

**Exploring New Teaching Practices: Refining My Use of Case Studies to Increase Student
Interest in Biology**

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Submitted to the Graduate Faculty of the
School of Education in partial fulfillment
of the requirements for the degree of
Doctor of Education

University of Pittsburgh

2022

UNIVERSITY OF PITTSBURGH

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2022

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University of Pittsburgh, 2022

The biology curriculum used in high school classrooms is not currently relevant or connected to students' lives causing student interest in biology to rapidly decline. Though Biology teachers are omnipresent in nearly every topic area of what they teach, they struggle to use applicable curricula or pedagogical methods that can increase student interest. While a substantial body of research has established that pedagogical tools like case studies are beneficial to increasing student interest, the majority are written for the collegiate level and secondary teachers are unaware that this basic, yet useful tool can be refined for use in their secondary classrooms. The aim of this study was to extend research, which examines how my use of refined case studies were used to increase student interest and learning outcomes while also promoting social justice issues that occur in Biology.

The study design incorporated an analysis of my journal responses to determine what I had observed throughout the process of using refined case studies for two difficult topics in Biology: heredity and evolution; and analysis of student responses to prompts using Flipgrid. Participants shared their insight of using case studies when compared to traditional lecture/notes and how it affected their interest and learning outcomes for the topics. The participants included 24 Honors Biology students. Over the course of two weeks, students used two case studies for the topics of heredity and evolution without any lecture or note taking methods. Students were asked to complete various assignments throughout the case study, and at the conclusion, students used

Flipgrid to record their responses to prompts. The analysis of the prompts and my journal entries serve to extend the field of refined case studies and their role in increasing student interest in Biology. The findings from this study may also be interpreted as a basis for other teachers to create case studies of their own which are more relatable to secondary students.

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Dedication

I dedicate this dissertation to my son, AJ. You sacrificed so much during my doctoral journey. You waited for me to finish writing on so many weekends and weeknights so that we could spend quality time together. I spent many hockey tournament weekends with my head buried in my laptop in a hotel room; however, you never complained. Your pride for me kept me going, even on those days when I wondered why I ventured down this path. We did this together, AJ. I'll always be grateful for the fantastic son you are and the magnificent man you are becoming. I pray that you recognize how important education is, regardless of where you obtain it, and realize that *no one* can take it away. Never stop learning, AJ! I love you.

I dedicate this dissertation to my parents, Anthony and Regina Graziani. You cleaned, cooked, chauffeured AJ, and went above and beyond so many times for us, all so that I could attend class or write. Even through all of your illnesses, Dad, you were there to help me in any way you could. Mom, you are indeed a saint for all of your help; thank you. Both of you have always kept my world spinning, and you are continuously there to pick me up when it periodically stops, and I falter.

Lastly, I dedicate this dissertation to my former educators, who introduced me to the world of phenomenological-based teaching during the days before standardized testing. You all taught in the way I aspire to teach, with awe and fascination about the world around me. Because of YOU, I became a scientist and “accidentally” fell in love with teaching. Because of YOU, I dedicated my career and my research to changing how I teach science.

Acknowledgements

Thank you to my advisor, Dr. Quigley, for your guidance and support throughout the writing process. I appreciate your expertise and your wealth of knowledge in STEM. You pushed me to become a better teacher *and* student. Dr. Rainey, in one summer, you made me into a better writer, and I am forever grateful for that. Lastly, Dr. Connelly, thank you for always being a supportive coworker and mentor. Your pep talks throughout every step of the doctoral journey got me through so many days. I am forever grateful.

I want to thank the 2019 Ed.D. STEM cohort, Jana, Jenn, Liz, Chris, Amanda, and LV; you are now my “family.” We did this as one, and I couldn’t imagine doing it with any other group. Thank you for all of the laughs in the group chats. I will forever remember our favorite memes. In addition to the STEM cohort, I want to praise my coworker, Dr. Stefanie Guffey, for your support. We took turns pushing each other up the hill to success. You taught me that I am a strong woman and never let me give up. Thank you for continually reminding me that we have a purpose for what we are doing.

To my administration, especially Mr. Ron Suvak, Dr. Ted Benning, Mrs. Lauren Reiber, and Ms. Casey Miskimmin, thank you for your support throughout this journey and assistance in obtaining everything I needed to gather data for my research. I am excited to continue to improve my pedagogical methods to better our student outcomes and interests in biology.

1.0 Introduction and Rationale

The biology curriculum used in high school classrooms is not currently relevant or connected to students' lives (Hagay & Baram-Tsabari, 2015). Over the past few years, through questionnaires, surveys, and conversations with students, I have noticed decreased student interest in biology in my classroom. This pattern aligns with national results. For example, in one study, students reported that biology is more challenging to learn than other subjects (Lyons, 2006). Additionally, there is often a low completion rate of in-class assignments. Overwhelmingly, my students noted a lack of relevance to their lives and what they are interested in. The literature documents this lack of relevancy (Çimer 2012). Swarat et al. (2012) write,

It is reasonable to suggest that the lack of interest among young students threatens the production of the next generation of scientists and, more importantly, impedes students from becoming scientifically literate citizens, as they are unlikely or even unable to engage with important science-related societal issues. (p. 1)

Each day I present a challenge for my students, which is getting them to appreciate the value of scientific knowledge when making tough decisions. I use examples from my own life and inform them that they may be responsible for making important decisions for family members one day. In most biology curricula, teaching social justice connections is not taught. Instead, instructors assume that students can make connections through their interactions with media (Chamany, 2006). Promoting student connections between social justice issues and biology content is not widely supported, making teaching challenging, according to fellow teachers. My use of case studies has shown promise in increasing student interest by incorporating real-world phenomena relevant to students' lives.

Phenomenological learning through case studies can increase interest while also providing awareness of social justice connections in biology (Chamany et al., 2008). Feagin et al. (1991) define case studies as in-depth, multifaceted investigations using qualitative and quantitative research methods of a single social phenomenon. Case studies are stories with a message. They are not simply narratives for entertainment but are stories to educate (Herreid, 1988). According to Herreid, "Humans are story-telling animals. Thus, the teacher using the case method has an immediate advantage. It is the advantage of gaining the attention of the audience" (p. 92).

1.1 The System

I am a teacher at a suburban public school system in southwestern Pennsylvania that enrolls approximately 3,400 students and is served by a staff of 450 individuals, including educators and support personnel, with a student-to-teacher ratio of 15:1. According to state test scores, 70% of students are proficient in math and 84% in reading. Ethnically speaking, this high school does not have a diverse population, with 0% American Indian or Alaskan, 7.6% Asian, 2.1% African American, 1.8% Hispanic, 0.8% multi-racial, 0% Hawaiian/Pacific Islander, and 88% White. I teach Honors Anatomy & Physiology, and Project Lead the Way (Human Body Systems), Forensics, and Honors Biology. I will focus on Honors Biology courses for qualitative data collection for my research and data collection.

1.1.1 The mission of Meadows School District (MSD)

We, the Meadows School community, strive for excellence, learning, achievement, and citizenship in all we do.

1.1.2 Vision statement of MSD

Concerning my context and problem of practice is a shared vision statement, Everyone Can Learn. As with most "mission statements," this one contains some non-performatives; however, there is potential for these ideals to be happening, even daily. Tracking statistics will demonstrate that most of our students excel by learning and most achieve their goals. However, everyone can do more to ensure that *all* students reach those goals and excel, especially in STEM courses.

General education students or those who attend vocational school sometimes get excluded from class options that participate in extracurricular outings such as field trips offered to gifted or advanced-placement classes. In conversations with numerous students over three years regarding tracking and being labeled as "academic," they feel their efforts are futile and not as accepted as those of their honors and gifted peers. They envy their friends who may be in the more advanced courses, especially when hearing about the opportunities they experience in their classes compared to those on the academic track. The academic students feel they are missing out and stigmatized for being in lower-level courses. The minority students especially feel this stigmatization and lose whatever confidence they have/had for the subject. Sensoy and DiAngelo (2017) discuss this form of oppression, known as ableism:

Ableism is based on the assumption that there is a physical, intellectual, and emotional standard for human beings and that this standard is the only one accepted as normal. All

human body variations are considered abnormal, deviant, and inherently inferior. This norm is institutionalized in school policies and practices and legal segregation of persons with disabilities. (p. 221)

The curriculum also tends to be ableist. The general academic coursework includes minimal content compared to honors. Failure may be expected (by some) on the state standardized tests (Keystone Exam).

When discussing non-performatives, we must not forget to consider the micro and macro connections. The best example of a macro connection is the Pennsylvania Keystone Exam, for which the district (i.e., the micro-component) requires a score of at least "proficient" for graduation. Everyone can learn. This is another shared value, this time of the state. Yes, everyone can indeed learn if they are *present*; however, many of our students miss numerous learning and instruction days unexcused. Everyone can learn if they understand English; however, we have English as a second language for some students. Everyone can learn if they can understand the questions; however, the Keystone Exam is notorious for abstract wording. As previously mentioned, standardized testing for tracking purposes is standard. By definition, ability grouping, or "tracking," refers to pupils' placement into special categories based on assessment techniques (Williams, 1983). It is indeed true that a person who scores low in the first grade and is thus placed in a low ability track will continue to score low in the fourth grade without an extra investment to raise performance levels (Scarr, 1977). By additional investment, the author refers to time and effort put forth toward the student to ensure they are showing growth. Still, also they are becoming engaged with the material and making connections with it, not just learning it for the sake of learning. How is it fair to use a standardized test with an inherent bias for tracking purposes while keeping students in their labeled groups and claiming that "everyone can learn?"

In conclusion, I am learning how I can be an agent of change in my place of practice. I may not be able to change everything that I feel is failing students in education; however, I can be persistent in making essential changes in my practice as I learn communication techniques and new pedagogical methods. As Ahmed (2012) states,

Persistence is needed because not everyone has an interest in equity and diversity issues. It always has to be present so that they eventually think of it automatically and that it becomes part of their considerations. The aim is to make thought about equality and diversity issues automatic. (p. 25)

I still have a lot to learn; however, one thing I have is persistence.

1.2 The Stakeholders

I have created a list of stakeholders related to my problem of practice: students, parents, administration, and other teachers. The most important stakeholders to my problem of practice are the students in my classroom who are losing interest in the biology curriculum as currently taught. The students are very interested in being involved in curriculum changes; however, they have very little power.

1.2.1 Students of MSD

Students are an influential part of my research in my fishbone diagram (see Appendix A). Through informal empathy interviews with students, I discovered that they could not easily relate to the curriculum material, a matter of equity. Students feel as though the curriculum is not only

outdated but does not represent them culturally or demographically. Students express dislike for repetitive passive lecture teaching methods and rote memorization. They prefer to learn how the materials will benefit them in the "real world" and why they should care about the subject matter even if they are not planning to further their education in a STEM field. My problem of practice directly impacts students. I am seeking to improve student interest through a pedagogical shift in my teaching to incorporate case studies. I have the potential to influence more high school students to pursue careers in STEM, whether that means a 4-year college degree or a certificate from a technical school. The desire to pursue a career in STEM starts with an interest in the subject matter. Since the students are the subjects for whom I am trying to be a change agent, they are my primary stakeholder.

