THE EFFECTS OF DESCRIPTIVE FEEDBACK ON STUDENTS' LEARNING OUTCOMES AND ATTITUDES TOWARD SCIENCE

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By

MELANIE LABUS

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Advisor:

Valentina M. Abordonado, Ph.D

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Abstract

The study investigated the effects of descriptive feedback without using letter grades on elementary students' learning outcomes and attitudes toward science.

This mixed-method research study was a case study that included a pre-and post-survey and pre-and post-test. It was conducted in a fourth-grade classroom with fourteen female students in the Honolulu downtown area.

The primary data was collected from the students through surveys, assessments, and portfolios to provide the researcher with better information about the effects of descriptive feedback on students' learning outcomes and attitudes toward science. The data analysis method was mainly represented in a qualitative manner; however, a few quantitative analyses were presented. Criterion sampling strategies were applied to collect qualitative and quantitative data, including surveys and questionnaires.

Along with the theory researched for the literature review, the study revealed specific strategies that positively impacted students' learning outcomes and attitudes toward learning.

Through the study, the reader will discover new meaning, extend the readers' experience, or knowledge, or confirm what the reader already knows. The study is linked to the literature of progressive approaches in education.

Keywords: descriptive feedback, progressive approaches, elementary science education, alternatives to letter grades

The Effects of Descriptive Feedback on Students' Learning Outcomes and Attitudes toward Science

Introduction

Imagine a teaching tool that prioritizes students' learning and takes the stress out of grading. Imagine students who are free from stress and anxiety, who understand their learning progress, and who do not have to worry about grades. Imagine a tool that not only positively impacts students' learning outcomes but also improves their attitude toward learning.

Such a tool might sound familiar; it is called formative assessment without the use of letter-grades.

This study sought to learn more about the characteristics of formative assessments, how to effectively use formative assessments in the classroom (especially in science), and to learn how formative assessments affect students' learning outcomes and attitudes toward learning.

Statement of the Problem

The practical problem of this study emanates from my own beliefs and assumptions captured from personal experiences dealing with assessing students in elementary schools. Having experienced assessment of student learning firsthand, I have formed my belief that assessing students should be an ongoing process in which they feel safe and genuinely understand the learned concepts. In my experience, assessing students through letter grades results in anxiety and disinterest, and fear of school. This study shows the effect of using descriptive feedback as a formative assessment technique without using letter grades and to determine how it will affect students' attitudes and learning outcomes. The theoretical concept that is used to underpin the problem of using letter grades to assess students' comprehension

including research on approaches to formative assessment, studies of school systems that do not use letter grades, studies of the use of letter grades in relation to student's well-being, and studies of students' attitude toward learning and learning outcomes when using formative assessments in the classroom.

Review of Literature

Development of Formative Assessments

Formative assessment tools have been around since the early 1970s. Benjamin Bloom was one of the first educational pioneers who applied formative versus summative techniques to educational assessments (Greenstein). Bloom helped to lay the foundation for the concept of mastery learning. During the early developmental stages of formative assessments, teachers could differentiate instruction to meet individual students' needs by selecting teaching strategies and corrective responses that fit those specific needs (Greenstein).

Nowadays, formative assessments are still powerful assessment tools that help provide information about how students receive information, how well students understand the content, and how well students can apply the learned content. Through formative assessments, teachers gather information about their students' progress and learning needs. Formative assessments are powerful and essential tools that need to be implemented in todays' lessons because they provide opportunities for students to improve, they offer objective student self-assessments, they track individual student achievement, they consider each student's learning needs, and they adapt instruction accordingly (Greenstein). In short, formative assessments are student-focused, instructional, informative, and based on learning outcomes.

Now more than ever, it is essential to use progressive teaching approaches in the classroom to better prepare students for the real world. One of the many progressive approaches in education is formative assessments. It assesses students through activities. Providing ongoing feedback to help identify students' strengths and weaknesses and to target those areas. Formative assessment has risen in importance and has gained support as a useful teaching tool because it is a valid and vital part of teaching and assessment (Ozan, 2018). It provides feedback for students to increase their academic achievement, it informs teachers about students learning progress, and it directs teachers in their planning and teaching activity selections.

Components of Formative Assessment

According to Ozan (2018), there are four main components of formative assessment. The first component involves explaining learning objectives and success criteria, which helps students to become active participants and lets them know what and why they will learn. The second component entails increasing the quality of inquiry through questions or dialogues that actively involve students in their learning process. These questions need to be effective at determining the learner's depth of knowledge. The third component includes increasing the quality of feedback and record keeping. Providing feedback is an essential part of formative assessments because it informs students about their learning and teachers about their teaching strategies (Ozan, 2018). The last component of formative assessment concerns the use of self and peer assessment. Self-assessment is an excellent strategy that provides students with immediate feedback on their performance and gives them suggestions for improving what they learn and how they learn.

Descriptive Feedback on Students Academic Achievement

The book "Visible Learning" written by Hattie, includes evidence-based research into what works in schools to improve learning. One of Hattie's research projects included 52,637 studies and investigated the effects of educational factors on students' academic achievement. Formative assessment was the third most influential factor among 138 factors for students' achievement (Hattie, 2009). Constructive and descriptive feedback, one of the essential components of formative assessment, came in at an eighth place. Descriptive feedback is a formative and gradeless assessment that provides useful comments and suggestions that lead to successful teaching and learning. Descriptive feedback should be tailored to specific needs and performance, and should be factual, timely, relevant, and encouraging (Ovando, 1994).

Gradeless Assessments

Also, gradeless assessments such as descriptive feedback support, report learning better than grades (Brookhart, 2019). Optimizing students' performance and understanding, feedback, and opportunities to use the feedback would be ideal. Teachers can independently follow strategies to change grading practices; for example, they can implement formative assessments more frequently. According to Brookhart, increasing teachers' knowledge of feedback concepts and strategies takes professional development, but increasing skills in delivering feedback comes with practice.

Correlation between letter grades and students' well-being

Formative assessment should be gradeless because it reduces students' anxiety and stress levels, which affects their attitude toward learning. Students often undergo relentless pressure to succeed, often measured by letter grades, resulting in students being sleep-deprived, anxious, and even engaging in self-harm (Feldman, 2020). A study from Stanford University's Challenge

Success program surveyed roughly 54,000 students between January 2019 and February 2020 and showed that over seventy percent of students reported that they always or often worry about the possibility of not doing well in school, feel stressed by their schoolwork, and worry about taking summative assessments (Feldman, 2020). In fact, Luckett and Sutherland found that feedback provided through formative assessment has significant benefits when motivating students, helping students improve their learning, reinforcing their work, and providing them with a learning profile.

Grade-Less School Systems

Letter grades have been around since the late 16th century. They are still used as the primary assessment tool to evaluate student's performance and learning progress in the United States' school system. Although letter grades have evolved over the years and been replaced with other forms of assessments, the standardized grading system is an ingrained part of American schooling and hard for many people to imagine school without it (Suzi An).

Progressive schools, such as public schools in the Winnetka district (Illinois), have been integrated the grade-less report card to include detailed comments by the teachers. The report card emphasizes the commitment to equity for all students and reflects individuals' school performance through a set of four tiers. The four tiers include Exemplary, Commendable, Underperforming/Comprehensive, and Lowest Performing/Targeted (School Report Cards). The different tiers explicitly state if a student is developing a specific skill, whether the student is mastering a skill or needing extra help to master a particular skill.

The Winnetka school district adopted the report cards in 2018 and has helped teachers, students, and parents better understand students' learning progress. A parent of the Winnetka school

district stated that the report cards helped him understand how to better support his children through the feedback on the report cards. He also said that he prefers to receive detailed feedback from teachers instead of only being informed about his children's grades. This particular progressive approach in education has a positive impact on parents and the learner itself. A student who grew up going to Winnetka Public School District said that through the progressive approaches at his school, the focus is on understanding the content and teaching more to engage the student than teaching to a test (Suzi An).

Statement of Hypothesis

Drawing from the literature review, gradeless assessments are a vital progressive approach in todays' education. It was interesting that most of the research review included components of formative assessments and how it affected students' academic growth. Research to validate the factors extracted from the literature review on formative assessment and specializing in descriptive feedback appeared to be relevant and meaningful. Therefore, it was hypothesized that descriptive feedback positively affects elementary students' learning outcomes and attitudes toward science.

Method

Description of Community Factors

The research study took place at St. Andrew's Priory. St. Andrew's School is a private school located in Honolulu, Hawaii, on Oahu's southern coast. St. Andrew's School includes The Priory, an all-girls K-12 program; The Prep, the all-boys K-5 program; and a Preschool. The preschool is located on Pali Highway, while The Priory and The Prep are located on the main downtown campus by Queen Emma Square. The downtown campus consists of the Centennial

Hall, Jubinsky Hall, Kennedy Hall, Sellon Hall, Transfiguration Hall, and the Weinberg Center ("Home -St. Andrew's Schools", 2021).

A 2019 census collected for urban Honolulu estimated a population of 345,064, which is approximately 35 percent of Oahu's population. The socio-economic statistics show a median household income of $71,465, which is significantly smaller than the median household income of Honolulu County of $85,857. Interestingly, 37 percent of the persons age 25 and older in the community have a college degree, and 11 percent of the community do not have a high school diploma ("Census", 2019).

The census numbers on race and ethnicity highlight the increasingly diverse population of urban Honolulu. Approximately 53 percent of urban Honolulu is Asian, which is the largest racial group in the community. Eighteen percent are residents with multi-ethnic backgrounds (two or more races), 17 percent are White, eight percent are Native Hawaiian and other Pacific Islander, seven percent are Hispanic or Latino, two percent are Black or African American, and 0.1 percent is American Indian and Alaska Native ("Census", 2019).

Description of School Factors

St. Andrew's Priory has a total of 117 students, without information on race or students with special needs. According to the school, St. Andrew's does not have a special education population because they do not have a population designated as special education. The English Language Learner population of St. Andrew's Priory is also unknown ("Home -St. Andrew's Schools", 2021). However, according to Census, 36.5 percent of the Honolulu Urban community speaks a language other than English at home ("Census", 2019).

Description of Classroom Factors

The 4th-grade classroom was an all-girls classroom with a total of 15 students. Twelve students participated in face-to-face learning, meaning that the class content was taught in person with live interactions between learner and teacher. Three out of fifteen students participated via zoom, which allowed them to connect online in real-time. The student-teacher ratio was 15 to one.

Due to safety reasons, students sat 6 feet apart from each other in a 6-row seating arrangement. In the front of the classroom were a projector, whiteboard, teacher's desk, and a carpet. Along the right side of the classroom were students' cubbies, student mailboxes, and a computer cart. Each student was provided a MacBook in the class. In the back of the classroom was the library. The two entry/exit doors on the left side of the classroom feature posters, daily homework assignments, learning art, and reminders. The routine and expectations were modeled and well established in the classroom. Science lessons were on Mondays and Tuesdays from 1:30 p.mm-2:20 p.m., and Wednesdays from 11:10 a.m.-noon.

Description of Student Characteristics

The sample size consisted of 14 students ranging in age from 9 to 10 years old. The class included 14 female students: 5 Pacific Islander, 1 White, 4 Asian, 1 Black, 3 Mixed. No information was found on English Language Learner or special needs students. Overall, the students in the class used a mix of learning styles that vary from auditory, visual, kinesthetic, and reading/writing learners.

When looking at the student characteristics, it is vital to understand that every student is unique and brings something valuable to the class community. Every student has their own learning style and processes information differently.

Participants

The research study conducted consisted of a population of students assigned from the Honolulu Downtown area. The target population of the study was elementary students who were enrolled in a science class. The accessible population of my research was a 4th-grade science class that included 14 female students (N=14), ranging in age from nine to ten years old. Various races and ethnicities were represented within the population, which included 5 Pacific Islander, 1 White, 4 Asian, 1 African American, 3 Two or More Races.

Sampling Procedures

The non-probability sampling method finds in this research includes a criterion sample because the participants met the predetermined criteria of importance, which were elementary students enrolled in science. The criterion sampling strategy was chosen to identify and understand the effect of formative assessment in a science classroom through descriptive feedback.

The sample size, which combined 14 participants, does not represent the target population because the population designated to the study was limited through the school's placement choice. Although the class included 15 students, only 14 students and their parents gave consent to participate in the study. Generalization is not supported due to the small sample size (small-N problem). Results may differ when conducting the research at other schools due to the various variables such as gender, location, age, school resources, ethnicities, classroom size, student characteristics, and school factors.

There was no cost or personal benefit for participating in this research study; the participants were not compensated for participating in the study. All participation was voluntary,

and the participants and their guardians granted their consent before participating in the research study. Participants had the freedom to withdraw from this research at any time without getting penalized if they choose not to participate.

The majority of the survey and assessment focused on the participants' science background knowledge, performance, and attitude toward science. The surveys, tests, and portfolios were confidential, and the data was collected via google forms. The google forms were stored and analyzed through an online platform (Gmail) and protected by the researcher's login credentials.

The research design was approved by the Institutional Research Board (IRB) of Hawaii Pacific University (HPU), which made certain ethical and legal standards were met.

Measures

This study used a mixed-method research design of both quantitative (surveys and tests) and qualitative (observations) data. To find the answer to the research problem, the researcher collected data from various sources, such as surveys, tests, observation protocols, and portfolios. The pre-and post-surveys (Appendix A) and pre-and post-tests (Appendix B) were created by the researcher and were taken by the participants before and after teaching the science unit. The surveys and tests helped to quickly and easily gain a lot of information from the participants in a non-threatening way. Another method that was used to gather relevant information for the study was a research observation protocol (Appendix C), in which the researcher recorded essential findings. This method helped to gather accurate information about how formative assessment affects students' attitudes toward learning. Another data collection tool was the learning outcome (product) of students, a science portfolio (Appendix D). The portfolios helped gain a more in-

depth understanding of the topic and the concept being taught. Also, a rubric (Appendix E) was used to provide descriptive feedback in written form at the end of the study. The trustworthiness of the data collection is through the use of a triangulation, where the researcher used multiple data sources to address the research question.

Various data sources were managed as followed:

- Pre-test/pre-survey: Before teaching the science unit
- Post-test/pre-survey: At the very last day of the research study (after the unit was taught)
- Personal observation protocol: throughout the unit
- Portfolios (artifacts): shared with researcher during the entire research
- Rubric: provided with written descriptive feedback at the end of the unit

Research Design

This research study utilized a mixed-methods design, which included qualitative and quantitative frameworks. Factors extracted from the literature review included the effects of descriptive feedback, strategies for providing descriptive feedback, and studies of students' attitudes toward learning and learning outcomes when using formative assessments in the classroom. These factors represented the point of view of professional researchers on formative assessments, but the use of descriptive feedback without using letter grades is rarely included in today's school systems. Thus, the purpose of this study was to explore the effects of descriptive feedback without using letter grades on elementary students' learning outcomes and attitudes.

The hypothesis for the study proposed that formative assessments, in particular descriptive feedback, have a positive effect on the learning outcomes and attitudes of 4th- grade students in science. The researcher used descriptive analysis to obtain a holistic view of the

effectiveness of descriptive feedback approaches on students learning outcomes and attitude. For the quantitative analysis, an electronic pre-and post-survey was used to measure students' attitudes toward science, using a Likert-type scale. An electronic pre-and post-test was also used for the quantitative analysis to examine students' learning outcomes in science. Further, qualitative data was collected from the one-on-one conversations and observation protocols throughout the study.

This study was established without any grant or sponsorship. Therefore, the survey, tests, and portfolios had to be conducted at no cost to the researcher. Electronic distributions were the easiest, safest and quickest way to reach participants. After discussing distribution options with the classroom teacher, google forms and google share was decided as the final solution for sharing and distributing forms during this study. Participants met the following requirements for having access to Google Form and Google Share during the study; each participant had their electronic device (MacBook), Gmail account, and access to Wi-Fi.

Procedures

This study's procedures took place over two semesters, Fall 2020 and Spring 2021, including drafting thesis proposals, initial literature reviews, Collaborative Institutional Training Initiative (CITI) Program Training (Appendix F), IRB application approval, further literature reviews, school placement, conduction of the research study, the written report, and the final presentation.

During the first semester, the draft of the thesis proposal, the initial literature review, the CITI program training, and the IRB application were all completed in sequential order under the close supervision of the thesis course advisor. Before drafting the thesis proposal, different

research techniques were browsed, the research field was narrowed down, and literature for potential proposal was assessed. To meet one of the requirements of the IRB application, the CITI program training was completed, which covered the historical development of human subject protections and information on ethical issues.

After receiving approval for the thesis proposal from the IRB in December 2020, further literature review and lesson planning were carried out during the start of the second semester in January 2021. The school placement was set for the beginning of February. The research was conducted over five weeks, from February 8th to March 12th, 2021. The researcher attended all science lessons during the timeframe, Mondays and Tuesdays from 1:30 p.m.-2:20 p.m., and Wednesdays from 11:10 a.m.-noon.

Before conducting the research, parental consent (Appendix G) and student assent (Appendix H) forms were handed out. Fourteen out of fifteen students and their parents gave consent to participate in the study. All aspects of the study were the same for all participants.

For the first week of the research study (February 8th – February 12th, 2021), observation of classroom dynamics and students' attitude toward learning took place, including the research observation protocols. At the same time, the lesson planning was finalized to teach the upcoming science unit (Appendix I). During the second week of the study (February 15th – February 19th, 2021), participants were asked to take the pre-survey and the non-graded pre-test. Also, participants started to create their portfolios on Google Share. After introducing the science unit and teaching for a whole week, participants received descriptive feedback verbally during small group activities (February 22nd - February 26th, 2021). At the end of the fourth week (March 1st – March 5th, 2021), participants received descriptive feedback verbally again during a one-on-

one session. During the fifth week of the research study (March 8th – March 12th), participants received their final descriptive feedback in a written form (rubric).

Results

The guiding question for this research study was, "Would descriptive feedback with no letter grades as a formative assessment technique positively affect students' learning outcomes and attitudes in science?"

