) states the “value of writing to learn science extends beyond gaining knowledge of the subject to acquiring understanding of oneself and one’s reflection to the world, clearly a desired outcome of science” (p.11).

My project implements a similar treatment to that of McLaren and Webber (2009), but adds the element of teacher collaboration on the development of materials to determine the effects of writing on scientific lab exercises. An implementation of new strategies may present difficulties with my collaborative team as the focus is on common assessments, particularly tests. This focus requires a shift from tests to instructional techniques to bridge the gap between teacher collaboration and student motivation. The success and sustainability of teacher collaboration also depends on the level of commitment by the teachers and administrators in a PLC. An exhaustive list of district initiatives to be addressed through collaboration can yield an overwhelming feeling for those participants, which can present difficulties to the process that newly minted collaborative groups cannot withstand (Wood, 2007). In addition, Leonard and Leonard

(2001) note the challenges of teacher participation due to the reluctance to accept the value of teamwork. This aspect continually presents challenges to a team and takes persistence to overcome and move forward.

In conclusion, the value of collaboration clearly offsets the challenges. A successful collaboration yields desired results and there are numerous case studies that provide evidence of success. Review of literature suggests that instructional strategies developed in the guidance of teacher collaboration yield an increased level of student understanding while simultaneously increasing student and teacher motivation. An increased level of classroom participation and teacher engagement in collaborative team sessions is a product of building a professional learning community. While my project focuses more on the instructional practices piece of collaboration, the other abovementioned benefits come with the practice itself.

METHODOLOGY

Project Treatment

A district-wide mandate for teacher collaboration was implemented at the beginning of the academic year (2009-2010) in an effort to increase student achievement and to develop a professional learning community across the district and in each of the high schools. CHS is one of five major high schools within Joint District 2 that encompasses the towns of Meridian, Star, and the most western edge of Boise. The district is the largest in the state of Idaho with approximately 35,000 students. Teacher collaboration has become the single most important component of each high school in the district and

has been a work in progress since its recent inception. Collaboration at CHS occurs through academic departments. The district requires that all high school teachers meet each week on Wednesday morning for 45 minutes to collaborate.

As the chair for the science department, I facilitate our weekly collaborations. The science faculty meets briefly as a department each week and then teachers from each subject area break into content area teams (CATs). I am one of five participants in the Earth science CAT and all Earth science teachers are participants.

The effects of teacher collaboration on Earth science students and teachers were assessed through the implementation of a nontreatment unit of instruction and two treatment units of instruction. The nontreatment unit was taught using methods and materials that I have previously used in absence of teacher collaboration. The treatment units integrated scientific report writing on group-based classroom lab activities. This strategy was evaluated and refined through the collaboration of Earth science teachers in the CAT. The nontreatment and treatment, also called the intervention, was compared through an analysis of data to determine the results.

The intervention encompassed a thematic unit of instruction called Earth materials, which included smaller units with such topics as atomic structure, minerals, rocks, and the rock cycle. The nontreatment unit focused on atomic structure and matter and was delivered using materials that I had developed without my collaborator's assistance. The content was aligned with the curriculum in years past and the teaching materials were retrieved from digital archives for this part of the project. The objective for the unit was for students to develop an understanding that matter is composed of atoms and elements and how they are the building blocks for minerals and rocks. The content was delivered

using a teacher-centered approach of delivering notes via PowerPoint along with student-centered worksheets and activities. The activities are found in Appendix A. Students were administered a pretest (Appendix B) at the beginning of the unit and a posttest (Appendix B) at the end of the unit. In addition, three selected students were interviewed on concepts prior to the unit and upon the completion of the unit. The interview questions are found in Appendix C.

The Earth science teachers in the CAT have collaborated prior to the treatment units, but the collaboration focused on the development and analysis of summative assessments, particularly multiple-choice pretests and posttests for large thematic units. The basis for collaboration at (CHS) is the school-wide model that is found in Appendix D. The model is cyclical in format, however, curriculum alignment was provided as a starting point for teachers. The creation of common assessments follow, which guided the team to develop multiple-choice summative assessments that were given throughout the academic year. The model then requires collaborative teams to discuss the best instructional strategies to meet assessment goals, which is what the treatment for this project focuses on and what differentiates it from the nontreatment.

The treatment is the addition of labs and subsequent reports as instructional strategies. The teaching materials were evaluated by the CAT during collaboration in an effort to increase student understanding in the Earth science classroom. Because collaboration is yearlong, students were already familiar with it, even if they had a different teacher during the first semester, but the nontreatment and treatment units began in my classroom. The nontreatment unit was implemented at the beginning of the second semester, when students' schedules shuffled from the first semester, which often results

in most students having a different Earth Science teacher than they had during the first semester.

Throughout the year, all earth science teachers gave their students unit pretests and posttests on a specific scheduled date. This maintained a consistent pace for instruction and it also provided an opportunity for teachers to deliver the same content within a narrow time range during a unit. As a result, teachers always had an opportunity to collaborate on curriculum and assessment results, which presented many opportunities for sharing instructional strategies for the content that was to be covered. This also fostered stronger relationships between content area teachers in an effort to help students gain an understanding of the curriculum.

Prior to the treatment unit, students in earth science classes have exercised report writing, regardless of the teacher they had the first semester. At the beginning of the treatment, students in the study group were given a questionnaire regarding their perceptions of Earth science, teacher collaboration, and scientific report writing. The questionnaire is found in Appendix E. My students were made aware that scientific reports were to be the centerpiece of their lab investigations for the treatment unit and that all Earth science teachers collaborated on the materials they received in the treatment.

The treatment unit focused on mineral and rocks in the Earth system and the teaching materials were reviewed and evaluated within collaboration, making it integral to the project. Two treatment units were implemented for the project: one for minerals, and another for rocks. The treatment content was delivered with the inclusion of formal scientific report writing for classroom lab activities. The CAT suggested that reading and

writing were observed to be the most effective strategies for developing student understanding of Earth science concepts.

The treatment involved the collaboration of CAT teachers to refine lab exercises, report criteria, and report rubrics. The format for the aforementioned components was aligned with the district curriculum and state standards to target key concepts that are found in unit tests and in the district's end of course test. The report criteria were developed with this in mind, which is critical to the treatment. The criteria for the report were also dialed so that all of the key components embedded within the curriculum were included in their reports and are consequently evaluated by students. Student reports are the evidence of understanding for teachers in the CAT as they provide an artifact of higher order thinking skills, particularly in the conclusion sections of the written reports where students are required to evaluate and synthesize their findings.

Discussions regarding content for the treatment are the bulk of discussion in many collaborative sessions by the Earth science CAT. There are many components to this treatment that were considered in its development. The sequence of instructional materials requires students to understand the material at cognitive levels beyond comprehension, particularly application and evaluation. It was discussed within the collaborative team that for students to actually understand the material, higher level of cognitive abilities would have to be exercised. This was the rationale for the framework of the treatment.

At the beginning of the treatment unit for minerals, students were given a pretest (Appendix F) to assess their knowledge of the topic. Again, three selected students were also interviewed on concepts before the treatment began. The interview questions are

found Appendix G. That same day, notes containing key concepts were delivered using a teacher-centered approach. The procedures of the lab investigation (Appendix H) were explained and demonstrated before students began the process of the lab investigation. The objective of the lab was for students to identify 10 unknown minerals by collecting and classifying data regarding mineral properties. The objective is specific to district curriculum and targeted as a task that students will be able to do. Students had the remaining portion of that class and the following 90-minute class period to complete the lab work.

During the subsequent class, the report format and the rubric were explained and given to students. These are found in Appendix I and Appendix J, respectively. Students were required to produce a formal typed report that adhered to the contents of the rubric. Students were then given two additional 90-minute class periods to write a report that met the criteria outlined in the format and rubric by using the data they had collected in lab groups. As a large part of the treatment, students were coached through example and their work was simultaneously edited in the computer lab as they documented their findings in report format. After the completion of the report, students were given a posttest (Appendix F) along with the postunit concept interview (Appendix G) to assess their understanding of the topic after the treatment.

In terms of methods, Treatment Unit 2 on rocks and the rock cycle progressed similarly to the mineral unit; however, the objective of the rock lab and unit was for students to be able to differentiate within rock types by using a dichotomous key. At the beginning of the treatment unit for rocks, students were given a pretest (Appendix K) to assess their knowledge of the topic. The same selected students were interviewed on

concepts pertaining to this treatment unit before it began. The interview questions are found in Appendix L. The procedures of the lab investigation (Appendix M) were explained and demonstrated before students began the process. Students identified 25 unknown rocks and provided an understanding of how those rocks cycled through the Earth in their report. The format found in Appendix N, and the rubric found in Appendix O, were similar to the first treatment in terms of the development. Likewise, the rock unit also met the standards for the district curriculum. Upon the completion of the second treatment, students were given a posttest (Appendix K) and concept interviews (Appendix L) to assess their understanding of the topic.

For both units of treatment, students worked in groups to solve the problems they were presented with. The key to both treatments was for students to identify unknown samples by using their resources and their ability to communicate with their partners, which made the labs hands on and interactive. The labs have multiple components that encompass the curriculum, which provided many opportunities on which teachers could collaborate. The student generated reports for both treatment units indicate the level of understanding that was achieved from the task to determine whether or not the objective was met. The postunit assessment and concept interviews were also used to verify a level of understanding.

Data Collection Instruments

CHS is a large traditional public high school within the Meridian School District in Boise, Idaho. The school is situated among subdivisions in the western suburbs of the city in a fairly affluent area. The school embodies a cross section of the population that is of fairly high socioeconomic class and the majority of the student body represents a

demographic that is generally Caucasian and conservative, with a growing population of Latinos and English language learners. The district experienced immense growth during the past decade that paralleled the national housing boom. As a result, it is the largest district in the state with 35,000 students and grew from two traditional high schools in 1987, to five in 2008, each of which has approximately 1,900 students. CHS opened its doors in 1987, prior to the boom. Although the school is not that old, it has a culture that is proud of its accomplishments, both academic and athletic.

Earth science is a required core class for all Grade 9 students in the district and CHS has five earth science teachers who teach a combined total of 19 classes. Of the three earth science classes that I teach, I selected one class for this project to make the data collection manageable. The class has 30 students, 15 males, and 15 females. All of the students are freshmen, except for two juniors. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

The cross section of the class mostly consists of medium-level learners with a few low and high-level learners. This demographic is similar across the spectrum of earth science classes, giving the team of earth science teachers' comparability during collaborative discussions. We all have a similar audience, therefore our goals to improve student understanding are compatible in collaboration. In addition, earth science teachers frequent each other's rooms and eat lunch together, often discussing strategies and developing teaching materials in unison.

The intervention took place over the first seven weeks of the second semester. A week and half was spent teaching the nontreatment unit and two weeks were spent on teaching each treatment unit. A detailed timeframe of the intervention is provided in Appendix P.

The triangulation matrix shown in Table 1 provides an outline of the sources of data that were used to answer the focus questions. This framework ensured that each question was answered with more than one source of data. The matrix also served as a reference and a guide for evaluating the instrument that was most appropriate for each question. Each of the data collection instruments are found within the matrix and can be located within the appendices.