1.2.2 Administration/leaders of MSD

This group includes the Superintendent and Assistant Superintendent, the MSD School Board, the Director of Curriculum and Instruction, and building principals for the high school. All of these individuals want what is best for the students and embrace any intervention that may improve the outcome for the district, but more importantly, the student. The administration at MSD is well aware that equitable matters for student learning need to be examined and improved upon to make our district and community as strong as possible. With an abundance of employment opportunities in the STEM fields in the community, the administrators appreciate and understand the importance of maintaining the student body population in the community to further the success of our district. They are eager to hear ideas from faculty and staff and will do their best to implement changes when they deem it beneficial to the students without adding an extra burden to the teacher workload.

1.2.3 MSD science educators

When asked during PLC meetings, teachers express that they all want the same thing, for our students to be successful and learn more about biology. Therefore, teachers have both an interest and significant power since they are the primary intended users of the case studies. Teachers will be using this teaching method themselves. It may affect others since teachers will collect unofficial data and share it with other teachers if it promotes interest, improving student learning. Teachers stated that they agree that the biology curriculum needs an overhaul. We need to adopt new pedagogical methods that will allow for the content to be covered but do so in ways that pique our students' interest by making the material relatable. The most significant factor is time. Due to the standardized testing schedule, teachers stress that they do not have the time to perform exercises, such as case studies, in the classroom since they might not meet all of the assessment anchors set forth by Pennsylvania by May if they add to their already rich curriculum. Therefore, teachers see no choice but to "teach to the test," which is disheartening.

However, at our most recent PLC meeting, two teachers have decided to adopt storylines in conjunction with case studies for the next school year, which is very promising. Upon a pilot year where the two teachers will test the pedagogical tools for themselves, along with evidence of successful data collection by myself, the future of increasing student interest in biology looks promising.

1.2.4 Parents of MSD

Parents are stakeholders with a variable interest in my teaching methods; however, they have the power to change my pedagogical approach through their feedback, especially if it is

negative against case studies. From conversations with two parents of current students, I have a positive outlook on using case studies to help transfer knowledge of a few of the more complex topics we cover in biology. The parents felt their students would better connect with the material using real-world phenomena such as case studies.

1.2.5 Potential stakeholders

One perspective I am missing is that of a new teacher who recently completed a teacher certification program. I would like to know if teacher-preparatory programs promote more active-type learning in classrooms than passive lecture/note and rote memorization methods and if teaching social justice issues is part of the curriculum.

My fishbone diagram is influenced directly by my problem of practice. It includes case study materials themselves, including curriculum integration, formative assessment rather than summative assessment, and varying teaching methods to incorporate case studies. My stakeholders also influenced my fishbone because I walked into instructional contexts that I cannot change without extensive curricula re-write and school board permission; however, I cannot ignore high-stakes testing, full curriculum, and outdated and inequitable textbooks with complex vocabulary for even the most affluent students.

1.3 Statement of Problem of Practice

The need for well-qualified and well-versed science, technology, engineering, and math (STEM) professionals is at an all-time high with an anticipated increase. The United States has

fallen from ranking first among industrialized nations in both high school completion rates and the percentage of adults with a 2- or 4-year degree to 22nd in high school graduation and 14th in the percentage of 25- to 34-year-olds with a 2- or 4-year degree (OECD, 2012).

Through informal questionnaires and student surveys, low completion rates, and documented comments, empirical evidence shows that student interest in biology is declining. I teach Honors Biology and Academic Biology in alternating years. My completion rates for in-class work average 60% for Honors Biology; my completion rates average 30% in my academic sections. Poor performance on formative and summative assessments in the Academic Biology sections also decreases learning outcomes. Christidou (2011), in her review of literature, argued that, as students advance from primary to secondary education, students rapidly lose their interest in science and cease seeing it as a viable option for their future, or associating it with their aspirations. The biology content has not changed through the years; therefore, it begs the question, what *has* changed to make students more disengaged and demonstrate such a decline in interest?

When questioned, most current biology teachers will say that they teach to the test and that the emphasis placed on high stakes testing and how the material must be covered in a short amount of time is to blame (Bhattacharyya et al., 2013). In my classroom, I have discovered that students have trouble relating and connecting to the current biology curriculum, leading to this decline in interest. Biology has an abundance of abstract concepts that one cannot use their ordinary senses to understand, such as seeing and touching. This abstractness makes ideas difficult to understand, which frustrates the students. Good science teaching incorporates phenomena, engages students with the content, and entices them to learn more about abstract concepts without losing their fundamental components.

My problem of practice is that student interest in biology is declining. As a result, I seek to alter my teaching practices to increase student interest. I will have some control over my instructional practice for my doctoral research in my place of practice. I aspire to deepen my practice to improve student interest through the use of case studies about biology concepts. My current instructional practice is traditional lecture/notes with a lab when applicable which still utilizes rote memorization. I am not convinced that this is the best approach to teaching science in today's high schools. Research has shown dissatisfaction with the lecture pedagogy; many students are not performing at acceptable levels.

2.0 Review of Supporting Knowledge

2.1 Purpose of Review

This literature review aims to understand better how using refined case studies can assist in increasing student interest in biology by introducing real-world phenomena and applicability into the curriculum.

The following questions will guide my review of the literature study:

1. How am I refining my use of case studies?
2. How and to what extent does case study-based instruction support student interest?

2.2 Road Map

In what follows, I identify three fundamental principles underpinning case studies: Student interest, motivation, and the benefit of using case studies to introduce social justice issues in biology. I will first define interest as it pertains to educating students and the science behind what makes a student interested in a subject. I will summarize research from other scholars whose findings corroborate the main ideas of my study regarding case studies and how they have been used in various classroom settings. Lastly, I will discuss how case studies are helpful to high school students when introducing topics dealing with social justice issues such as heredity and skin color.

2.3 Review of Scholarship Inquiry Question 1

How am I refining my use of case studies?

Scholarly work was the basis for which the design of case studies originated. Harvard University's law and business schools introduced case studies over 100 years ago (Herreid, 2006). Using the discussion methods, the professors' real-world problems introduced students to actual scenarios they were likely to face upon graduation. Given the piece meal's limited information, a Canadian medical school also used similar case studies to diagnose patients' ailments. The above examples actively engaged students in the learning process (Herreid, 2006). Medical students like the use of case studies because they allow them to remember a wealth of information in each case, and this can also be true for high school students; however, medical students anticipate encountering issues when they begin to practice medicine, whereas high school students may not envision themselves facing cases soon. Sudzina (1997) outlines the presentation of a typical case study: Students are presented with a dilemma to problem solve. Next, the teacher will provide feedback and ask questions based on student interpretations, demonstrating where any misconceptions may lie. Additionally, the teacher facilitates discussion on the real issues involved and the consequences of solutions. Finally, responses are reevaluated based on all of the presented information.

Although there are abundant options for case studies in biology, the collegiate level is where most are designed to be used, which can pose a challenge for high school students due to the higher-level writing and extensive vocabulary. The National Science Teachers Association (NSTA) recently acquired an extensive library of case studies once owned by the National Center for Case Study Teaching in Science (NCCTS) at the University of Buffalo. These resources serve

as great tools; however, it may benefit the students if someone refined these original case studies for high school-aged students.

2.4 Review of Scholarship Inquiry Question 2

How and to what extent does case study-based instruction support student interest?

2.4.1 Motivation

One cannot discuss student interest without first discussing motivation. One fundamental principle guiding the teaching and learning of science is the critical role of motivation, and the terms motivation, interest, and engagement are often connected and used interchangeably. However, they are different. Brophy (1988) defines motivation to learn as a student's tendency to find academic activities meaningful and worthwhile and derive the intended academic benefits. Martin (2003) defines motivation as ways students choose to behave, their self-confidence in their ability, their ability to overcome obstacles and challenges, and their capacity to recover from academic setbacks. A student's motivations determine whether they will engage in a given task or lesson and whether or not those motivations exist as part of one's beliefs about what is essential (Eccles & Wigfield, 2002). It is often hard to convince a 9th grade biology class that the information they are receiving is critical for their future and possibly for decisions they will have to make, whether for themselves, a friend, or a family member. It is difficult for adolescents to appreciate the value of knowledge that may be useful for their future. They also may assume they will forget the material by then. Because of this, we as educators must make learning more interesting to

motivate students to continue with their exploration of the subject matter. Jansen and Middleton (2011) define motivation as why people have to behave a certain way in a specific situation. It is often assumed that they will be engaged and interested if a student is motivated in education.

When discussing motivation, one must consider both intrinsic and extrinsic motivation. Jansen and Middleton (2011) define extrinsic motivation as describing any time we engage in something to gain some reward or escape negative consequences. Extrinsic rewards are subjective and dependent on the student. What may appear to be a powerful extrinsic reward for one may not affect another student's interest. For example, suppose a student considers admission to a college to obtain an attractive career with increased income and high social status as a reward. They may value that reward and understand that their hard work will pay off, engaging them with the content material (Newmann et al., 1992). This author also states that the material needs to be of interest to the student to not withdraw them from learning. Exciting material is considered stimulating, fascinating, or enjoyable. Students' prior experience of the topic or prior knowledge will depend on how the teacher presents this information.

The statement above by Newmann et al. (1992) regarding students' prior experience demonstrates that intrinsic motivation is directly related to prior student knowledge and is an essential component of my problem of practice. People can look back on earlier experiences and use their memories to guide their future interests (Jansen & Middleton, 2011).

Students often explain their disinterest by calling schoolwork irrelevant, unrelated to issues, competencies, or real-world concerns. Why devote effort to the mastery of knowledge that seems necessary to succeed only in school but in no other aspects of life? The authenticity of schoolwork depends primarily on its connections to work beyond instructional settings (Newmann et al., 1992).

The case study method allows students to use their prior knowledge and interests related to the case to construct new knowledge, thereby connecting the mastery of knowledge to other aspects of life. Cases facilitate active and reflective learning by exposing learners to complex situations, allowing them to discuss and debate courses of action, and providing them with the opportunity to create and discover new ideas. Good cases are realistic and generate intrinsic motivation by encouraging teamwork and accountability (Tomey, 2003).

Case studies find their roots in constructivist learning theories where making meaning of subject matter is based on personal experiences and connections with the subject. An essential theorist in education is Jerome Bruner. One of Bruner's (2002) significant arguments is that student learning should be based on past experiences and knowledge. The activity of science itself is centered on an inquiry about prior knowledge, and we should be teaching science education in that way in the classroom.

Other scholars have advocated a similar perspective. For example, Bransford and Donovan (2006) argue that simply telling students about scientific discoveries does not engage students like discovering phenomena through inquiry does, and the things students do and encounter every day are what help decipher those phenomena. According to Donovan and Bransford (2006), one must be quick not to assume that inquiry means just answering questions. Inquiry means searching for meaning because the student is interested in the topic, not because they were assigned the topic. In the rapidly changing world of STEM activities, an understanding of criteria for evaluating knowledge claims, that is, deciding what counts, is as important as an understanding of conceptual frameworks for developing knowledge claims (Duschl, 2008).