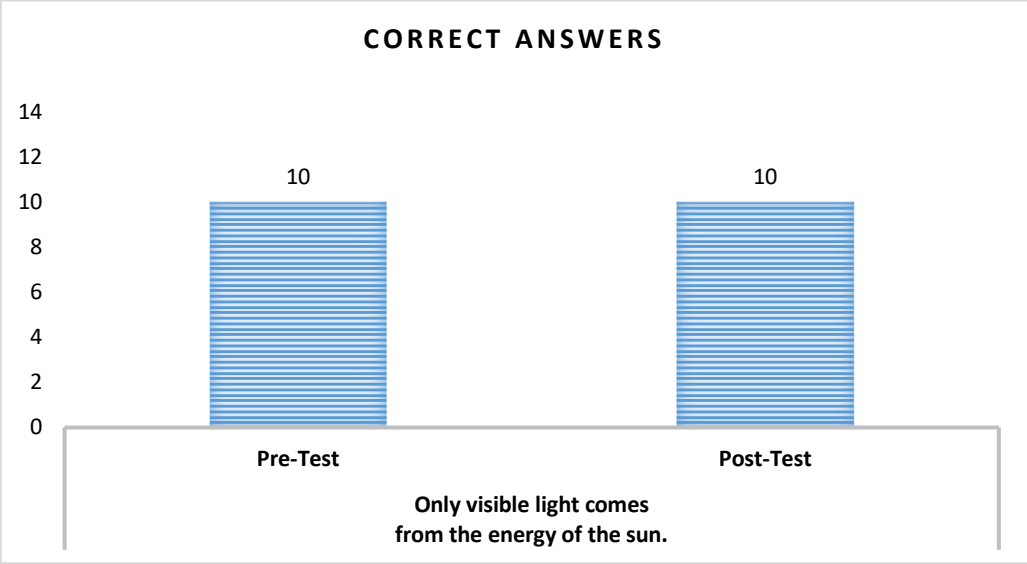
Two factors were examined during this study: students' learning outcomes and students' attitude toward science when only using formative assessment approaches, mainly descriptive feedback. The learning outcome during the study was measured through a pre-and post-test and student portfolios. The attitude of students toward science was measured through a pre-and post-survey and an observation protocol.

The pre-and post-test consisted of 15 questions, eight true and false questions, six multiple-choice questions, and one short answer question. The short answer question was not considered in the analysis because it was an open-ended question. The only purpose of the short-answer question was to determine students' background knowledge further to guide lesson planning. That means that only fourteen questions were calculated in the overall learning performance result. The pre-and post-survey consisted of nine questions, eight Likert scaled questions, and one two-choice question. During the study, each student received the same formative assessments, which included descriptive feedback. The descriptive feedback was conveyed verbally via one-on-one sessions throughout the unit (February 15th, 2021 to March 12th, 2021) and written form through rubrics towards the end of the unit.

Test Results

Figure 1. Question One Pre- and Post- Test Results

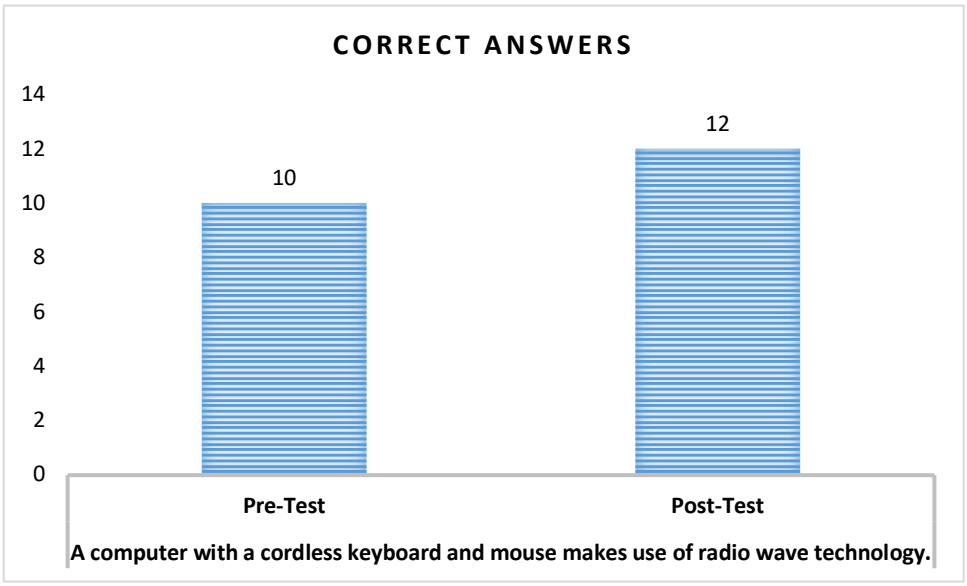
Question One: Examination of Light Energy Sources



This figure shows the number of correct answers of all participants to question one. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "only visible light comes from the sun." Ten participants got the answer correct on the pre-test as well as on the post-test.

Figure 2. Question Two Pre- and Post- Test Results

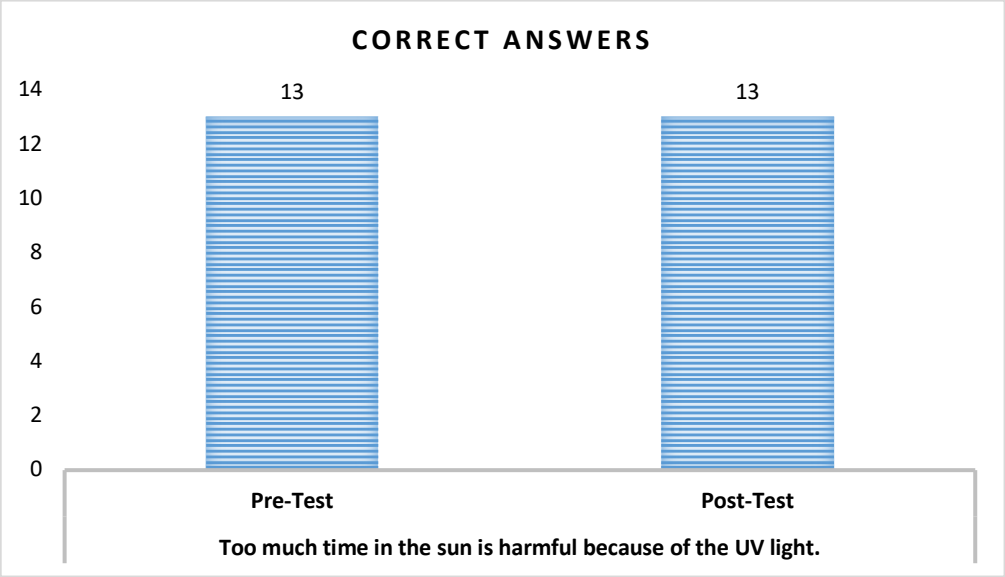
Question Two: Assessment of Electromagnetic Spectrum



This figure demonstrates the number of correct answers of all participants to question two. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "A computer with a cordless keyboard and mouse makes use of radio wave technology." Ten participants got the answer correct on the pre-test and twelve got the question correct on the post-test.

Figure 3. Question Three Pre- and Post- Test Results

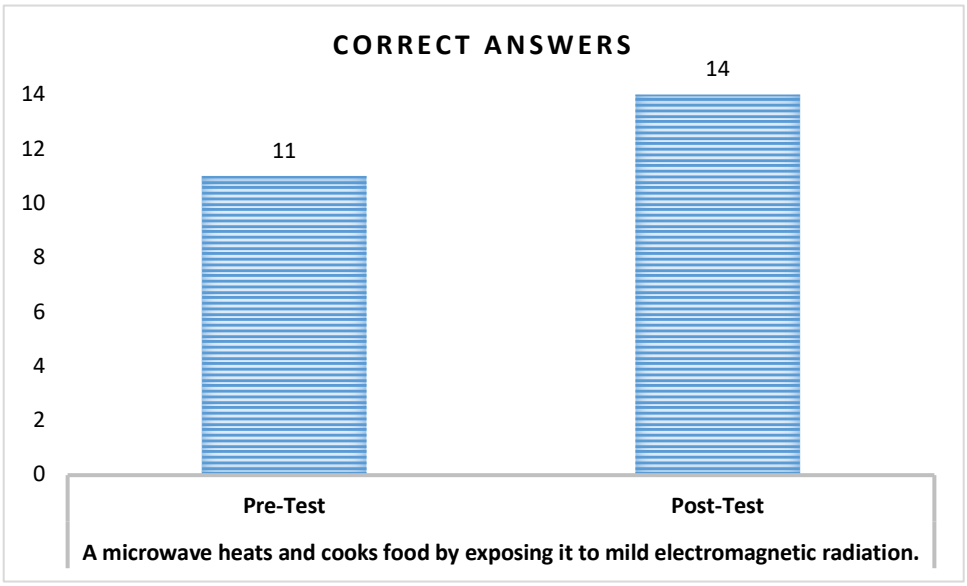
Question Three: Assessing Knowledge of UV Light



This figure displays the number of correct answers of all participants to question three. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "Too much time in the sun is harmful because of the UV light." Thirteen participants got the answer correct on the pre-test as well as on the post-test.

Figure 4. Question Four Pre- and Post- Test Results

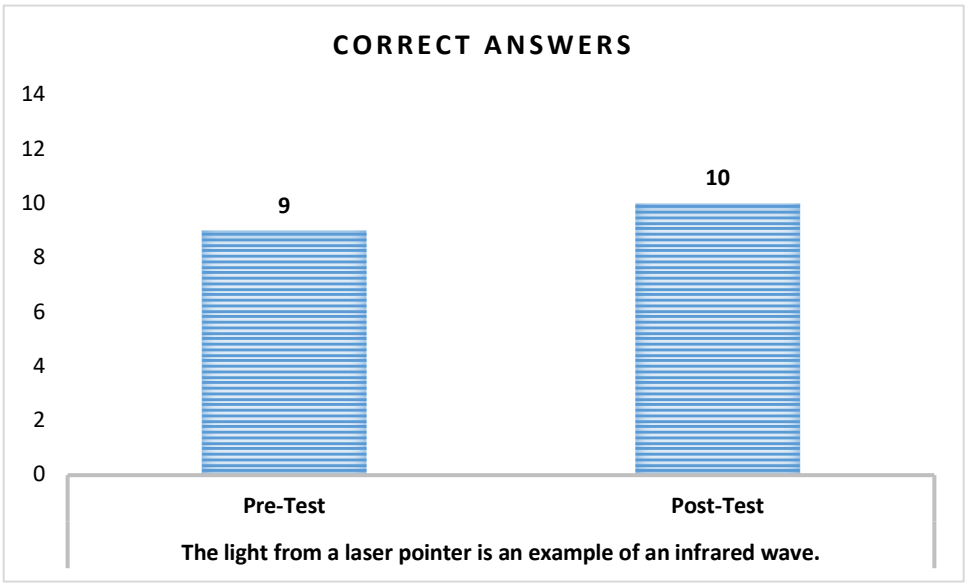
Question Four: Assessment of Electromagnetic Spectrum Knowledge



This figure demonstrates the number of correct answers of all participants to question four. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "A microwave heats and cooks food by exposing it to mild electromagnetic radiation." Eleven participants got the answer correct on the pre-test and fourteen got the question correct on the post-test.

Figure 5. Question Five Pre- and Post- Test Results

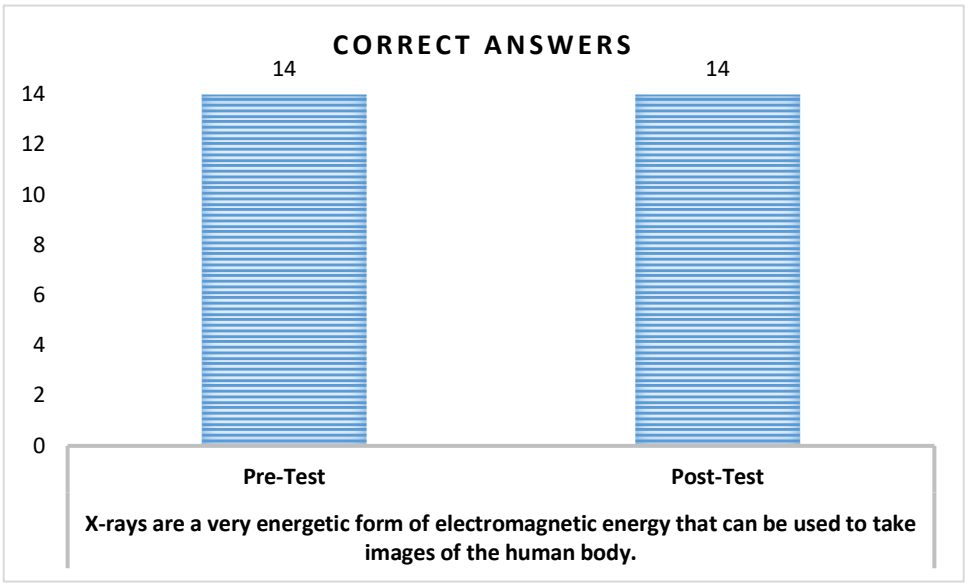
Question Five: Assessment of Electromagnetic Spectrum Knowledge



This figure demonstrates the number of correct answers of all participants to question five. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "The light from a laser pointer is an example of an infrared wave." Nine participants got the answer correct on the pre-test and ten got the question correct on the post-test.

Figure 6. Question Six Pre- and Post- Test Results

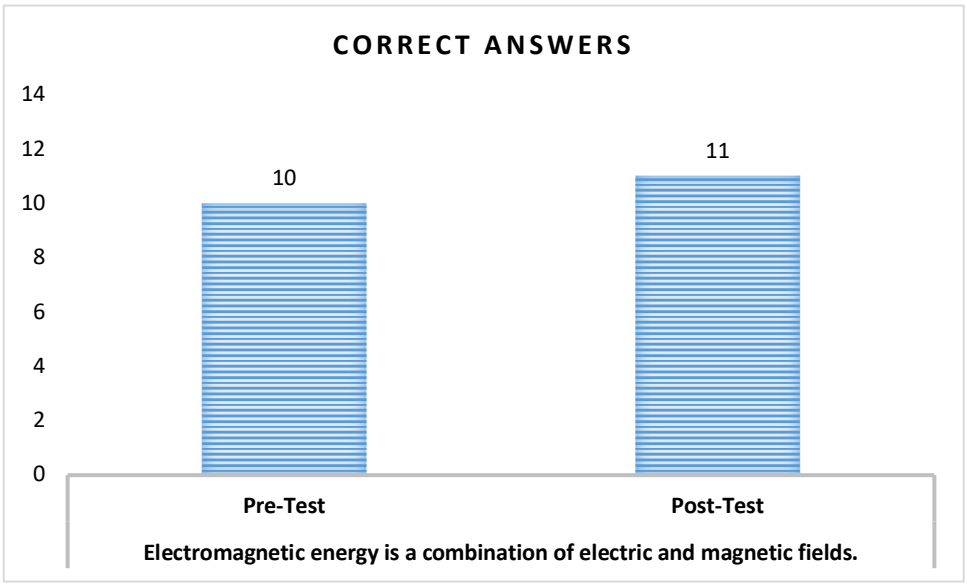
Question Six: Assessment of Electromagnetic Spectrum Knowledge



This figure shows the number of correct answers of all participants to question six. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "X-rays are a very energetic form of electromagnetic energy that can be used to take images of the human body." Fourteen participants got the answer correct on the pre-test as well as on the post-test.

Figure 7. Question Seven Pre- and Post- Test Results

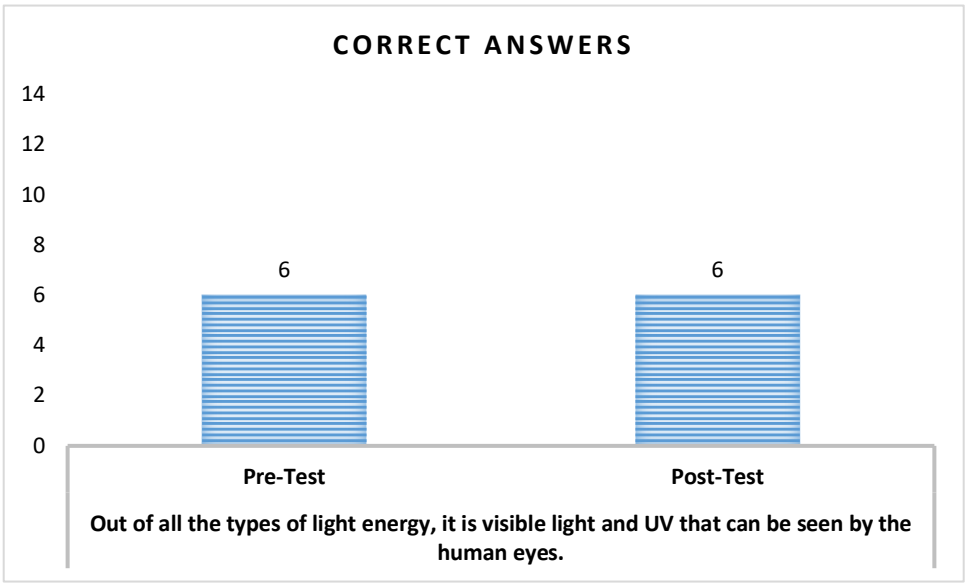
Question Seven: Assessment of Electromagnetic Energy Knowledge



This figure shows the number of correct answers of all participants to question seven. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "Electromagnetic energy is a combination of electric and magnetic fields." Ten participants got the answer correct on the pre-test and eleven participants got the answer correct on the post-test.