Table 1
Triangulation Matrix

Research Questions	Data Source		
	1	2	3
Increases understanding	Student Concept Interviews	Student Survey	Pre and Postunit Assessments
Student motivation	Teacher Journal Using Prompts	Student Survey	Teacher Interviews
Teacher motivation	Teacher Questionnaire	Teacher Journal Using Prompts	Administrator Interview

To verify the effects of teacher collaboration on student understanding in earth science classes, data were collected from student interviews, student surveys, and assessments given before and after each unit was taught. Average scores from pre and postunit assessments allowed for a comparison of percent change in student understanding. The interviews and questionnaires provided an overview of student perceptions. The

interviews included open-ended questions to provide an additional evaluation of student understanding. The data sources for the focus questions were both qualitative and quantitative in nature.

Students were conceptually interviewed at the beginning and end of each treatment unit using a structured format. I selected three students from the class to interview; one high-level learner, one medium-level learner, and one low-level learner. The learning levels for students were determined by their course grades in the first semester along with my judgment of their level of understanding based on past classroom experience. The same students were selected for the nontreatment and both treatment units. The interviews took place at a convenient time toward the beginning or end of the class period. The interviews took place in the hallway to avoid disruptions from others and to ensure that students would feel comfortable. I followed the interviews with student surveys (Appendix R) given to the whole class at the completion of both treatment units. Student reports were evaluated using the two rubrics developed in collaboration, Appendix J and Appendix O, respectively.

The effects of teacher collaboration on student motivation were assessed through teacher observations, student surveys, and teacher interviews with earth science CAT teachers. My observations were recorded as field notes in a journal (Appendix Q) and were taken during the nontreatment and the treatment unit to observe student and teacher motivation. These notes were used for comparative purposes and were taken using prompts each day of the intervention and were critical to answering both subquestions. There are questions in the student survey (Appendix R) that target student motivation to answer the second research question. The survey was designed to specifically target the

perceptions of the entire study group. Open ended questions in the survey gave an opportunity for students to express their thoughts regarding the effects of the treatment.

Since the focus involves teacher collaboration, I followed up with teacher interviews of the earth science CAT. Other teachers in the team implemented the same labs and reports for both treatment units. Because of this I analyzed their perceptions of student understanding of the treatment content through individual interviews. The structured interview questions are found in Appendix S. The interviews were held after the second treatment unit to encompass the entire treatment of the project. Since the teachers had a vested interest in the development of the teaching materials, I felt compelled to collect their outlook on the merits of the project.

Collaboration is designed to foster teacher relationships in an effort to help develop a professional learning community, thus, increasing teacher motivation in effort to increase student learning and motivation. Teacher questionnaires (Appendix T) were distributed to the other four earth science teachers to assess their level of motivation of the CAT in context of this project. Their responses also provide additional evaluation of student motivation. In order to assess my own level of motivation, I referred to my journal, which included reflections on the lessons in terms of motivation for students and the instructor.

Lastly, I interviewed my principal, Dave Moser, who oversees the implementation of collaboration school wide and is an advocate for collaboration in effort to increase student understanding. The interview was administered at the end of the nontreatment unit and the whole intervention, after he made a formal observation of a nontreatment lesson, a treatment lesson, and a collaboration meeting in my classroom. The questions can be found in Appendix U. The interview questions were designed to gather his

perceptions, which are valuable to evaluating the motivational value of collaboration on teachers and the effects it has on student understanding of earth science.

The data collected in this project were both qualitative and quantitative. Both types of data were mined from the results of the various data collection instruments mentioned and are found in the appendices. The evaluation of the qualitative data allows a determination of general trends and perceptions to be made on the intervention. The quantitative data was processed by analyzing the results of Likert scales embedded within the questionnaires and surveys. Additionally, analysis of student performance on the assessments was made in order to make a quantitative evaluation of the treatment.

In order to evaluate the effects of teacher collaboration on student understanding, many techniques were employed. The evaluation of those techniques that were gathered through triangulated data collectively led to an assertion of whether collaboration on instructional strategies is beneficial to student learning. That learning was assessed on multiple levels to incorporate views from all those involved.

DATA AND ANALYSIS

Data from the nontreatment and treatment units were methodically compared to determine the effects of teacher collaboration on student understanding in one of my three freshmen Earth science classes. In order to answer the research question for this project, the data was collected and triangulated. The use of pre and postunit assessments allowed for comparable change between the nontreatment and the treatment units. This data is displayed in Table 2. Overall, the results indicate a large gain in student

understanding for both units; however, the treatment unit shows a greater gain as reflected in the percent change.

Table 2

Average Scores of Nontreatment Unit and Treatment Unit Preassessments and Postassessments (N = 30)

Description of Data	Nontreatment Unit (%)	Treatment Unit (%)
Preassessment Average	44	44
Postassessment Average	75	87
Percent Change	70	98

When comparing the nontreatment unit to each individual treatment unit, there is a lesser contrast between preassessment scores and postassessment scores for the first treatment, but not the second. These data are displayed in Table 3 and depicts that contrast, which impacts the varying percent change between each unit. In the nontreatment unit, there was a larger percent change between the pre and postassessments in comparison with the first treatment unit, although the average for the first treatment postassessment was higher. This indicates that while a higher degree of understanding occurred, a lesser gain in student understanding was made in the first treatment unit. Some of the concepts taught in the nontreatment thematically bridged over to the first treatment providing a higher subsequent preassessment average and thus a lesser percent change for that unit.

The highest gain in student understanding took place in the second treatment unit, as did the highest percent change between pre and postunit assessments. The positive effects of the intervention became evident during this unit with the comparison of pre and postunit assessment results. Students also gained a level of comfort with the treatment

and its procedures, which I also believe attributed to the higher level of understanding gained.

Table 3
Average Scores of Preassessments and Postassessments for Nontreatment Unit and both Treatment Unit 1 and Treatment Unit 2 (N = 30)

Description of Data	Nontreatment (%)	Treatment Unit 1 (%)	Treatment Unit 2 (%)
Preassessment Average	44	53	34
Postassessment Average	75	83	90
Percent Change	70	56	142

Data were also collected to determine the change in understanding of Earth science concepts through concept interviews. These findings draw similar comparisons to the pre and postunit assessment results and are found in Table 4.

Table 4
Average Scores for Pre and Postunit Concept Interviews (N = 3)

Description of Data	Nontreatment (%)	Treatment Unit 1 (%)	Treatment Unit 2 (%)
Preassessment Average	56	31	54
Postassessment Average	83	94	92
Percent Change	48	203	70

In the nontreatment unit, students initially scored higher on the preassessment. This was most likely due to the prior experience they had with the nontreatment content. This unit focused on atomic structure, which was covered in the previous year (Grade 8) with the physical science curriculum. This was evident when all three students were quick in their responses during the concept interview. Many students left treatment preassessment questions unanswered, an indication that the treatment content was initially more difficult

for students to understand as students had no prior content knowledge. During the first treatment unit concept interview, the high-level learner expressed concern by saying “I don’t understand the vocabulary.” Certainly, this initially impacted student understanding and clearly explains why treatment preassessment scores were lower than the nontreatment scores.

In both treatment units, all of the postassessment scores, including the interviews, were higher than the nontreatment unit. The impact of writing the formal report following a lab investigation allowed for an increase in student understanding, particularly when students had to explain the class concepts again using their own words in the introduction and procedure sections of their reports. Most required a great deal of coaching through this process, allowing an additional opportunity for me to teach the class concepts to students by reviewing the purpose, the hypothesis, and methods for the lab investigation, surely a benefit of this treatment. This was also when I observed the highest degree of understanding, when I engaged individually with students and questioned them while simultaneously using the lab format and the rubric as a basis for questioning.

The shift from the group-based lab work to the independent practice of report writing provided a gateway to higher understanding. When my administrative advisor, Dave Moser, observed the report writing in the classroom, he noted that “there was no class time dedicated to student redirection” and that the “student behavior was exemplary.” This indicates that while I am working individually with a student, the rest of the class remained focused. The treatment offered a strategy to better classroom management, which in turned increased understanding because they were engaged.

The reports that the students submitted at the completion of each treatment unit provided further evidence of increased understanding. Of the 30 students in the class, 27 submitted the mineral lab report and 26 submitted the rock lab report. This is comparatively a much higher rate of task completion in relation to other assignments. In addition, the class average for each report was 87% and 89%, respectively, which is comparatively higher among class averages of other assignments.

Students successfully documented their findings and synthesized their hypothesis with the data they collected. They were able to connect their lab work with class concepts more effectively with the lab and report than they did with class activities in the nontreatment unit. The writing provided an artifact of original work from each student that was graded using the rubric, making it simple for me to evaluate their level of understanding.

Additionally, to evaluate student understanding, the class was given a student survey (Appendix R) upon the submission of their formal scientific report at the end of each treatment unit. The survey was designed with the intent to retrieve both quantitative and qualitative data. The responses of survey questions 1 through 8 for the first treatment are displayed in Figure 1. The survey employed a Likert scale to evaluate student perceptions. The survey also included open-ended responses in order to support the quantitative data. These results provide insight to student perceptions about the subject, the difficulty of the class, and their reflections concerning the treatment.

These data reveal that students in the class are indifferent to the subject and they overall agree that it is difficult for them. Their preference for learning is to work in lab groups, a strategy employed within the project treatment; however, they are not

inherently motivated by writing the associated lab report. Most students find the formal report portion of the treatment difficult and generally feel indifferent toward its value in increasing their understanding. Although after the first treatment was complete, they agreed that the report writing helped in learning and conceptual understanding.

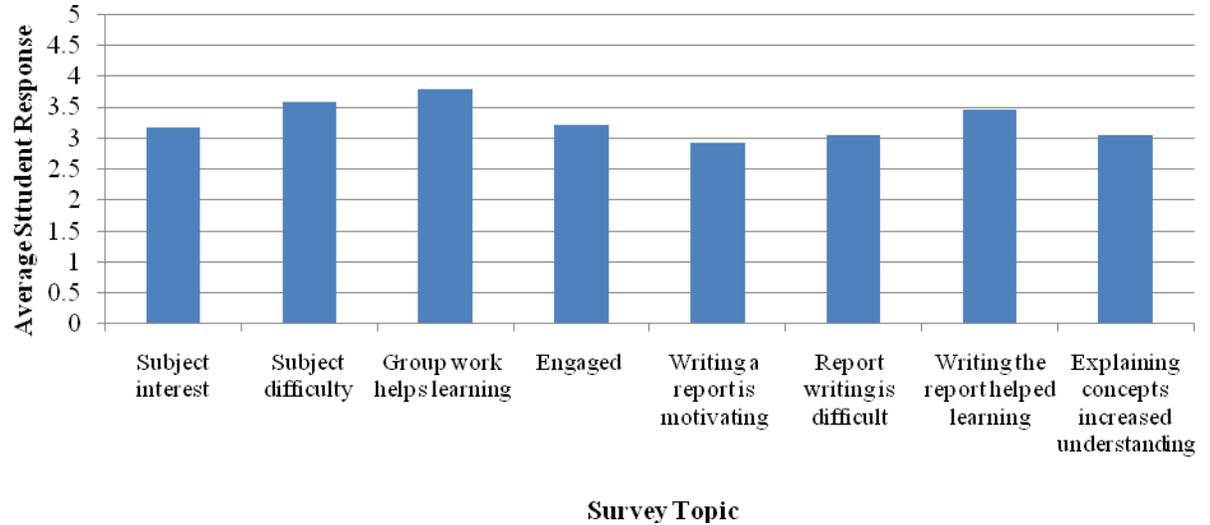


Figure 1. Treatment 1 Survey; Average student response to selected survey questions concerning the effects of labs and reports on student understanding of Earth science, ($N = 29$).