2.4.2 Motivation and goal setting

Goal setting is a commonly used instructional strategy; however, educators rarely consider its contribution to motivation. Glynn et al. (2007) define motivation as the internal state that arouses, directs, and sustains students' behavior toward achieving specific goals. There are two types of goal orientations: learning (also called mastery goal) and performance goal. Learning or mastery goals deal with the desire to learn content and incorporate the beliefs that hard work leads to success and that a person's ability is malleable (Dweck & Leggett, 1998). Students who are more learning-goal focused tend to work hard to meet their goals and usually go beyond those goals. Performance goals involve the desire to compare favorably against the norm. These students believe that success hinges on social comparison (e.g., having a higher grade than others). Research indicates that students tend to disengage early from challenging tasks, do what is necessary to get by to not look bad compared to their peers. For this reason, educators must determine more exciting phenomena for the science classroom to steer students more toward the learning goal rather than the performance mindset. If presented correctly, case studies may potentially motivate students to be more mastery-minded.

2.4.3 Interest

Interest has been found to have a powerful influence on learning (e.g., attention, persistence, deep-level knowledge) (Hidi & Renninger, 2006) and career choices (Krapp, 2000; Maltese & Tai, 2010). School science has not been effective in meeting the goal of promoting interest in science; an important reason is the lack of knowledge about what makes science interesting (or not) to the students (Swarat et al., 2012). Aschbacher et al. (2013) report that despite

the new Next Generation Science Standards (NGSS) curriculum, many students think science is too hard, uninteresting, and irrelevant. Adults are not doing much to help students discover their fascination with science or point them toward science careers. “Interest” is difficult to define, especially in educational terms. However, it is essential to understand that most college students in STEM fields who decide to forfeit their education in STEM claim they do so because of a lack of interest in the subject matter (Seymour & Hewitt, 1997).

A student’s confidence level regarding a subject can directly affect how interested they become in it. One study highlighted the confidence in one’s ability to learn science as the key to student aspirations (Aschbacher et al., 2013). Many students said they wanted to learn science in high school, but as it became increasingly complex, they struggled to keep up and became less engaged; their confidence in their science abilities fell, and they questioned their ambitions in science (Aschbacher et al., 2013).

2.4.4 Issues of social justice in biology

Besides the desire to make biology content more relatable to students, Chamany (2006) wanted to incorporate race, class, and gender issues into the biology curriculum. Case studies provide a significant sector to do that. Case studies have been around for a long time, as we saw earlier, in law and medical school; and case studies can also be centered on social justice issues. Case studies are often used to entice students who are generally not interested in science, which is usually the situation of many high school students enrolled in a required biology course.

With biology at the forefront of STEM news, it is essential to teach students to form connections between what they learn and what they see daily, especially with their continuous use of social media platforms. At times, social context is not covered in the biology curriculum

(Chamany, 2006). Students respect their teachers. If teachers begin to incorporate social justice issues into the curriculum, students will learn social responsibility while gaining valuable content knowledge. Social justice issues may also contribute to increased retention since student interest in the topic will assist content retrieval. Using real-world problems under the biology umbrella, students begin to connect why the subject matter is essential rather than just textbook chapters and units full of complex concepts (Chamany et al., 2008). This pedagogical method of incorporating social justice into the biology curriculum helps prepare today's students for twenty-first-century learning, one of the significant administration interests for science education today. Chamany et al. (2008) used case studies in this manner and had much success. Chamany went on to author various case studies that covered the biological concepts and incorporated social justice issues that occurred along the way of research.

Vygotsky demonstrated that previous knowledge could influence how students organize and link new information by constructing "schemas" deeply rooted in personal and cultural experiences (Vygotsky & Cole, 1978). By tying social justice issues into the biology curriculum, minoritized students can connect to scientific problems that may have affected their ancestors. These connections will make the biological content more relevant and accessible to form relationships, increasing student interest.

How can we connect biological content knowledge to social issues? Case studies. These help students make connections between content and real-world problems. Chamany et al. (2008) do an excellent job demonstrating how to use case studies for issues like genetics appropriately. Genetics is one of many complex topics in high school biology. Sickle Cell Anemia (SCA) is often used to teach and demonstrate allele frequency to students. However, few biology teachers (or textbooks) discussed the social justice issues during the pivotal research conducted for SCA, which

led to the understanding that hemoglobin from patients suffering from sickle cell anemia has a different electrical charge than hemoglobin from healthy individuals. SCA typically affects people that live where malaria is prevalent and has developed as an evolutionary protective mechanism for those populations of people living in those areas. African Americans tend to be most prone to this inherited blood disorder. Teachers can introduce case studies regarding SCA screening in the African American population. This case demonstrates how complex concepts in biology can be better understood and how biology led to wide-scale social injustice. SCA alleles are found in other populations; however, the African American population was racially defined as the primary carriers of the disorder. The Black Panthers promoted the SCA Control Act, making it seem acceptable, although mass discrimination against African Americans occurred. People lost their health insurance, access to school, and their jobs since they were likely carriers of the disease. Linus Pauling (1951) is often regarded as a hero in physical textbooks and lectures due to being one of the pioneers of molecular biology for SCA screening. However, he unfortunately was a proponent of the screening, which resulted in discrimination.

Learning about allele frequency is a great segue to in-depth conversations regarding inheritance patterns which are often overlooked in the traditional lecture/note-taking classroom routine. Case studies use a narrative to describe real people who go through real-life experiences dealing with the learned biological concepts. By using case studies, teachers become liaisons between the complex topics of the curriculum and the real-world affiliation of the material to life.

Other case studies illustrate topics where medical professionals and researchers committed social injustice against particular minorities. Some of these case studies demonstrate dehumanization of the worst kind. One of which covers how African HIV-positive pregnant women were used in research trials for a drug that has been shown to save the life of their unborn

baby; however, 50% of the participants still received a placebo, rendering their fetuses unviable after birth. The explanation why any participant would not be given a drug known to save lives was that this subgroup of women would not have originally had access to adequate healthcare due to their socio-economic status and geographical location. Therefore, it was deemed acceptable to use placebos in place of life-saving therapeutics for double-blind scientific research. Even the most inexperienced student can recognize the lack of humanity in studies such as these. Freire (2018) explains that dehumanization marks not only those whose humanity has been stolen but also (in a different way) those who have stolen it and is a *distortion* of the vocation of becoming more fully human. This research was similar to the ethical issues during the Tuskegee research trials for syphilis, where access to adequate healthcare was minimal. Through this case study, students are made aware of two social justice issues of the time. Still, they also understand more about HIV transmission, the chemistry of antivirals, and the statistics behind double-blind trials.

According to Chamany (2006), other practical case studies that tie social justice with biological content are Genetics and Evolution of Human Skin Color (HHMI, 2019), which focuses on classical inheritance and evolution. This case study revolves around "Desiree's Baby" (Chopin, 1893), discussing the tension and gender discrimination in the late 1800s in the South, to teach polygenic inheritance. Desiree's Baby is the case study used in my research for Cycle 1 data collection.

2.5 Synthesis

In sum, Chamany (2006) states that we cannot just prepare students for future careers by using a curriculum that talks about science; however, we must have students engage in scientific

problems while also engaging with the social context that is going on around them. A large body of scholarship supports my use of case studies in the science classroom: the importance of motivation and interest and areas of social justice in biology.

Based on my literature review, case studies may be a practical approach for teaching complex biology concepts, such as genetics, for which students do not typically have the fundamental background to understand. The research referenced in this literature review supports case studies to improve students' interests that are not focused on memory and instead focused on concepts and have the opportunity to introduce students to social justice issues that occurred during many renowned discoveries that have shaped biological research through the years.

3.0 Methodology

I completed qualitative data analysis for this study in my biology classroom. I collected data to assess how I refined my use of case studies and how they may have influenced student interest in Honors Biology. I collected data in two cycles over two units, heredity and evolution, taking about a week to complete. The following qualitative research questions guided this study:

1. How am I refining my use of case studies?
2. How and to what extent does case study-based instruction support student interest?

3.1 Positionality of Researcher

My background is rooted in science and research. Before becoming an educator, I worked in the biotechnology sector, conducting research for the U.S. government, academia, and private industry. I had always found science, especially biology, incredibly fascinating, even in high school. However, I come from a generation where standardized testing was not as essential or prevalent as it is now. We learned by phenomena through stories and discussions of real-world issues occurring at the time. We rarely depended on rote memorization or the use of overcomplicated textbooks. I have heard students say they hate science through the years, which affects me personally. I aspire to change the views of current students by showing them how fascinating biology can be.

Anyone can use numerous pedagogical methods to increase interest through various teaching methods; however, I aspire to research one I have been passionate about since I began

teaching. I hold a B.A. in Biology, an M.S. in Safety Management, and an M.A. in Teaching. I chose to change careers from research to education when I became an adjunct faculty member at a local community college teaching biology to non-majors. I discovered that I love science, but I love *teaching* even more. Having students who began a class with no interest in biology but left with a greater appreciation and respect for it left me with a feeling of pride and elation. I hope the results of this study will shed light on the problems that exist in both higher education and the pedagogical methods used to teach at the secondary level. I will be the data collector and conductor of data analysis in this research study; therefore, I recognize that my personal experiences and opinions should be clear and on the forefront as I practice self-awareness through the process to recognize when the data begins to represent personal views rather than those of participants. I identify as a white, middle-class female with a strong background in science, similar to the majority of my students. My passion for biology and seeing the difference in how biology is taught now compared to how it was taught when I had it influences my study. Although there is an age gap between my students and me, the concepts that intrigued me about biology were similar to today's; however, how they are taught has changed.

3.2 Cycle One

3.2.1 Study sample

The study population consisted of my randomly assigned roster of 9th grade Honors Biology students ($n = 24$) from my place of practice. These students would have taken basic Pennsylvania science before taking biology as a requirement. Because these are honors students,

they have more intrinsic motivation, as discussed earlier, with a desire to learn scientific topics compared to those who take general biology or Career and Technical Education Center (CTC) Biology. Therefore, they come to the classroom with the inherent expectations that biology is complicated.

I chose biology students for my study despite teaching three other courses (i.e., Anatomy, Forensics, and Project Lead the Way) because biology is the course where I most notice students disinterest. The apathy is primarily due to how biology is now taught on the Keystone Biology Exam, making it unappealing and dull. So much of the material is presented in a traditional lecture fashion with much rote memorization. Biology is the introductory science class to convince students to pursue a career in a STEM-related field. My problem of practice referred to the disinterest of students in biology. The biology students are the students I am referring to in my problem of practice. The biology students are also my primary stakeholders since it is their lack of interest that I am trying to change. They have the most to gain from the implementation of case studies. During the small group parts of the case studies, students broke into small groups of 3-4 students.

Before data collection, I obtained permission from the International Review Board (IRB). The IRB indicated that my study would fall under the "exempt" category since my research was not incorporating anything outside my typical curriculum's realm and was not introducing any novel practices or identifying information.

3.2.2 Methods and data collection

Cycle one began reviewing different complex inheritance patterns covered previously using traditional notes (i.e., incomplete dominance, codominance, x-linked traits). I briefly

mentioned polygenic inheritance without going too in-depth since this is what the case study was meant to teach without using traditional lecture and note-taking methods. I introduced Chopin (1893), who wrote the case study, "Desiree's Baby," to the students explaining that case studies are used in medical and law school and some natural sciences. This particular case study was designed for nonscience majors at the collegiate level.

This case study is about a young couple in Louisiana in the late 1800s who, after marriage, had a baby that at birth appeared white; however, after three weeks, the baby's skin color became dark. At first, the case study leads readers to believe that Desiree may have had an affair with an enslaved person on the property. Desiree's husband, Armand, also accuses her of this forcing her out of the house. In despair, Desiree commits suicide after killing the baby. After Armand discovers this, he finds letters sent to him by Desiree before her death, along with a letter written to him by his mother detailing that Armand himself came from a mother who was Black. This case study is meant to teach the topic of polygenic inheritance and how there are seven shades of skin color. Despite our expressed phenotype, we have the potential to have offspring with a different phenotype dependent upon which alleles were expressed from genetic crossing over.

