THE IMPACT OF SELF-ASSESSMENTS ON ACADEMIC PERFORMANCE OF HIGH SCHOOL BIOLOGY STUDENTS.

by

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DEDICATION

I dedicate this work to my family. To my husband, who has been my constant support, sounding board, and daily chef throughout this endeavor. And to my daughters, whose encouragement kept me going throughout life's difficulties. Their belief in me has been an invaluable motivator and comfort.

ACKNOWLEDGEMENTS

I thank Dr. Anderson for her continuous guidance and support throughout this journey. Her guidance enabled me to channel my ideas into a working project, leading to a fulfilling experience. I would also like to thank Dr. Dan Lawver for his feedback and suggestions on my project. His knowledge and expertise have enriched my MSSE experience both in the classroom and out in the field. Last, but not least, I would like to thank all the students in my cohort, who provided so much knowledge, perspective, and support.

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ABSTRACT

Students in an academically advanced high school program have demanding schedules. They balance academics and extracurricular activities while staying focused on achieving high grades. Observations show that students often overestimate their knowledge before assessments, only to realize later that they were not adequately prepared. Students could benefit from identifying areas needing improvement, enabling them to concentrate their study time on the most critical topics. This research project examined the influence of self-assessment strategies on the academic performance of 97 high school biology students. The students completed a pretest and then pinpointed the topics where they aimed to improve their scores. Choosing from a selection of activities, they remediated or challenged themselves on specific standards. After completing the activities, the students took a posttest, compared their results, and provided feedback on the process. The results demonstrated a statistically significant improvement in test scores and an increase in student confidence in their knowledge. Survey data revealed that many students are interested in using this method for future study in biology and other subjects.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND

Context of the Study

I have taught high school biology for eight years at Park Vista High School in Lake Worth, Florida. While at Park Vista, I have taught Biology Regular, Honors, and CAAPP classes. CAAPP Biology is an honor-level class that is part of Park Vista's Comprehensive Advanced International Certificate of Education (AICE) and Advanced Placement (AP) Program (Palm Beach Schools, 2023). Students in the CAAPP program comprise a freshman student cohort who will complete a combination of AICE and AP courses during their four years at Park Vista. The biology course requires students to take a cumulative end-of-course exam at the end of the school year. Upon completion of the CAAPP program, students will earn an AICE diploma that qualifies them for a full university scholarship in the state of Florida through the Bright Futures Program (Bright Futures Student Handbook, 2023).

The total number of students enrolled in Park Vista was 2,859. According to school data provided by Assistant Principal Higley (2025), our student population is 17% Black, 26% Hispanic, 47% White, and 10% other ethnicities. Overall, 24% of students qualified for Free and Reduced lunch, 5% were English Language Learners (Higley, 2024). During the 2024-2025 academic year, I have the privilege of instructing all five CAAPP Biology sections, which comprise 137 students. The demographic composition of my students is 6.6% Asian, 6.6% Black, 22.6% Hispanic, 7.3% Multiracial, and 59% White. My students are in the 9th grade and enrolled in the same courses within the CAAPP program. Our school district provides each

student with a Chromebook for use in class. While students must bring their Chromebooks to class daily, teachers are not required to give online assignments. Students are expected to use Google Classroom as the primary means of accessing their class information.

CAAPP Biology is a demanding course that requires considerable time and effort. My students typically have challenging schedules and are expected to excel academically. Despite their high level of achievement, I have observed that many students could benefit from identifying areas where they need improvement, which would enable them to concentrate their study time on the most critical topics. Unfortunately, students often overestimate their knowledge before assessments and only later discover they were not adequately prepared. This research project aims to examine the influence of self-assessment strategies on the academic performance of high school biology students.

Focus Question

My focus question was, What is the impact on the academic performance of high school biology students who use a self-assessment strategy?

My sub-questions include the following:

1. Does self-assessment affect how students evaluate their strengths and weaknesses?
2. Does self-assessment have a positive, negative, or neutral effect on academic performance?

CHAPTER TWO

CONCEPTUAL FRAMEWORK

Introduction

Academic growth requires students to assess their strengths and weaknesses. Monitoring one's processes to improve performance is known as self-assessment (Andrade, 2019). While self-assessment may not come naturally to students, with practice, they can learn to master these skills. This includes assessing their growth and skills, determining gaps in their knowledge, and developing critical thinking skills (Student Self-Assessment, n.d.). One of the many roles of secondary school educators is to prepare students for future success in post-high school academics. Pandero (2017) identifies a need for self-assessment skills for students to transition to higher education, adulthood, and future careers. Even though some students will attend college after school, many will join the workforce or learn a technical vocation. Self-assessment skills promote metacognition, enhance learning depth, and allow students to reflect on their educational journeys (Gehringer, 2017). This study will investigate the impact of a self-assessment strategy in a high school biology class and its effect on students' academic performance.

Self-Assessment Learning Theory

As high school students are at the formative stage of their lives, they are influenced by the perceptions of others and their outward appearance toward their peers. Allowing students to explore how to influence their study habits through reflection may provide an outlet that is not

perceived as a weakness. Several theories have been explored to help students increase their awareness and develop their own learning skill sets. Self-determination theory and social cognitive theory explain several key points required to assist students in their learning journeys.

Self-Determination Theory

By utilizing self-knowledge, students can enhance their study techniques and academic outcomes. Ryan and Deci (2020) relate autonomy and competence as two important values that support self-determination by increasing intrinsic motivation. Applied to a classroom setting, Bogunović et al. (2023) showed that when motivation is self-determined, students tend to achieve better academic progress. When provided with greater autonomy, students are more likely to have their psychological needs met (Ryan & Deci, 2020). These studies suggest that self-determination and autonomy enhance students' academic performance.

Because autonomy should be a goal of all students in their post-academic years, self-assessment skills will create an awareness that leads to self-determination. Remojo et al. (2018) found that underachieving students who participated in a self-determination program increased their academic performance. The same students acknowledged that self-determination methods for academics could transition to taking charge of their lives outside of the classroom. Egorenko (2018) suggested that fostering self-determination in high school students positively influences their performance and motivation. High school students are still in a formative time of development, so self-determination skills can support them in academic and life skills. To develop these skills, teachers must provide opportunities to students through classroom strategies. Fostering self-determination through autonomy and self-assessment not only enhances

academic success but also equips students with essential life skills, preparing them for future independence and personal growth.

Social Cognitive Theory

Self-determination is a motivating force for some students, but one cannot exclude the influence of others to explain the drive to do better and perform at the level of other students. Social cognitive theory emphasizes the influence of external factors (Bandura, 1991) on intrinsic motivation. Social networks are important for developing individual behavior (Gross & Medina-DeVilliers, 2020; Miao et al., 2023). Bandura (1991) stated that through self-reflection, individuals combine their social experiences and internal thoughts to form their responses. High school students are aware of both their motivations and their social groups. During these years, they have integrated both internal and external experiences into their academic development.