Note. 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree.

Similar findings were experienced with the second treatment survey, found in Figure 2, though the overall agreement that the report writing helped their understanding increased. The class also disagreed that report writing is difficult in the second survey, which insinuates that students became more efficient with the process as the project treatment progressed.

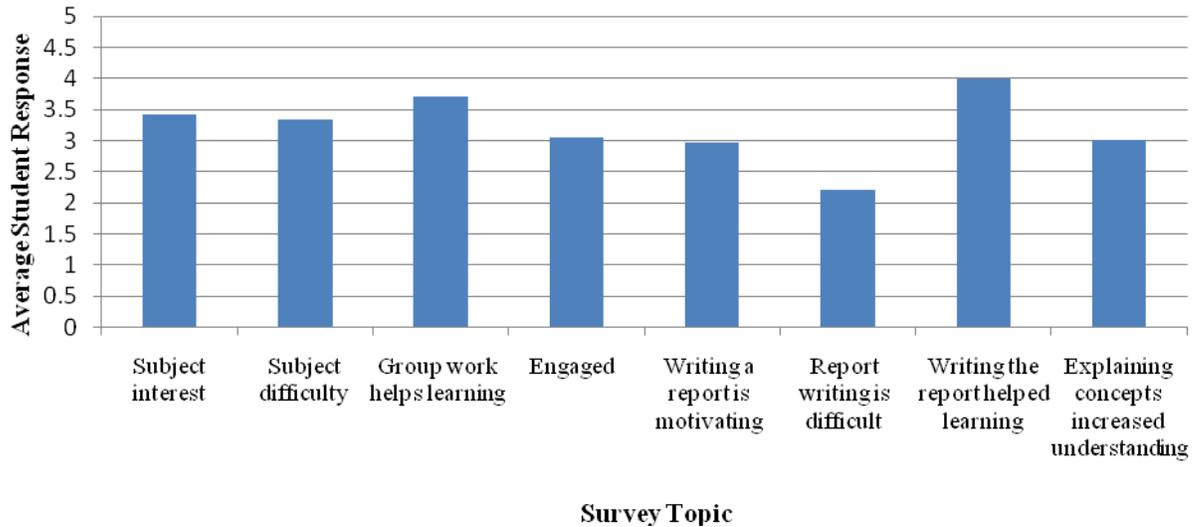


Figure 2. Treatment 2 Survey; Average student response to selected survey questions concerning the effects of labs and reports on student understanding of Earth science, ($N = 26$).

Note. 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree.

Each question on the survey was followed with an open-ended response, which provides supplementary information for each survey topic. The percentages of students who agree, are indifferent, or disagree to each of the open-ended survey questions are found in Table 5.

Table 5.
Combined Student Responses to Survey Questions (N=54)

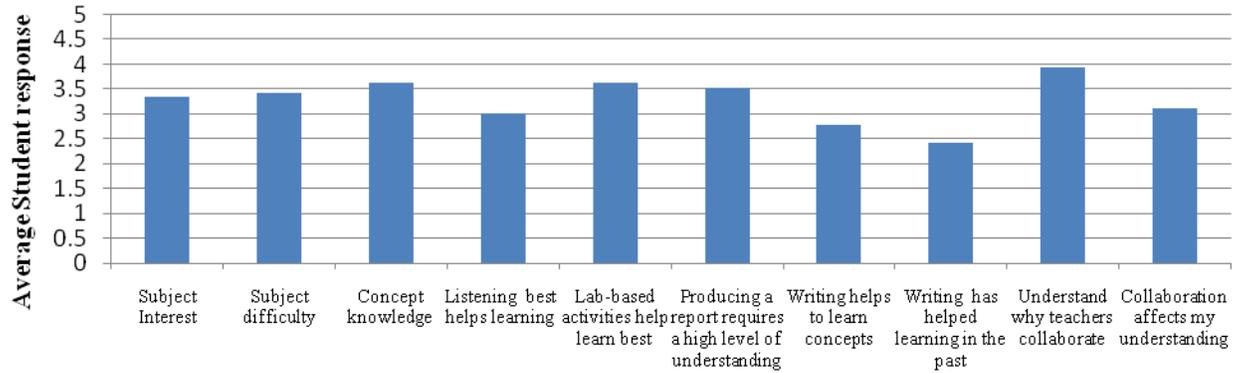
Student Survey Question	Agree and Strongly Agree (%)	Indifferent (%)	Disagree or Strongly Disagree (%)
Working with others on lab helps learning	73.6	13.2	13.2
The report encourages participation	37.2	41.2	21.6
Report writing is motivating	35.2	27.8	37.0
Report writing is difficult	19.6	37.3	43.1
Report writing helps learning	65.4	23.1	11.5
Understanding increased due to report writing	40.0	24.0	36.0

A strong majority of students agreed that working in lab groups was most beneficial to their understanding of the topic. This was justified by students, who in their responses

elaborated on the value of having others readily available to explain difficult or misunderstood concepts using their means of communication. One student stated “Because someone might understand it very well and then tell me how to do it, then I understand.” Another student supported that sentiment and conveyed that with the following, “if you didn’t know something, but a group member did, they could explain it to you.”

Most students shared a common opinion that the report writing was an arduous task, but a large majority of them recorded that the report writing helped with their level of learning. This was what Earth science teachers in the CAT hoped for during collaboration when it was agreed that lab investigations and report writing promotes engagement and learning. However, the class was closely split in terms of their opinions regarding on whether the report writing promoted an increased level of understanding. It is evident through the triangulation of data that student understanding did increase as a result of the treatment, deeming the effects of the instructional strategies developed in teacher collaboration to have an positive impact on student understanding.

Prior to the treatment, students were given a questionnaire to determine what their opinions were in regards to the proposed treatment. This instrument allowed for a comparison to be made with the survey (Table 5) that was given after each treatment unit ended. The data from the questionnaire and the student surveys were used to answer the research subquestion on the treatment’s impact on the level of student motivation. The results of the questionnaire are found in Figure 3.



Student Questionnaire

Figure 3. Average student response on a pretreatment questionnaire concerning the effects of labs and reports on student understanding of Earth science, (N = 27).

Note. 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree.

Most of the students felt that they understood most class concepts prior to the treatment and that participating in lab-based activities helps them learn better than teacher-centered instruction. They also agreed that producing a report requires a high level of understanding, but disagreed that writing helps them learn about science and that it has helped them in the past. Several students noted in the questionnaire that when visual concepts are used in class that better helps them to understand, more so than writing. One student said “writing only helps me when I already understand the concept.”

Prior to the treatment, students disagreed that writing has helped them learn in the past, which affects their level of motivation toward writing scientific reports. This reflection changed with the implementation of the treatment units, where the survey responses indicate that 65.4% of students agreed that writing the reports helped their understanding. The class was evenly split on their opinions regarding motivation in terms of agreement, indifference, and disagreement; this shows that the treatment helped

with understanding, but did not motivate students to learn the curriculum more than methods used in the nontreatment.

My observation of student motivation changed slightly between nontreatment and treatment units. My assessment of student motivation in class was recorded each day of the respective intervention unit in my field notes, where student motivation was rated on a scale of one to five, one being low and five being high. These ratings are displayed in Figure 4.

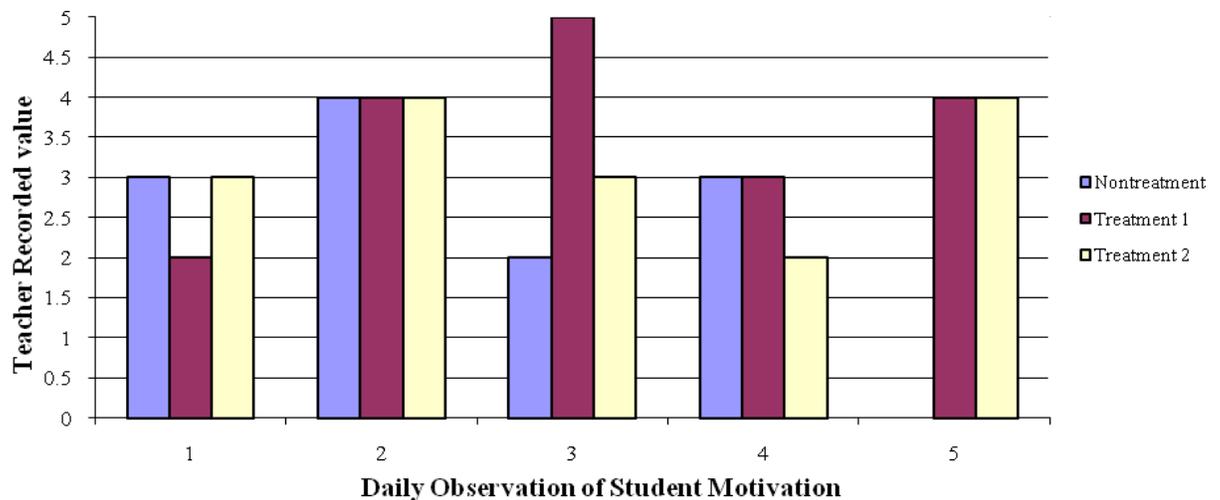


Figure 4. Daily teacher recorded value of student motivation for each intervention day.
Note 5 = High, 1 = Low

The average Likert ratings on my assessment of student motivation between the nontreatment and treatment units were 3.0 and 3.4, respectively. The difference in these values shows a perceived slight increase in their motivation; however, the values I had recorded fluctuated daily in both nontreatment and treatment units, depending upon the task at hand. If the lesson was consumed with interactive lab activities, then student motivation was high. If the lesson was the third consecutive 90-minute class period devoted to the report writing, then the motivation was low. This indicates that the while

the components of the treatment have a positive effect on motivation, the overall effect of the treatment is negligible in comparison to the nontreatment.

Since the treatment was developed through the lens of teacher collaboration, the data retrieved through teacher questionnaires and interviews were critical to answering all of the research questions, particularly the subquestions. All five of the teachers in the Earth science CAT responded to the questionnaire that was given after the treatment. In regards to student motivation, each teacher rated student motivation a three, which essentially compared with my average assessment value for student motivation. The results of the teacher questionnaire are found in Figure 5.

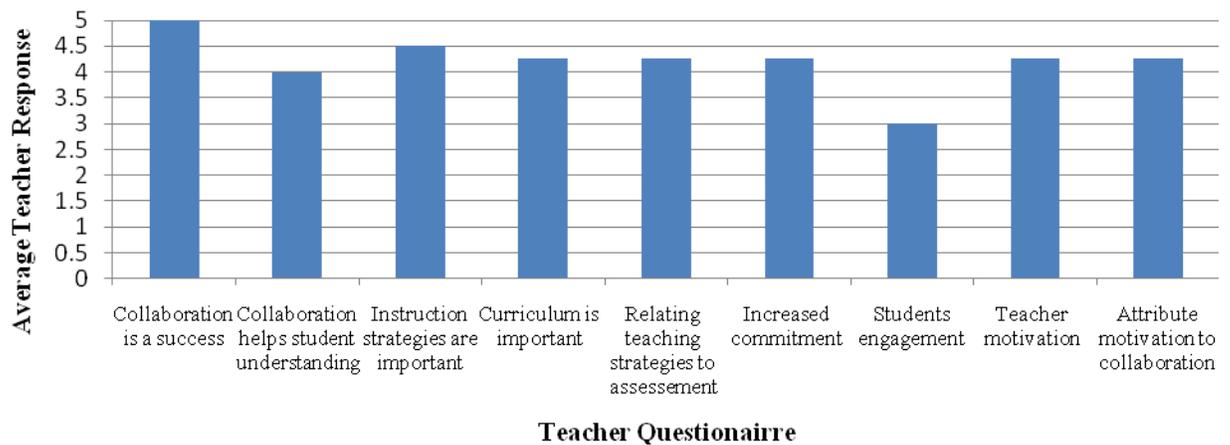


Figure 5. Average teacher response on a posttreatment questionnaire concerning the effects of teacher collaboration and the effects on the treatment on student understanding of Earth science, ($N = 4$).
Note. 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree.