This particular class of 9th grade honors students is an eccentric group of energetic students. I was hesitant to use the non-directive style of teaching that case studies required when I knew that it would be easy to lose control quickly, especially during heated discussions for which case studies are meant to ignite. However, I did use this style of teaching for the case study. Reading comprehension, especially in science, is difficult for this generation of students. They do not enjoy reading and skip over large amounts of required material. Instead, they skim and try to search for answers rather than try to understand the content. To keep the students on task and contribute to

their reading comprehension, I instructed them to read together in small groups. The students participated in group reading to ensure that students read the entire case study.

Students then gathered in small groups of 2, 3, or 4 to answer questions about what they read. We discussed the questions aloud before working in small groups to ensure they understood what was asked. There were some misconceptions; therefore, I encouraged them to use resources if they were still confused about the basic understanding of inheritance. I noted these misconceptions in my teacher journal. I expressed concern that students did not comprehend all that they had read and that perhaps there were some misunderstandings or that students misinterpreted some of the passages.

As we began to discuss answers, I instructed students not to change their original answers. I reminded them that I was not looking for right/wrong but how they were going about thinking through the topic to see who understood and what their thinking patterns were.

The subsequent day, students and I reviewed the case study. We began Part II of the case study, where I read the instructions aloud. Students were made aware that there are different amounts of melanin in the skin depending on which allele is expressed, leading to seven different shades of skin color ranging from very dark to very light. Next, students were presented with a large Punnett square filled in for them. I asked students to gather different shades of colored pencils. I made another change that would not have occurred at the college level for which this case study was initially designed. Using the overhead document camera, the students and I colored each Punnett Square box for the seven skin color shades based on the alleles. I then demonstrated how the phenotypic ratios created a bell-shaped curve, and I explained what a bell-shaped curve could represent. Students would have been expected to do this part of the case study independently at the collegiate level. After answering questions together for Part II, students worked again in

pairs/small groups to make a family tree to determine the genotypes of both Armand and Desiree's parents and their baby. I gave them one example to get them started and another change to the original plan of the case study to make it more high-school-friendly. Students worked on the rest before turning the assignment in.

The next day, students began class by reading an article by Jablonski and Chaplin (2002) entitled "Skin Deep." Students read this together and aloud to ensure they stayed on task as I walked around the classroom to see if I could determine if students comprehended what they read since this is a scientific article written for higher-level readers. The report contained some terminology that would need to be further explained to them, another refinement I made to the original case study plan. Students were asked to complete one last written assignment for this case, and that was to create a one-page essay. This writing activity determined their understanding of the content matter from the case study.

This case study included two videos, *Race: The Power of an Illusion* and *HHMI: The Biology of Skin Color* (2019). Students were asked to answer some reflective questions using Flipgrid to conclude the case study for heredity during the next class.

The following questions were used as prompts for the students to answer on Flipgrid regarding the case study, Desiree's Baby:

1. What was your first reaction to the case study, Desiree's Baby? Please be as specific as possible in your response.
2. How has it been for you to use a case study versus note-taking and lecture while learning this topic in biology?
3. What was the genetic topic that we learned about in Desiree's Baby? In other words, what was this case study trying to teach you?

Using Flipgrid, students successfully recorded their videos without issues. I used Microsoft Word to create transcripts from the recordings, and codes were assigned and analyzed from both the Flipgrid and the teacher journal using NVIVO software.

3.2.2.1 Teacher reflection journal

I used a teacher reflection journal daily during data collection for both PDSA cycles, which helped form the change ideas for Cycle 2. When conducting research in the social sciences, there has always been a long-standing tradition of reporting the research process (Quilgars et al., 2009). Journaling helps when making decisions quickly and documenting unexpected issues during data collection.

3.3 Cycle Two

To begin the second cycle of data collection, I briefly introduced evolution to the students by using a similar storyline to a case study. This storyline involved dog breeding and how it relates to evolution. I used a storyline similar to a case study because it is easily relatable to the students and a topic that is easy to understand without much background knowledge on evolution.

The next class began with introducing a new case study written by Wilson (2011) entitled “Super Bug: Antibiotics & Evolution,” which demonstrates evolution because the production of antibiotics has created an evolutionary advantage for the bacteria that are the target of antibiotics. Bacteria continue to evolve and develop strong resistance, which requires the medical community to consider the evolving nature of infectious agents. Through this case study, students learn about complications associated with antibiotic resistance and how evolution was the reason for this

ongoing problem. By learning about evolution in terms of resistant bacteria, students learn how evolution impacts their daily lives despite taking many years.

3.3.1 Theory of improvement

According to assignment completion rates and preliminary student surveys, student interest is decreasing, indicating that the current pedagogical methods used for teaching biology are not the most motivating. I seek to improve student interest in biology by incorporating refined case studies that may call upon previous student knowledge by introducing phenomena, motivating students to complete assignments, increasing their understanding of the subject, and making them more aware of social justice issues in biology.

A pedagogical method that can increase student interest in the biology classroom is case studies for abstract concepts that prove difficult to understand and relate to ordinarily. We can define case studies as “stories with an educational message.” There are many ways to tell a story. Case studies have been used for years, namely in the social sciences, to demonstrate applying a theory or concept, especially for unusual or interesting topics. Case studies have great potential for motivating students with examples, increasing their understanding, expanding independent learning, and promoting information assessment skills (AAAS, 1989). According to Herreid (1998), case studies can be categorized into several major types depending on how the story is used in the classroom:

1. Lecture
2. Whole-class discussion
3. Small groups
4. Individual analysis

5. Lecture in large classes using personal devices such as clickers or apps

One of the significant goals of case studies is to support students' context-based learning. Context-based learning refers to using real-life and fictitious examples in teaching environments to learn through the actual, practical experience with a subject rather than just its mere theoretical parts. Students may not naturally have a curiosity and interest in biological topics alone; however, they may be interested in uncommon diseases that drive their curiosity to learn more while also understanding and appreciating the content.

It is hard to dispute that case studies are beneficial in the biology classroom, especially for complex topics in which students quickly lose interest. There are still interventions that need to be done; especially for the 9th grade students returning from the pandemic years and whose science literacy and reading comprehension skills are not as strong as they could be.

3.3.2 Drivers and driver diagram

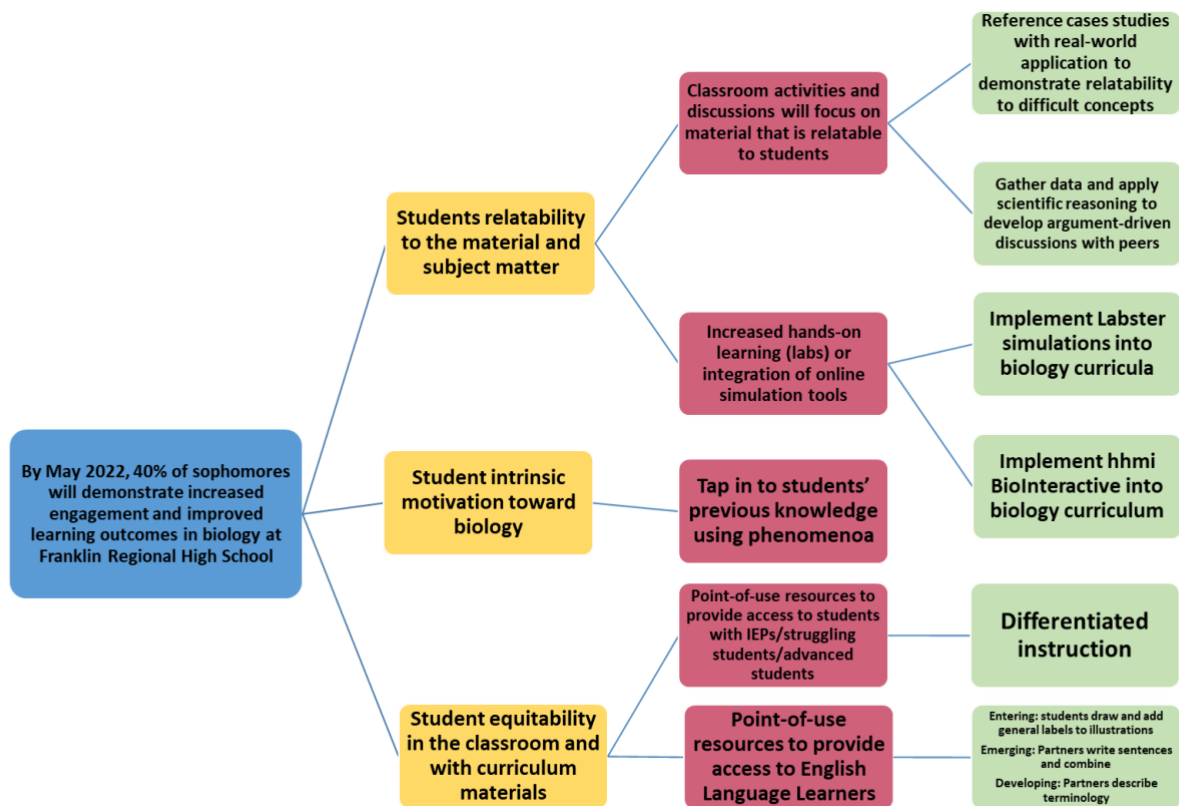


Figure 1. Driver Descriptions

Suppose we want to increase student interest in biology by 40% of students in biology courses by May 2022. In that case, we need to focus on improving student relatability to the material and subject matter by introducing classroom activities and discussions that will focus on the material that is relatable to the students, and the best way to do that is to reference case studies with real-world applications to demonstrate relatability to complex concepts.

The main goal of this study is to improve student interest in biology by improving student relatability to the subject matter being taught. The first primary driver, as illustrated above, relates

to students' relatability to the material and subject matter. The biology textbooks and curriculum currently stand out as very vocabulary dense, making it difficult for students to relate to and comprehend. The literature review shows that when a student comes across unfamiliar words while reading text, they then "tune out" and have minimal comprehension. Biology textbooks are full of foreign words and phrases. Biology is a subject for which many ideas are abstract, meaning that the process learned cannot be seen with the naked eye. The inherent complexity also makes understanding new concepts even more difficult for a high school student.

Additionally, teachers must focus on students' intrinsic motivation toward biology, my second primary driver. Most students do not consider what it means to be "motivated" and do not realize that they are intrinsically motivated to do many things throughout the day. Unfortunately, biology is not usually one of them, primarily due to that relatability factor. If we can spark intrinsic motivation in our high school biology students, it will naturally lead to interest and completion rates. Newmann et al. (1992) state that students' prior experience demonstrates that intrinsic motivation is directly related to prior student knowledge and is an essential component of my problem of practice. People can look back on earlier experiences and use their memories to guide their future engagement/interests (Middleton & Jansen, 2011).