Figure 8. Question Eight Pre- and Post- Test Results

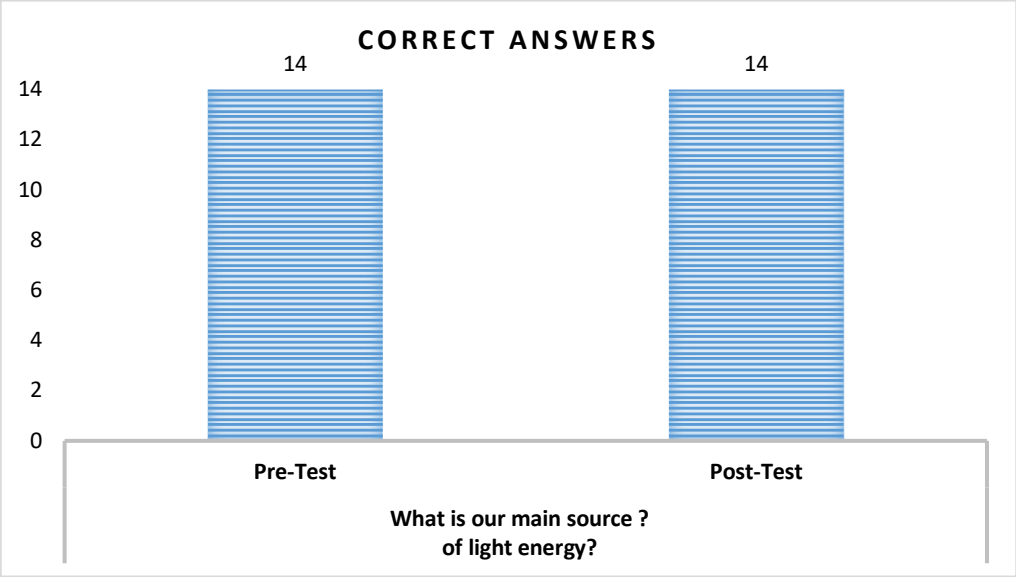
Question Eight: Assessment of Different Types of Light Energy



This figure illustrates the number of correct answers of all participants to question eight. It compares the number of correct answers from the pre-test to the post-test results. This true or false question consisted of the statement "Out of all the types of light energy, it is visible light and UV that can be seen by the human eyes." Six participants got the answer correct on the pre-test as well as on the post-test.

Figure 9. Question Nine Pre- and Post- Test Results

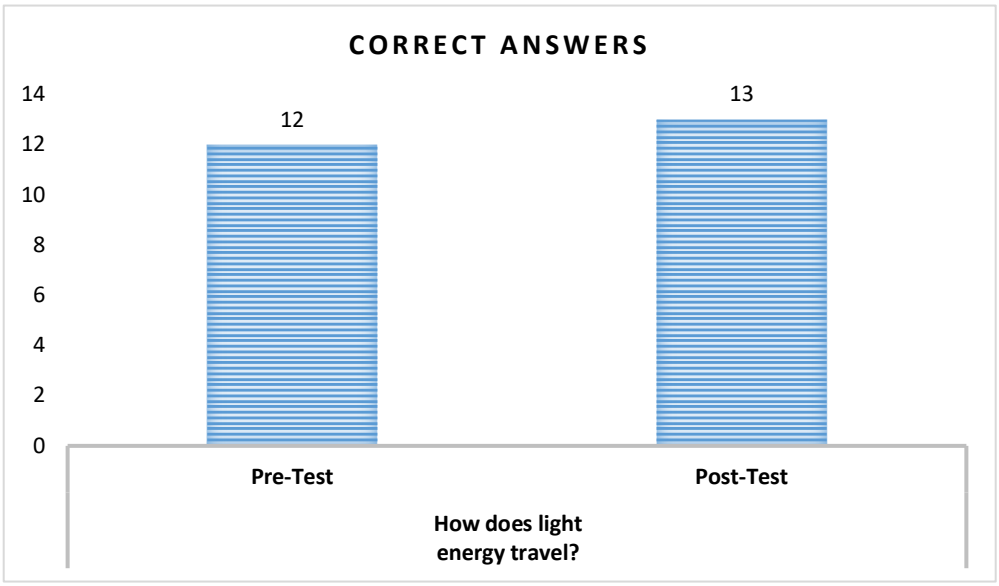
Question Nine: Assessment of Different Types of Light Energy



Note. This figure illustrates the number of correct answers of all participants to question nine. It compares the number of correct answers from the pre-test to the post-test results. This multiple-choice question consisted of the question "What is our main source?" Fourteen participants got the answer correct on the pre-test as well as on the post-test.

Figure 10. Question Ten Pre- and Post- Test Results

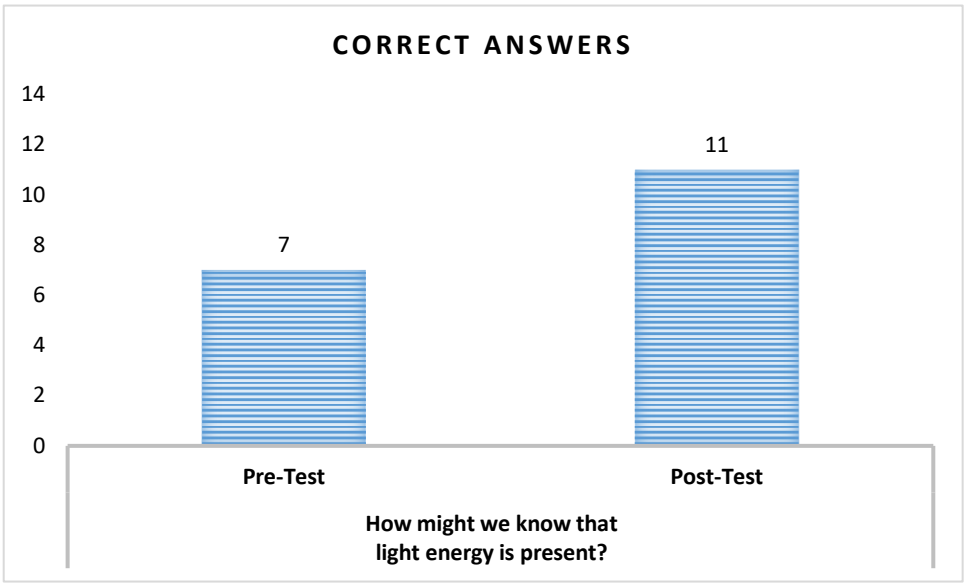
Question Ten: Examination of Light Energy Characteristics



This figure illustrates the number of correct answers of all participants to question ten. It compares the number of correct answers from the pre-test to the post-test results. This multiple-choice question consisted of the question "What is our main source?" Twelve participants got the answer correct on the pre-test and thirteen participants got the question correct on the post-test.

Figure 11. Question Eleven Pre- and Post- Test Results

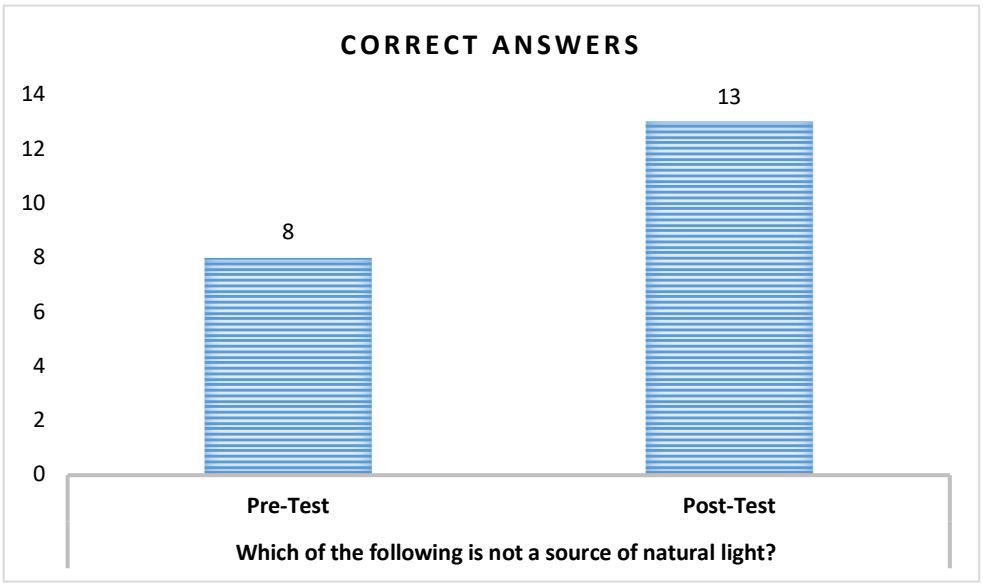
Question Eleven: Examination of Light Energy Characteristics



This figure displays the number of correct answers of all participants to question eleven. It compares the number of correct answers from the pre-test to the post-test results. This multiple-choice question consisted of the question "How might we know that light energy is present?" Seven participants got the answer correct on the pre-test and eleven participants got the question correct on the post-test.

Figure 12. Question Twelve Pre- and Post- Test Results

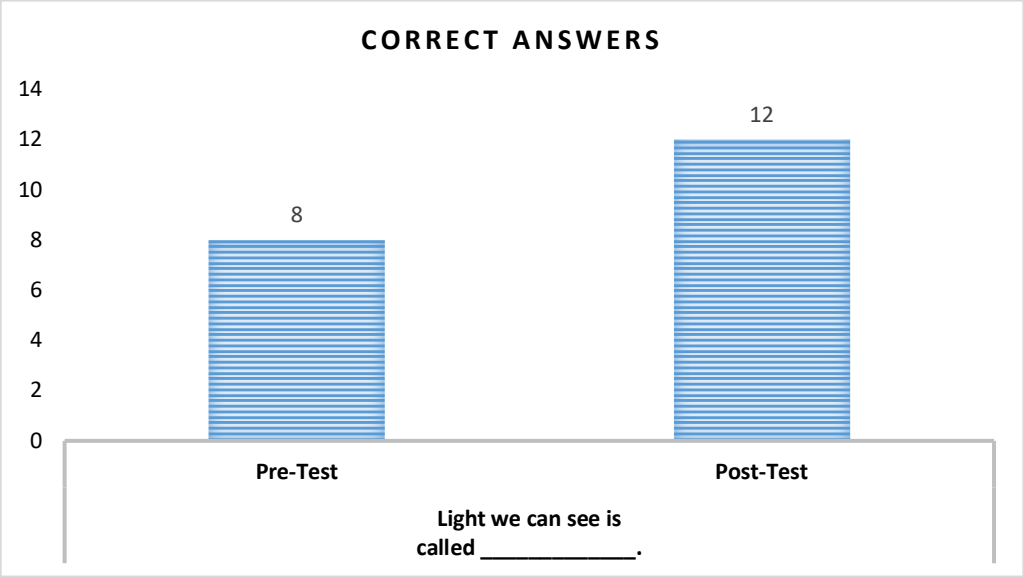
Question Twelve: Examination of Natural Light Sources



This figure displays the number of correct answers of all participants to question twelve. It compares the number of correct answers from the pre-test to the post-test results. This multiple-choice question consisted of the question "Which of the following is not a source of natural light? Eight participants got the answer correct on the pre-test and eleven participants got the question correct on the post-test.

Figure 13. Question Thirteen Pre- and Post- Test Results

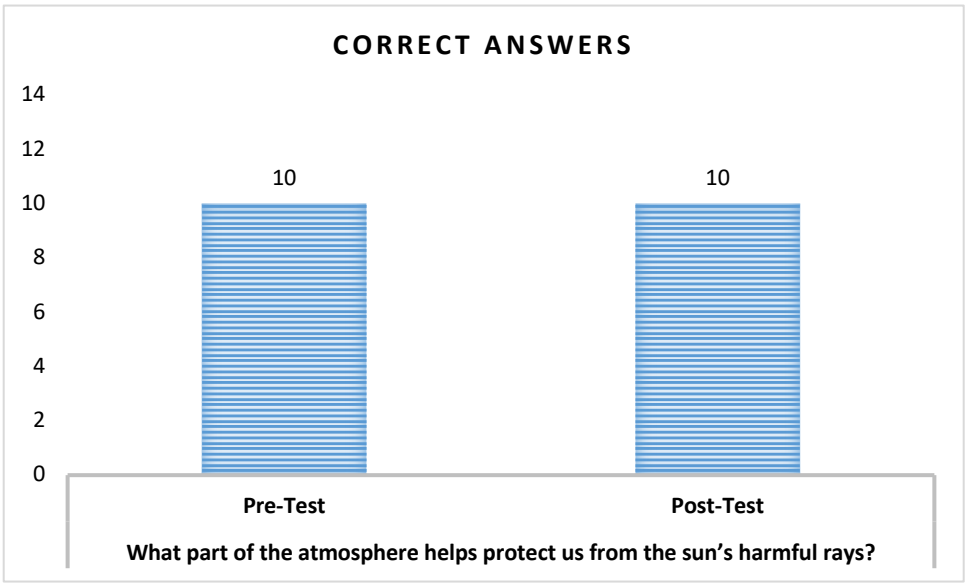
Question Thirteen: Examination of Natural Light Characteristics



This figure displays the number of correct answers of all participants to question thirteen. It compares the number of correct answers from the pre-test to the post-test results. This fill-in-the-blank with multiple-choice option question consisted of the question "Light we can see is called _____." Eight participants got the answer correct on the pre-test and twelve participants got the question correct on the post-test.

Figure 14. Question Fourteen Pre- and Post- Test Results

Question Fourteen: Examination of Relation Between Light Energy and the Environment

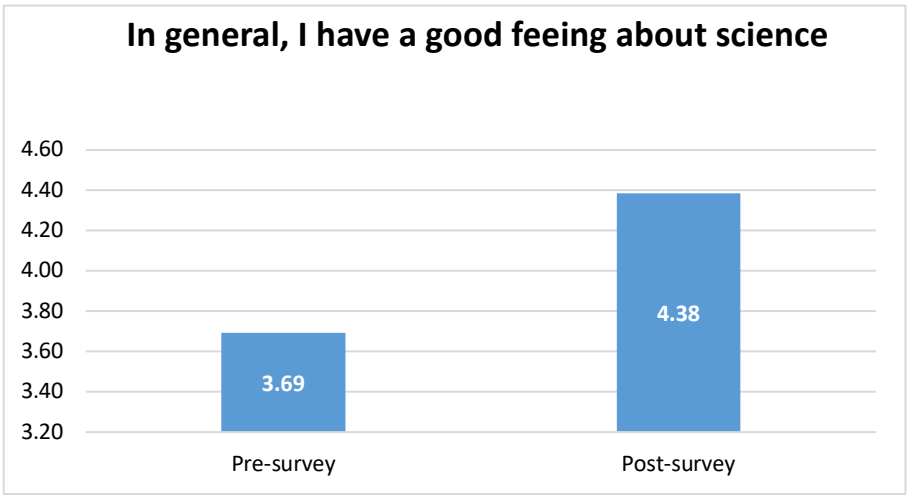


This figure displays the number of correct answers of all participants to question fourteen. It compares the number of correct answers from the pre-test to the post-test results. This multiple-choice question consisted of the question "What part of the atmosphere helps protect us from the sun's harmful rays?" Ten participants got the answer correct on the pre-test as well as on the post-test.

Survey Results

Figure 15. Statement One Survey Results

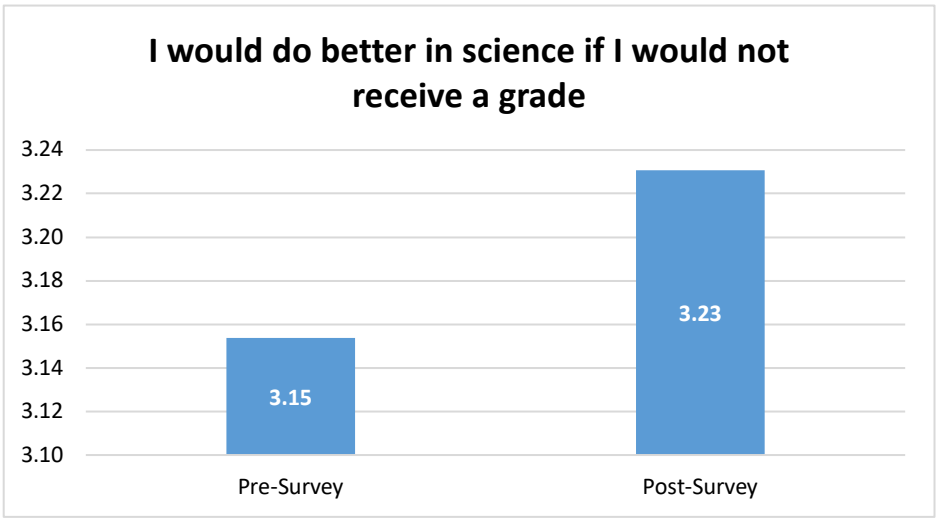
Statement one: General Feeling about Science



This figure demonstrates the average response of participants if they have a good feeling about science in general. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "In general, I have a good feeling about science" on the pre-test with an average score of 3.69. On the post-test the average student chose "agree" to the same statement with an average score of 4.38.

Figure 16. Statement Two Survey Results

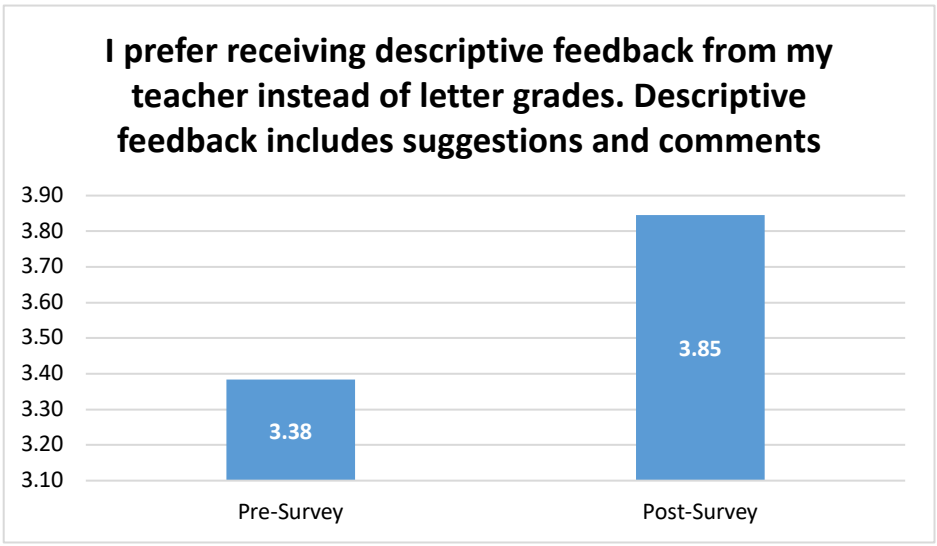
Statement two: participants perception on letter grades



Note. This figure demonstrates the average participant's perception on letter grades. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "I would do better in science if I would not receive a grade" on the pre-test with an average score of 3.15 on the pre-test and average score of 3.23 on the post-test.