The data illustrate that while collaboration has had a very positive effect on the CAT teachers and their students, the effect on student engagement from the instructional strategies implemented in the treatment was comparatively low. This was the only low value among the questions polled to the CAT teachers. Overall, it was observed from the

teacher questionnaire that collaboration holds value for both student understanding and teacher motivation.

Of the four other Earth science CAT teachers, two of them implemented the treatment materials that were developed for this project. Both teachers quickly recognized in the teacher interviews that they prefer to work with other teachers rather than working individually, citing that they feel empowered as team players and that the work of developing instructional materials and strategies is shared. They both thought that the development of the instructional materials helped with teaching the content in the classroom. One teacher said “it formalized the approach and the methods” used to teach, while the other viewed the development as a benefit to curriculum alignment, targeting content effectively.

According to the data in Figure 5, consensus exists among the CAT teachers that student understanding is an important piece of collaboration and that relating teaching strategies to assessment strategies is important to enhance that understanding. The teachers interviewed acknowledged that and pointed out that strategies developed in collaboration helped close the feedback loop of understanding by learning different teaching techniques, aligning instruction with other teachers, and targeting assessments to evaluate student understanding. One other Earth science teacher had given pre and postunit assessments for the treatment materials and observed marked improvement with the implementation of the strategies the CAT developed. Teachers in the CAT expressed that the instruction and assessments brought a synergistic effect to the process, which in turn enhanced their level of motivation.

This enhancement was also noted when our collaborative team was observed by my administrative advisor, Dave Moser, while our meeting was being evaluated for the purposes of this project. He recorded that “Team participation was very high as was the respectful nature of the interactions throughout the meeting.” In addition, he highlighted that it was evident through observation that teachers in the CAT demonstrated a solid understanding of the curriculum and the treatment content was discussed thoroughly with student learning as the explicit topic.

I interviewed Mr. Moser after his observations of teacher collaborations and intervention lessons at the completion of the treatment to substantiate findings addressed in this project. When asked if teacher collaboration is valuable for student understanding, he replied “Yes, we wouldn’t do it otherwise.” He suggested that when teachers come together to validate student expectations, that inherently motivates teachers and subsequently motivates students to learn. Teachers in the CAT supported this sentiment in the questionnaire (Figure 5) and agree that they feel motivated when students are motivated. They also attribute a large degree of their motivation to teacher collaboration. At the conclusion of a teacher interview, one Earth science teacher said “I think collaboration is really valuable for our department” as it “brings focus and frees time.”

Throughout my own observations, I found that my level of motivation fluctuated similarly to students in both the nontreatment and treatment units. The average levels of my motivation were calculated and are displayed in Figure 6. The results indicate a slight increase in my motivation over the course of the treatment in comparison to the

nontreatment, but both of the intervention units included motivation values that were conversely high and low, yielding close averages.

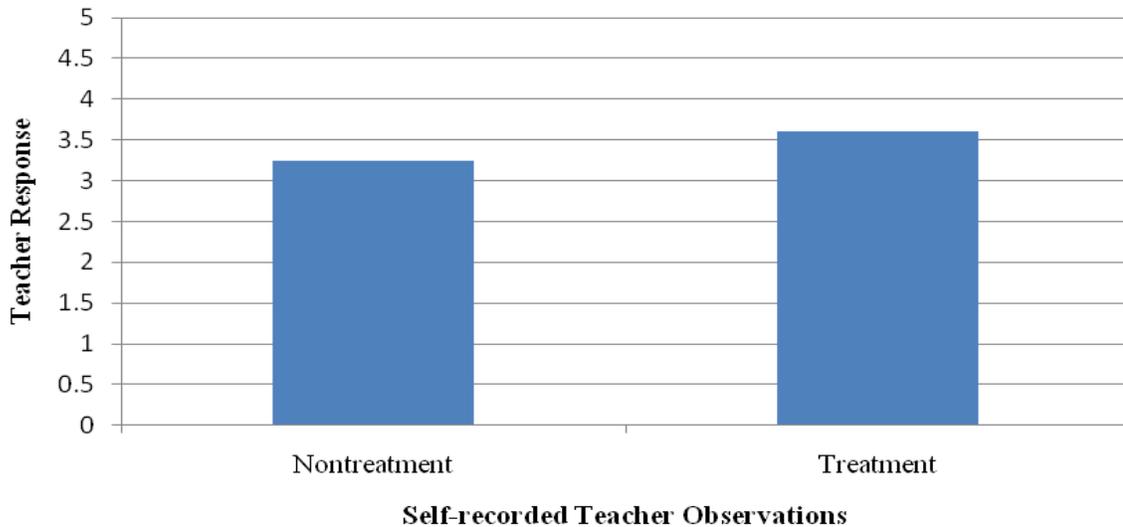


Figure 6. Average response to recorded teacher reflection prompts for self-motivation
Note. Likert Scale 5 = high to 1 = low

Reflections in my journal were made to support my evaluations in a qualitative sense. I found that my motivation was low while I was delivering the mechanics of the treatment, which included the introduction of the labs and the explanations of the reports' formats and rubrics. In contrast, my motivation was high during student engagement, when lab activities were taking place and while I was engaged individually with students during the report writing piece of the treatment.

Peer evaluations supported my own findings, though the administrative evaluations did not contrast that strongly between nontreatment and treatment units. For both lessons, the evaluations documented that classroom management was flawless, the learning environment was positive, and that students and the teacher were working efficiently and were fully engaged. What was noticed as a point of distinction was that the treatment corresponded to what was discussed and implemented to collaboration.

Although it was not apparent from an administrative evaluation of the treatment in the classroom, it was evident that through the collaboration observation that teacher engagement was high, thus, teacher motivation was an outcome of the treatment.

INTERPRETATION AND CONCLUSION

The methodology of this project provided a measurable approach to analyze how teacher collaboration affects student understanding, student motivation, and teacher motivation. The use of lab exercises and scientific reports worked reasonably well to assess the research questions, bringing clarity to the project by providing an instructional path for which the effects of weekly collaborative efforts were determined. Evaluation of the data through a quantitative and qualitative analysis suggests that teacher collaboration on instructional strategies helps both students and teachers in the Earth science classroom. Particularly, the triangulated data for the project implied that collaboration on an instructional strategy enhances student understanding while simultaneously increasing teacher level of motivation; however, the effect on student motivation is questionable.

A higher level of understanding was seen as a clear distinction between the nontreatment and treatment units. The increase in student understanding was clearly evident in the assessment results between the two comparative units. Initially, students were not perceptive to the benefits of the implemented strategy but their opinions changed as the treatment progressed. Feedback from the surveys and interviews were critical to supporting student sentiment and the positive results that were tallied as percent change between the pre and postassessments. Data collected indicated that the

treatment methods were arduous for students, but they had support from their peers for the lab portion and individually from me during the report writing. According to the survey results, students greatly valued this support as a part of their learning and with that support structure in place, increased understanding followed.

Collaboration on instructional techniques was deemed as a benefit to students throughout this project, but the data indicated that this particular interventional strategy could have been replaced to yield equal or perhaps better results in terms of increased understanding. It would be interesting to implement a strategy that focuses more on what students think is most beneficial to their learning, group work that is based solely on lab activities rather than report writing. Most students are not inherently motivated by the writing component; therefore, the lack of motivation is a variable to how much understanding takes place. Other teachers in the CAT experienced similar findings, though their observations were more informal. Their students expressed indifference and dislike to the writing and preference to the lab activities.

My observations of student motivation throughout the intervention correlated well with student questionnaire and survey results. These triangulated instruments offered a reasonable level of support to the outcome that the treatment was negligible to the level of student motivation. If the report piece of the treatment were removed, perhaps collaboration could be linked to a positive trend in student motivation.

Interestingly, teacher motivation was determined to be very high throughout the treatment. Motivation was high in the classroom and in collaborative sessions, although my own levels of motivation wavered slightly through the units, depending on the lesson. It was shown through this project that collaboration did indeed motivate this group of

teachers. The interviews were most telling and teachers in the Earth science CAT voiced their passion and support to this component of school improvement. Teachers resoundingly support collaborative endeavors and feel the need to continue moving forward in collaboration of instructional techniques in the hope of increasing student understanding. In addition, administrative support was high and is in agreement with the CAT teachers in terms of motivation and student understanding.

The treatment for the capstone successfully integrated the data collection instruments highlighted in triangulation matrix to simultaneously bring clarity to the focus and subquestions of this project. I really did not feel the need to change much of the components within the instruments and thought the data provided through the results was user friendly and telling. What I would like to alter if this project were to continue would be the methods themselves, specifically removing the report writing piece and focusing on the lab exercises while using scientific inquiry. Collaboration provides that opportunity and this project showed that the collaboration on instructional techniques is not only feasible, but valuable to both students and teachers.

VALUE

The essence of this project was to integrate teachers together in an effort to increase student understanding. Thus, the benefits reach outside of my own classroom and expand into the school community. The methods of the project were avenues to determine the value of collaboration within a school and were built with the opinions and consensus of my colleagues, which simultaneously fostered a stronger working relationship as the

project pursued. In turn, students have become equal beneficiaries as the recipients of the materials that were developed under collaborative agreement of what was deemed best by all teachers, and not just one.

This project can easily serve as a reference for teachers in the school community who are eager to implement methods for collecting data to determine the value for their own collaborative teams in the subject they teach. The techniques can easily be modified to span the gap across subjects to provide evaluation of teacher collaboration on students understanding in any classroom. The act of implementing this project also helped me to understand what types of data collection are best used to provide reasonable assessments of what a collaborative team wants to know about themselves and their students. I now view myself as a resource within a PLC that can provide support to other departments and teachers in regards to the act of collaborating, which all teachers in my district are required to do.

I think it would be interesting to further the project to data collection over a longer period of time and to collect data departmentally within a school. Such analysis could include an evaluation of annual standardized test scores and perceptions of collaboration across departments throughout the school. There is much potential for research regarding this topic.

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APPENDICES

APPENDIX A

NONTREATMENT ACTIVITIES

Appendix A.
Nontreatment Activities

Matter Concept Map

Instructions: Use the words and phrases in the word bank below to complete the concept map. Be sure to use all of them. Place the appropriate terms in the boxes and in between the arrows.