A third and final primary driver deals with student equitability in the classroom with curricular materials. Like not being able to relate to the curriculum, students who feel lost in the rich vocabulary and unfamiliar phrases will not be inclined to continue in such a discipline or be concerned about their understanding of the material. Textbooks are generally written on a higher reading level than some students in general academic biology classrooms. The curriculum is usually designed according to standards that are banded by grade. Therefore, some students have difficulty relating to the concepts from the start, which discourages them from going further with

the materials or engaging in conversation for fear of incorrect or misspeaking. English Language Learners are also included in this cohort of students since biology is based on Latin or Greek roots, which is difficult for even the most experienced English speaker.

The other half of the theory of improvement involves the secondary drivers, which specify what is required to change to achieve the desired outcome. One of my secondary drivers for my study is classroom activity, and discussions should focus on the material relatable to students. To reiterate, students need to relate to the material to learn it, which is not difficult to accomplish; therefore, I focused on relatability for my PDSA cycle.

The curriculum should include as much hands-on learning as possible, such as labs. If labs are not possible, the teacher should consider the integration of an online simulation tool. Nothing beats a live, hands-on lab experience; however, simulations are very advanced when not possible and are the next best thing. One significant cause of students becoming less engaged in biology is the lack of hands-on learning (i.e., labs) due to time constraints placed upon them from the Keystone Exam and teachers having to have met all of the anchors by May to have time to prepare students for the exam. When time is of the essence, labs are usually the first to cut from the curriculum due to the setup and tear-down time. Add something like a pandemic to the equation, and labs are but a memory in most biology classrooms, unfortunately.

Everyone learns based on previous experiences and knowledge (Middleton & Jansen, 2011), so the third secondary driver is essential. When we can provide students with the opportunity to recall past knowledge and experiences, we can introduce them to unique phenomena relating to science that will “hook” them and cause them to want to learn more about the subject and perhaps even contribute enough to consider studying toward a STEM career.

The remaining secondary drivers deal with point-of-use resources for struggling students or perhaps students who are English Language Learners or even students from socio-economic backgrounds that do not support the type of language found in a biology textbook or curriculum material. These point-of-use resources can be found in newer textbooks and seem beneficial for struggling students and English Language Learners.

3.3.3 Change idea and intervention overview

During Cycle 1 data collection for the case study of Desiree's Baby, I learned that 9th grade students seemed to struggle with science literacy and reading comprehension. Therefore, for this case study, one change idea was to use “popcorn reading,” where a student reads aloud to a designated point and then stops and calls out another student’s name to take over for the oral reading. It keeps the students more focused to listen along while someone else reads the material. After each section, I stopped the oral reading to ensure students understood the material presented. If they had misconceptions, we discussed them before moving forward. Discussions at this point in the case study are something that teachers would not be doing in the original plan of the case study as it is meant to be presented, especially since it is initially designed for a collegiate age group.

Next, students answered questions in Part I and defined definitions using a think-pair-share method. Students were permitted to use online resources and textbooks to aid in determining unfamiliar terms. The use of the supplemental materials is another intervention that was not originally designed to be part of the case study; however, in Cycle 1 data collection, the students did well with sharing information when given the opportunity. They seemed to bounce ideas off

each other, adding to their sentences. Extensive class discussions took place when I addressed more misconceptions before moving on to the next part of the case study.

Part II proved to be too difficult for 9th grade students; therefore, I had students skip this part, and I was careful that students understood what they needed to know to move on to the next section.

Part III had students try to determine the significance of evolution by taking on the role of a doctor, politician, parent, or journalist and dictate how each would deal differently with antibiotic resistance issues. Students had no problems choosing a position from within their small groups; however, they needed reminders to stay on task. Students worked individually to interpret the graphs associated with their roles. This proved difficult for some since the charts were in color and printed in black and white. I, therefore, had to project the graphs onto the whiteboard in color so that they could complete their interpretation of the data. Each student received different information, which encouraged participation by all members. They all collaborated better than expected. The collective answers contributed to how the information related to economic, environmental, political, and health-related medical issues. To end this part of the case study, students brainstormed a possible solution for antibiotic resistance.

For the final day of the Superbug case study, students returned to the small groups that they used when role-playing as a politician, parent, journalist, and doctor. They received the following instructions:

“Today, I want you to collectively, as a group, discuss ideas or solutions that you propose for the growing problem of antibiotic resistance due to EVOLUTION.”

1. Take turns reading your conclusions from your graph and then have an informal discussion. This discussion is not recorded; however, the point is for everyone to understand your thinking.
2. Discuss, as a group, the answer to the question: *How should we reduce antibiotic resistance and the continuous evolution of more potent bacteria (superbugs)? Keep in mind the pros and cons.*
3. Go to Flipgrid, and as a group, answer that question from number two above along with the following question:
 - a. What would happen if we chose to do nothing about antibiotic resistance? Think of a worst-case scenario (think about movies or recent events).
 - b. What would a standard surgical procedure be like with increased antibiotic resistance?
 - c. How does antibiotic resistance of bacteria demonstrate various principles of evolution? Make sure to mention selection, mutation, adaptation, and alleles.
4. How has it been for you to use a case study versus note taking and lecture while learning about evolution in biology?

Data was collected using Microsoft Word to transcribe the Flipgrid videos and NVIVO software for determining themes and assigning codes.

3.3.3.1 Methods and data collection

The data collection methods were the same as in phase one. Using Flipgrid, students successfully recorded their reflection videos based on prompts without issue. I used Microsoft Word to create transcripts from the recordings, and codes were assigned and analyzed from both the Flipgrid and the teacher journal using NVIVO software.

System measures. As researchers, we must ask ourselves, “How do I know if the change is working?” We, as researchers, can use measures to determine the answer to this question.

Outcome measures. The tools used to measure outcome were teacher reflection journals for cycles one and two and the student think-aloud discussions using Flipgrid videos. These data sources were transcribed using Microsoft Word and coded with NVIVO to look for themes. I used the teacher reflection journals to answer inquiry question one and the Flipgrid think-aloud primarily used to answer question two.

Driver measures. Potential driver measures helped me see if the change impacts the driver areas (i.e., primary and secondary). I researched if the refining, implementation, and integration of case studies into my current biology curriculum have influenced my secondary driver (i.e., focusing on relatable material) by examining the results of my first test of the module in an improvement cycle. Relational relatable materials have improved if the results indicate that the case studies have increased interest. If case studies have improved the use of relatable materials, my change has improved my primary driver (i.e., student relatability to material and subject matter). These driver measures indicated if I was on the right path to reaching my aim. The tool I used to measure the outcome measures’ success was the Flipgrid think aloud. If the students responded that they had gained knowledge of complex topics in a unit where we used case studies, they would have more motivation to complete classwork. Ultimately, completing classwork due to interest from motivation from case studies should lead to increased learning overall.

Process measures. Potential process measures that may quickly and easily answer how my change idea worked are simple measures such as Flipgrid videos, think-aloud, and teacher journaling. Data focused on students’ attitudes toward various pedagogical methods that include and do not include the utilization of case studies. Using these methods, I measured how sound

refined case studies may increase interest by motivating students, tapping into their prior knowledge, and using the phenomenon. Using these process measures told me if the change idea (i.e., refined case studies) produced the results I predicted. The subject that best informed me about the change's impact was independent student responses and the responses from the peer discussions (i.e., think aloud). The data was qualitative. I implemented a cycle of unit lessons, analyzed the data from the Flipgrid videos (i.e., think aloud) and teacher journals, and reflected on whether or not (and to what degree) the refined case studies impacted student interest.

Balancing measures. As multiple improvement cycles occurred, the results impacted the drivers demonstrating if I reached my aim (i.e., leading outcome drivers). I also considered balance measures to monitor if the change improved or disrupted the system. The study's potential driver measures did not affect other faculty members since I incorporated case studies into my long-standing curriculum only (initially). No other faculty had to do any additional work. The case studies did not replace any unit material component; instead, they were a supplemental pedagogical tool to aid student interest and understanding. While implementing refined case studies, I measured how the change ideas' implementation impacted all of the other measures mentioned and adjusted my next improvement cycle. Since the aim was reached, refined case studies will be introduced to other faculty members during a PLC meeting to determine if there is interest in adopting them into the curriculum and possibly creating our case studies explicitly geared to our students.

4.0 Results

My study looked at how I could refine my use of case studies to make them beneficial for high school students to increase interest in biology. According to the qualitative data I collected, my refined case studies benefitted the students by increasing interest in the biology topic, staying on task, and assisting in their comprehension of the subject matter that the case conveyed. When asked, the students unanimously agreed that refined case studies were more beneficial for learning than traditional note-taking and lecturing. In vivo coding of student responses recorded using Flipgrid was used to collect data. An example of in vivo coding of my teacher journal seen in Table 1.

Table 1. Teacher Journal Coding Example

Transcript (Teacher Journal)	Code
This case study was set up for the students to read independently. I felt that if the students were left to try and decipher the meaning of the case study on their own, they would have missed a lot of the pertinent information needed to understand polygenic inheritance. Therefore, I recommend popcorn reading with interrupted slots to ensure student understanding before moving on to the next Part.	missing pertinent information popcorn reading

I organized the codes into specific themes for each inquiry question.

4.1 Inquiry Question 1: How am I Refining My Use of Case Studies?

4.1.1 Theme 1: Refining case studies

The method of presenting the case studies was different than what was outlined initially in the teacher notes for implementation. It was necessary to make the material more understandable to high school students since the case studies are written for the collegiate level. The refinements proved beneficial and worth continuing with subsequent case studies written for the collegiate level. High school teachers overlook many case studies because they believe the content is too difficult for high school biology students; however, my analysis indicates that with some refinement, they can be instrumental and demonstrate better results than with lecture and note-taking alone as far as increasing student interest in biology.

The case study, Desiree's Baby (Cycle 1), was initially written for collegiate biology majors and non-majors, making it difficult for freshmen high school students to comprehend as it is written. The following themes were discovered through in vivo coding of transcripts of both my journals and student responses on Flipgrid.

4.1.1.1 Reading comprehension

I observed that students struggled with some aspects of the case study, Desiree's Baby, regarding understanding at the college reading level. Therefore, I had to refine the teacher's plan and use popcorn reading to assist with their comprehension. Coding demonstrated that students could not pay close attention to the lesson on their own unless I reiterated what each paragraph was conveying.

Students were placed in small groups to answer questions at the end of Part I, and it was quickly apparent that they were also having some trouble understanding what the questions were asking. I went over the questions aloud with the students to ensure they understood. This was beneficial.

For the case study used in Cycle 2, Super Bug: Antibiotics & Evolution, popcorn reading proved very effective since it was used from the beginning of the case study. Another modification I made to the original case study was discussing some definitions as a class and how each definition relates to Sam and his antibiotic-resistant urinary tract infection (UTI).

4.1.1.2 Identifying misconceptions

During Cycle 1, students were confused about the whereabouts of Desiree once she entered the woods and "never returned." Although not explicitly stated if Desiree committed suicide and killed her baby, the students did *not* interpret this, as they assumed she just went for a long walk. If students were left to decipher the case study on their own, I feel that the students would have missed much pertinent information needed to understand polygenic inheritance.

Additionally, a significant misconception from Cycle 1 was that Desiree and Armand did not know that the baby was Black right away because they thought melanin cells were "growing" and did not appear dark enough to cause a change in skin pigmentation. Students did not understand that melanin gets more pronounced once an organism is exposed to light.

Students will also confuse albinism with light skin. The teacher will have to explain the difference to them if this is asked. A refinement that aided in decreasing misconceptions was stopping the students and correcting these misconceptions *during* their reading and discussions of the case study rather than waiting until the end, when they may have misinterpreted the necessary information.