Figure 17. Statement Three Survey Results

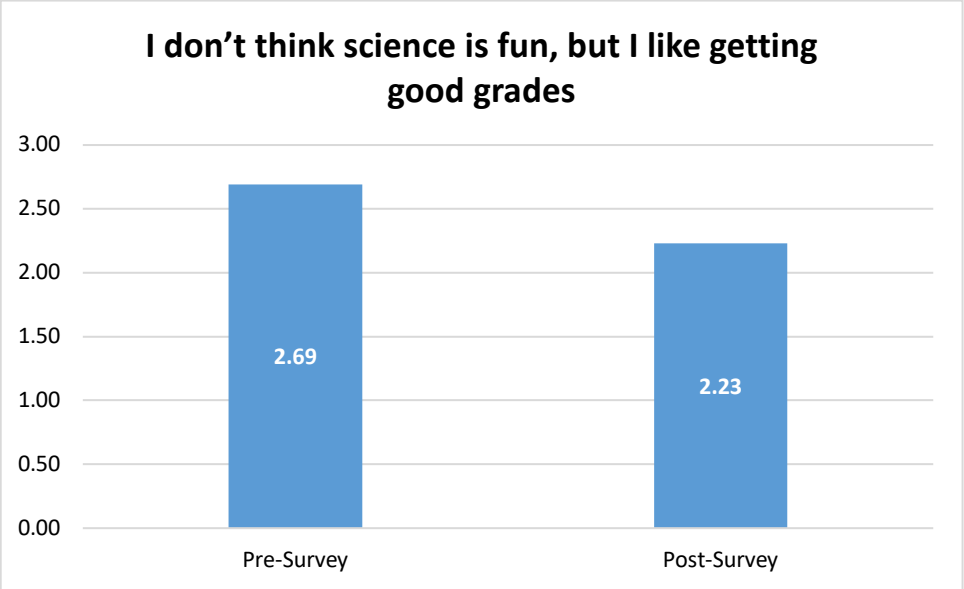
Statement three: Participant's preferences



This figure demonstrates the average participant's preference on either descriptive feedback or letter grades. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "I prefer receiving descriptive feedback from my teacher instead of letter grades. Descriptive feedback included suggestions and comments" with an average score of 3.38 on the pre-test, and an average score of 3.85 on the post-test.

Figure 18. Statement Four Survey Results

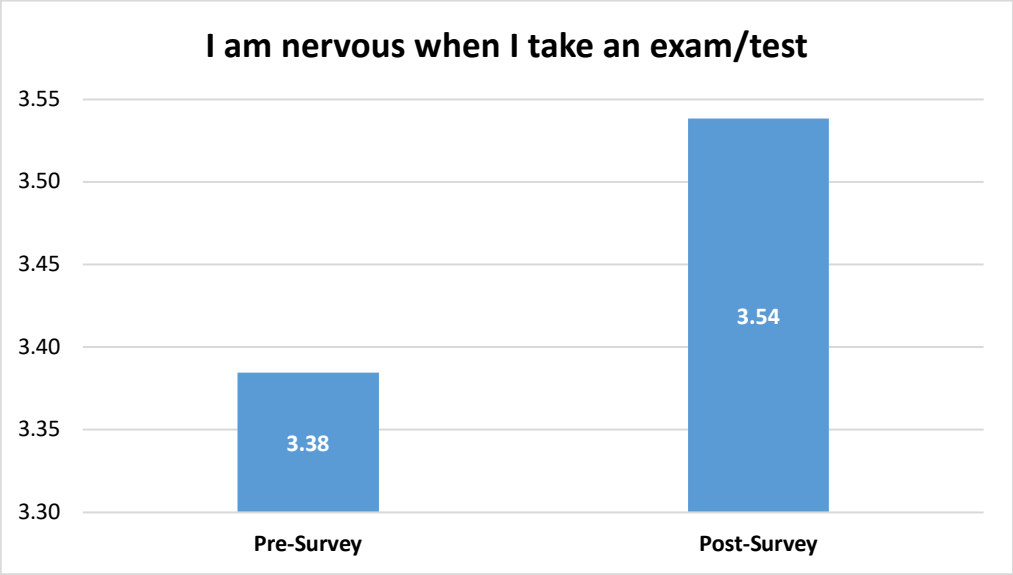
Statement four: Participant's motivation level on learning science



Note. This figure illustrates the average participant's motivation level learning science. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "disagree" to the statement "I don't think science is fun, but I like getting good grades" with an average score of 2.69 on the pre-test, and an average score of 2.23 on the post-test.

Figure 19. Statement Five of Survey Results

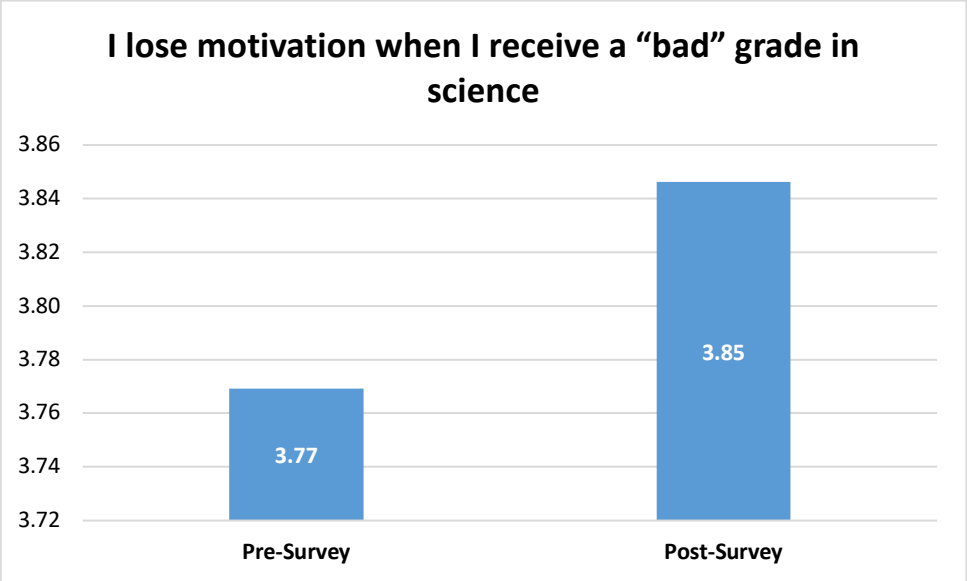
Statement five: Participant's nervousness when taking an exam



This figure displays if the average participant's feels nervous when taking an exam. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "I am nervous when I take an exam/test" with an average score of 3.38 on the pre-test, and an average score of 3.54 on the post-test.

Figure 20. Statement Six Survey Results

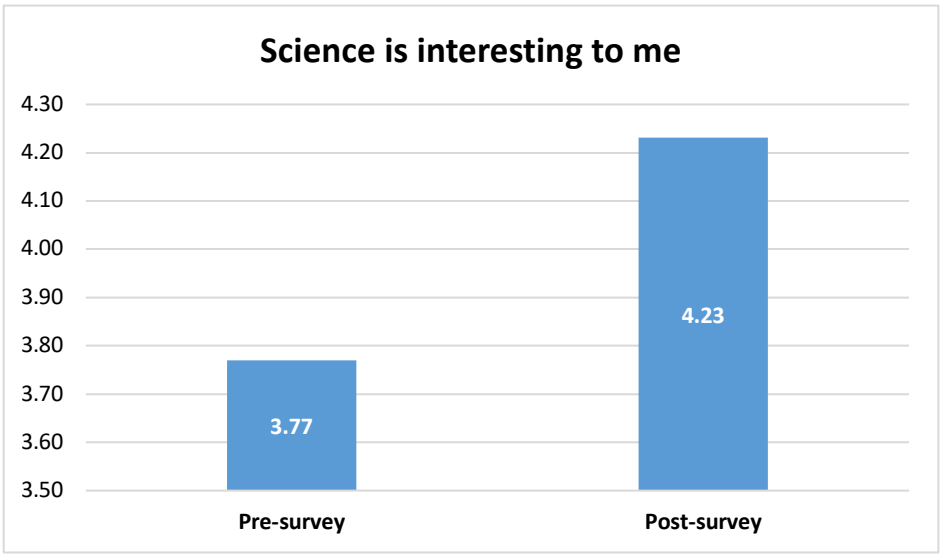
Statement six: Correlation between motivation and letter grades



This figure shows the average participant's response to motivation when receiving a "bad" grade in science. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "I lose motivation when I receive a "bad" grade in science," with an average score of 3.77 on the pre-test, and an average score of 3.85 on the post-test.

Figure 21. Statement Seven Survey Results

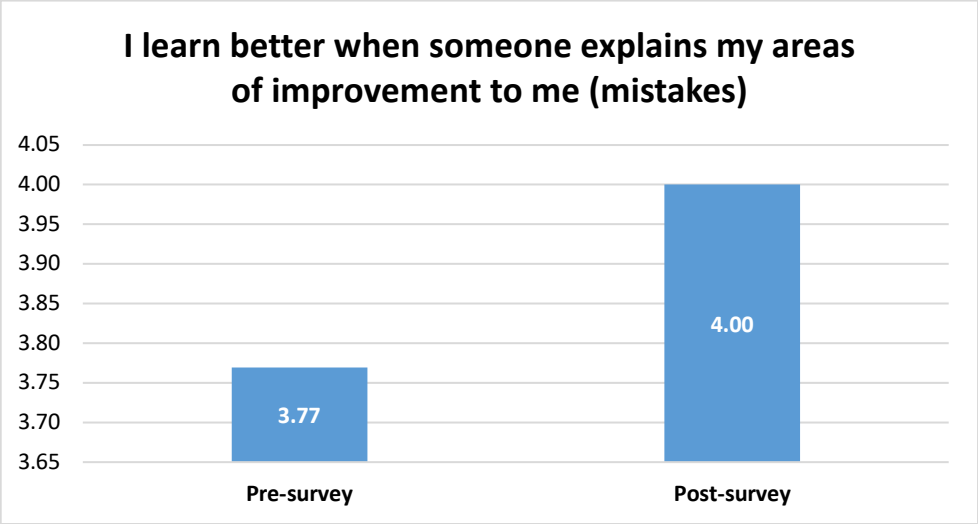
Statement seven: Participants Interest Level in Science



This figure illustrates the average participant's interest level in learning science. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure shows that the average participant chose "neutral" to the statement "Science is interesting to me" with an average score of 3.77 on the pre-test, but agreed to the statement with an average score of 4.23 on the post-survey.

Figure 22. Statement Eight Survey Results

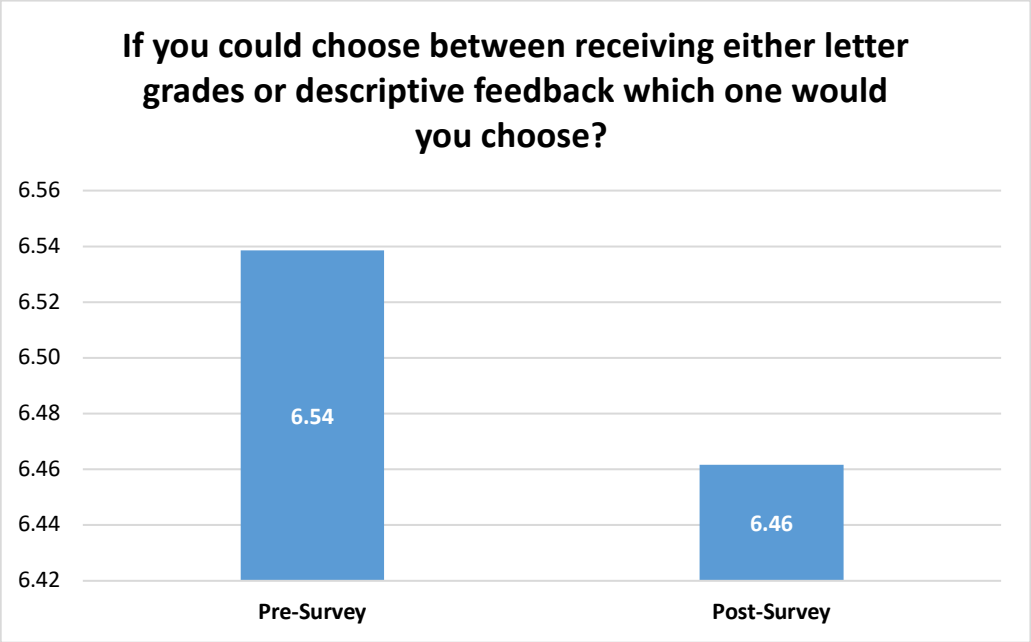
Statement eight: Participants views on the effectiveness of descriptive feedback



This figure signifies the average participant's views on the effectiveness of descriptive feedback. It compares the responses from the pre-survey to the post-survey. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). This figure displays that the average participant chose "neutral" to the statement "I learn better when someone explains my areas of improvement to me (mistakes)" with an average score of 3.77on the pre-test, but participants agreed to the statement with an average score of 4.00 on the post-survey.

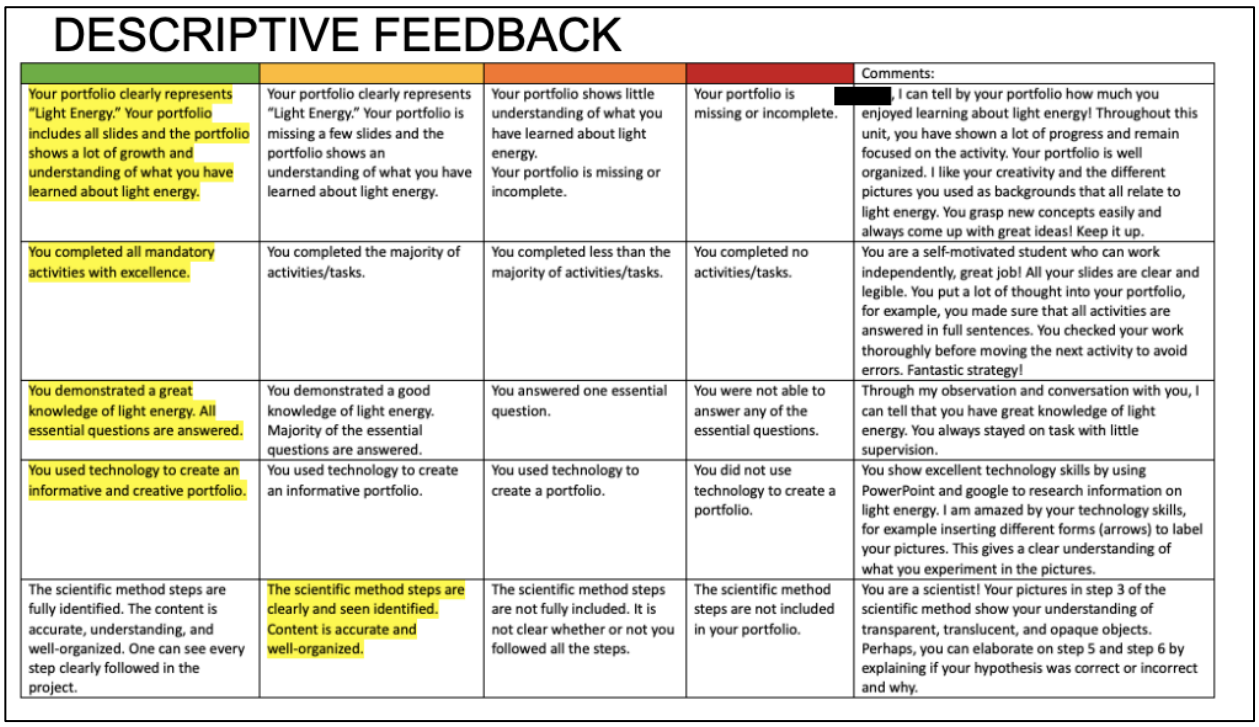
Figure 23. Statement Nine Survey Results

Statement nine: Preferred Choice of either Descriptive Feedback or Letter Grades



This figure displays the average participant's preferred choice of either descriptive feedback or letter grades. It compares the responses from the pre-survey to the post-survey. For this two-choice statement, participant had the choice to choose between descriptive feedback (6) and letter grades (7). Figure 24 below indicates that the average participant chose "descriptive feedback" on the pre- and post-survey.

Figure 24. Sample Descriptive Feedback Rubric



DESCRIPTIVE FEEDBACK

				Comments:
Your portfolio clearly represents "Light Energy." Your portfolio includes all slides and the portfolio shows a lot of growth and understanding of what you have learned about light energy.	Your portfolio clearly represents "Light Energy." Your portfolio is missing a few slides and the portfolio shows an understanding of what you have learned about light energy.	Your portfolio shows little understanding of what you have learned about light energy. Your portfolio is missing or incomplete.	Your portfolio is [redacted].	[redacted], I can tell by your portfolio how much you enjoyed learning about light energy! Throughout this unit, you have shown a lot of progress and remain focused on the activity. Your portfolio is well organized. I like your creativity and the different pictures you used as backgrounds that all relate to light energy. You grasp new concepts easily and always come up with great ideas! Keep it up.
You completed all mandatory activities with excellence.	You completed the majority of activities/tasks.	You completed less than the majority of activities/tasks.	You completed no activities/tasks.	You are a self-motivated student who can work independently, great job! All your slides are clear and legible. You put a lot of thought into your portfolio, for example, you made sure that all activities are answered in full sentences. You checked your work thoroughly before moving the next activity to avoid errors. Fantastic strategy!
You demonstrated a great knowledge of light energy. All essential questions are answered.	You demonstrated a good knowledge of light energy. Majority of the essential questions are answered.	You answered one essential question.	You were not able to answer any of the essential questions.	Through my observation and conversation with you, I can tell that you have great knowledge of light energy. You always stayed on task with little supervision.
You used technology to create an informative and creative portfolio.	You used technology to create an informative portfolio.	You used technology to create a portfolio.	You did not use technology to create a portfolio.	You show excellent technology skills by using PowerPoint and google to research information on light energy. I am amazed by your technology skills, for example inserting different forms (arrows) to label your pictures. This gives a clear understanding of what you experiment in the pictures.
The scientific method steps are fully identified. The content is accurate, understanding, and well-organized. One can see every step clearly followed in the project.	The scientific method steps are clearly and seen identified. Content is accurate and well-organized.	The scientific method steps are not fully included. It is not clear whether or not you followed all the steps.	The scientific method steps are not included in your portfolio.	You are a scientist! Your pictures in step 3 of the scientific method show your understanding of transparent, translucent, and opaque objects. Perhaps, you can elaborate on step 5 and step 6 by explaining if your hypothesis was correct or incorrect and why.