The connection between self-determination and social cognitive theory clarifies the factors leading to intrinsic motivation. Whether it is an internal or external force, the drive to attain goals must involve self-reflection by the student. The teacher must be able to recognize the forces that most influence their students to exploit their potential and help them achieve their goals.

Self-Assessment

Teachers may use formative and summative self-assessments to evaluate student achievement. Formative assessments enable teachers to monitor student learning, whereas summative assessment is used at the end of a unit of instruction (Angelo & Cross, 1993). Formative assessments allow students to evaluate their learning through reflection and feedback

while summative assessments measure overall achievement (Muhammed et al., 2024). A combination of both methods can be used in the learning environment.

Types of Student Self-Assessment

There are many tools available for formative student self-assessment. Formative self-assessment allows students to participate in assessment techniques, leading to reflections on their learning and study methods (Angelo & Cross, 1993). Reflective journals are one method that allows students to evaluate their work and record their thoughts in an unobtrusive setting (Onodipe et al., 2020). Reviewing journal entries allows both students and teachers to monitor progress over time. A second tool is peer assessment, which allows students to provide feedback (Yu & Levesque-Bristol, 2020) and evaluate their peers' work. These types of assessments can include peer review, peer questioning, and peer grading. Using peer assessment deepens comprehension and develops critical thinking skills (Budiarti & Istiyono, 2023). The confidence that students gain through this process can have additional benefits. Vedder (2018) stated that the student-teacher relationship may improve when students gain confidence through formative assessment. Overall, the use of various methods of formative self-assessment can promote reflection and self-reliance among students.

Summative assessments are frequently employed after the conclusion of a lesson or unit to evaluate students' proficiency in academic content. In portfolios, students compile their work over the academic year, providing a thorough picture of their accomplishments and learning progress over time (Andika et al., 2021; Cruz & Zambo, 2015). Performance assessments evaluate students on their ability to perform a task. Often student achievement is measured

through standardized testing or end-of-course exams. This action research project will investigate a self-assessment strategy to support student achievement and foster intellectual growth.

Benefits of Self-Assessment

There is evidence that self-assessment leads to many benefits for students in a learning environment (Andrade, 2019). These include ownership of their learning, goal setting, and critical thinking skills. A benefit of self-assessment is that students can develop the ability to learn from both their successes and mistakes by developing confidence in their abilities (Sharma et al., 2016). Identifying deficiencies in understanding fosters motivation to set goals to gain mastery in an academic setting (Zimmerman et al., 1992). Students must connect new knowledge with prior knowledge during the learning process. The ability to integrate this information develops critical thinking skills rather than rote memorization (McMillian & Hearn, 2008). Pilotti et al. (2023) explain that students often overestimate their abilities due to a lack of knowledge or wishful thinking. Using practice tests, students can better learn to evaluate their abilities. Opportunities for self-assessment allow students to build self-confidence. As noted by Gehringer (2017), the development of self-assessment skills supports students in higher education and future careers. Teachers can prepare students for success beyond the classroom by providing these opportunities to students during their high school careers.

CHAPTER THREE

METHODOLOGY

Demographics

The purpose of this study was to examine the impact of using a self-assessment strategy in a high school biology class on academic performance. My project was conducted in five ninth-grade Biology Honors classes with 137 students. The demographic composition of my students is 6.6% Asian, 6.6% Black, 22.6% Hispanic, 7.3% Multiracial, and 56.9% White. This project used a one-group pretest-posttest design. The one-group pretest-posttest is useful in exploratory research when the research is conducted in a short time frame (Spector, 2018). The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for work with human subjects was maintained (Appendix A).

Treatment

At the end of our unit on Plant Structure and Physiology, my students took a Standards-Based Pretest (Appendix B) to assess their knowledge. After completing the Standards-Based Pretest, the students scored their results and calculated the percentage of correctly answered questions for each standard. These results were recorded on their Pretest Self-Assessment (Appendix C). Taking the pretest allowed students to self-identify their strengths and weaknesses. They pinpointed areas that required remediation if they scored 50 percent or lower on a standard, or areas where they wished to challenge themselves. Once they identified targets for improvement, the students employed a self-assessment technique called Fill-in-the-Gaps

(Bertrand et al., n.d.). This method enabled students to select activities to enhance their understanding in self-identified areas of need. The Fill-in-the-Gaps technique also helped the students concentrate their study efforts on the most crucial areas, allowing them to use their time effectively. Using their pretest scores, students selected a remediation or challenge task from the Fill-in-the-Gaps Remediation and Challenge list (Appendix D). Four different tasks were provided for remediation and challenge. Students were provided a selection of two types of video tasks. The first was interactive CPALMS (Collaborate, Plan, Align, Learn, Motivate) tutorials aligned to curriculum standards (Florida State University, 2025). Upon completion of the CPALMS tutorial, students entered their name into a digital certificate to be emailed as verification of their work. The second set of video tasks was selected from Science with the Amoeba Sisters (2025). Students chose the video that corresponded to their area of remediation or challenge. A hard copy of the accompanying Amoeba Sisters video handout was available to students in the classroom.

The remaining activities consisted of card manipulatives (Figure 1). Students could work individually or in pairs to complete the manipulative activities. A tarsia puzzle manipulative required students to match vocabulary terms and definitions to complete the puzzle correctly (Palm Beach Portal Login, n.d.). Once completed, students could self-check their work using an answer key provided in the classroom. A second manipulative required students to arrange and label the processes of photosynthesis and cellular respiration using cards (Getting Nerdy Science, 2012). Because there are multiple possible arrangements for this card sort, students justified their final work product upon completion of the task, making adjustments if needed.