4.1.1.3 Improving student communication regarding science

Students were asked to read a scientific article dealing with melanin, explaining that there are different amounts of melanin in people depending on which form of the allele is expressed, which directly affects evolution based on how close to the equator their ancestors lived. I read the introduction paragraph aloud for Part II, which explained melanin. The students asked me to continue reading the article since they did not recognize some of the terms they stated helped them comprehend what was written.

Students reported that case studies put the vocabulary together so that they are not just learning one term at a time, but they are learning how all of the terms affect each other collectively. Another student reported, *"The case study helped me with scientific literacy because I could write an entire paragraph because I had a solid idea of what was going on."*

After Cycle 1, students were asked to write a one-page summative essay for Desiree's Baby. Students had much trouble with this assignment. For example, students struggled with using written material to postulate novel ideas or decipher and interpret what the reader was trying to teach them. Students wanted precise instructions. Numerous students asked, *"How long does this essay have to be? How many pages? What font size should we use? Is it double or single spaced?"* I gave very open responses and tried to get them to decide these things on their own and teach them that they would answer the questions once they began to write. I wanted them to have some ownership of their work.

4.1.1.4 Think-Pair-Share

Students used much think-pair-share to assist in the understanding of the case study. After students worked in their small groups to answer the questions at the end of Part I, I went over the questions aloud to ensure they knew what the question was asking. This proved to be beneficial in

ensuring students were on the path to understanding what the case study was trying to convey before moving on to Part II.

For Cycle 2, the think-pair-share method was beneficial since students had little background in evolution and how evolution relates to Sam's case. Think-pair-share allows students to use each other for insight on topics they may not know a lot about individually. Collectively, however, they can brainstorm ideas and help each other arrive at correct answers through more profound thought. Below is an excerpt from my journal:

"Students had a little background in evolution and used a think-pair-share method to answer the questions about part I, the definitions for the part I, and how they relate to Sam's case."

4.1.2 Theme 2: Shortening of case studies

The *only* negative comments on Flipgrid from the students about case studies dealt with the length of the case studies. One student commented during their Flipgrid recording that they felt the case study for Cycle 1, Desiree's Baby, was too long. They thought that the case study held their interest and aided in their understanding; however, they felt that it could have been shortened and had the same beneficial effect. The student stated, *"I liked the case studies better than lecture and notes, but I feel like it could have been shortened. It started to get too long."* One example of how the case study was shortened dealt with the Punnett square. It was an extensive Punnett square, having 64 possible allele combinations. If used in the manner the case study was designed initially, students would need to figure out the various genotypic and phenotypic ratios. Analyzing this extensive Punnett square would have taken much time and may have frustrated the students.

Therefore, the students appreciated the slight change of reviewing the Punnett square together using the document camera and colored pencils to isolate each genotype.

The case study for Cycle 2 was shortened and held the students' attention without issues. They agreed that the refinement made a big difference in keeping their attention.

4.2 Inquiry Question 2: How and to What Extent Does Case Study-Based Instruction Support Student Interest?

4.2.1 Theme 1: Critical thinking

My data showed that students demonstrated higher-order thinking and curiosity when using case studies. The students themselves stated the following regarding the refined case studies, *"They made us think more and think for ourselves."* Students also expressed that the refined case studies had an element that made them figure things out and think. While observing students answering questions to Part I of Desiree's Baby, I overheard the students trying to figure out the probability of the parents being heterozygous and the likelihood of the baby being mixed or all Black. Students also started to question albinism during the last part of the case study. It is mentioned in the teacher notes that students that may be thinking more critically may ask about albinism and that teachers should be prepared to answer that question. One student reported, *"The case studies made me go deeper to find my answers instead of just being laid out. I learned more because instead of just a lecture, I had to think more and deeper to understand it truly."*

4.2.1.1 Curiosity

Many students posed questions regarding inheritance patterns during this unit. Does my journal indicate that students asked about what it means if a person does not have a variable shade of skin color? For example, when a person only burns in the sun, their skin never develops a tan color. This curiosity was welcoming for me; however, it did extend the time needed to cover the topic since a discussion ensued.

One student posed the question during class, *"What would my phenotype be if my mom is white but my dad is brown?"* The students gladly offered up their answers about which of the seven skin color shades he would be. It was enlightening that a student would ask his classmates their opinion of his skin shade based on what we had just learned.

4.2.1.2 Seeking reassurance

I recorded that students were much more concerned with reporting correct responses during the case study lessons. Below are some examples taken from my teacher journal:

"I heard them chatter about their possible answers, and some asked for reassurance that they were on the right path. I explained that they might be wrong, but it was ok. I wasn't looking for correct answers but more for misconceptions about their thinking."

"I kept instructing the students to answer the best they could and not worry about being correct or incorrect; however, instead of responding as they see fit for now, we would discuss the answers shortly. This did not change the fact that they were concerned about providing the correct answers immediately."

4.2.2 Theme 2: Improved understanding

Students reported that material was easier to comprehend using refined case studies compared to traditional lecture note-taking methods for the concepts of polygenic inheritance and evolution. Some examples of their claims include the following:

"I have better knowledge and understanding of the material from using the case studies."

"I feel like you learn more and have more opportunities for questions than just taking notes."

"I like the case study version because it allows me to learn faster because you can see how it applies as long as it is all laid out beforehand."

"I like the case studies more than notes because it is more like an example, a good one. I can read better; it's just how I work."

"The case study helped me understand how genes work, replicate, and get passed along."

"I found the case studies were easier than taking notes because it was confusing to me, but then I found out what it was about, and it was easier to understand! I was able to pay attention easier, so that was good."

"I prefer case studies over lectures because I picked up more from them because they were written like a story which helped further the understanding of the topic."

4.2.2.1 Better retainment

Data show that students perceived improved learning from using case studies. Case studies were perceived to aid in retaining material for polygenic inheritance and evolution. Students claimed that the case studies are easier to remember the information because they get more involved in the story and not just write down notes that they will forget. One student stated, *"With*

notes, I feel like I am just trying to fill them in and not retaining as much information as the case studies." Another student claimed, *"It was an exciting way of learning (with case studies), but it also helped me keep it all in my mind and remember it. I don't always remember my notes very well, but this (case study) was a little easier to remember because of the characters and the whole context of the situation."* Lastly, one student had a comment that resonated with me and one that I can relate to, *"I think it is good in that we aren't just memorizing terms and then forgetting about them."*

4.2.3 Theme 3: Increased interest

My teacher journal noted that students demonstrated excitement about what would happen next and wanted to continue with the "story." My journal indicates that students were mind-blown and gasped when discussing the cases with each other. I was delighted with the level of interest that I saw from students and their willingness to cooperate. Below is a sample of how some students commented:

"I think case studies are a much more fun and interactive way to go on about doing the learning."

"Case studies are also more interesting than note-taking, so it is easier to remember everything, definitely more engaging!"

"I thought it didn't feel like work!"

"I find it more interesting to use case studies since it provides a real-world example, and I felt that I understood it more than note-taking."

"It is more fun, interactive, and engaging, and I feel like we are learning more than we would be if we were reading off of a slide and taking notes."

4.2.3.1 Engagement with classmates

Students were much more inclined to have open discussions with classmates when using the refined case studies when compared to traditional lecture and note-taking methods. During observations of the students working, I heard them explaining to their friends what happened in the lesson since some may have misinterpreted what was meant to be conveyed. I question if this increased interest was due to the subject matter or the way it was presented.

4.2.4 Theme 4: Willingness to work

Students had more engagement with me and had a 100% completion rate for in-class work during the use of the case studies. During other units for which refined case studies were not used, the average completion rate was about 60%. Upon returning from a break during a 90-minute class, students were willing to begin working again right away, which is not typical for this class. I had numerous students wanting to be next to answer questions. All students reported in my journal appeared to be invested personally in sharing their answers with me.

4.2.5 Theme 5: Real-world applicability

Students reported that they could connect subject matter with real-world situations using case studies, and they greatly appreciated this applicability. One student stated, "*The case study is a real-life situation at hand, and it does not just have a note that you have to copy down. It is easier to understand it in a real-life situation.*" Another student stated something similar: "*When you can apply something to the real world, it gives us a perspective of how this stuff works in real life.*" Students repeatedly noted that taking notes is boring and that with case studies, you learn

something and see real-life experiences. They also stated that they appreciated getting to see a Punnett square used in an actual real-life scenario that helped them understand polygenic inheritance rather than use examples dealing only with pea plants that students do not have much interest in learning.

4.2.5.1 Relatability

Many students could personally relate to the case studies in their own lives. The statement that most resonated with me by a student and reminds me of why this research is so important to me follows: *"It is nice having a real-world application, and you're not like, 'What am I going to do with this later in my life?'"* Another student stated, *"I thought it was better because you put the information that you learn in the notes into something that applies to real life, and you can experience this personally."*

I noted in my journal, *"I am beginning to see firsthand how constructivist theory comes into play in education. Genuine connections are made (and learning) when students can relate to the material. If students have somewhat of a knowledge of something, they are more inquisitive about it."*

There was one group that did not seem to grasp the concepts as easily as others despite using the case studies. They still had misconceptions toward the end that I had expected to be clearer. One of these students did miss two days at the beginning of the unit; therefore, this may have affected his understanding and more consideration will need to be put forth for how to handle case studies for absent students.

5.0 Discussion

Based on my research findings, I can declare that when refined for the high-school level biology class, case studies have the potential to significantly increase student interest in the content area for which they are used. Similarly, Hoag et al. (2005) and Lundeberg & Yadav (2006) reported that students believe content is easier to remember and apply when using case studies. Students experience more enjoyment when using case studies in class than lectures and notes.

The reflective teacher journal was one of the most insightful tools I have ever used. I did not expect to bring so many emotions to my study; however, journaling helped keep me focused on how and why I am doing this study and reminded me of my passion for increasing student interest in Biology. Although I may not use the notes on feelings and emotions directly in the write-up, it kept me grounded and reminded me why I did the research. Journaling is beneficial when researching independently, with no colleagues to collaborate with for ideas. Researchers discover possible future studies by journaling and finding things about themselves that they never realized. A sample excerpt of my teacher journal is below:

"To see the students so engaged with the content and subject matter is pleasing. For the first time in years, I remember why I wanted to be a Biology teacher. They do want to know more; I have just been teaching it in a way that was not reaching them (the students)! They respect the content and see where it will be applicable for them in their lives or the lives of their loved ones. This change in pedagogical method is not rocket science that I used to spark interest. It is a case study. I cannot figure out why educators do not use this method more often. It is no more difficult than lesson planning for traditional lectures. I cannot wait to begin Cycle 2; however, I cannot wait to incorporate refined case studies into all of my lessons for the next school year." Using

NVIVO software to code the transcripts of the student think-aloud responses to both case studies, I determined the themes reported in the results section. Below I will discuss some of those themes broken down by inquiry question.

5.1 Discussion by Inquiry Question 1: How am I Refining My Use of Case Studies?

5.1.1 Theme 1: Refining case studies

Throughout my study, I discovered various ways of refining case studies to make them more applicable to my group of students to increase their interest in the subject matter. The results demonstrated that the refinements were successful in reaching my goals. I believe that if more teachers looked at data showing the positive effects of phenomenological-based pedagogy and understood that there are multiple resources available for them to use, the number of students whose interest in biology would dramatically increase, primarily if refined case studies are used throughout the year for complex topics.