Word bank:

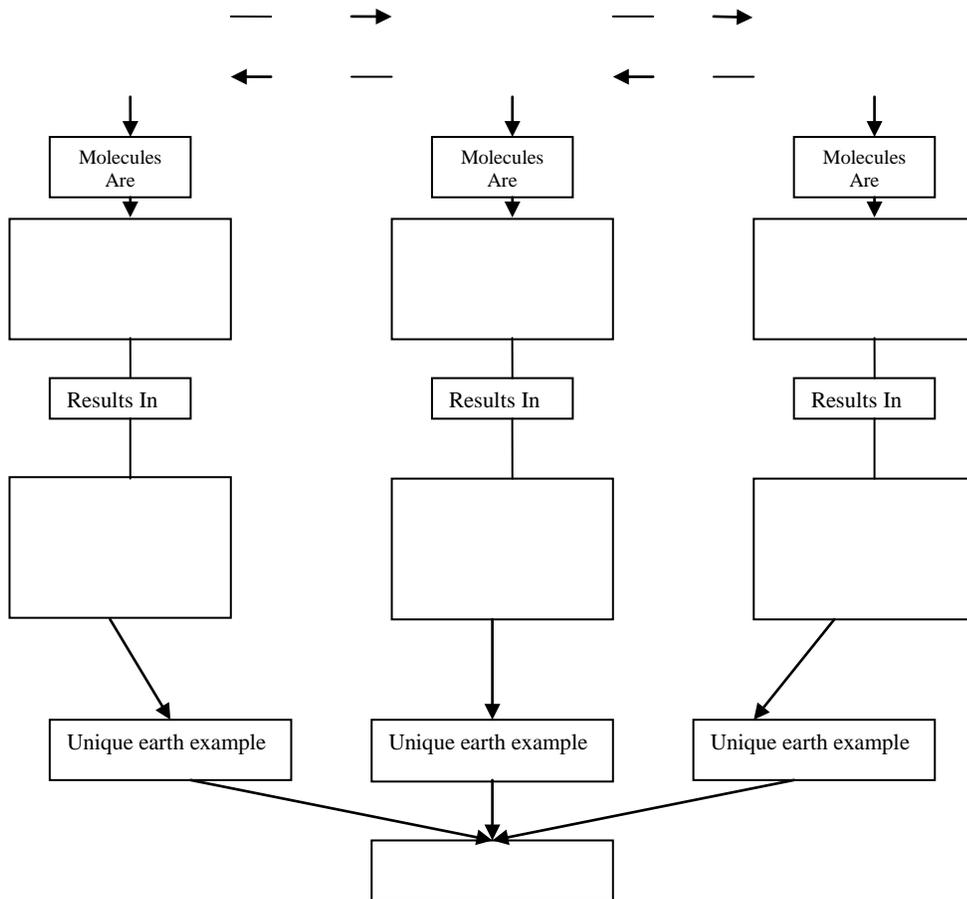
fixed in position
completely fills a container
liquid
freeze
melt

freely moving and independent
water
takes shape of container
evaporate
close together and moves freely

solid
definite shape & size
gas
condense

MATTER ON EARTH

↓
May Be A.....



Name _____ Period _____

Atoms and Their Parts (Subatomic Particles)

Substances that contain only one kind of atom are called **elements**. Some familiar elements are oxygen, gold, silver, and helium. An **atom** is the smallest part of an element that can be broken down and still have the characteristics of that element. All atoms have the same basic structure.

With the exception of hydrogen, all the atoms have three main parts. The parts of an atom are **protons**, **electrons**, and **neutrons**. A proton is positively charged and is located in the center or **nucleus** of the atom. All atoms of the same element have the same number of protons. The number of protons in the nucleus is called the **atomic number** and again, is unique to each element. A different number of protons would mean you have a different element. Electrons are negatively charged and are located in shells or orbits spinning around the nucleus. The number of protons and electrons can be equal. This equality is important so that the atom is neither positively nor negatively charged. It is said to be **neutral**. The third part of an atom is the neutron. Neutrons are neither positive nor negative and are located in the center of the nucleus of an atom along with the protons. Protons and neutrons are the massive parts of an atom. Their combined masses are called the **atomic mass** of an element. Electrons are so light that we say they have essentially no mass.

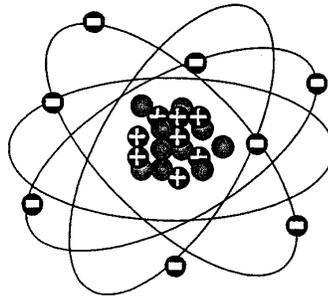
After reading the above, use the table below to help you understand the basics about protons, electrons, and neutrons.

Subatomic Particle	Mass		Charge			Where Found	
	Yes	No	Positive	Negative	Neutral	Inside Nucleus	Outside Nucleus
Proton							
Electron							
Neutron							

Study the drawings and answer the questions at the bottom of the page.



Atom A



Atom B

Legend:

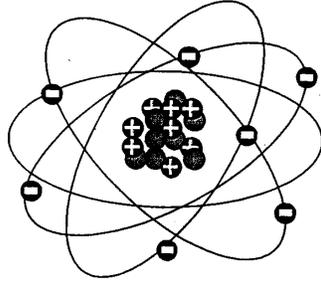
- ⊕ Proton
- Neutron
- ⊖ Electron

- How many protons are in atom A? _____ atom B? _____
- How many neutrons are in atom A? _____ atom B? _____
- How many electrons are in atom A? _____ atom B? _____
- What is the atomic mass of atom A? _____ atom B? _____
- What is the atomic number of atom A? _____ atom B? _____

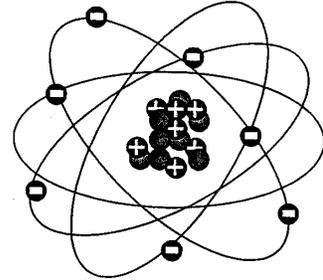


Identifying Atoms Worksheet: From Elements to Subatomic Particles

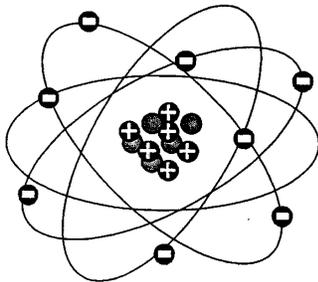
DIRECTIONS: Determine the requested quantities and info about each atom.



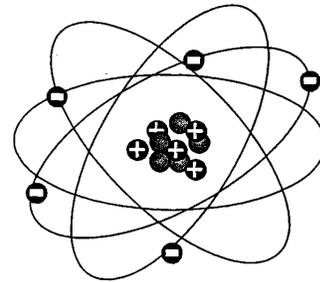
6. Protons _____ Atomic Mass _____
 Neutrons _____ Atomic Number _____
 Electrons _____ Element Symbol _____
 Element Name _____
 Ion: cation/anion/no Charge _____



7. Protons _____ Atomic Mass _____
 Neutrons _____ Atomic Number _____
 Electrons _____ Element Symbol _____
 Element Name _____
 Ion: cation/anion/no Charge _____



8. Protons _____ Atomic Mass _____
 Neutrons _____ Atomic Number _____
 Electrons _____ Element Symbol _____
 Element Name _____
 Ion: cation/anion/no Charge _____



9. Protons _____ Atomic Mass _____
 Neutrons _____ Atomic Number _____
 Electrons _____ Element Symbol _____
 Element Name _____
 Ion: cation/anion/no Charge _____



The Atomic Structure of an Element....

Objective: To make an illustration of a commonly found earth element that includes physical and chemical properties.

Procedure:

1. With a ruler frame out a piece of paper in portrait mode with straight lines.
2. Locate the element you were given by your card selection on the Periodic Table.
3. Within your framed paper, record the atomic number, the mass number, and the chemical symbol.
4. Color your element diagram.
5. Go to the following web address and click the link that represents your element. <http://gwydir.demon.co.uk/jo/minerals/element.htm>
6. Record on the back side of your paper some of the info given for your element. List the minerals that form from your element.

Lab - Measuring Mass: A Means of Counting

Counting Particles in Common Substances

Number	Formula	Name of substance	Number on Periodic table of each element	Total Atomic mass	Number of elements	Number of atoms in each compound
1	NaCl	Salt				
2	H ₂ O	Water				
3	C ₁₂ H ₂₂ O ₁₁	Sugar				
4	CaCO ₃	Calcium Carbonate				
5	Al ₂ Si ₂ O ₅ (OH) ₄	Kaolinite				
6	Al(OH) ₃	Bauxite				
7	CaSiO ₃	Wollastonite				
8	Fe ₃ O ₄	Ferrite				
9	Al ₂ O ₃	Corundum				
10	(Ca ₂ Mg ₅)Si ₈ O ₂₂ (OH) ₂	Amphibole				
11	CaAl ₂ Si ₂ O ₈	Anorthite				

APPENDIX B

PRE/POSTUNIT ASSESSMENT: NONTREATMENT

Appendix B
Pre/Postunit Assessment: Nontreatment

1. What is an element?
2. If an element has an atomic number of 26 and a mass number of 56, how many neutrons does the element contain in its nucleus?
3. Differentiate between an ion and an isotope.
4. What three states of matter does water on earth exist as?
5. Elements and minerals are related. Support that statement by summarizing in a brief paragraph the relationship between the two earth materials.

APPENDIX C

NONTREATMENT PRE/POST UNIT CONCEPT INTERVIEW

Appendix C
Nontreatment Pre and Post Unit Student Concept Interview

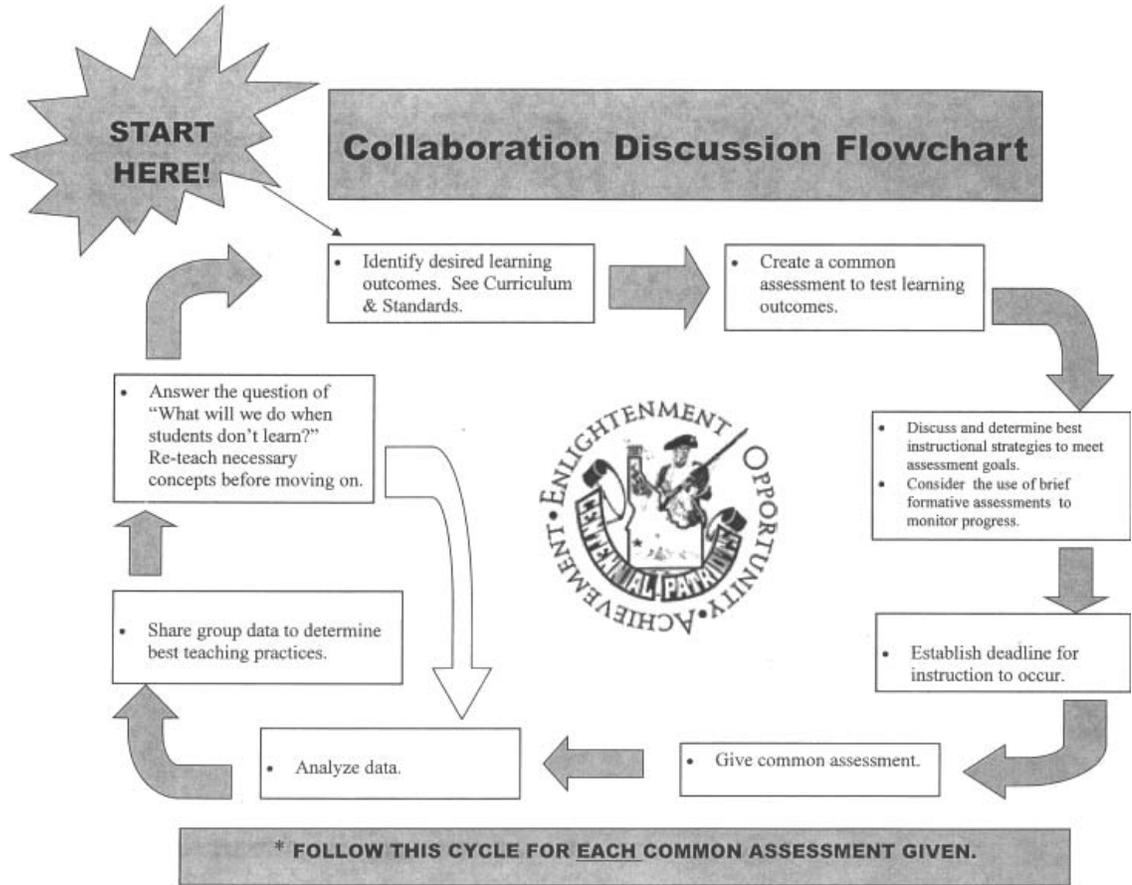
I am going to ask you some basic questions about the unit we (WILL study, or HAVE studied) about atomic structure.