This image shows a sample of descriptive feedback that a student received during a one-on-one session. It outlines the third component of formative assessment, feedback and record keeping. The highlighted statements show student's standpoint and descriptive feedback is given in the comment section.

Figure 25. Sample of Observation Protocol

Descriptive Notes (Detailed, chronological notes about what the observer sees, hears, what occurred; the physical setting)	**Reflective Notes** (Concurrent notes about the observer's thoughts, personal reactions, experiences)
1. *Who is being observed? How many people are involved? Who are they? What individual roles and mannerism are evident? (Refer to students, using a student ID to maintain confidentiality.)*	- 11 female students in the classroom - 4 students via zoom - One teacher - 4 groups with 2-3 students per group
2. *What is going on? What is the nature of the conversation? What are people saying or doing?*	- Science lesson - Group work: building a rollercoaster made of recycled material to show potential and kinetic energy - The language between the students was informational, personal, and relational - Students discussed their knowledge of potential/kinetic energy, problem-solved the project together as a group, negotiated about details of the project, adapted learned material, predicted successful strategies on how to build a rollercoaster
3. *What is the physical setting like? How are people seated, and where? How do the participants interact with each other?*	- Classroom with single chairs/desks and seating options - 3 of the groups chose to sit on the floor to do their project, one group chose the library corner to do their project on shelves (to have the rollercoaster slide down a shelf) - Students interacted positively with each other, each student was actively engaged in conversations with each other and in building their rollercoaster
4. *What is the status or roles of who leads, who follows, who is decisive, and who is not? What is the tone of the session? What beliefs, attitudes, values, and so on, seem to emerge?*	- Each student was contributing to the project although no particular roles were given - The tone of the session was fulfilled with curiosity - Students were asking lots of questions during teamwork - Student-centered, hands-on learning, Pono
5. *How did the meeting end? Was the group divided, united, upset, bored, or relieved?*	- Lesson ended by teacher giving directions to clean up - Students followed instructions and expectations although it was difficult for some students to stop working on their project (eager to learn)
6. *What activities or interactions seemed unusual or significant?*	- The teacher regularly checked in with the students that were doing their rollercoaster via zoom from home - There was not really a closing part of the lesson, meaning no short get together before releasing students off to the next lesson
7. *What was the observer doing during the session? What was the observer's level of participation in the observation? (e.g., participant observer, nonparticipant observer, etc.?*	- Participant observer: fully engaged in activities and student were aware of me observing them

This figure demonstrates a sample of the researchers' observation protocol. This observation protocol was taken on February 9th, 2021 during a science class which lasted 50 minutes. It shows descriptive notes and reflective notes that helped to better understand participants knowledge and attitude toward science.

Data Analysis

Description of the Overall Performance and Progress of the Whole Class

Analyzing the pre-and post-test results, I can say that the formative assessments positively affected the whole class's learning outcomes. On average, each students' score increased by 10.2 %. On the pre-test, the average student achieved 72.45%, whereas, on the post-test, the average student achieved 82.65%.

As seen in Table 1, nine out of 14 fourth-grade students in science who received formative assessments, verbally and in written form, enhanced their science knowledge. Two of the nine students increased their test scores by 36%, one student by 28%, two students by 14%, and four students by 7%. Five out of fourteen students showed no growth based on their test results. Ten students in the class achieved a 79% or higher on their post-test score, and only four students received below 71% on their post-tests.

Table 1. Participant Pre- and Post-Test Results

Student	Pre-Score	%	Post-Score	%	Increase/decrease	% Point Change
1	13	92.86%	12	85.71%	-1	-7.14%
2	9	64.29%	10	71.43%	1	7.14%
3	13	92.86%	14	100.00%	1	7.14%
4	9	64.29%	11	78.57%	2	14.29%

5	10	71.43%	10	71.43%	0	0.00%
6	6	42.86%	8	57.14%	2	14.29%
7	12	85.71%	11	78.57%	-1	-7.14%
8	9	64.29%	14	100.00%	5	35.71%
9	11	78.57%	12	85.71%	1	7.14%
10	11	78.57%	12	85.71%	1	7.14%
11	13	92.86%	13	92.86%	0	0.00%
12	9	64.29%	13	92.86%	4	28.57%
13	9	64.29%	14	100.00%	5	35.71%
14	8	57.14%	8	57.14%	0	0.00%
Average participant	10.1	72.45%	11.6	82.65%	1.4	10.20%

This table compares the participants learning outcomes on their pre- and post-test as well as the learning outcome of the average participant. The increase/decrease section shows how many more questions the participant had correct (increase) or incorrect (decrease) on their post-test in comparison to their pre-test results. The percentage point change demonstrates the numerical difference between the pre-test score and the post-test score.

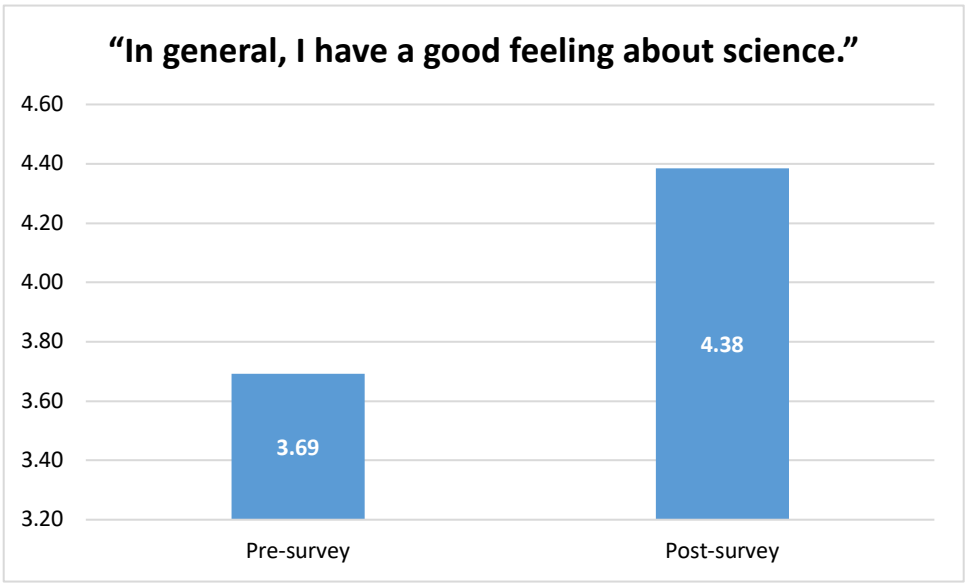
Positive Changes in Student Performance. Figure 26. below one displays average number of correct questions of the whole class on pre- and post-test. The correct and incorrect questions on the pre-and post-test results show that the average student had 10.1 questions correct on the pre-test and 11.6 questions correct on the post-test. That shows that the average students scored 3.4 questions out of fourteen questions incorrect on the post-test (Figure 1).

Figure 26. Average Number of Correct Questions of Whole Class on Pre- and Post-Test

This figure demonstrates the average of correct questions of the whole class. This figure compares the pre-test results with the post-test results. The average student had 10.1 questions correct on the pre-test and 11.6 questions correct on the post-test.

Positive Changes in Students' Attainment of Learning Outcomes. Moreover, the descriptive feedback positively affected students' learning outcomes, and their attitude toward science changed. The findings of the pre-survey result, as seen in figure 27 below shows that the average student selected "neutral" to the statement, "In general, I have a good feeling about science." However, on the post-survey, the average student agreed to the same statement. That shows that students had a better feeling about science after receiving descriptive feedback.

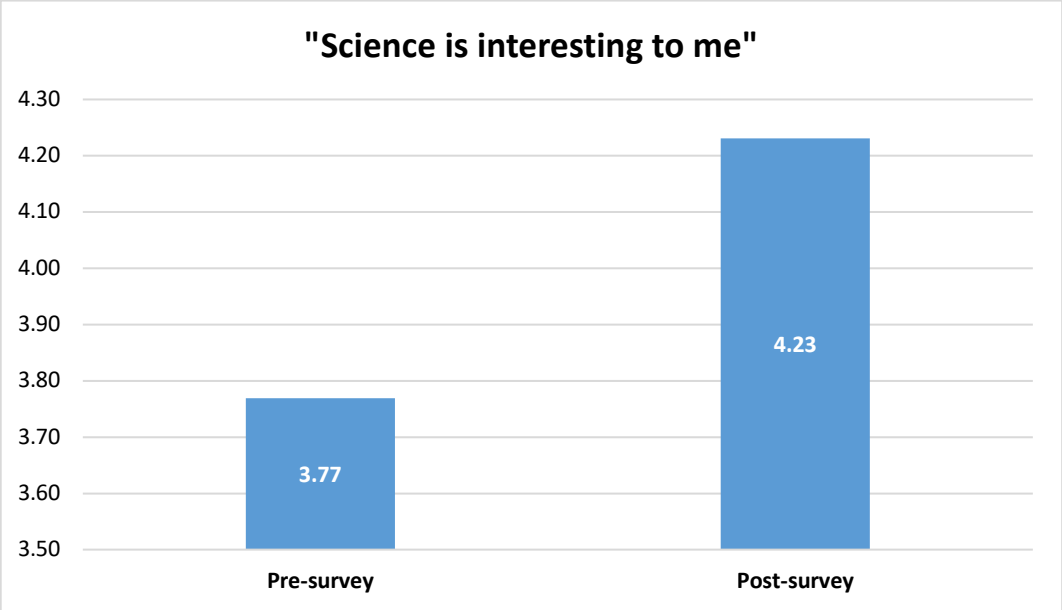
Figure 27. Survey Results of Students Attitudes Toward Science



Note. The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree).

Positive Changes in Interest Level in Science. Another significant change seen in the survey results is the change of interest level in science. Figure 28 summarizes the survey results of the average students' interest level in science. The average student selected "neutral" as their answer to the statement "Science is interesting to me" on the pre-survey. In contrast, the average student agreed to the statement on the post-test (Figure 3).

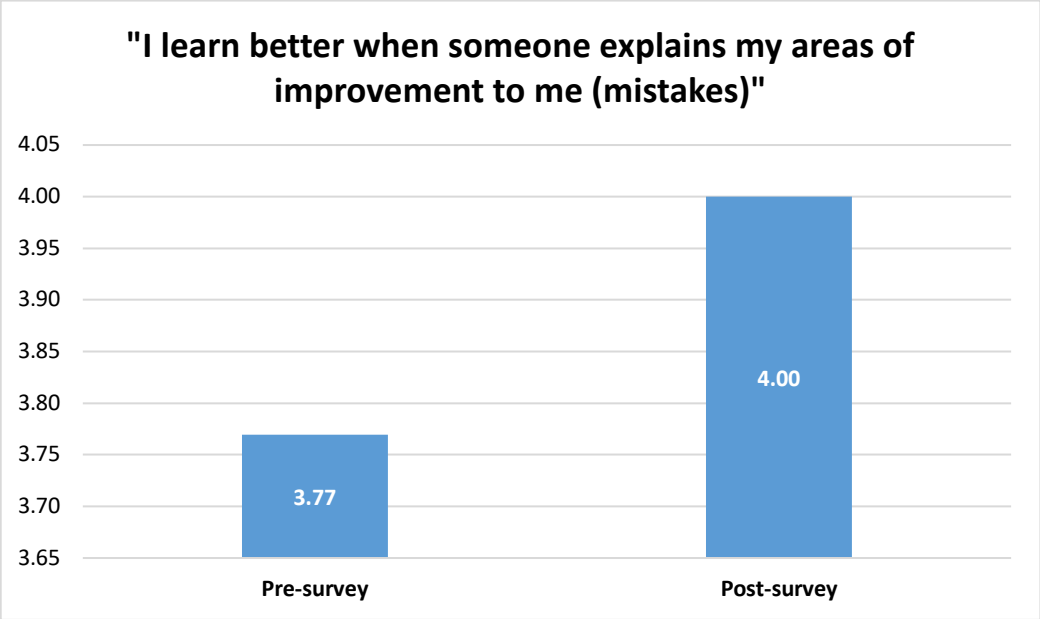
Figure 28. Survey Results of Students' Interest Level in Science



The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree).

Besides, students showed a change of attitude when analyzing the survey results to the statement, "I learn better when someone explains my areas of improvement to me," as seen on Figure 29 below. While the average students selected "neutral" on their pre-survey to this statement, the average students selected "agree" on the post-survey.

Figure 29. Survey Results on the Effect of Descriptive Feedback on Students' Interest Level in Science



The survey was based on a Likert-type scale and ranged from strongly disagree to strongly agree (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree).

These three significant results on the surveys show that descriptive feedback in science positively changed students' attitudes toward science. To conclude, the study shows that descriptive feedback enhances learning and positive attitudes toward science.

Description of the Overall Performance and Progress of a Subgroup

The subgroup, which includes three students who showed the most growth during the study, improved their learning outcome significantly. As seen on the table 2, student number twelve increased her test score result by 29%, whereas students' number eight and thirteen increased their test score results by 36%. All three students achieved a test score of 93% or higher on their post-test and only 64% on their pre-test. Students number eight and thirteen even scored 100% on their post-test.

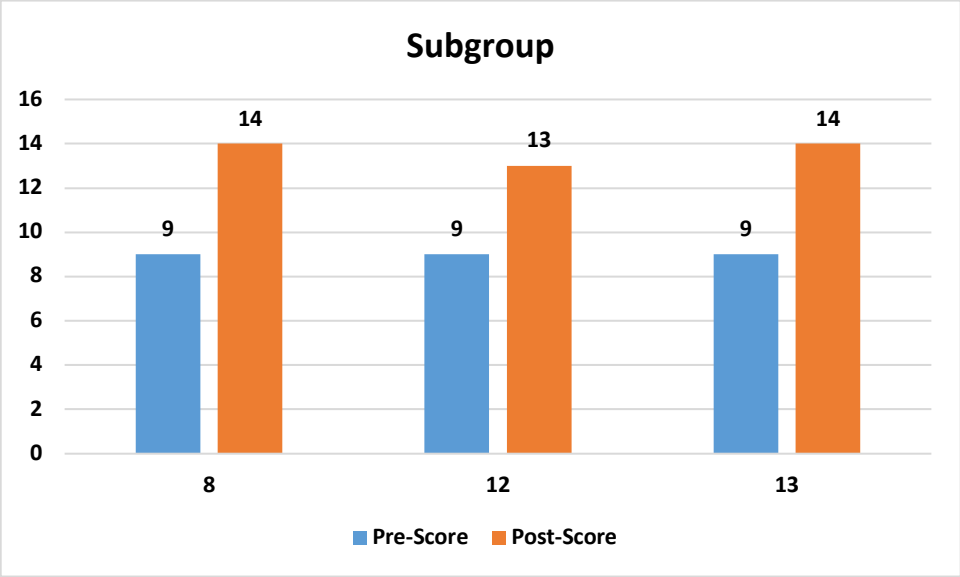
Table 2. Pre- and Post-Test Results for a Subgroup

Student	Pre-Score	%	Post-Score	%	Increase/decrease	% Point Change
8	9	64.29%	14	100.00%	5	35.71%
12	9	64.29%	13	92.86%	4	28.57%
13	9	64.29%	14	100.00%	5	35.71%

This table compares the subgroup's learning outcomes on their pre- and post-test. The increase/decrease section shows how many more questions the participant had correct (increase) or incorrect (decrease) on their post-test in comparison to their pre-test results. The percentage point change demonstrates the numerical difference between the pre-test score and the post-test score.

Figure 30 below shows the correct number of questions of the subgroup. Student number eight and thirteen scored nine questions correct on their pre-test and fourteen questions correct on their post-test, which is an increase of five questions. Student number twelve had thirteen questions correct on her post-test and only nine questions on her pre-test, which is an increase of four questions. Student number twelve had only one question incorrect on their post-test.

Figure 30. Correct Number of Questions of a Subgroup

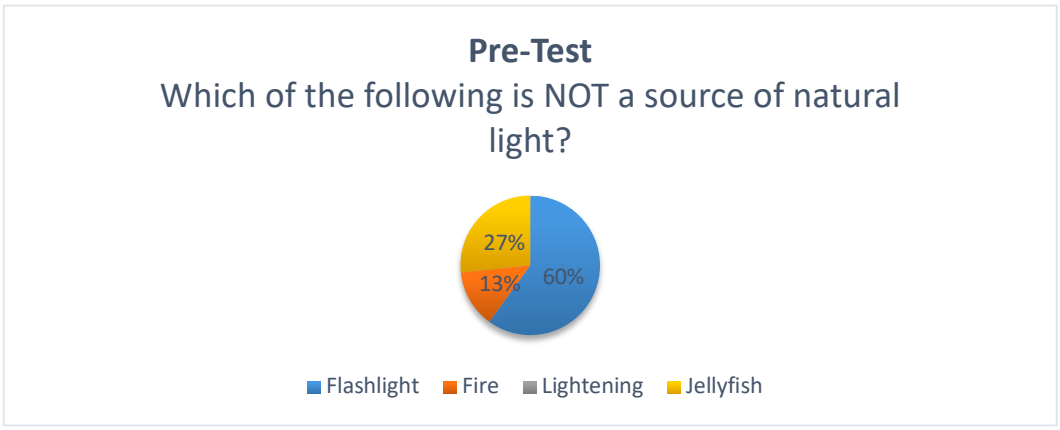


This Figure illustrates the correct number of questions on the pre- and post-test of student number eight, student number twelve, and student number thirteen. The subgroup includes students who showed the most growth during the study.

Successes

The learning outcome where students were most successful was examining how light energy plays a role in everyday life. Figure 31 summarizes the finding of the pre-test to the for the question, "Which of the following is not a source of natural light."