5.1.1.1 Reading Comprehension

Reading comprehension cannot solely be fixed in a biology classroom; however, it is something that can be refined. I utilized popcorn reading first as a way to support my students' comprehension because I saw that they needed some support. Although group reading was beneficial in keeping students on task and aided in their reading comprehension for learning the subject matter the case study was trying to convey, I now want to develop more sound ways of supporting their comprehension as part of my instruction.

5.1.1.2 Identifying Misconceptions

My journaling initially demonstrated many student misconceptions about Desiree's Baby's case study. By stopping the students periodically throughout the case study and discussing those misconceptions, I believe it aided their overall understanding of what the case study was trying to convey. If the case study was used in the way it was originally designed, stopping for misconceptions would not have occurred.

5.1.1.3 Think-Pair-Share

Think-pair-sharing is not a new pedagogical tool; it is underused and an underestimated one. When used with refined case studies, the discussions that ensue are fascinating. It is pleasing to hear students explain complex scientific topics about the characters they just read about. They have much more passion for the subject matter, knowing that it occurred in real life and not simply on the pages of a textbook written in technical terms they glance over because they do not understand.

5.1.2 Theme 2: Shortening Case Studies

The length of the case studies was the only complaint by the students, which is understandable. Considering they are written for collegiate students, this is a perfect example of how pre-written case studies can be refined for high school students. Although case studies in high school will benefit the students if they attend college, many universities use case studies in all subject areas. Assisting students with the Punnett square and completing it together greatly shortened the length of time it took to complete the case study. It also allowed me to introduce them to some basic statistics used in science such as the bell-shaped curve. Grade 9 students have

not taken statistics yet; therefore, having this opportunity to present it may spark some interest in that subject and biology.

Giving up control of the classroom when switching from a passive lecture/note type setting to one in which you let the students have more control through discussion and arguments is daunting at first. That loss of control is terrifying for people with Type-A personalities, which many teachers have. Having a vested interest in student performance made this paradigm shift even more difficult during my data collection. I had to step back and remind myself that they are still 9th graders that are products of the pandemic and more immature than students in previous years. Allowing them some freedom to have independent conversations on the side regarding the case would be fine. I just wanted to gather as much evidence as possible and was fearful that I would miss something.

5.2 Inquiry question 2: How and to what extent does case study-based instruction support student interest?

5.2.1 Theme 1: Critical thinking and curiosity

For years, I have brainstormed about ways in which I could have gotten my students to think more critically. I have tried using more questioning using the depth of knowledge charts to create more profound questions; however, all have ended without success. That is, until I introduced refined case studies. Through observation, I discovered my students thinking deeper than they ever have before, questioning not only me but each other, pondering their polygenic inheritance. This critical thinking led to increased curiosity. Students were genially curious about

both topics for which the refined case studies were used. We did not finish what I had initially planned on certain days because the number of questions took time. I did not stop the questions from coming. I always dreamed about this type of classroom, learning through discussion, phenomena, and curiosity. The case study, Desiree's Baby, had the students contemplating many questions. Students were inquisitive about what it means if a person does not ever have a variable shade of skin color (e.g., becoming tan in the summer) and wanted to know why some people only get sunburned. This indicated that the students were thinking deeper and had a vested interest in the subject matter more than during lectures and notes of previous units. The questions about sunburn led us to discuss varying melanin levels that led to the introduction of evolution, which led to the subsequent case study about super bugs.

It was apparent from student responses that students prefer a challenge. Rather than be fed information full of complex vocabulary and graphics that do not appeal to them, they prefer a refined case study that challenges them to delve deeper into the meaning of what is being taught. The case study authors create this desire to learn more because of how they set up the story.

Bruner (2002) tells us that students learn best when they can attach learning of new material to prior knowledge. There are no better means of sparking interest than connecting learning new content to real-world phenomena, which case studies do. Students themselves report that the case studies helped them form connections and understand what is being taught. The refined case studies help students learn the information at present; students also admit to retaining the material better since it is presented in an attractive and memorable way. We as adults do not choose to retain information that we do not find beneficial for our future. High school students are no different; however, we expect them to force themselves to retain information that they cannot find value in a presented way. Case studies allow teachers to convince students that there is a reason

for keeping the information presented to them. They may not see its value now; however, through the use of the case study, they may be able to see the potential value the context has for their future.

5.2.1.1 Seeking Reassurance

I was surprised at how fearful the students were of answering incorrectly during discussions of the case studies. Discussions during other units did not result in these long, debate-like discussions where students demonstrated a true passion for the subject matter. With this newfound passion comes the relinquishment of one's classroom, however. Students seemed to take over during most of the discussions, and it was difficult for me to regain control. Students became loud when stating their opinions during both data collection cycles, and a few arguments amongst themselves did occur; however, it was all for the goodness of education. I was able to regain control; however, this may cause some anxiety for specific teachers. This change in instruction challenged my previously held notions about “good teaching.” One does not have to have complete control nor does one have to fear open discussions amongst students with their classmates and/or teacher. Real learning is loud sometimes, and the loudness is necessary in order to gain knowledge. Students may not remember every vocabulary word that we discuss in class; however, they will remember the powerful discussions that sparked emotions in them for a lifetime.

5.2.2 Themes 2 and 3: Improved interest, understanding and retaining of material

Students reported that the material was easier to comprehend and retain due to refined case studies. Their Flipgrid responses were authentic and honest. They had no reason or incentive to state otherwise. In the end, what we want as teachers are improved learning outcomes. For some, this means writing an essay, reciting what they learned, and successfully passing an assessment or

a high-stakes end-of-course exam. For others, improved learning outcomes suggest that the students state that they are more interested in the subject matter than before they took the class. Year after year, I get students that claim they did not remember anything from their previous science class, or they will state that they never learned about a particular topic. As I became more experienced, I realized that students only retain what they choose to retain, or at least their brain decides what to retain based on how interested they are in the subject matter. As shown in this study and those outlined in the literature review, phenomenological-based teaching is the key to allowing students to retain what they learn for a lifetime. When students get excited about a topic, they will not forget that topic.

To hear a student say that the classwork did not feel like classwork is why I am so passionate about my study. If we expect students to want to choose careers in STEM, they first have to find interest in STEM subjects. The key to finding interest in anything is to make it not feel like “work.” To do that, we as teachers must present the topics attractively. Refined case studies are a worthwhile way to accomplish that.

5.2.2.1 Engagement

With the influx of cellular phones and the social disruptions due to COVID-19, teenage students are accustomed to conversations related to cell phones. I was pleased to see how much engagement with classmates occurred during the think-pair-share times with the refined case studies. Showing students that case study topics relate to real life, with real people, helps them become more open with the issues. For example, thinking back to the Asian student that asked his classmates to identify which of the seven possible skin shades, he demonstrated to me that the students felt more comfortable analyzing themselves against the material we had just learned than if we were to be learning this material in a textbook or through lecture. I question if this increased

engagement among each other was due to the subject matter itself or the way it was presented. I plan to conduct further research on this later.

5.2.3 Theme 4: Willingness to Work

Over the last few years, especially since the pandemic, I have seen a considerable decrease in students' work being completed in the classroom. The completion rates have drastically decreased and continued to do so; however, I had 100% completion on the days for which they were used with the refined case studies. Students finished the assignments early and claimed that the case studies did not feel like “work.” This is the best compliment a teacher can receive.

5.2.4 Theme 5: Real-world applicability

The student comments regarding using real-world phenomena to learn biological concepts were remarkable. Unanimously, students agreed that this method of learning new material makes it easier to understand and retain. Refined case studies offer the perfect opportunity to bring real-world applicability to every topic taught in biology, especially those which are the most difficult to understand, like macromolecules, cellular respiration, and photosynthesis. All three of these require a basic knowledge of chemistry which most 9th grade students do not have. The most beneficial aspect of using the refined case studies is the relatability of the subject matter to the real world. Students understandably want to know where they will ever use the material they are learning again in life. It is difficult for young adults to relate to the concept that they may have to make decisions regarding their health and safety for themselves or their loved ones in the future.

Having an understanding of these topics can significantly benefit them in making these future decisions with confidence.

5.3 Limitations

The first limitation to this study was the low sample size. Due to this limitation, the sample was not representative of the entire target population which includes both honors and general biology students. I taught only honors biology this year. The case studies may have had more or less of an impact on student interest if it were to be conducted in a general or CTC biology class. Another limitation of the study was the means or methods of data collection. If I were to repeat this study, I would include quantitative measures such as pre and post assessments to measure not only student interest but true learning outcomes. Additionally, I have been very invested in case studies as a useful instructional approach. This might have made me more likely to focus on the good stuff I saw in my classroom while using case studies. If someone else had taught the two units that I did using the case studies that I chose, they may not have seen the same very positive results that I did. Lastly, although there is an abundance of research and data pertaining to the usefulness of case studies, there was a lack of previous research studies directly related to refining case studies for high school students.

5.4 Implications for Practice

Based on the results from this study, and especially the interventions promulgated by the PDSA cycle in Cycle 2, I believe that student interest in biology can increase with the use of refined case studies. Implications for practice based on the findings of Cycle 1 results indicate how students appreciate phenomenological-based learning methods to increase interest and improve learning outcomes. In my practice, I will continue to use case studies; however, I will increase the frequency for which I use them and also add them to the other disciplines that I teach.

There are many ways an educational researcher can refine case studies to make them more applicable to students, thereby increasing their interests and learning outcomes for inherently tricky topics. Because of this study, colleagues are beginning to move toward teaching with phenomena, such as case studies and storylines. My district has agreed to hire a contractor to instruct teachers on how to teach with phenomena by creating case studies and storylines specific to their students and personal demographics.

5.5 Recommendations for Further Research

Educational researchers could refine case studies from the collegiate to the high school level and incorporate topics that students can apply to other disciplines besides biology. My district is currently working with a consultant to provide teacher training sessions on creating case studies and phenomenological-based lessons to increase student engagement. The science courses will become an example for other departments for this curriculum design. This will lead to enormous

amounts of potential data pools to conduct further research studies about student interest and refined case studies.

Another direction for future research is to compare students who want to pursue a career in science versus students who do not to compare their interest in biology and how it changes concerning the use of refined case studies. As previously mentioned, confidence directly affects student interest, and if students can become more confident with the content and feel as though they are learning (and retaining) the information, they may decide to pursue other classes or a career in a STEM field.

Pedagogical methods could also be tested while using case studies. I conducted both cycles of this study by leading discussions and students working together in small groups to think-pair-share. In subsequent studies, one could look at the case study presented in a lecture-type format, which would appease students who still prefer to take notes. One variation of this research could be to look at two teachers teaching the same case study in two different ways. If case studies were widely used in schools, they could become more standardized for districts that prefer common assessments.

A valuable study is one in which an educational researcher analyzes what makes a case study “suitable.” I believe this question is essential for teachers considering creating their case studies, especially those in secondary education. Questions that could be answered are: What is more critical when designing case studies, relevance to the student or relevance to their career path? How can one ensure that vocabulary is covered, assuming the student has no background knowledge of the subject matter?