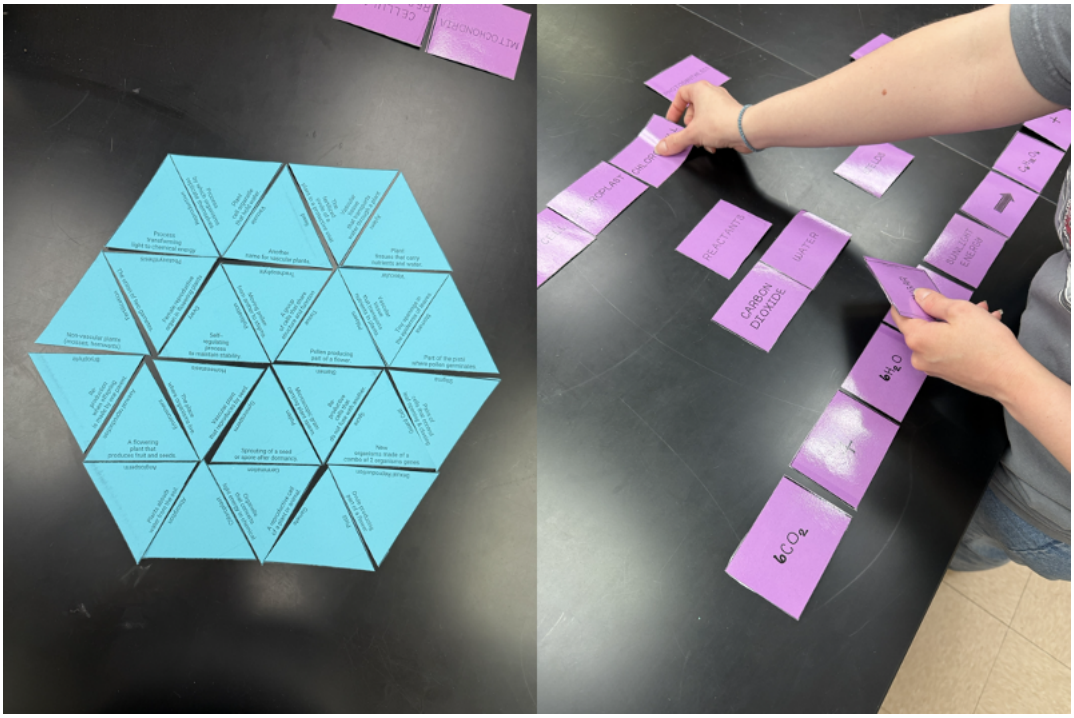
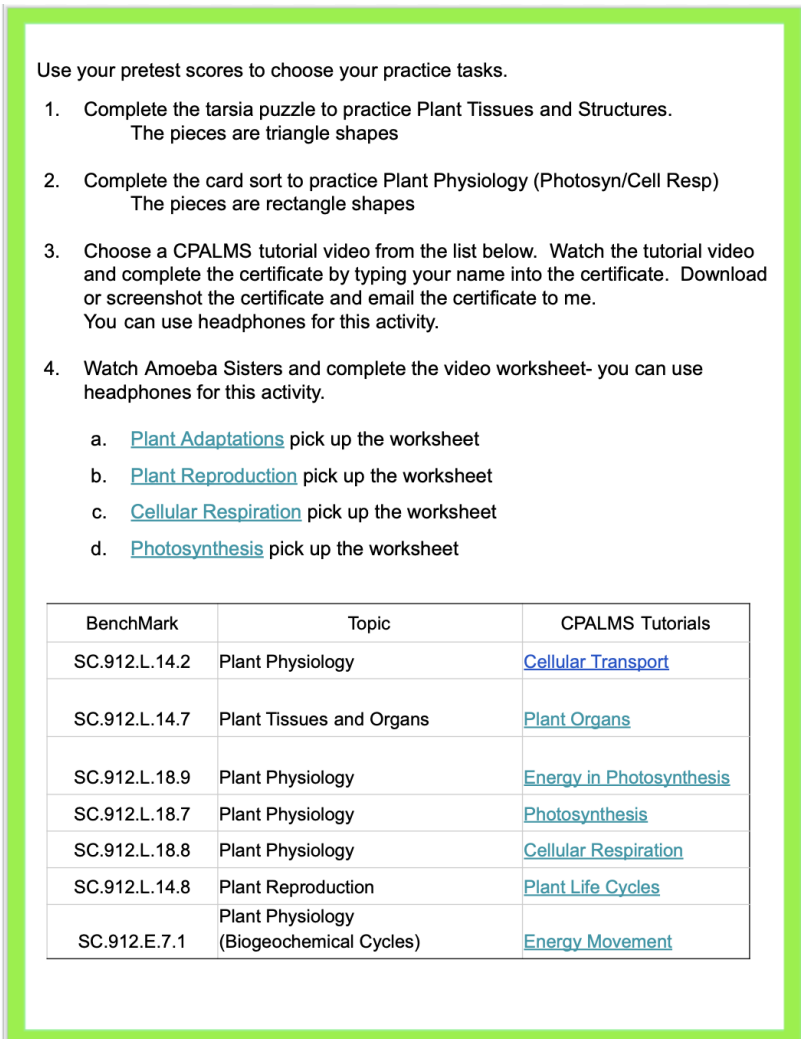


Figure 1. Tarsia puzzle and photosynthesis cellular respiration manipulatives.

To assist students in choosing remediation or challenge activities, a summary list was provided in Google Classroom and displayed on the smartboard in the classroom (Figure 2). This list provided links for interactive CPALMS tutorials, Amoeba Sister videos, and a description of the manipulatives.



Use your pretest scores to choose your practice tasks.

1. Complete the tarsia puzzle to practice Plant Tissues and Structures.
   The pieces are triangle shapes
2. Complete the card sort to practice Plant Physiology (Photosyn/Cell Resp)
   The pieces are rectangle shapes
3. Choose a CPALMS tutorial video from the list below. Watch the tutorial video and complete the certificate by typing your name into the certificate. Download or screenshot the certificate and email the certificate to me.
   You can use headphones for this activity.
4. Watch Amoeba Sisters and complete the video worksheet- you can use headphones for this activity.
   a. Plant Adaptations pick up the worksheet
   b. Plant Reproduction pick up the worksheet
   c. Cellular Respiration pick up the worksheet
   d. Photosynthesis pick up the worksheet

BenchMark	Topic	CPALMS Tutorials
SC.912.L.14.2	Plant Physiology	Cellular Transport
SC.912.L.14.7	Plant Tissues and Organs	Plant Organs
SC.912.L.18.9	Plant Physiology	Energy in Photosynthesis
SC.912.L.18.7	Plant Physiology	Photosynthesis
SC.912.L.18.8	Plant Physiology	Cellular Respiration
SC.912.L.14.8	Plant Reproduction	Plant Life Cycles
SC.912.E.7.1	Plant Physiology (Biogeochemical Cycles)	Energy Movement

Figure 2. Summary of student remediation and challenge tasks.

Providing specific resources ensured that the materials aligned with our standards. For this study, students were provided with two to three different tasks for each standard. The students could choose any activity from the list, allowing them autonomy to select the style most suited to their interests.

After completing their fill-in-the-gaps tasks, the students took a standards-based posttest (Appendix B) and scored themselves to determine how many questions they answered correctly. The results of posttests provide feedback not only to students but also to the teacher. By using

information from a posttest, a teacher can measure student learning and develop further instruction (Guskey, 2003), addressing misconceptions and providing academic support. The Standards-based posttest results were compared to the Standards-Based Pretest results. Students evaluated their results to assess changes in their academic performance. They also reflected on their ability to evaluate their strengths and weaknesses. This process can help students build confidence in their abilities (Sharma et al., 2016) and guide further learning.

After completing both the Standards-Based Pretest and Posttests, students were asked to provide feedback through a Student Survey (Appendix E). The survey was distributed using a Google Form to make the analysis of student responses easier. Digital surveys are an efficient way to collect feedback from sample sizes exceeding one hundred and to manage time constraints (Sue & Ritter, 2012; Uhlig et al., 2014) compared to paper surveys. This method allowed me to gather feedback from each of my students. Depending on time limitations, students could submit their responses anonymously, either in class or outside of it.