1. Describe the three states of matter most commonly found on earth and discuss the processes that allow change from one state to another.
2. In your terms, describe what an element is.
3. What are the three basic components of an element?
4. If an element has a charge, do you know what it is called?
5. If an element has 5 protons and a mass number of 10, then how many neutrons does it have?
6. How many elements are in the compound SiO_2 ?

APPENDIX D

CHS COLLABORATIVE MODEL

Appendix D
CHS Collaborative Model



APPENDIX E
STUDENT QUESTIONNAIRE

Appendix E
Student Questionnaire

Teachers at Centennial collaborate weekly on Wednesday morning from 7:15 to 8:00 AM. During that time strategies for increasing student learning in earth science classes are discussed. The earth science teachers are collaborating on scientific reports to determine whether or not collaboration affects your understanding of topics taught in class.

Answer the following questions honestly and to the best of your ability. Use the following scale 1 (strongly disagree), 2 (disagree), 3 (indifferent), 4 (agree), 5 (strongly agree).

- | | |
|--|-----------|
| 1. Earth science is an interesting subject.
Explain? | 1 2 3 4 5 |
| 2. Earth science is a difficult subject.
Explain? | 1 2 3 4 5 |
| 3. I am able to understand most concepts taught in earth science. | 1 2 3 4 5 |
| 4. Listening to teachers talk about earth science helps me learn best. | 1 2 3 4 5 |
| 5. Participating in lab-based earth science activities helps me learn best. | 1 2 3 4 5 |
| 6. Producing a scientific report requires a high level of understanding
Explain. | 1 2 3 4 5 |
| 7. Writing helps me learn about concepts of earth science.
Explain. | 1 2 3 4 5 |
| 8. The rubric was helpful for writing the report.
Explain. | 1 2 3 4 5 |
| 9. Writing reports has helped me learn in the past. | 1 2 3 4 5 |
| 10. Writing the conclusion of the lab helps me understand how the lab
relates to concepts taught in class. Explain. | 1 2 3 4 5 |
| 11. I understand why teachers collaborate every week. | 1 2 3 4 5 |
| 12. Teacher collaboration has an effect on my understanding in class. | 1 2 3 4 5 |

APPENDIX F

PRE/POSTUNIT ASSESSMENT: TREATMENT 1

Appendix F
Pre/Postunit Assessment: Treatment 1

1. What is a mineral?
2. Explain the relationship between an element and a mineral.
3. List 3 mineral properties?
4. How can mineral properties be used to identify a mineral?
5. Differentiate between a mineral and a rock.
6. Construct a paragraph that would describe to a reader the process they would go through to identify a mineral.

APPENDIX G

TREATMENT 1: PRE/POST UNIT CONCEPT INTERVIEW

APPENDIX H

TREATMENT 1: MINERAL LAB PROCEDURES

Appendix H
Treatment 1: Mineral Lab Procedures

Mineral ID Lab

Introduction: In this lab you will be given ten unknown mineral samples. You will have to identify these minerals by their properties. The following properties will be used: Hardness, Density, Color, Streak, Luster, and breakage.

Procedure: Each property for the unknown mineral samples is explained in detail below. Read carefully, so the procedures are understood. The properties for each of the unknown minerals will be recorded in the data table within the lab. The properties will then be matched with known data (yellow sheet) to match your data to and identify each of the ten unknowns.

- **Color:** Simply observe the color of the mineral and record it in the chart. Be as descriptive as possible.....don't forget the "ish." You can use several different colors in your description.
- **Luster:** Refers to the way a mineral reflects light. Use the following terms to describe luster: earthy or dull, pearly, glassy, or metallic.
- **Breakage:** When a mineral breaks, you will have either cleavage or fracture. Cleavage refers to a break that has flat surfaces, or planes. Whereas, fracture has an irregular shape. Be specific if the mineral takes on a specific shape for either type of breakage.....cubic, hexagonal, conchoidal (glass-like).
- **Streak:** You are provided with a streak plate, which is an un-glazed piece of tile. Simply scratch the mineral across the plate, and record the color of the streak left behind.
- **Density:** Remember $D=M/V$, that is mass over volume. Since these are minerals, they are solids. The units will be in g/cm^3 . Measure the mass on the triple beam balance and record the value to the nearest tenth of a gram. Use the displacement method to determine the volume, that is, record how much water is displaced by each mineral. Do the math on a piece of scrap paper.
- **Hardness:** You will use the Moh's kit, which contains 8 of the minerals in the chart below. The scale is based on the values of one to ten. If a mineral in the kit **CAN** scratch your unknown sample, your sample is softer than the value of the kit mineral. If a mineral in the kit **CAN NOT** scratch your unknown sample, your sample is harder than the value of the kit mineral. You will have to perform this scratch test several times before determining the hardness. There are also some man-made objects in the chart below that have specific values of hardness.

Use this chart!!!!

MOH'S SCALE OF HARDNESS		
MINERAL	HARDNESS	HARDNESS OF SOME COMMON OBJECTS
Talc	1	
Gypsum	2	
		Fingernail (2.5)
Calcite	3	Copper penny
Fluorite	4	
Apatite	5	
		Glass (5.5)
Orthoclase	6	
		Steel Nail (6.5)
Quartz	7	
*Topaz	8	
Corundum	9	
*Diamond	10	

* not in the kit

REPORT:

You will be required to write a report that has four sections. Follow the format and the rubric for specific details.

Your report will contain the following information:

- ✓ **INTRODUCTION:** Write a brief paragraph that details what you are investigating and the purpose of this lab activity.
- ✓ **PROCEDURE:** Explain how you collected the data and the processes you went through to identify what each unknown mineral sample was using properties of minerals.
- ✓ **DATA:** Include both mineral charts. With a highlighter, draw a line through the mineral samples you identified on the chart containing the list of minerals.
- ✓ **CONCLUSION:** Provide an evaluation that summarizes the data that was collected. In your evaluation, explain in detail what troubles were experienced with the identification. Discuss what properties were the most useful, and what properties were least useful for the identification process.

DATA TABLE

Unknown	Color	Luster	Streak	Breakage	Hardness	Density (g/cm³)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

APPENDIX I

TREATMENT 1: MINERAL LAB FORMAT

Appendix I
Treatment 1: Mineral Lab Format

Earth Science Lab Format

- Always use the instruction sheet/manual as a guide for writing the report, especially when determining what the lab report should contain. Use your notes as reference too.
- There should be at least FOUR sections for written lab reports.
- The report is a piece of technical writing and is to be written in the third person without the use of pronouns. Each section below prompts the writing with statements or questions that should be answered in each section.
- A person should be able to replicate and/or interpret the lab exercise, making the lab testable through sound scientific methods.

Use the format below for the lab report.

Introduction: The introduction should provide the purpose or objective of the lab through a rational explanation. Provide an overview of what the lab entails.

Include:

- Purpose
- Hypothesis
- What a mineral is These are the class concepts
- How mineral properties can be used to identify them. These are the class concepts
- Basic explanation of what was done in lab.

Procedure: Discuss the observations made in the lab, both direct and indirect. Include details as needed.

Explain:

- Each of the properties used to identify and whether they were a direct or indirect observations.
- How those properties were used in the identification.

Data: Any collected and classified data can be recorded. A table, spreadsheet, graph, or explanation of observations should be included in the data section.

Include:

- A data table of the mineral properties recorded.
- A data table of the unknown samples.

Conclusion: Discuss the results of the lab and justify the results based on what was observed and recorded through data collection. A conclusion represents all parts of the report and connects each part in a summary. Use what was written in previous sections to write an evaluation of the process used to identify unknown minerals using their properties. Think about the process and create a synthesis of all the parts by using the concepts in the introduction. See the class example to get an idea of what this includes.

APPENDIX J

TREATMENT 1: MINERAL LAB RUBRIC

Appendix J
Treatment 1: Mineral Lab Rubric

___ / 60

	Introduction What is the purpose of this lab?	Procedure How the lab was performed.	Data Recorded observations.	Conclusion I: The results of the lab.	Conclusion II: The results of the lab.	Grammar: Title, spelling, use of pronouns, format.
10	Clear, accurate description of mineral lab. Includes a hypothesis, a definition of a mineral, and how properties are used to identify.	Procedure is complete and comprehensive and includes processes used for each property.	10 correctly identified minerals, no missing data sheets, mineral sheet highlighted.	Conclusion clearly stated and well written. The results of the lab were justified based on a thorough analysis of data.	Conclusion uses the concepts mentioned in the introduction to support a evaluation that combines all parts of the lab, particularly data collection and interpretation.	Appropriate title, no spelling errors, no pronouns, and correct format
8	Description incomplete.	Procedure is missing a few details.	9 – 6 correctly identified minerals, no missing data sheets, mineral sheet highlighted.	Conclusion adequate with few errors.	Makes a connection, but is not completely thorough.	Appropriate title, few spelling errors, few pronouns, and correct format
6	Vague incomplete description.	Procedure incomplete, unclear, or missing key details.	5 - 3 correctly identified minerals, has data sheet.	Conclusion not clearly identified or described	Some basic ideas are presented but the connection between them is missing	Appropriate title, several spelling errors, numerous pronouns, and correct format
4	Inconsistent or confusing description.	Very limited procedure, inaccurate, or confusing.	3 - 1 correctly identified minerals, has data sheet.	Conclusion incomplete or inaccurate description.	Inconsistent or confusing.	Appropriate title, no spelling errors, no pronouns, and incorrect format
2	Made up, or inaccurate description	Procedure unrelated to mineral lab.	0 correctly identified minerals, has data sheet.	Conclusion is scientifically inept.	Too brief and virtually incomplete.	Incorrect title , many spelling errors, numerous pronouns, and incorrect format
0	Introduction missing.	Procedure Missing.	Data Missing.	Conclusion Missing.	No synthesis present	No title, many spelling errors, pronouns throughout the paper, incorrect format.

APPENDIX K

PRE/POST ASSESSMENT: TREATMENT 2

Appendix K
Pre/Post Assessment: Treatment 2

1. What is a rock?
2. Explain the relationship between a mineral and rock.
3. List and explain the three rock types?
4. How are rocks identified?
5. How would the process of identifying rocks help geologists in their jobs?
6. Construct a diagram of the rock cycle with the three rock types and the processes that allow them to change rock types.

APPENDIX L

TREATMENT 2: PRE/POST UNIT CONCEPT INTERVIEW

APPENDIX M

TREATMENT 2: ROCK LAB PROCEDURES

Appendix M
Treatment 2: Rock Lab Procedures

ROCK LAB

Introduction:

The purpose of this lab is to become familiar with the major rock groups; Igneous, Sedimentary, and Metamorphic. You will identify and classify rocks based on their origin, texture, and mineral composition.