Figure 31. Pre- Test Result of Whole Class in Understanding of Natural Light



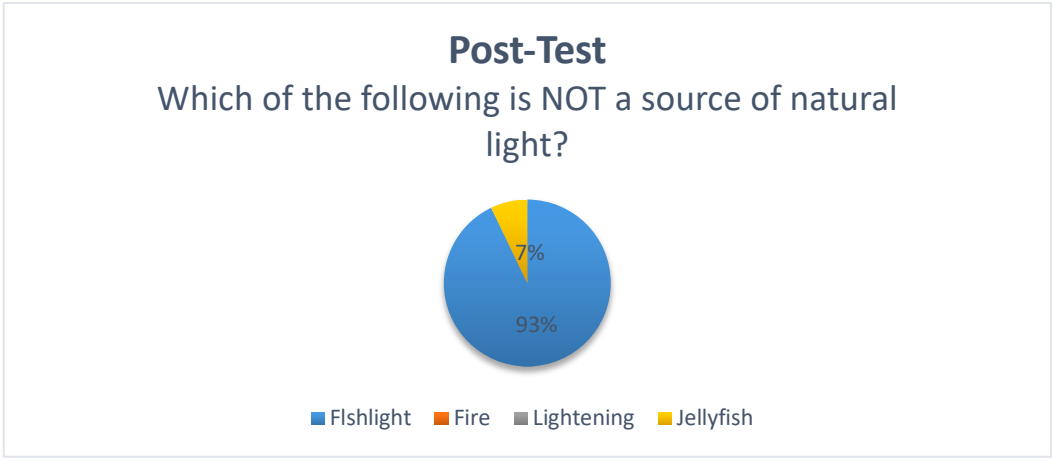
The figure shows the pre-test results of question number twelve of the whole class, including 14 responses.

As seen on figure 6, 60% of the participants chose "Flashlight" as the answer to the question "Which of the following is NOT a source of natural light?" The rest of the participants chose "Jellyfish" with 27%, and 13% of the participant chose "Fire" as the answer.

Figure 32. below summarizes the finding of the post-test to the for the question, "Which of the following is not a source of natural light."

Figure 32 Post-Test Results of Whole Class Understanding of Natural Light

Post-test results of whole class of understanding of natural light

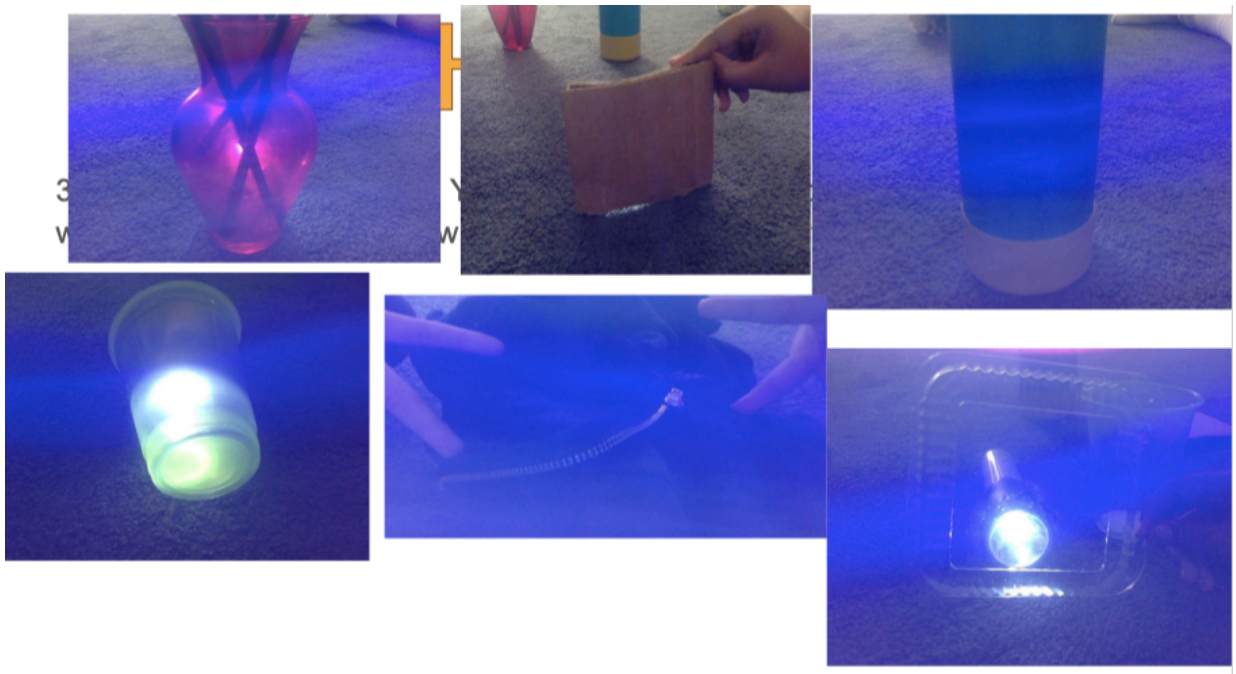


The figure shows the post-test results of question number twelve of the whole class, including 14 responses. 93% of the participants chose "Flashlight" as the correct answer to the question "Which of the following is NOT a source of natural light?" on the post-test and only 7% chose "Jellyfish."

Students' progress is shown when comparing the pre-and post-tests result for the question "Which of the following is not a source of natural light?" On the pre-test, 60% of the class got the question correct, whereas, on the post-test, 93% of the class got the question correct. This particular question on the pre-and post-test aligns with the learning outcome because students had to differentiate and apply natural and artificial light sources to everyday life situations.

Students successfully mastered this learning outcome because all learning styles were presented. Image one shows a hands-on activity where a participant used a flashlight during the scientific method activity. This image is an example for kinesthetic learning.

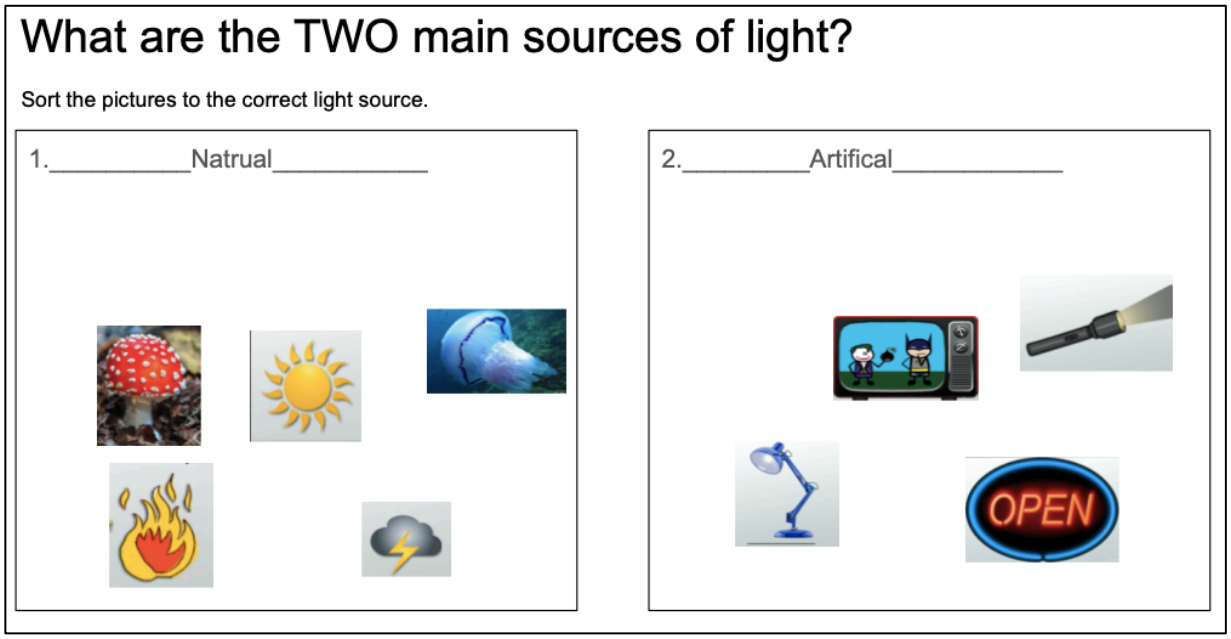
Figure 33. Sample of Hands-on Experimental Activity of Student Using a Flashlight



This figure shows hands-on learning where a participant uses a flashlight to test different object if they are transparent, translucent, or opaque.

Figure 34 below presents an example that benefit the visual student. The visual student had to sort and distinguish between pictures where light energy was present in everyday examples.

Figure 34. Sample of an Activity that Benefited the Visual Learner



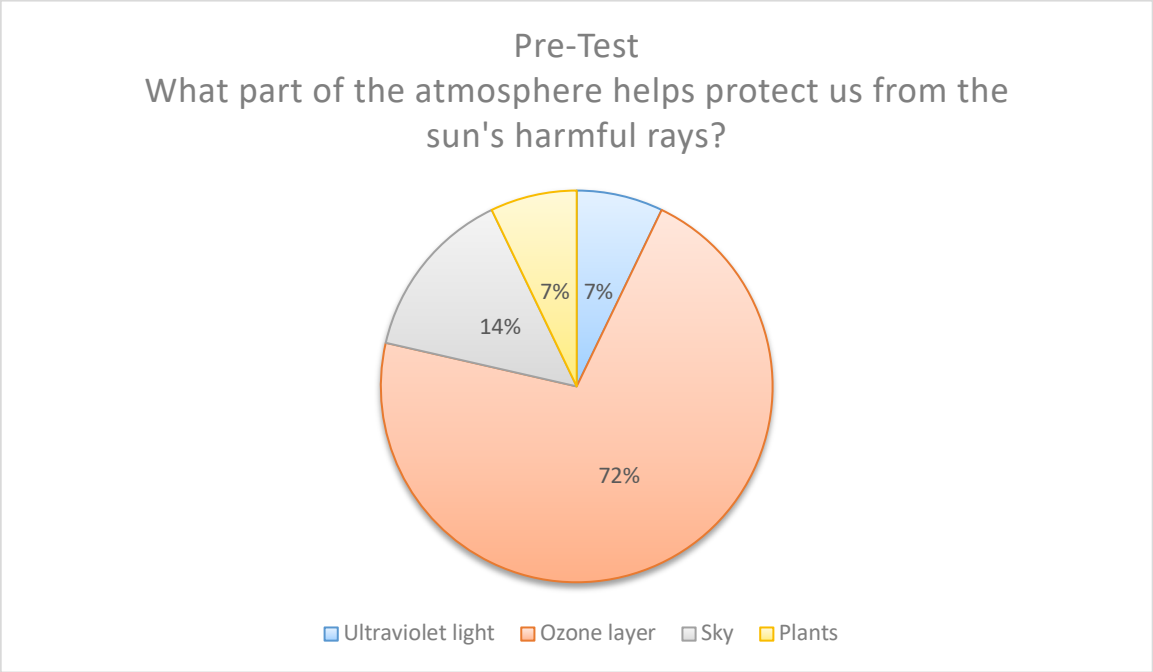
This figure shows a sample of a visual activity where participants had to distinguish between the two main sources of light by sorting visuals to the correct source of light.

Further, short videos of natural light sources and artificial light sources benefited the auditory learner. Short texts of the videos were provided and benefited the reading/writing learners. The different learning styles and teaching instructions that were used during the unit positively impacted the whole class's learning outcome.

Challenges

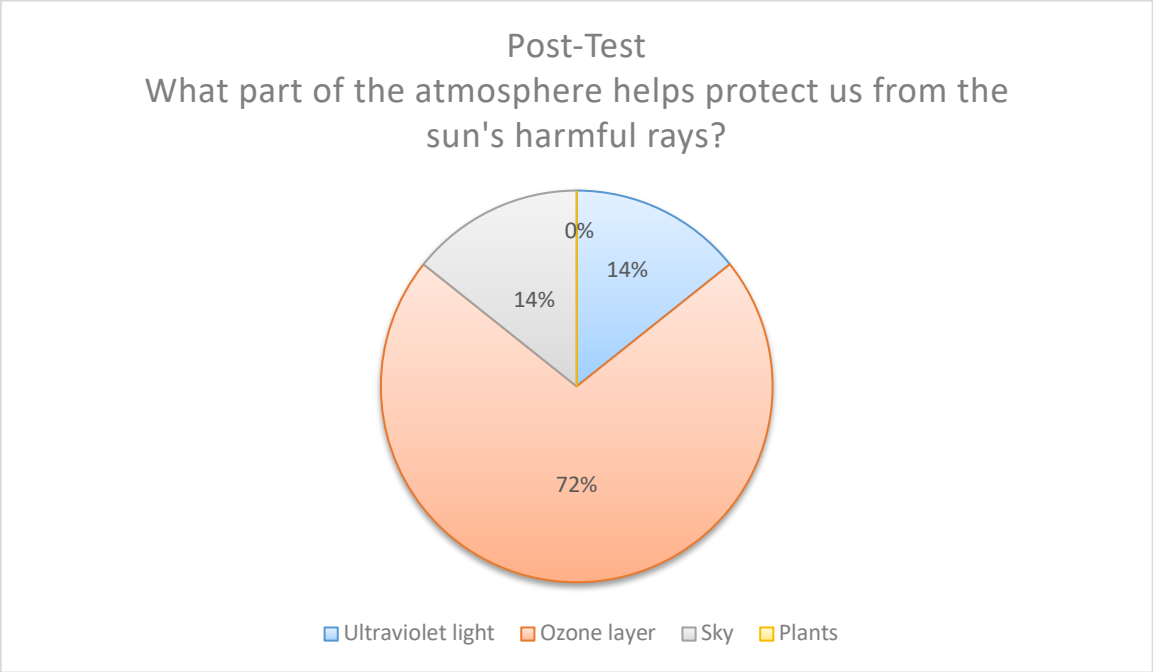
The learning outcome that showed the least success was how the atmosphere is connected to light energy. As seen on the results of the question, "What part of the atmosphere helps protect us from the sun's harmful rays?" 28% of students got the answer incorrect on the pre-test, and still, 28% of the students got the answer incorrect on the post-test. The reasons for the low improvement rate on this particular learning outcome could be a lack of sufficient content coverage and poor time management. Reflecting on the lesson plans, I must say that I had to make several changes that affected timing. When creating the pre-and post-surveys, I planned to cover how light energy affects the environment. However, students needed more time on other concepts related to light energy, so that I did not have sufficient time to cover how the atmospheres connects to light energy. It was challenging to create a unit plan for a class I had just met since I was not quite aware of students' background knowledge in science and their learning pace. I had planned for too much content during the unit and could not teach all of it, although I included it in the pre-and post-test, which I could not change during the unit. One thing I can do better in the future to improve students' performance is to allow for buffer times in between lessons. Buffer time, extra time added to learning activities, allows students to understand the material more meaningfully. Buffer time can be used to allow students to finish up their activities, so they do not feel rushed, allow students to research concepts more in-depth, stay on track with timing and content and assess students for understanding.

Figure 35. Pre-Test Results for Understanding the Connection Between the Atmosphere and Light Energy



The figure shows the pre-test results of question number fourteen of the whole class, including 14 responses.

Figure 36. Post-Test Results for Understanding the Connection Between the Atmosphere and Light Energy



The figure shows the post-test results of question number fourteen of the whole class, including 14 responses.

Discussion

The purpose of this study was to examine the effects of descriptive feedback on students' learning outcomes and attitude. Throughout this exploratory and descriptive research, significant findings were harvested both qualitatively and quantitatively.

For qualitative framework, major factors were defined in the literature review: approaches to formative assessment, school systems that do not use letter grades, and studies on students' attitude toward learning and learning outcomes when using formative assessments in the classroom. In addition, one-on-one conversations with the participants and observations protocols that were reported by the researcher offered evaluations about the effectiveness of formative assessment, in particular descriptive feedback. The evaluation of the qualitative work

reflected the literature review; for example, a study by Hattie shows that formative assessment is the third most influential factor among 138 factors for students' academic achievement (Hattie, 2009). For quantitative framework, the pre-and post-surveys and the pre-and post-tests expanded the interpretation of the analysis of the research as explained in the data analysis section.

Meanwhile, this study did have limitations and biases. The pandemic limited the school placement availabilities. Not every school offered in-person classes, which was crucial for the research. Therefore, only fourteen students participated in the study.

The sample size was small. Compared to the population of all elementary students in the Honolulu Downtown area. Therefore, the small sample size limited the potential for generalization of the results. Not only did the small sample size limit the researcher's ability to generalize the research findings, but the study was limited by the characteristics of the participants, who were all female participants. That means, the results of the study may not be applied to the larger population, which is all elementary students. Also, the small sample size potentially decreased the statistical power of the study because of the small effect. Large effects are easier to notice and increase the power of the study. Also, the small sample size might have affected the reliability of the results because of the variability, which may lead to bias. Sampling biases would have occurred due to the nature of purposive sampling.

Another limitation that occurred in this study was due to time constraints. Ideally, participants would be observed and exposed to the educational research for the entire school year to assess its effectiveness more accurately; however, the researcher only had permission to be in the school for a maximum of five weeks.

A future study should increase the sample size, change the sampling method, conduct research over longer period of time, and explore the benefits of formative assessment beyond the classroom. A future study should have a clearer focus, which either should be focus on the learning outcomes of students or the change in attitude of students toward science.

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Appendices

Appendix A: Pre-and Post-Survey

Likert Scale: Strongly Agree/ Agree/ Neutral/ Disagree/Strongly Disagree

1. In general, I have a good feeling about science.
2. I would do better in science if I would not receive a grade.
3. I prefer receiving descriptive feedback from my teacher instead of letter grades. Descriptive feedback includes suggestions and comments.
4. I don't think science is fun, but I like getting good grades.
5. I am nervous when I take an exam/test.
6. I lose motivation when I receive a "bad" grade in science.
7. Science is interesting to me.
8. I learn better when someone explains my areas of improvement to me.
9. If you could choose between receiving either letter grades or descriptive feedback which one would you choose?

Appendix B: Pre-and Post-Test

True | False

1. Only visible light comes from the energy of the sun.
2. A computer with a cordless keyboard and mouse makes use of radio wave technology.