Data Collection and Analysis Strategies

Since I am interested in learning both how my students perceive their ability to evaluate their strengths and weaknesses after using self-assessment and what impact it had on their academic performance, I used a mixed-methods approach for my analysis. Using both qualitative and quantitative data strengthens the credibility, depth of action research, and reduces bias by using multiple methods, allowing for cross-analysis of the data (Flick, 2019; Mertler, 2020).

Data Collection Methods

Each of my data collection instruments (Table 1) provided insight into my students' experience with self-assessment. The pretest and posttest measured student mastery of the standards. The Student Survey recorded the students' perceptions of the self-assessment process.

Table 1. Data Triangulation Matrix.

	Focus Question	Sub Questions	
Data Collection Instruments	What is the impact on the academic performance of high school biology students who use a self-assessment strategy?	Does self-assessment affect how students evaluate their strengths and weaknesses?	Does self-assessment have a positive, negative, or neutral effect on academic performance?
Standards-Based Pretest	X	X	X
Standards-Based Posttest	X	X	X
Student Survey	X	X	X

Pretest and Posttest. Students assessed their knowledge by completing a Standards-Based Pretest and a Standards-Based Posttest (Appendix B). ChatGPT was used to create standards-based multiple-choice questions to avoid copyright infringement of materials (OpenAI, 2024). The use of a one-group pretest-posttest design is part of a pre-experimental design. This research design, commonly used in social sciences, uses only one group for the treatment and does not include a control group (Spector, 2018). Without a control group, the researcher can evaluate the data but cannot rule out other factors that may have contributed to the results (Mertler, 2020). The use of pretests and posttests allows data analysis to determine if a change has occurred during the use of the treatment. Knapp (2016) was critical of the one-group pretest posttest method; however, he indicated the test is appropriate for use in exploratory research. Spector (2018) acknowledges limitations in this method but clarifies that the test is appropriate when used in a short time frame, for evaluating the effectiveness of a program, and for use when a

control group is not possible. This approach is appropriate for my research because it allows for a comparison of student academic performance before and after the treatment.

While I want to understand the students' attitudes about their perceived impact of self-assessment, it is important to look for a statistically significant impact on academic performance after using self-assessment. Paired t-tests were used to analyze the differences between the Standards-Based Pretest and Standards-Based Posttest scores. A paired t-test analysis is used to measure the difference between a pretest and a posttest for significant differences (Bowen & Bartley, 2014; Knapp, 2016). This data was used to answer my research question by determining whether the treatment caused a change in their academic performance.

Student Survey. Students completed a digital Student Survey, which contained both Likert statements and open-ended responses. Likert statements ask the individual to indicate how much they *agree* or *disagree* with a statement. Often, the questions are five or more answer choices, ranging from *completely disagree* to *neutral,* then to *completely agree.* For this study, I chose to exclude a neutral option in the Student Survey to elicit either a positive or negative response (Bowen & Bartley, 2014). Not being able to choose a safe, neutral option will encourage students to reflect on their experience. Having their feedback will allow me to evaluate the impact of the treatment better. For the survey, I used an open-ended question to follow up each Likert statement. Peterson (2000) refers to the follow-up question as a reason-why question. The follow-up question provides an opportunity for students to give details and insight into their quantitative responses on the Likert statement. The combination of the open and closed questions is a mixed-methods research design.

CHAPTER FOUR

DATA ANALYSIS: CLAIMS AND EVIDENCE

Pretest and Posttest Scores

Self-assessment led to an improvement in academic performance. Data was collected from the students via Google Forms (Appendix F) following the treatment and posttest. While 134 students participated in the study during class, 37 did not complete the anonymous student survey. Some students may not have finished the activities within the allotted class time or may not have complied with the request for feedback since it was anonymous. Data was gathered from 97 students who provided scores and feedback in the Student Survey. The mean pretest score was 73% and the mean posttest score was 86% (Figure 3).

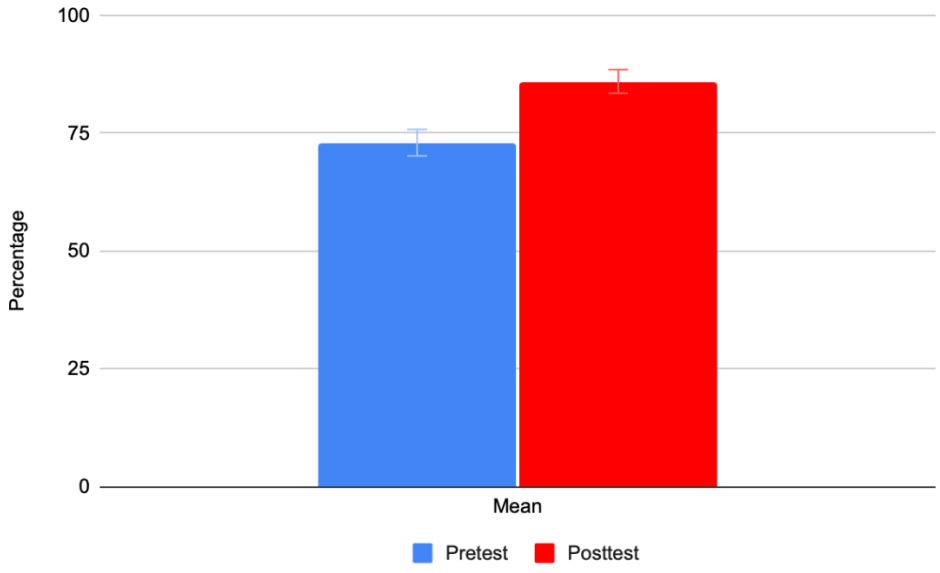


Figure 3. Mean pretest and mean posttest scores, (*N*=97).

The increase in the mean scores is 13 percentage points. Error bars shown in Figure 3 represent two times the standard error. The lack of overlap between the error bars indicates that the increase in mean score from pretest to posttest is significant. Pretest and Posttest scores were analyzed using a paired t-test. The paired t-test yielded a p-value of <0.05, indicating a significant increase in the students' scores.

After the use of the self-assessment strategy, the distribution of student scores shifted higher, indicating overall improvement. The median pretest score of 75% increased to 85% (Figure 4).