Procedure:

Data tables and dichotomous keys for each of the 3 rock groups are provided to record and classify the data collected. A fourth chart of unknown rock samples is also included. You are to determine the rock group, the classification scheme, and the identity of 5 unknown rock samples.

1. The “flow charts” are *Class Sets*, which you are to return before leaving.
2. The lab will be completed in the same groups as the mineral lab.
3. Put your desks together and work in a civil manner to identify the rocks.
4. There are “four stations” of rocks per group. The stations are located on the cardboard trays, which are found on the back lab counter.
5. DO NOT mix up the rocks!!!! The rocks have specific sample numbers.
6. Use the to dichotomous keys to identify the rocks.
7. Record as much data as possible on the provided charts.
8. When the identification process is complete, you will then work on the report.

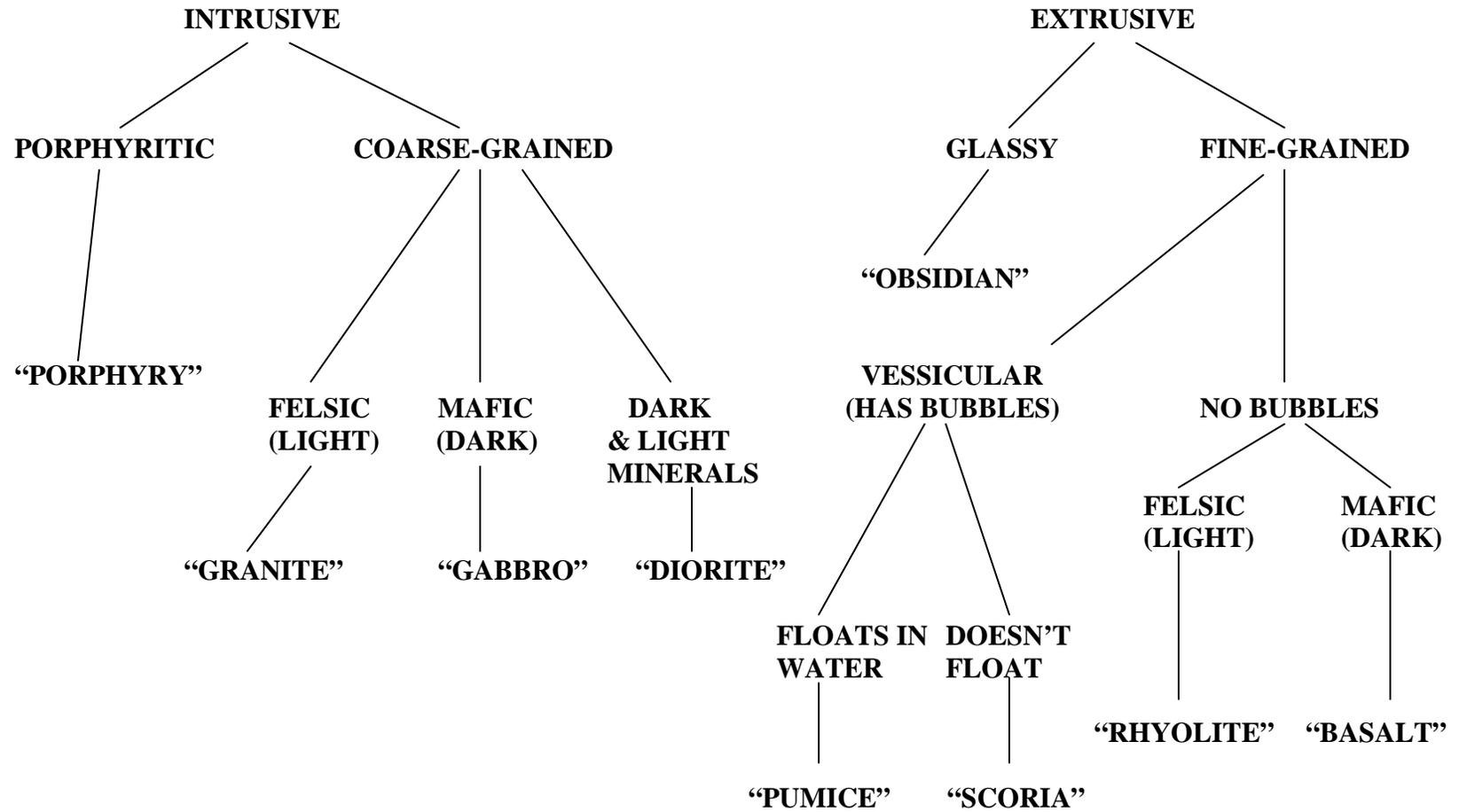
Report:

You will be required to write a report that has four sections. Follow the format and the rubric for specific details.

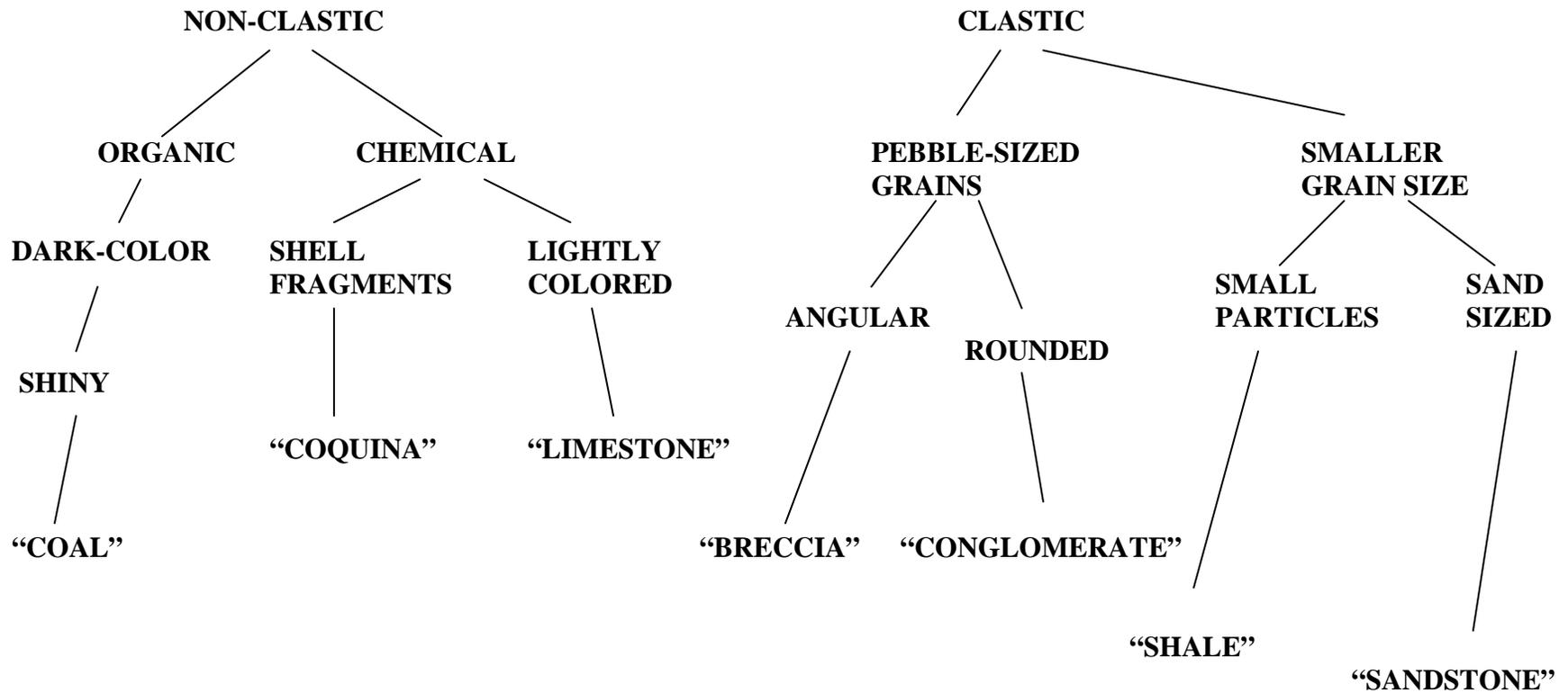
Your report will contain the following information:

- ✓ **INTRODUCTION:** Write a brief paragraph that details what you are investigating and the purpose of this lab activity. Include three factors that geologists use to identify rocks and how rocks types are differentiated.
- ✓ **PROCEDURE:** Explain how you collected the data and the processes you went through to identify what each unknown rock sample was.
- ✓ **DATA:** Include the data charts.
- ✓ **CONCLUSION:** Explain what troubles you had with the identification. Explain the value of having a procedure to identify rocks and how that is helpful to scientists. Discuss the differences between the three rock types and the key to identifying them.

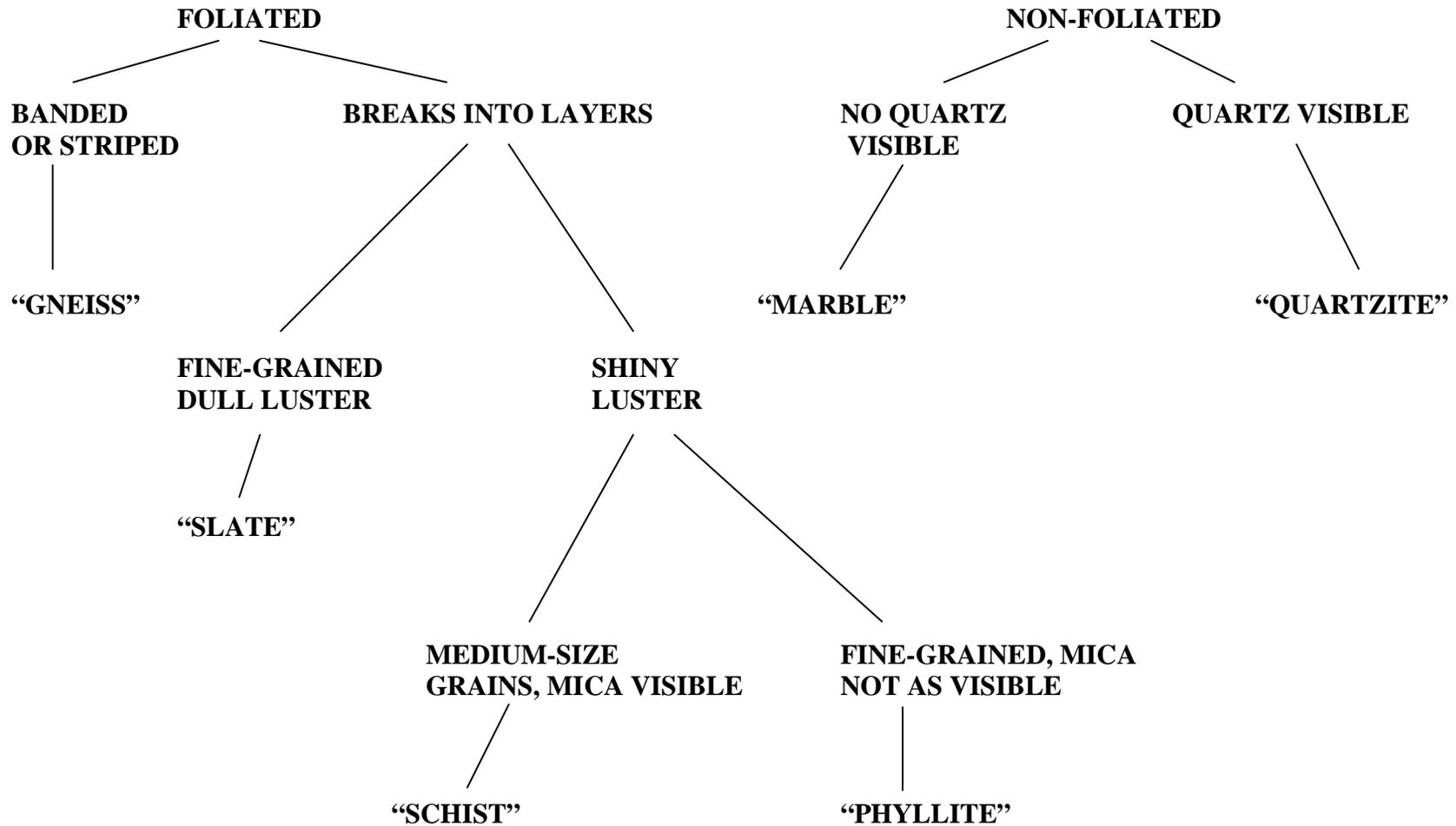
IGNEOUS ROCK FLOW CHART (Class Set)