3. Too much time in the sun is harmful because of the UV light.

4. A microwave heats and cooks food by exposing it to mild electromagnetic radiation.

5. The light from a laser pointer is an example of an infrared wave.

6. X-rays are a very energetic form of electromagnetic energy that can be used to take images of the human body.

7. Electromagnetic energy is a combination of electric and magnetic fields.

8. Out of all the types of light energy, it is visible light and UV that can be seen by the human eyes.

Questions:

1. What is our main source of light energy?
   a. Fire
   b. Sun
   c. Stars
   d. Solar panels

2. How does light energy travel?
   a. It travels in a straight line
   b. It travels in wavelengths
   c. It travels farthest at night
   d. It travels only during the day

3. How might we know that light energy is present?
   a. There is a light switch
   b. We can light a candle
   c. There might also be heat present
   d. We need to wear sunglasses

4. Which of the following is not a source of natural light?
   a. Fire
   b. Lightening
   c. Flashlight

d. Jellyfish

5. Light we can see is called _____.
   a. X-rays
   b. Visible light
   c. Ultraviolet light
   d. Sunlight

6. What part of the atmosphere helps protect us from the sun's harmful rays?
   a. Ultraviolet light
   b. Ozone layer
   c. Sky
   d. Plants

7. What is refraction?

_____

_____

_____

Appendix C: Observation Protocol Template

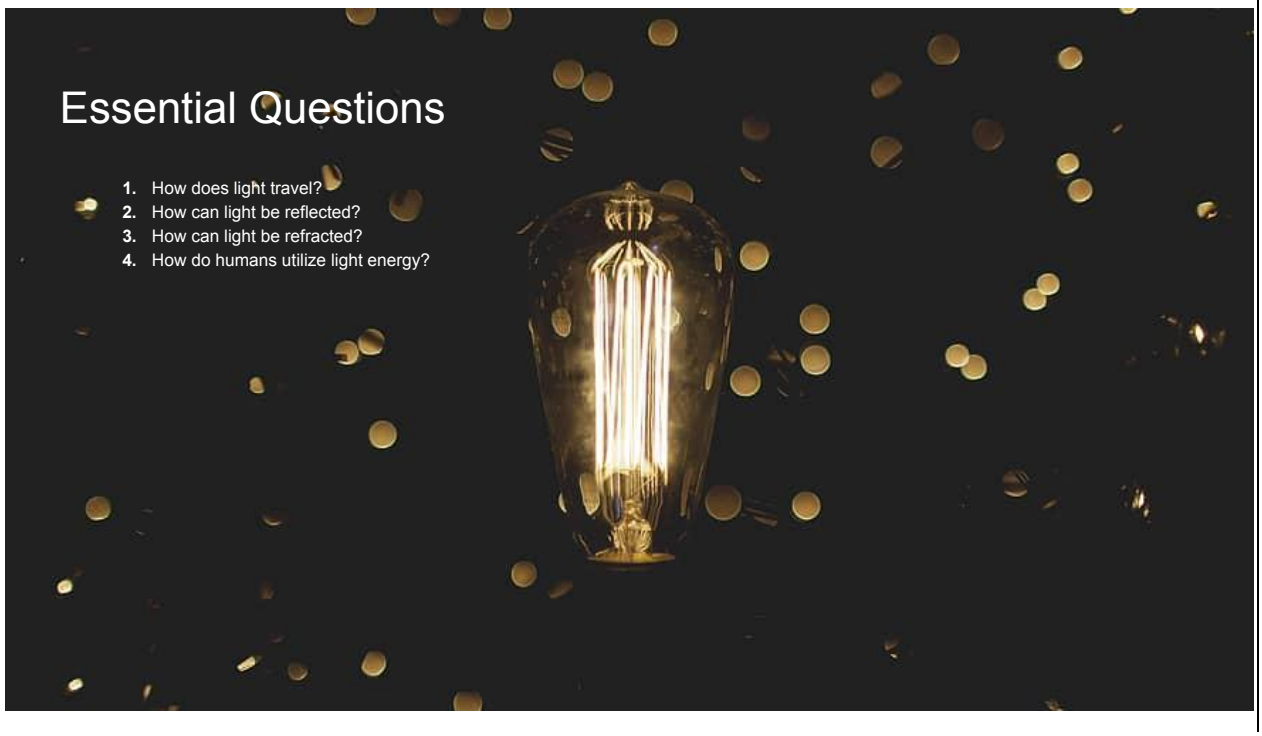
Setting:	
Individual(s) Observed:	
Observer Involvement:	
Date/Time:	
Place:	
Duration of the Observation (start/end time):	

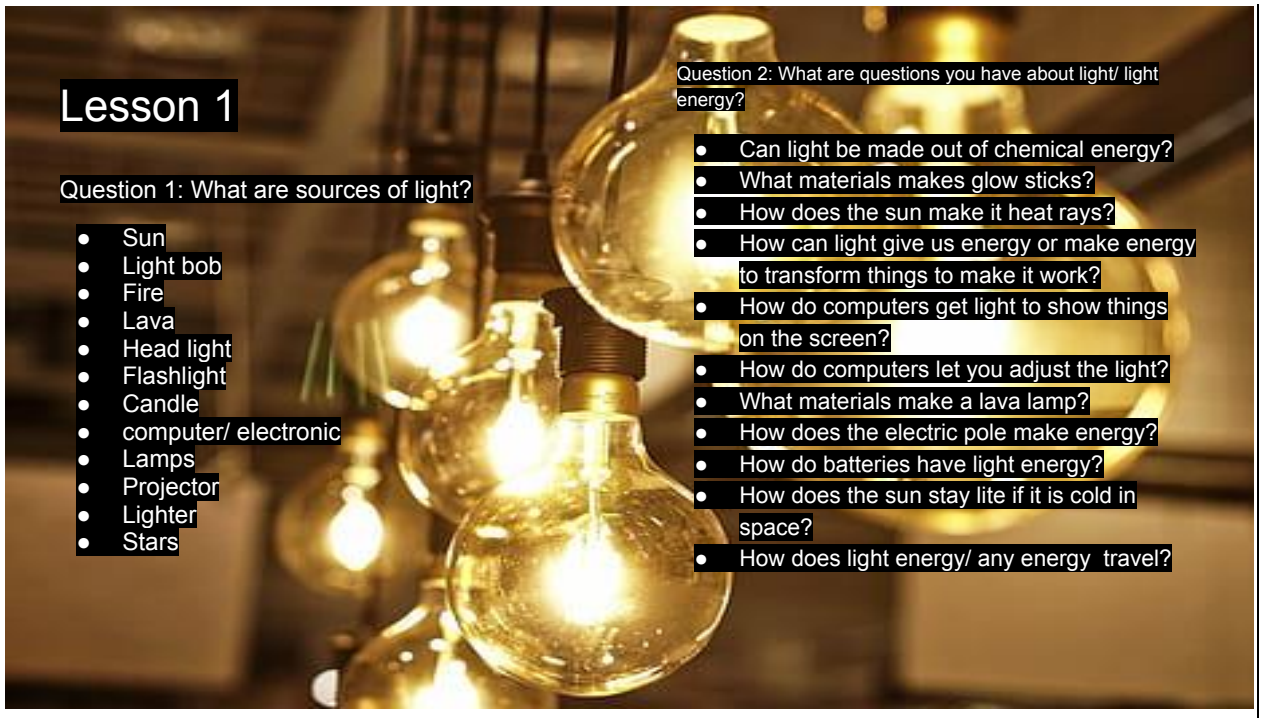
Descriptive Notes (Detailed, chronological notes about what the observer sees, hears, what occurred; the physical setting)	**Reflective Notes** (Concurrent notes about the observer's thoughts, personal reactions, experiences)

1. *Who is being observed? How many people are involved? Who are they? What individual roles and mannerism are evident? (Refer to students, using a student ID to maintain confidentiality.)*	
2. *What is going on? What is the nature of the conversation? What are people saying or doing?*	
3. *How is the motivation level of students during the observation period? Why are or aren't students motivated? How do students interact with each other?*	
4. *What is the status or roles of who leads, who follows, who is decisive, and who is not? What is the tone of the session? What beliefs, attitudes, values, and so on, seem to emerge?*	
5. *How did the meeting end? Was the group divided, united, upset, bored, motivated or relieved?*	
6. *What activities or interactions seemed unusual or significant?*	
7. *What was the observer doing during the session? What was the observer's level of participation in the observation? (e.g., participant observer, nonparticipant observer, etc.?*	

Appendix D: Student Portfolio Sample


Light Energy Unit Portfolio

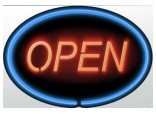

Essential Questions
1. How does light travel?
2. How can light be reflected?
3. How can light be refracted?
4. How do humans utilize light energy?



What are the TWO main sources of light?

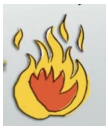
Sort the pictures to the correct light source.

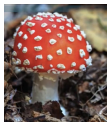
1._____Artificial_light_____





2._____Natural_light_____

Light Energy Sources

Now that you're familiar with what light energy is and the two main sources, you're going to apply it to your surroundings. In this activity, you'll be finding two sources of natural light and two sources of artificial light in your environment. For each source, you'll describe what it is, how you interact with it, and which type of light source it is. Then, answer the reflection questions.

Example	Description	How it affects you	Type of light source
Sunlight	The sun shines bright during the day and fills the outside and our house	I use sunlight to find my way during and see all types of things, both inside and outside	Natural light
Jellyfish	The jellyfish glows up	Lights up the ocean	Bioluminescent Natural light
Lightning	It goes kaboom then it lights up	It's a loud noise	Natural light
Tv	It entertains us by showing us colors	The screen lights up and it damage your eyes	Artificial light
Lightbulb / Light BOB	It works by turning on a light switch	You can see better	Artificial light

Electromagnetic Spectrum

Electromagnetic waves are a form of energy waves that have both an electric and magnetic field.

Electromagnetic waves are classified according to their frequency.

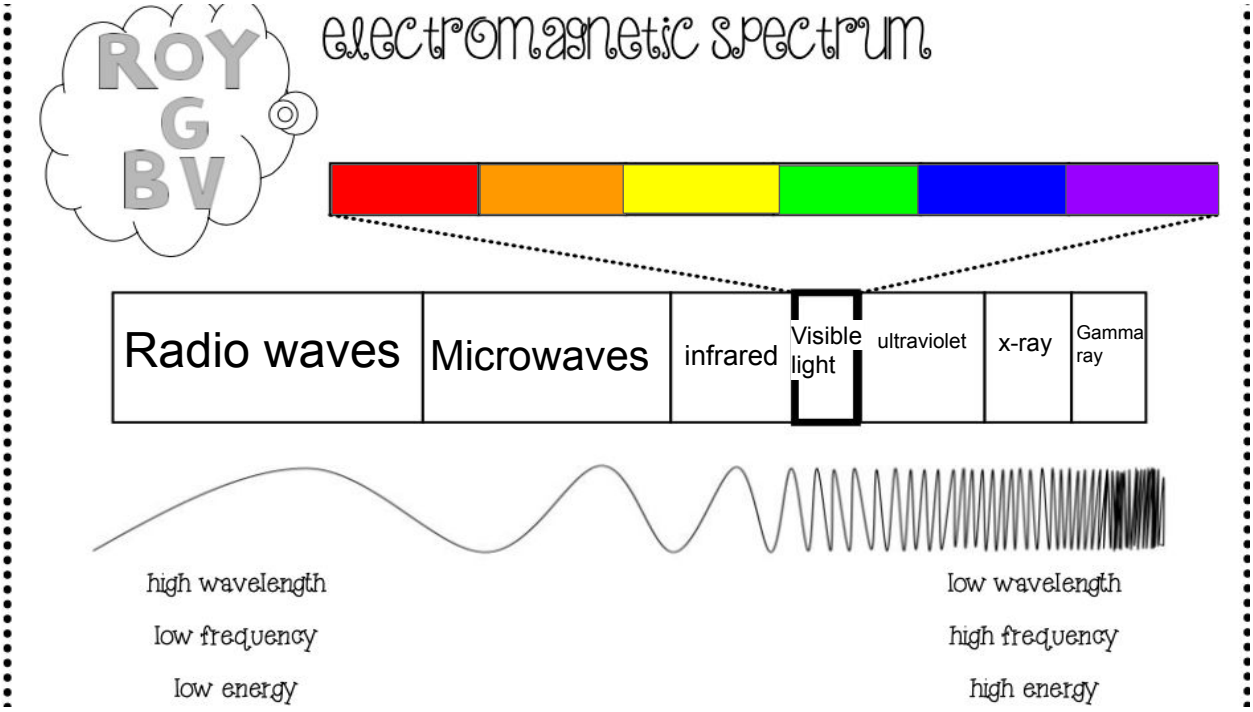
Vocabulary	**Definition**
Wave length	The distance between the crest of one wave and the crest of the following wave.
Frequency	The number of times a crest occurs in a set time amount.

Frequency Activity Review

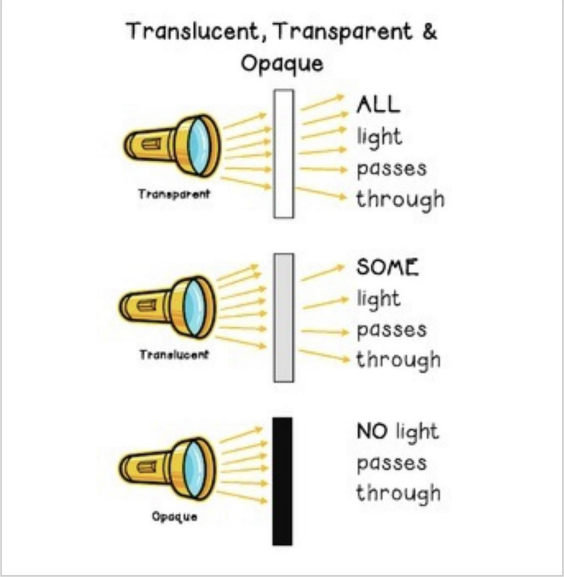
Energy Level	Frequency (per 10 seconds)
low	10 per 10 sec
Medium	27 per 10 sec
High	33 per 10 sec

What is frequency (in your own words)?

Frequency means the wavelengths from top to the bottom. Also it is kind of frequent that we are talking about this.



Transparent, Translucent, Opaque



Transparent light example: glass, window, glass table, clear hand sanitizer, clear plastic, eye glasses, water, air, clear mask

Translucent light example: blurry shower glass, tinted window, white paper, fingernails, thin socks, sea glass, foggy glass, thin blanket

Opaque light example: black paper, wall, book, mask, doll, chair, tree, human body, orca,

I AM A SCIENTIST!

I use the SCIENTIFIC METHOD:

1. Ask a question

2. Make a Hypothesis

3. Conduct Experiment

4. Observation

5. Recording Data and draw conclusion

6. Report the results

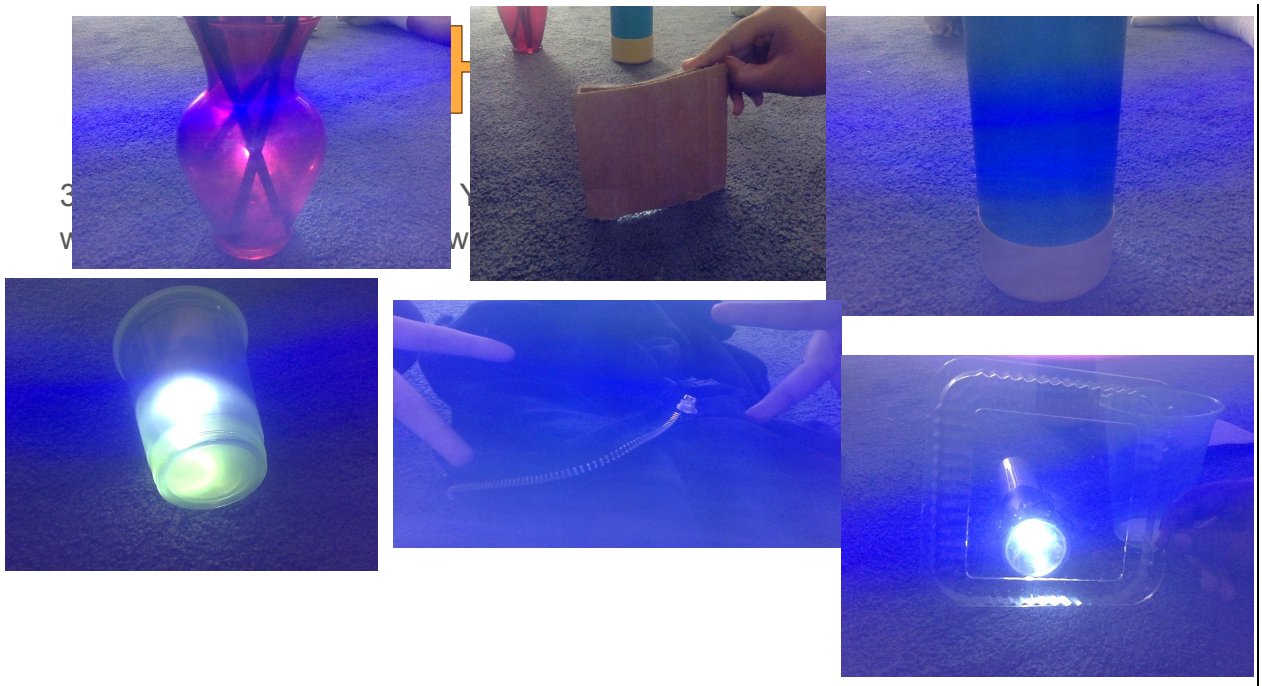
LIGHT IT UP!

We will use the SCIENTIFIC METHOD to experiment with light!

1. Ask a question: How much light will pass through each material?
2. Make a Hypothesis:

I think the _____platic box_____ will let the light pass through the most because_____it is clear._____.

I think the _____card board_____ will block the light best because the card board can block out the light._____.



LIGHT IT UP!

4. Make an observation: Sort the objects into groups by the amount of light that shines through them. Give each group a name that describes how much light they let shine.

Group 1 Name: transparent	Group 2 Name: opaque	Group 3 name: translucent
Objects in this group: Plastic box Plastic cup	Objects in this group: Jacket Water bottle Cardboard	Objects in this group: Flower pot

LIGHT IT UP!

5. Draw a conclusion:

I learned that Light can be transferred into different places and at different times, But also how fast light can travel too.

6. Report results: Summarize your experiment and findings and prepare to share with the class. We discover that light energy can also Form into different matters and are results were correct.

Great job, you now know how to use the scientific method!

SIMIE ME:

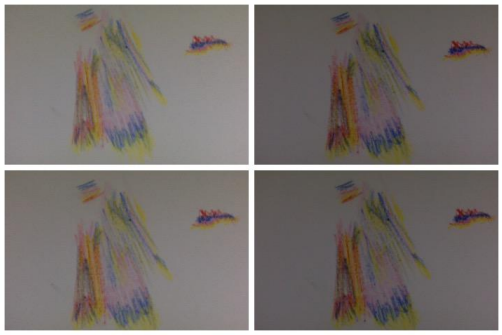
Complete the following sentence:

"The scientific method is like __a great method to use when you are doing sciences_____ because __it can help you learn more stuff and things you never knew about_____."