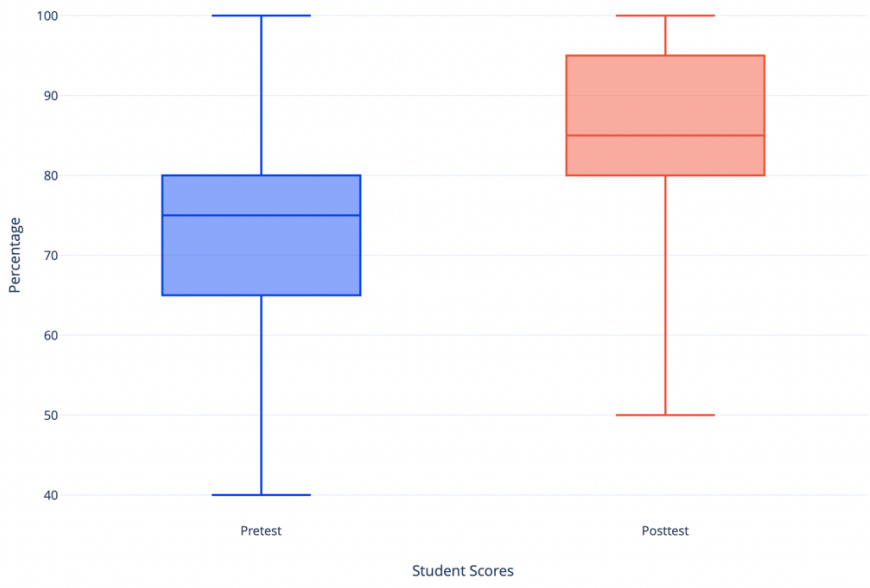


Figure 4. Box and whisker plot of pretest and posttest scores, (*N*=97).

The box plot indicates that 50% of the pretest scores were between 65 and 80 percent, while 50% of the posttest scores fell between 80 and 95 percent. More posttest scores were in the upper quadrant. The upper whisker shows that the top score was 100 in both the pretest and the

posttest; however, the lower whisker shows that the lowest score increased from 40 to 50, reducing the spread. The Pearson correlation test yielded a correlation value of 0.47. This moderate correlation indicates that the posttest score is not strongly related to the pretest score, suggesting that the treatment affected the scores. The average of gains was 0.47, indicating that student gains were moderate and that more learning was possible.

Student Perception

Students provided feedback in the Student Survey by responding to Likert scale statements asking whether they *strongly disagree*, *disagree*, *agree*, or *strongly agree*. Following each statement, students had the opportunity to give an open-ended explanation for their response. The addition of a written explanation was optional. Although not required, some students submitted their Pretest/Posttest Self-Assessment with handwritten comments about their experience.

Self-Confidence

Student confidence in their knowledge of the standards before and after the treatment showed a significant increase. Prior to the treatment, 42.3% of the students *disagreed* or *strongly disagreed* that they felt confident in their knowledge of the standards (Figure 5). Many students expressed a lack of confidence due to the time lapse between completing the unit and the pretest. One student simply stated, “I felt that I had forgotten a majority of the information due to spring break.” After the treatment, the percentage of students who did not feel confident dropped from 42.3% to 7.2%.

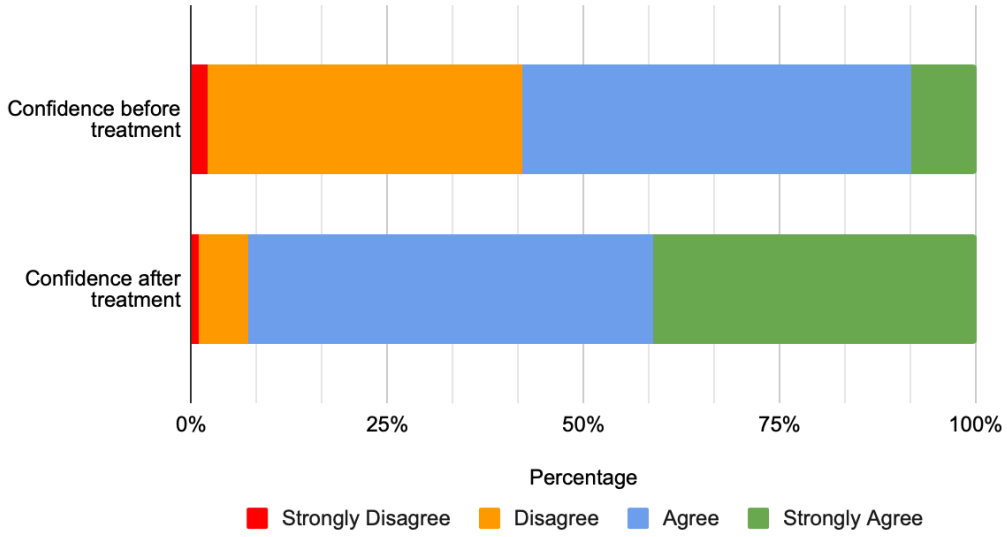


Figure 5. Student confidence before and after the treatment, (*N*=97).

After the treatment, the percentage of students who *agreed* or *strongly agreed* that they felt confident in their knowledge rose from 57.7% to 92.7%. Within this group, the percentage of students who *strongly agreed* they felt confident increased from 8.2% to 41.2%. One student wrote, "I felt much more confident because I worked hard on the practices." Another student wrote, "I felt pretty good when I took the pretest, but the remediation tasks made me feel very confident," showing that their confidence grew even though they did not lack confidence before using the self-assessment strategy. Chi-square analysis returned a p-value of <0.05, indicating that the increase in confidence level is statistically significant.

Impact on Ownership and Learning

This self-assessment strategy supported students in taking ownership of their learning. An analysis of the student responses indicated that students had an overwhelmingly positive experience with this self-assessment strategy (Figure 6).

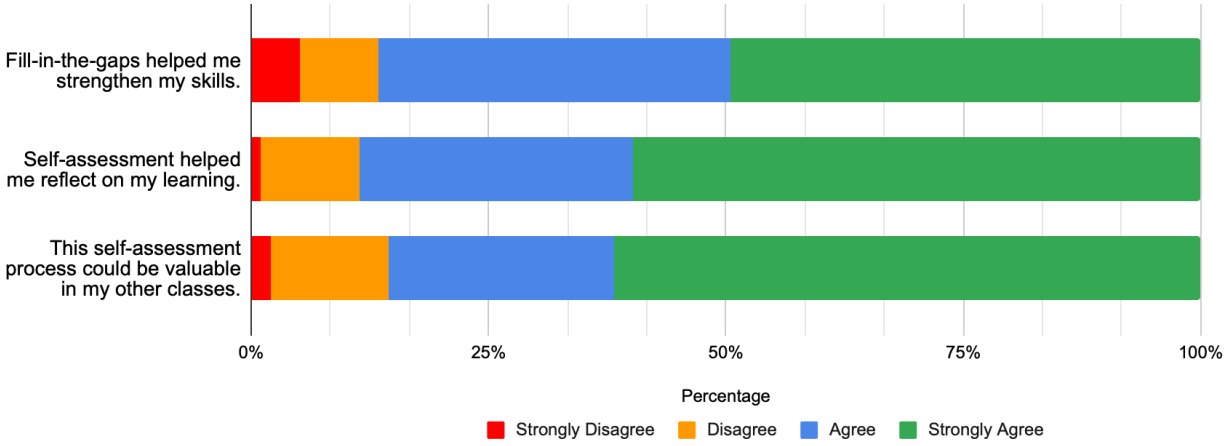


Figure 6. Student perception of use of self-assessment strategy, (*N*=97).