SEDIMENTARY ROCK FLOW CHART (Class Set)



METAMORPHIC ROCK FLOW CHART (Class Set)



APPENDIX N

TREATMENT 2: ROCK LAB FORMAT

Appendix N
Treatment 2: Rock lab format

Earth Science Lab Format

- Always use the instruction sheet/manual as a guide for writing the report, especially when determining what the lab report should contain. Use your notes as reference too.
- There should be at least FOUR sections for written lab reports.
- The report is a piece of technical writing and is to be written in the third person without the use of pronouns. Each section below prompts the writing with statements or questions that should be answered in each section.
- A person should be able to replicate and/or interpret the lab exercise, making the lab testable through sound scientific methods.

Use the format below for the lab report.

Introduction: The introduction should provide the purpose or objective of the lab through a rational explanation. Provide an overview of what the lab entails.

Include:

- A statement of purpose or an objective of the lab.
- Explain what a rock is and include a basic description of the three types of rocks
- How origin, texture, and mineral composition can be used to identify rocks.
- Basic explanation of what was completed in the lab as an overview.

Procedure: Discuss the observations made in the lab, both direct and indirect. Include details as needed.

Explain:

- How a dichotomous key was used to identify the rocks by their origin, texture, and mineral composition

Data: Any collected and classified data can be recorded. A table, spreadsheet, graph, or explanation of observations should be included in the data section.

Include:

- A data table of the rocks recorded with the number of the unknown samples.

Conclusion: Discuss the results of the lab and justify the results based on what was observed and recorded through data collection. A conclusion represents all parts of the report and connects each part in a summary. Use what was written in previous sections to write an evaluation of the process used to identify unknown minerals using their properties. Think about the process and create a synthesis of all the parts by using the concepts in the introduction. See the class example to get an idea of what this includes.

APPENDIX O

TREATMENT 2: ROCK LAB RUBRIC

Appendix O
Rock Lab Rubric

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	Introduction What is the purpose of this lab?	Procedure How the lab was performed.	Data Recorded observations.	Conclusion I: The results of the lab.	Conclusion II: The results of the lab.	Grammar: Title, spelling, use of pronouns, format.
10	Clear, accurate description of rock lab. Includes a hypothesis, an explanation of the 3 rock types, and how geologists use origin, texture, and mineral composition to identify rocks.	Procedure is complete and comprehensive and includes processes used for each property.	At least 20 correctly identified rocks, no missing data sheets	Conclusion clearly stated and well written. The results of the lab were justified based on a thorough analysis of data.	Conclusion uses the concepts mentioned in the introduction to support a synthesis that combines all parts of the lab, particularly data collection and interpretation.	Appropriate title, no spelling errors, no pronouns, and correct format
8	Description incomplete.	Procedure is missing a few details.	15 – 19 correctly identified rocks, no missing data sheets	Conclusion adequate with few errors.	Makes a connection, but is not completely thorough.	Appropriate title, few spelling errors, few pronouns, and correct format
6	Vague incomplete description.	Procedure incomplete, unclear, or missing key details.	10 - 14 correctly identified rocks, has at least data sheet	Conclusion not clearly identified or described	Some basic ideas are presented but the connection between them is missing	Appropriate title, several spelling errors, numerous pronouns, and correct format
4	Inconsistent or confusing description.	Very limited procedure, inaccurate, or confusing.	5 - 9 correctly identified rocks, has at least data sheet	Conclusion incomplete or inaccurate.	Inconsistent or confusing.	Appropriate title, no spelling errors, no pronouns, and incorrect format
2	Made up, or inaccurate description	Procedure unrelated to rock lab.	0 - 5 correctly identified rocks, has at least data sheet	Conclusion is scientifically inept.	Too brief and virtually incomplete.	Incorrect title , many spelling errors, numerous pronouns, and incorrect format
0	Introduction missing.	Procedure Missing.	Data Missing	Conclusion Missing.	Conclusion Missing.	No title, many spelling errors, pronouns throughout the paper, incorrect format.

APPENDIX P

TIMELINE

Appendix P
Timeline

Note: CHS uses an A/B Block schedule. Students are in class every other school day for 90 minutes.

January 26th – Nontreatment Unit begins.

Give Unit Pretest

Give Preunit Concept Interviews

Teach matter and give matter concept map

January 28th – Teach atomic structure

February 1st – Review previous concepts and give atomic structure assignment

February 3rd - **Give Unit Posttest**

February 7th – Treatment Unit 1 begins

Give unit pretest

Give Preunit Concept Interviews

Give Student Questionnaire

Teach mineral characteristics and properties

February 9th – Give mineral reading assignment and begin mineral lab

February 11th – finish mineral lab data collection

February 15th – work on mineral lab report in computer lab

February 17th –Finish mineral lab report in computer lab

Give Unit Posttest

Administer Student Interviews

Administer Student Surveys

February 22nd – Treatment Unit 2 begins

Give Unit Pretest

Give Preunit Concept Interviews

Teach rock types and identification techniques

February 24th – Begin rock lab

Collect mineral lab report

February 28th – Finish rock lab

March 2nd - work on rock lab report in computer lab

March 4th –Finish mineral lab report in computer lab

Administer Student Interviews

March 8th – Give Unit Posttest

Administer Student Surveys

March 10th – Exam

Collect rock lab report

Administer Teacher Interviews

Give Teacher Questionnaire

Administer Administrator Interview

APPENDIX Q

TEACHER JOURNAL PROMPTS

Appendix Q
Teacher Journal Prompts

Lesson:

Date:

Objective:

1. General reflections on the lesson/activity:

2. Reflections on student level of motivation (1 is low, 5 is high). 1 2 3 4 5
Explain rating.

3. Reflections on teacher level of motivation (1 is low, 5 is high). 1 2 3 4 5
Explain rating.

APPENDIX R
STUDENT SURVEY

Appendix R
Student Survey

Please complete this survey on scientific report writing in earth science. Answer each question to the best of your ability and provide as much information as you can. Your answers will help me know if teacher collaboration on earth science labs and reports helps you learn. You do not have to place your name on the survey.

Use the following scale where appropriate: 1 (strongly disagree), 2 (disagree), 3 (indifferent), 4 (agree), 5 (strongly agree).

1. Earth science is an interesting subject. 1 2 3 4 5

2. Earth science is a difficult subject. 1 2 3 4 5
Explain why?

3. Working with others on this lab has helped me understand the concept. 1 2 3 4 5
How?

4. I feel more active in class during labs, especially when I know I have to produce a report. 1 2 3 4 5

5. Writing a report motivates me to understand the topic. 1 2 3 4 5
How?

6. The report was difficult to write. 1 2 3 4 5
Explain why?

7. I learned more about the concept by writing the report. 1 2 3 4 5
How?

8. I felt like I understood the concept better because I had to explain it myself. 1 2 3 4 5
Provide detail.

APPENDIX S

TEACHER INTERVIEW

Appendix S
Teacher Interview

1. Do you prefer working individually as a teacher or with other earth science teacher in collaboration? Why?
2. How has teacher collaboration impacted your students' understanding of earth science?
3. Did the materials that we developed for minerals and rocks help with teaching the content? If so, how?
4. Did writing the report help students' understanding of the concept better? How?
5. Did the outline for the report help students' understand what to include with the report? How?
6. Did rubric with the report help students' understand the concept better? How?
7. Did the activities that supplemented the lab and the report help students understand better? How?
8. What was the impact of collaborating on instructional strategies that are targeted to remedying students' lack of understanding in addition to assessment strategies? Explain.
9. Why is it important to consider instructional strategies? Explain.
10. How is using improved teaching strategies and closing the feedback loop of understanding related to assessment? Explain.
11. What was the feedback from your students regarding the lab and the subsequent reports?
12. Did you give pre and post assessments of the content for minerals and rocks?
13. Was there marked improvement?
14. What do you think the benefit of writing the report was to your understanding of the concept?
15. Do you think that because teachers collaborate about this class, that helps students to understand?
16. Is there anything else you would like to add?

APPENDIX T

TEACHER QUESTIONNAIRE

Appendix T Teacher Questionnaire

Please complete this survey on the effects of teacher collaboration and the implementation of scientific report writing to determine the effects on student understanding in earth science classes.

Answer each question to the best of your ability and provide as much information as you can. Your answers will help me assess if teacher collaboration on earth science labs and reports helps our students learn.

Use the following scale where appropriate: 1 (strongly disagree), 2 (disagree), 3 (indifferent), 4 (agree), 5 (strongly agree).

- | | |
|--|-----------|
| 1. Collaboration for earth science has been a successful endeavor. | 1 2 3 4 5 |
| 2. Collaboration has helped my students understand earth science.
Provide an example. | 1 2 3 4 5 |
| 3. Considering instructional strategies in an important part of
Collaboration. | 1 2 3 4 5 |
| 4. Considering how to help students understand curriculum
concepts is an important part of collaboration. | 1 2 3 4 5 |
| 5. Relating teaching strategies to assessment strategies is important. | 1 2 3 4 5 |
| 6. Working with other teachers has increased my level of commitment
to collaboration. How? | 1 2 3 4 5 |
| 7. My students are more engaged in class during labs, especially when
they have a lab that requires producing a report. | 1 2 3 4 5 |
| 8. I feel a stronger motivation when my students are actively engaged.
Why? | 1 2 3 4 5 |
| 9. I attribute a high level of my motivation to collaboration.
Provide detail? | 1 2 3 4 5 |
| 10. Feel free to provide any other information. | |

APPENDIX U

ADMINISTRATOR INTERVIEW

Appendix U
Administrator Interview

1. Do you think teacher collaboration is valuable for improving student understanding? How?
2. Do you think that collaboration inherently motivates students to engage in earth science classes if the activities are developed with collaborative efforts? Why?
3. When could you observe the effects of collaboration using the instructional strategy employed, or the lack thereof, during the classroom observations of my lessons? Explain.
4. What is your perception of the relationship between instructional strategies and assessments.
5. How do you see future collaboration on instructional strategies develop in relationship to assessment?
6. What did you observe that was valuable to student understanding of the lesson content when students were reporting on the lab activities they completed? Explain.
7. Do you think that because teachers collaborate about this class, that helps students to understand?