Refraction of light

Definition: refraction means when the light bends as it passes through a distorting material from one material to another.

Draw what happened to the white light when it was shone through the water. Draw on paper and then take a picture and insert your drawing



What happened to the white light when it was shone through the water?

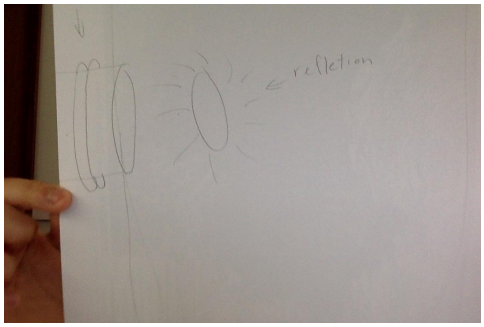
It change its color to a rainbow.

Reflection of light

Definition: Reflection means the light colors reflect but it doesn't change its color.

reflection

Draw what happened to the white light when it was shone in the mirror. Draw on paper and then take a picture and insert your drawing.



What happened to the light in the mirror?

It reflect the white light and didn't change its color.

Mini Research project

1) Decide on something to research that uses light energy or makes light energy
2) Research how it works
3) Make a slide that explains how the energy is used. Make a slide that states your question and answers it with words and/or pictures.
4) Make your slide look interesting
5) Be ready to share your findings with the class on Wednesday.

Appendix E: Rubric

				Comments:

Portfolio clearly represent "Light Energy." Portfolio includes all slides. Portfolio shows a lot of growth and understanding of what you have learned about light energy.	Portfolio clearly represent "Light Energy." Portfolio is missing a few slides. Portfolio shows an understanding of what you have learned about light energy.	Portfolio shows little understanding of what you have learned about light energy. Portfolio is missing or incomplete.	Portfolio is missing or incomplete.	
Student completed all mandatory activities with excellence.	Student completed the majority of activities/tasks. Only a few are missing.	Student completed less than the majority of activities/tasks.	Student completed no activities/tasks.	
Student demonstrates great knowledge of light energy. All essential questions are answered.	Student demonstrates a good knowledge of light energy. Majority of the essential questions are answered.	Student answered one essential question.	Student was not able to answer any of the essential questions.	
Student uses technology to create an extremely informative and creative portfolio.	Student uses technology to create an informative and creative portfolio.	Student uses technology to create portfolio.	Student does not use technology to create portfolio.	
Scientific method steps are fully identified. The content is accurate, understanding, and well-	Scientific method steps are clearly and seen identified. Content is accurate and well-organized.	Scientific method steps are not fully included. It is not clear whether or not the student	Scientific method steps are not included in the portfolio.	

organized. One can see every step clearly followed in the project.		followed all the steps.		

Appendix F: CITI Certificate

CITI PROGRAM

Completion Date 05-Sep-2020
Expiration Date 05-Sep-2023
Record ID 38257381

This is to certify that:

Melanie Trzebiatowski

Has completed the following CITI Program course:

Not valid for renewal of certification through CME. Do not use for TransCelerate mutual recognition (see Completion Report).

Social & Behavioral Research - Basic/Refresher (Curriculum Group)
Social & Behavioral Research - Basic/Refresher (Course Learner Group)
1 - Basic Course (Stage)

Under requirements set by:

Hawaii Pacific University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w0d411774-213f-4347-bc97-06b35d6f371a-38257381

Appendix G: Parent Consent Form

INVITATION TO PARTICIPATE:

Dear Parent,

THE EFFECTS OF DESCRIPTIVE FEEDBACK ON STUDENTS' LEARNING OUTCOMES AND ATTITUDES TOWARD SCIENCE

My name is Melanie Trzebiatowski and I am a Master of Education student in at Hawai'i Pacific University. I am conducting a research study to describe the effects of descriptive feedback without using letter grades on elementary students' learning outcomes and attitudes toward science. The purpose of this form is to provide you with information that will help you decide if you will give consent for your child to participate in this research.

KEY INFORMATION ABOUT THIS RESEARCH STUDY:

The following is a short summary of this study to help you decide whether you want your child to be a part of this study. Information that is more detailed is listed later on in this form.

The purpose of this study is to examine the effects of formative assessments on elementary students in science. Your child will be asked to do a science portfolio and take a nongraded pre- and post-test. We expect that your child will be in this research study for about four weeks; twice a week for approximately two lessons. The possible risks associated with participating in this research project are as followed: minor psychological stress related to completing the science portfolio and/or pre- and/or post-tests, or receiving descriptive feedback. There may be no personal benefit for participating in this study.

STUDY PURPOSE:

This study intends to show the effect of using descriptive feedback as a formative assessment technique without using letter grades and to determine how it will affect students' attitudes and learning outcomes.

NUMBER OF PARTICIPANTS:

If you agree to participate, your child will be one of approximately 15 participants who will be participating in this research. We are inviting people to participate in this research because they are 4th grade students who are enrolled in a science class at St. Andrews Priority in Honolulu.

PROCEDURES FOR THE STUDY:

If you agree for your child to participate in the study, you can expect the following to occur:

- I will ask students to do a science portfolio
- Students will take a nongraded pre- and post-test
- I will observe students' behavior, attitude and learning progress throughout my research by taking notes
- I will co-teach a science unit
- I will give descriptive feedback once a week (orally or written)
- This research project will take about 5 weeks, including initial observations, planning and delivery of the unit, analysis of the findings, and completion of the professional paper.
- This will take about 10 (twice a week) visits and each visit will be two science lessons
- Students can learn about their strengths and areas of improvement in science

- Students can feel more motivated and less stressed when using formative assessments (descriptive feedback) that are not letter graded in science

RISKS AND INCONVENIENCES:

There are no foreseeable risks to participating in this study.

CONFIDENTIALITY:

Your child's learning outcome will be confidential.

Records of participation in this research project will be maintained and kept confidential to the extent permitted by law. However, federal government regulatory agencies and the Hawai'i Pacific University IRB may inspect and copy a subject's records pertaining to the research, and these records may contain personal identifiers. To ensure confidentiality, all identifying information on documents will be removed. In the event of any report or publication from this study, the identity of subjects will not be disclosed. Results will be reported in a summarized manner in such a way that subjects cannot be identified.

The results of this study may be used in reports, presentations, or publications but your child's name will not be used, and only aggregated survey data will be reported. The data will be stored on a password protected computer and only the researcher and investigator will have access to the data. The data will be retained up to 3 years after the project is completed and digital files will be erased.

VOLUNTARY PARTICIPATION:

Your child's participation in this study is voluntary. Your child may decline participation at any time. You may also withdraw your child from the study at any time; there will be no penalty and it will not affect your child's science grade. Likewise, if your child chooses not to participate or to withdraw from the study at any time, there will be no consequences. If your child decides to withdraw from the study, your child will continue the regular science curriculum with the science teacher.

BENEFITS OF TAKING PART IN THE STUDY:

There are no benefits of your child participating in this study. Although there may be no direct benefit to your child, the possible benefit of your child's participation is to hope that in the future, society could benefit from this study by using formative assessment more frequently.

ALTERNATIVES TO TAKING PART IN THE STUDY:

If you decide not to participate in this study, your child will have the option to continue the regular science curriculum with the science teacher.

CONTACT INFORMATION:

If you have questions about the study, please call me at (808)308-8865 or e-mail me at mtrzebiatowski1@my.hpu.edu. Feel free to contact Dr. Valentina Abordonado, my research advisor, at (808)544-1143 or vabordonado@hpu.edu.

PARENT'S CONSENT:

By signing below, you are giving consent for your child to participate in the above study.

Your child's name: _____

Parent's name: _____

Parent's Signature: _____

Date:_____

Appendix H: Student Assent Form

My name is Melanie Trzebiatowski. I go to school at Hawai'i Pacific University. I am inviting you to participate in a research study. The study is about talking about your science schoolwork without receiving grades (A-F).

Your parent knows about this study. They said it was OK for you to be involved. If you agree, I will ask you to work on the unit: light energy in science.

This will happen during the research:

- I will ask you to do a science portfolio.
- I will look at how you act and what you feel about the work.
- This study will take about 4 weeks.
- This will take about 10 visits. Each visit will be a science lesson.
- You could learn about what you are good at in science.
- You could learn what you can work on in science.
- You could feel good about science after talking about it without receiving grades.

This study will help you understand science in a better way! ☺

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start the study, you can stop later if you want. You may ask questions about the study at any time.

If you decide to be in the study, I will not tell anyone else your answers. I will not tell anyone how you act as part of the study. Even if your parents or teachers ask, I will not tell them about what you say or do in the study.

Signing here means that you have read this form or have had it read to you. It means that you are willing to be in this study.

Name (Write your name in the line): _____

Signature (Put your signature in the line): _____

Date:_____

Appendix I: Unit Plan

Design for Instruction

Mentor Teacher's Name: Ms. Armstrong

Grade Level: 4th

Unit Title: Light Energy

Duration of the Unit: February 17th-March 10th

# of Lessons in the Unit: 10

Unit Outcomes

Enduring Understanding(s)

- Examine how light's reflection allows objects to be seen and develop a model.
- Explore how light can also be used as an energy source.
- Study how light energy surrounds us based on examples
- Visible light from the sun is made up of a mixture of all colors of light (Electromagnetic Spectrum)

- To see an object, light must be directly from the object or from an external source reflected or emitted from the object and enter the eye.

Essential Question(s)

1. How does light travel?
2. How can light be refracted?
3. How do human's utile light energy?

Hawai'i General Learner Outcome(s)

GLO #1: Self-Directed Learner

- Monitors progress and evaluates learning experiences

GLO #4: Quality Producer

- Recognizes and understands what quality performances and products are
- Produces evidence that meets or exceeds Hawaii Content and Performance Standards

GLO #6: Effective and Ethical Users of Technology

- Uses a variety of technologies in producing an idea or product

Hawai'i Content Performance Standards and Benchmarks

Standards:

4.S.01 Describe that energy is derived naturally and use affects the environment

4.S.06 Understand and implement an experiment following the scientific method

4.S.10 Describe patterns in waves; describe how waves cause objects to move

4.S.11 Explain how light reflection allows objects to be seen

Learning Outcomes

- Students will examine how light energy plays a role in everyday life.
- Students will understand that light travels in waves by recreating the electromagnetic spectrum.
- Students will create a science portfolio that shows their understanding that light can be reflected, refracted, or absorbed by objects.
- Students will use simple tools, skills, and technology to conduct scientific investigations.
- Students will be able to explain the different steps of a scientific method by using the scientific method on various objects with light.

Assessment Plan

Assessments of Learning Outcomes

- Portfolio that includes all activities during the unit. The portfolio is a PowerPoint.
- "Fun" quizzes taken as a whole class as ongoing formative assessments
- Exit slips
- Rubric with descriptive feedback (written)

Pre- and Post- Assessments

- Pre- and post-test
- Pre- and post-survey

Materials and Technology

- MacBook's (one per student)
- PowerPoint
- projector
- Speaker
- Zoom
- Google slides/form/mail access
- Flashlight
- Glass
- Water
- Colored pencils
- Scratch paper
- Mirror
- Card boxes
- Plastic container
- Rope
- Timer

Resources

- Study.com ("fun" quizzes & videos)
- Studyjams.scholastic.com
- Betterlessons.com
- DOE science standards
- Hawaiipublicschools.org (GLO's)

Universal Design for Learning (UDL)

Representation

The unit plan provides multiple means of representation because it provides interactions with flexible content that does not depend on a single sense like sight, hearing, movement, or touch. Technology, which mainly speaks to visual learners, is widely presented in this unit. However, I ensure that all learners have access to information by providing non-visual alternatives. For example, when watching short videos, I provide descriptions of the video in a written form (text). Another example is writing the instruction on the board for students who have difficulties processing oral instructions. During the unit, I provide auditory cues for key concepts and transitions in visual information as another means of representation. I also find it important to read text or questions aloud to better comprehend the context, introduce new vocabulary, and to build connections between the spoken and written word.

Moreover, communicating through languages that create a shared understanding and generates new understanding is vital for representation. An important aspect of accessibility is providing linguistic alternatives to promote cross-linguistic understanding, such as linking key vocabulary words to definition and pronunciation or defining domain-specific vocabulary. During the unit students will learn quite a few new vocabularies that are essential to know moving forward in the unit; for example, they will learn the vocabularies translucent, opaque and transparent. In some activities students are asked to use a graphic organizer for their new vocabularies which include a non-example, picture, and definition of the learned vocabulary.

Expression

It is essential for students to interact with accessible materials and tools, compose and share ideas using tools that help attain learning goals, and develop and act on plans to make the most out of learning.

Using multiple media for communication and expression to increase the opportunities for all learners to develop a wider range of expression in a media-rich world is seen throughout the unit; for instance, students are required to create a portfolio via a google form. Students use multiple media such as text, drawings, illustrations, comics, video, and pictures to express their knowledge of light energy. Students are given the choice to use manipulatives, such as books or media tools as resources.

To make the most out of learning, I will provide feedback that is explicit, timely, informative, and accessible for students to know how to improve. During the unit, I ask questions to guide self-monitoring and reflection, show their portfolio to see their progress, and use rubrics that guide self-reflection. Learning cannot happen without feedback; therefore, students need to know of their progress.

Engagement

Students differ tremendously in the ways in which they feel engaged or motivated. I believe that sparking excitement and curiosity for learning and controlling emotions and motivation in learning is essential for engagement in the classroom. Giving students choices and autonomy over their learning is one way I optimize engagement. For example, during the scientific method, students are asked to bring three different objects of their choice to demonstrate transparent, translucent, and opaque. Another example is

giving students the choice of how they will create and decorate their portfolio. Giving them the choice of the materials and portfolio layout ensures engagement.

Learning Activities

Lesson 1:

Opening Activities (10minutes)

- KWL
- Brainstorm the following questions:
  - What are sources of light?
  - What questions do you have about light energy?

Learning Activities (30 minutes)

- Watch video "Light Energy Sources" on study.com
- Activity "What are the two main sources of light?" (PowerPoint slide 4)

Closing Activities (10 minutes)

- Exit slip: define "light" in your own words

Lesson 2:

Opening Activities (5 minutes)

- Recap: fun quiz taken as a whole class on study.com about light energy sources

Learning Activities (35 minutes)

- Activity: "Light energy sources" – Example, Description, How it affects you, Type of light. (PowerPoint slide 5)
- Video "Visible light" on study.com (introduction to Electromagnetic spectrum)
- Activity: research the definition of wavelength and frequency (PowerPoint slide 6)

Closing Activities ***(*** 10 minutes)

- Describing wavelengths and comparing the frequencies (Radio, microwave, imfrared, visible, ultraviolet, x-ray, gamma ray)
- Exit slip:
  - A wave is measured from the ____ to _____?
  - How many times does a wavelength go through a certain point in a certain amount of time is called_____?
  - X-rays hav a high frequency or low frequency?

Lesson3:

Opening Activities (5 minutes)

- Think-Pair-Share: Define wavelength and how they are measured

Learning Activities (35 minutes)

- Activity: "Frequency of wavelengths" (PowerPoint slide 7)
  Groups of 3. One student is the counter, one student is the energy level (making the wavelengths with rope), the other student is the base (holds rope tight). Students are asked to measure the frequency of low, medium, and high frequency waves by counting how many times the crest of a wavelength is seen in 10 seconds.
- Electromagnet spectrum slide (better lesson)

Closing Activities ***(10*** minutes)

- Exit slip: Define frequency in your own words

Lesson 4:

Opening Activities (10 minutes)

- Recap: What did we learn in science last week? What is unclear?
- Graphic Organizer: "translucent, transparent, opaque"

Learning Activities (35 minutes)

- Activity: Examples-non examples of transparent, translucent, opaque
- Scientific method: discussing the scientific method by brainstorming the different steps of a scientific method and why scientist use this method
- "light it up!" scientific method activity – model one example (PowerPoint slide 11)

Closing Activities (5 minutes)

- Aunty Mary Cooks Me Rich Raisin Muffins (Mnememun)

Lesson 5:

Opening Activities (10 minutes)

- Video "light" from studyjam.scholastic.com (recap and introduction to transparent, translucent, and opaque)
- Name 2 things you have learned from the video

Learning Activities (35 minutes)

- **Scientific method "Light it up!" (PowerPoint slide 12-15)**

Closing Activities (5 minutes)

- Simile me: Students complete the following sentence: "The scientific method is like _____ because _____."

Lesson 6:

Opening Activities (10 minutes)

- Introduction to refraction: Video study.com with fun quiz

Learning Activities (30 minutes)

- Partner work: students will experiment with water and a flashlight to see how light can be refracted

Closing Activities (10 minutes)

- Think-Pair-Share: Where do you see refraction in real life?

Lesson 7:

Opening Activities (10 minutes)

- Introduction to refraction: Video study.com with fun quiz taken as whole class

Learning Activities (30 minutes)

- Activity "Refraction of light" (PowerPoint slide 17)
- Experiment "creating your own rainbow"
- Process:
    1. 1.Position your glass of water on a table.
    2. 2.Make sure that the room is dark. ...
    3. 3.Take the flashlight and aim the light towards the glass.
    4. Watch what happens!

Closing Activities (10 minutes)

- Draw a picture of your experiment and the outcome.

Lesson 8:

Opening Activities (10minutes)

- Introduction to reflection "Law of reflection" video study.com with fun quiz taken as whole class

Learning Activities (30 minutes)

- Activity "Reflection of light" (PowerPoint slide 18)
- Experiment: Flashlight reflection in mirror
    1. 1.Lay the **flashlight** on its side on a table in a dark room (switched on).
    2. 2.Hold a **mirror** in front of the **flashlight**.
    3. 3.Where does the beam of light shine?
    4. 4.Hold your nametag in front of you and let it reflect in the mirror.
    5. 5.What is reflection?

Closing Activities (10 minutes)

- Draw a picture of your experiment and the outcome.

Lesson 9 & 10:

Mini Research Project and Presentation:

1. Decide on something to research that uses light energy or makes light energy
2. Research how it works
3. Make a slide that explains how the energy is used. Make a slide that states your question and answers it with words and/or pictures.
4. Make your slide look interesting
5. Be ready to share your findings with the class on Wednesday.