Strengthening Skills. Most students, 86.6% (*n*=84), *agreed* or *strongly agreed* that the self-assessment and fill-in-the-gaps process helped them strengthen their skills. One student made a direct connection, writing "Using this 'fill in the gap' method helped me strengthen my skills. I was able to refresh my memory on everything we learned which helped a lot when I did the post test." Another student wrote, "This assessment helped a lot with the way my brain is personally wired, with the 'fill in the gap' concept of it," indicating that the student felt value in this method. Four of the students who *disagreed* or *strongly disagreed* that this method helped them strengthen their skills, 13.4% (*n*=13), did not seem to be aware of the name of the method used for self-assessment.

Reflection. When asked whether the self-assessment helped them reflect on their learning, 88.7% (*n*=86) *agreed* or *strongly agreed*. One student exemplified reflection when they wrote, "It made me realize my mistakes and made me understand what I must work on." Another student wrote, "It helped me understand why I was getting the answers wrong." On the other

hand, one student wrote, “I don't really reflect, just answer the questions,” indicating a need for experience with this process.

Transferability. Many students, 85.6% (*n*=83), *agreed* or *strongly agreed* that this strategy could be useful in other class subjects. Several students identified that they would be amenable to a strategy like Fill-In-The-Gaps. For example, one student wrote, “This strategy would be good for classes such as history, and in classes using large amounts of vocabulary.” This statement, however, received the highest negative response compared to others. Among the students who *disagreed* or *strongly disagreed*, 14.4% (*n*=14) felt this process would not transfer well to other subjects. A potential limitation was identified by a student who wrote, “I think it's a good way of studying, especially in classes using facts and memory, such as medical or history, rather than classes like reading or math.”

Ease of Use

Student feedback showed overwhelming support for the self-assessment strategy (Figure 7). Students were asked whether they *agreed* or *disagreed* that the self-assessment strategy was easy to use. Feedback indicated that 91.9% (*n*=89) *agreed* or *strongly agreed* that the self-assessment strategy was easy to use.

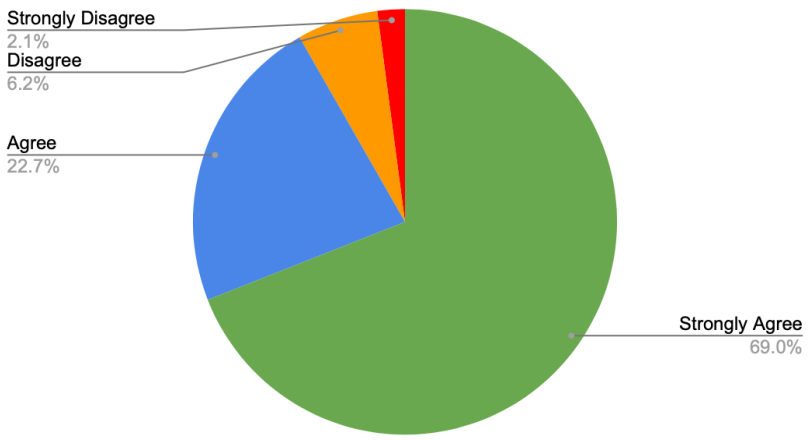


Figure 7. Student agreement of treatment ease of use, (*N*=97).

Ease of use was exemplified by a student who wrote, "The tasks were easy to follow and gave me a lot of information and helpful review tools." Not all students who agreed with the ease of use framed their agreement as a positive attribute. One student wrote, "It is easy, however it's not for everyone, personally I like getting taught by a teacher more than me personally," indicating that some students were less comfortable with self-directed reviews.

Engagement

Students reported a high level of engagement, as 85.6% (*n*=84) *agreed* or *strongly agreed* that they were engaged during the self-assessment process (Figure 8). One student wrote, "It was a fun way to review and realize where I am at in this class." Another student specified their remediation task by writing, "The puzzles were challenging and when completed, I felt I understood very well."

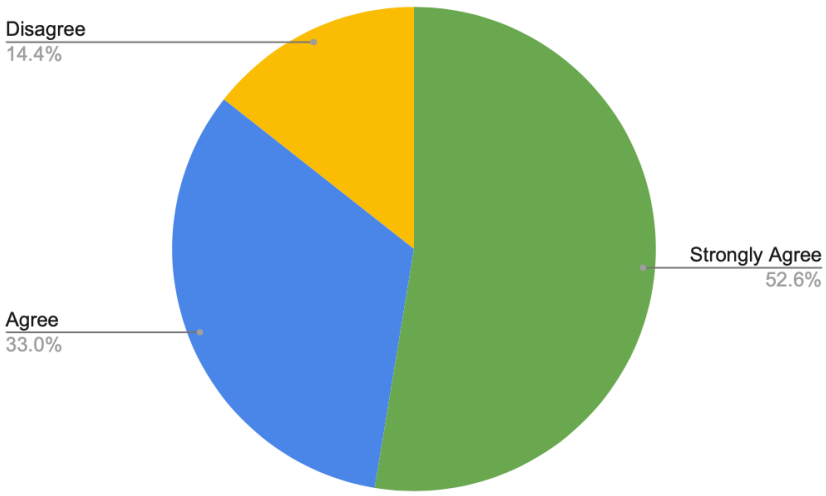


Figure 8. Student agreement on engagement during the treatment, (*N*=97).

Students chose their remediation tasks, but some enjoyed certain remediation tasks over others, as evidenced by a student who wrote, “I enjoyed the tarsia puzzle, but the card match was annoying and the CPALMS was boring.” Notably, no students reported that they *strongly disagreed* with feeling engaged during the remediation activities.

CHAPTER FIVE

VALUE: REASONING AND REFLECTION

Claims From the Study

Increase in Posttest Scores

This study demonstrated that using the Fill-In-The-Gaps self-assessment strategy led to a significant increase in the academic scores of the students who fully participated. Mean student scores increased from 73% to 86%. By using the treatment process, students could identify deficiencies in their learning and choose a remediation method. The remediation process allowed students to build their knowledge and not rely on memorization to help them achieve their goals as described by McMillian & Hearn (2008).

Some students participated in the study but did not complete the student survey. Several factors may have been involved in their lack of full participation. Because the student survey was anonymous, some students may have taken advantage of the fact that I would not know whether they had completed the survey. In addition, the self-assessment was not graded, so some students may not have seen value in providing feedback on their experience. Lastly, some students may have spent too much time completing their tasks and therefore did not have enough time to complete the survey.

Increase in Student Confidence

Students who learn from their successes and mistakes can develop confidence in their abilities (Sharma et al., 2016). After completing this process, my students reported a notable increase in confidence. The number of students who *strongly agreed* that they felt confident in

their knowledge increased by 33 percentage points. Students showed self-awareness by writing that pinpointing the areas where they could concentrate their efforts helped them feel more confident.

Positive Impact on Ownership and Learning

Students expressed a very positive experience with self-assessment. Most students indicated that the process helped them strengthen their skills by allowing them to identify their weakest areas and focus on remediation. They reported that this strategy was highly engaging and easy to use. One pair of students was so invested in the tarsia puzzle that they asked to save their work and let them continue it during the next class. This example of intrinsic motivation is important for students to improve their academic progress (Ryan & Deci, 2020).

Many students felt this strategy was beneficial in a high school biology class because the subject contains significant vocabulary. Many students could see the use of this method in a class such as history. Applying self-assessment strategies in other classes is a skill that can help students succeed in high school, college, or future careers (Pandero, 2017).

Value of the Study and Consideration for Future Research

Throughout my teaching years, I have often tried to incorporate self-assessment methods in my classroom. Participating in this research project has given me a deeper understanding of how to implement this with more organization and effectiveness. I feel that I can expand this strategy to assist students in each unit of study and end-of-year testing.

While the study showed a significant improvement in academic performance, I observed that some students felt unsure about the self-assessment and fill-in-the-gaps processes. I fielded

many student questions essentially asking, “Am I doing this right?” Since one student responded that they do not reflect on their work but only answer questions, a more direct instruction method would be beneficial. Introducing this process early in the school year would allow more time to model the technique for students. More practice with this approach would give students the confidence to use the method correctly. I plan to use this strategy frequently during the next school year to determine whether increased exposure to this method would help students develop a better ability to evaluate themselves without worrying that they are getting something wrong.

Future research should include applying this method with variations in pretest and posttest questions. Some students mentioned that they remembered the questions from the pretest and could select different answers based on their previous experience rather than their academic knowledge. At least one student stated that they preferred a longer pretest to better assess their knowledge. Practicing a strategy that boosts student confidence could help reduce anxiety.

In this study, students could choose from three remediation activities. I observed that many students preferred to use the puzzle activities even if they were not the most appropriate method for their remediation. Other students commented that the CPALMS videos were boring. In the future, I want to examine which types of remediation activities are most effective for filling in the gaps. Mertler (2020) describes action research as a cyclical process. By implementing and evaluating student feedback, I can continue to improve this process with my students.

Impact of Action Research on the Author

Implementing this action research project has made a significant impact on my growth as an educator. Learning how to design and implement this project has given me the confidence to

plan further research projects in my classroom. Before this research, I was able to develop engaging lessons for my students but could not implement a focused research design with clear goals. Additionally, learning how to apply the correct statistical analysis to student data has expanded my capabilities in the classroom. Rather than looking at test averages, I can more fully understand student responses. Especially impactful is my understanding of how to compare test scores before and after treatment. On a broader scale, this experience has given me the ability to share my knowledge of action research with my colleagues. I plan to share the results of my action research with my colleagues and collaborate with them to implement similar methods for all students in our subject area.

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APPENDICES

APPENDIX A

IRB APPROVAL

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for work with human subjects was maintained.

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
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MEMORANDUM

TO:	Sandra Gibson
FROM:	Mark Quinn, PhD Chair, Institutional Review Board for the Protection of Human Subjects
STUDY:	*The Impact of Self-Assessments on Academic Performance of High School Biology Students*
DATE:	January 17, 2024
IRB #:	2024-1832
REVIEW TYPE:	Exempt
EXPIRATION:	December 30, 2029

The application above was reviewed by the IRB under federal regulations (45 CFR 46) and has been approved.

Work described under this protocol may now commence. The PI is responsible for ensuring that the protocol accurately describes research practices being conducted.

- Review Category designation determined by the IRB can be found in the final section of your protocol.
- IRB-stamped active Consent Forms are attached within your protocol where applicable.
- Any changes must be submitted via Amendment prior to implementation.
- Per the Common Rule, research only requires Interim (annual) Review by the IRB if 1) it was reviewed via Full Committee or 2) is regulated by the FDA.
- All research is subject to post approval monitoring.
- All protocol types must be renewed 5 years after approval.
- Inform the IRB once your research is complete so that the protocol may be inactivated.

Please contact your IRB Program Manager with any questions or if you are in need of assistance. Thank you for your diligence in the care of human subjects research participants.

Institutional Review Board for the Protection of Human Subjects Research Integrity and Compliance.

APPENDIX B

STANDARDS-BASED PRETEST AND POSTTEST

Biology I Honors/CAAPP
Plant Structure and Physiology

Plant Tissues and Organs

1. A scientist applies a chemical that disrupts the cohesion between water molecules in a plant's vascular tissue. What is the most likely effect on the plant?

A. The chemical will increase photosynthesis by enhancing nutrient uptake.
B. Phloem transport will be disrupted, preventing sugar distribution.
C. The plant will lose its ability to absorb carbon dioxide through stomata.
D. Water will no longer be able to move through the xylem, leading to dehydration.

2. If a plant's meristematic tissue were removed, what long-term effect would this have on plant growth and development?

A. The plant would lose its ability to grow taller or form new tissues.
B. The plant would increase its root growth but decrease leaf expansion.
C. The plant would continue to grow normally since mature tissues can regenerate.
D. The plant would become more resistant to environmental stressors.

3. A scientist is studying a tree that has grown significantly wider over several years. Upon cross-sectioning the trunk, she notices several distinct growth rings. Which of the following structures is primarily responsible for this pattern of secondary growth?

A. Xylem
B. Phloem
C. Cambium
D. Stomata

4. A farmer notices that after applying excessive fertilizer, some of his crops start wilting, even though the soil is still moist. What is the most likely explanation?

A. The high concentration of solutes in the soil causes water to leave the roots, causing dehydration.
B. The extra nutrients in the soil increase photosynthesis, reducing the need for water.
C. The plant absorbs more water than usual, causing cells to burst.
D. The fertilizer creates an isotonic environment, balancing water movement in and out of the roots.

5. A plant is genetically modified to lack a root cap. What impact would this have on root growth?

A. The root would increase cell growth due to a lack of structural resistance.
B. The root would increase lateral branching to compensate for the missing cap.
C. The root would stop absorbing water and nutrients, leading to malnourishment and plant death.
D. The root would have difficulty penetrating the soil, leading to increased damage to meristematic cells.

Plant Physiology

6. The Calvin cycle, which occurs during the light-independent reactions of the chloroplast, serves primarily to:

A. Capture photons and transfer energy via electron transport chains
B. Fix carbon dioxide into organic molecules such as glucose
C. Break down glucose to generate ATP
D. Facilitate the transport of water from roots to leaves

7. The photolysis (breakdown) of water in light-dependent reactions is critical for which of the following reasons?

A. It regulates stomatal function by controlling transpiration rates
B. It converts glucose into ATP and NADPH
C. It provides electrons which leads to the release of oxygen as a byproduct
D. It enables the storage of excess carbon dioxide in organic molecules

8. A plant is growing in waterlogged soil with very low oxygen levels. Which of the following metabolic processes could it use for survival?

A. The Krebs cycle, which requires oxygen to generate ATP.
B. Fermentation, which allows limited ATP production in the absence of oxygen.
C. The Calvin cycle, which does not directly rely on oxygen.
D. The electron transport chain, which remains fully active without oxygen.

9. A researcher places a plant in an airtight chamber and measures gas exchange. Over time, she notices that the plant is producing carbon dioxide but consuming very little oxygen. What is the most likely explanation for the plant’s metabolic activity?

A. The plant is relying on anaerobic respiration due to oxygen deprivation.
B. The plant is using oxygen as an electron donor during glycolysis.
C. The plant is increasing ATP synthesis through oxygen-independent pathways.
D. The plant is engaging in enhanced photosynthesis, which decreases oxygen use.

10. Which of the following best describes the primary function of transpiration in plants?

A. Facilitating the uptake of nitrogen and phosphorus from the soil
B. Regulating carbohydrate storage within vascular tissues
C. Promoting ATP production in leaf cells by utilizing solar energy
D. Driving the movement of water through the xylem via cohesion forces

11. If a plant is subjected to high temperatures and low humidity, what physiological response is most likely to occur?

A. Increased photosynthetic rate due to greater CO_2 availability
B. Decreased transpiration rate to conserve water
C. Increased water loss due to higher transpiration rate
D. Reduced xylem flow, leading to greater phloem activity

12. On a hot summer day, a plant closes its stomata to conserve water. Which of the following effects is most likely to result from this physiological response?

A. Decreased photosynthesis due to reduced carbon dioxide intake.
B. Increased water uptake through the xylem to compensate.
C. Enhanced sugar transport through the phloem.
D. Increased transpiration through alternative pathways.

Plant Reproduction

13. A botanist is conducting a study on flower fertilization and removes a structure from the reproductive system. As a result, pollen can no longer be received or transported to the ovary. Which structure was most likely removed?

A. Style
B. Stigma
C. Ovary
D. Anther

14. If a plant lacks functional anthers, what consequence would most likely occur?

A. The plant would be unable to produce ovules
B. Pollen production would be absent, reducing fertilization success
C. Photosynthesis efficiency would decline due to lack of chlorophyll
D. Water transport would be inhibited, preventing seed formation

15. Why do some plants mature male and female reproductive structures at different times?

A. To maximize seed production and prevent dormancy
B. To enhance gamete formation and promote vegetative growth
C. To increase genetic diversity by preventing self-fertilization
D. To ensure that pollen is carried by insects rather than wind

16. A plant species that requires cross-pollination is most likely to have which characteristic?

A. Large colorful flowers with nectar to attract pollinators
B. Reduced leaf surface area to minimize water loss
C. Chloroplasts that store energy for fertilization
D. A closed stigma to prevent foreign pollen from entering

17. In an experimental study, a scientist compares the reproductive strategies of gymnosperms and angiosperms. She finds that one group of plants relies on animal pollinators, while the other primarily depends on wind dispersal. Which of the following characteristics is unique to the group that uses animal pollinators?

A. The dependence on water for fertilization.
B. The reliance on cones for seed dispersal.
C. The ability to produce seeds without fertilization.
D. The production of enclosed seeds within a fruit.

18. A key advantage of angiosperms over gymnosperms is their ability to:

A. Produce seeds without fertilization
B. Attract animal pollinators to increase reproductive success
C. Grow exclusively in aquatic environments
D. Generate spores instead of seeds for reproduction

19. A group of students is testing the germination of different seeds by placing them in wet and dry environments. They observe that seeds with a damaged outer layer germinate poorly. What is the most likely function of this structure?

A. Regulating gas exchange for cellular respiration
B. Providing protection to the embryo from mechanical damage and desiccation
C. Enhancing photosynthesis during early seedling development
D. Absorbing nutrients from the soil before germination

20. Which of the following best explains why wind-dispersed seeds often have lightweight structures or feathery appendages?

A. To increase their likelihood of pollination
B. To enhance their ability to remain viable in dry conditions
C. To maximize their distance from the parent plant, reducing competition
D. To ensure immediate germination upon landing

APPENDIX C

PRETEST SELF-ASSESSMENT

Standard	Plant Tissues and Structures	Plant Physiology	Plant Reproduction
Section Score			
Percent Correct			

Reflection:

1. What concepts are you strong in?
2. What areas would you like to improve in?
3. What areas would you like to challenge yourself in?

Directions:

1. If you scored 50% or less in any section, you must complete one remediation task per section..
2. If you have no concepts that are 50% or less, you must complete at least 2 challenges.
3. Fill in the table below with the name of the task you will complete.
4. Check off the task when it is completed.

Task	Date Completed

APPENDIX D

FILL IN THE GAPS REMEDIATION AND CHALLENGES

Standard	Remediation or Challenge		Tarsia Puzzle	Equation Card Sort	CPALMS	Amoeba Sisters Video and Worksheet
SC.912.L.14.7 Plant Structure and Tissues						
SC.912.L.14.7 Plant Physiology						
SC.912.L.14.7 Plant Reproduction						

APPENDIX E

POSTTEST SELF-ASSESSMENT

Standard	Plant Tissues and Structures	Plant Physiology	Plant Reproduction
Section Score			
Percent Correct			
Percent correct from pretest			
Difference between pretest and posttest			

Reflection:

1. How did your performance on the posttest compare to the pretest?

APPENDIX F

STUDENT SURVEY

Please answer the following questions thoughtfully and honestly. Your responses will help me understand your experience with the Fill in the Gaps self-assessment method. This form does not collect email addresses, so your response is anonymous. Opinions and comments shared on this survey will not affect your grade. Thank you.

1. I felt confident in my knowledge of the standards before the pretest.

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    1a. Please explain the reason for your answer.

2. I felt confident in my knowledge of the standards after the posttest.

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    2a. Please explain the reason for your answer.

3. The self-assessment strategy was easy to use.

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    3a. Please explain the reason for your answer.

4. Self-assessment helped me reflect on my learning

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    4a. Please explain the reason for your answer.

5. I felt engaged during the remediation/challenge tasks.

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    5a. Please explain the reason for your answer.

6. Using this “fill in the gap” method helped me strengthen my skills

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    6a. Please explain the reason for your answer.

7. Using this self-assessment process would be valuable in my other classes.

    1 Completely Disagree

    2 Somewhat Disagree

    3 Somewhat Agree

    4 Completely Agree

    7a. Please explain the reason for your answer.

Open-ended questions:

8. Which method(s) did you choose to strengthen your skills?
9. Which method was most effective at helping you strengthen your skills?
11. In what way did this self-assessment strategy impact your learning?
12. Can you explain one positive aspect of this process?
13. Can you explain one negative aspect of this process?
14. Will you change anything about the way you study because of this activity?
15. How could this self-assessment process be improved?