Engagement and interest, as mentioned previously, are often terms that are used interchangeably; however, they have very different meanings. It may be helpful to repeat this study

but instead of focusing on interest, focus on engagement. This would require more time for each case study and slight differences in collecting data. For example, quantitative data would be helpful for that type of analysis.

5.6 Conclusions

As of now, there are not many case studies explicitly written for high school biology classes. Luckily, since I began this study, I have found a few sources for case studies that are suitable for high school students. Some authors sell their materials on Teachers Pay Teachers (TpT); however, most are for subjects such as anatomy and forensics. Case studies for biology are still sparse for high school use. For me this study provided a basic foundation for which I plan to grow more data-driven studies from regarding phenomenological-based research. I will use this as my platform while continuing to build my knowledge base and experience and also begin to write case studies of my own to use with my various classes besides biology. Teaching has reached a difficult time due to COVID-19; however, if anything beneficial has come from the pandemic, it is that educators and administrators have begun to realize that standardized testing does not do much to help the students (or the teachers), and that sometimes we need to look behind us at how we taught the subject matter prior to high-stakes testing. For me, biology was taught with fascination and awe. I was told stories. I learned from real-life experiences that could not be learned in a textbook. I aspire to bring that back into the classroom and produce some strong men and women to join the STEM field where my passion resides.

Through the data collection and analysis of this study, I altered the way in which I thought about my Problem of Practice. In my early chapters, I framed my Problem of Practice as a problem of student interest. Now, I think I consider my problem as one of my own instruction.

At the conclusion of this doctoral journey, I like to ask myself who am I now as an educator compared to a few years ago? I can say that I am passionate about my phenomenological-based pedagogical methods. I spend my summers looking for more ways in which I can make my curricula relatable to my students. I believe that we should not find fault in the teaching methods we used in the past, but instead should embrace them. I feel as though educators and policy makers are hung up on the next big acronym that they can create for education. My assumptions about what good teaching and learning have definitely been challenged throughout my years as an educator, but more so as my years of being a doctoral student. Good teaching does not mean that you have 100% success on high-stakes testing. There are plenty of teachers who can teach to the test and produce proficient and advanced scores from their students; however, do their students leave the class with a *true* understanding of the subject? More importantly, do the students leave the class with an increased *interest* in the subject and an understanding of why it may be important for them in their future?

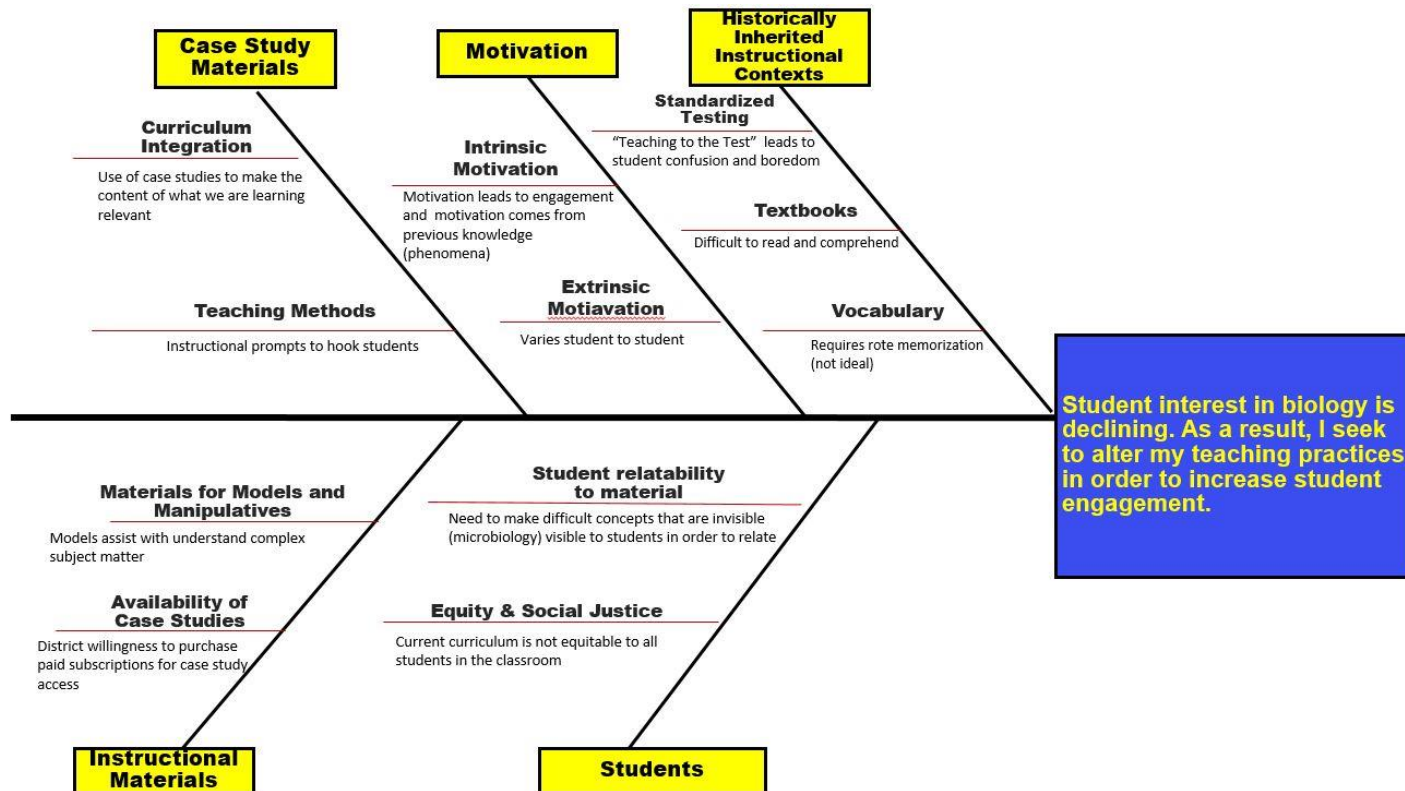
One thing I wrestle with as a result of my study should I begin trying to design case studies of my own or do I continue to refine the case studies that are already written? I also wrestle with the notion of note taking and exactly how beneficial it is for student understanding when using case studies. This is something that I will continue to collect data on and analyze on my own.

Of course, in any classroom, there are challenges. As I mentioned previously, there was still one group of students that did not get the full understanding of the unit topics despite using the case studies. I need to continue to consider ways in which I can help these students while still

allowing the other students to move ahead with the case study. I may need to make more supplemental materials or models to assist students with understanding and to ensure that all of my students can learn.

Appendix A Fishbone Diagram

The fishbone diagram was created to assist the researcher in determining the drivers that influence the problem of practice and how they could be used for improvement science.



Appendix B Flipgrid Think-Aloud Prompts

Cycle 1- Desiree's Baby (Heredity)

Get into groups of 2 or 3 students (max) and discuss the following questions using Flipgrid (no need to type any responses). I designed the Flipgrid to be more of a discussion between classmates. I set the record time to ten minutes; however, you do not need to use that much time if it is not necessary.

1. What was your initial reaction to the case study, Desiree's Baby? Please be as specific as possible in your response.
2. How has it been for you to use a case study versus note taking and lecture while learning this topic in biology?
3. What was the general topic that we learned about in Desiree's Baby? In other words, what was this case study trying to teach you?

Cycle 2 – Antibiotic Resistance (Evolution)

Get into groups of 2 or 3 students (max) and discuss the following questions using Flipgrid, just like you did for Desiree's Baby.

1. What would happen if we chose to do nothing about antibiotic resistance? Try to think of a worst-case scenario (think about movies or recent events).
2. What would standard surgical procedures be like with increased antibiotic resistance?
3. How does antibiotic resistance of bacteria demonstrate various principles of evolution? Make sure to mention things we discussed like selection, mutation, adaptation, and alleles (you don't have to say all of them, but at least some).
4. How has it been for you to use a case study versus note-taking and lectures while learning this topic in biology?

Appendix C Data and Code Summary Table

Codes for Inquiry Question 1: How am I refining my use of case studies?

Name	Description	Files	References
refining case studies	Some things were done differently than what is outlined in the teacher notes of the case study. It was necessary to make the material more understandable to high school students since they are written at the collegiate level.	2	2
reading comprehension	Students struggle with some aspects, especially reading comprehension at the college-reading level; therefore, I had to supplement and use popcorn reading to aid their understanding.	5	10
identifying misconceptions	Rather than let students continue with the case if they were incorrect, I stopped them and corrected misconceptions as we went through the case together.	3	5
Improving scientific literacy	Students were not strong in scientific literacy and needed much guidance for the one-page essay they required during the case study.	4	4
think-pair-share	Students used a lot of think-pair-share to assist in understanding the college-level case studies.	4	4
shortening of case studies	Student negative comments regarding case studies were all related to the length of the case study.	2	2
review of knowledge	Information covered in previous lessons was reviewed. Studies show that when you build off of prior knowledge, it helps with increasing interest and student outcomes	2	2

Codes for Inquiry Question 2: How and to what extent does case study-based instruction support student interest?

Name	Description	Files	References
critical thinking	Students demonstrate higher-order thinking and curiosity when using case studies	4	8
curiosity	Students are more inquisitive with case studies than with notes/lecture	3	6
seeking reassurance	Students are more concerned with correct responses demonstrating a passion for the subject matter	1	2
improved understanding	Students claim material comes more accessible to them in a story form	3	13
better retainment	Students claim that case studies help to retain material better	2	4
increased interest	Students demonstrate excitement about what will happen next	5	9
engagement-classmates	Increased willingness to have open discussions with classmates	2	4
willingness to work	Students have more engagement with the teacher, as demonstrated by asking and answering questions and completing all assignments about the case studies	1	2
real-world applicability	Students were able to connect subject matter with real-world situations	7	17
college readiness	Case studies are used in colleges for multiple disciplines	2	2
relatability	Students were able to relate to the case studies in their own lives	4	8

Appendix D PDSA Cycle 1

PDSA Form			
Test Title:	Exploring New Teaching Practices: Refining the Use of Case Studies to Increase Student Interest in Biology	Date:	03/14/2022-03/21/2022
Tester:	Monica Grasiani	Cycle #:	1
What Change Idea is being tested?	Reference cases studies with real-world application to demonstrate	Driver:	
What is the overall goal/hypothesis you are testing?	Increase student interest in Biology by incorporating refined case studies into the curriculum to make the material more relatable		
1) PLAN Details : Describe the who/what/where/when for the test. Include your data collection plan. I plan to use case studies in place of only lecture/note-taking to improve student engagement and learning outcomes in biology to teach a difficult concept of heredity to students of the freshman honors biology class. This PDSA will occur in March 2022. Data will be collected from student Flipgrids (think-alouds), direct observation by teacher, and a teacher journal.		2) DO Briefly describe what happened during the test. Students began the unit by being introduced to a case study that pertained to heredity and how it pertains to skin color. They were presented with a "story". They asked each other questions, argued amongst their groups, and had a vested interest in how the case study ended. Students completed small assignments as the case unfolded and submitted their answers post class discussion. At the end of the case study (unit), students completed a Flipgrid, using the video platform as a think-aloud while answering prompts regarding the case study and what they learned. I completed a teacher journal during and after each day's lesson to record observations and findings.	
Questions: Questions you have about what will happen. What do you want to learn? Will students be more interested with the difficult concept of heredity if a case study is used rather than a lecture/notetaking pedagogical method? How can I further refine the currently written case studies to make them more interesting to freshman honors biology students to increase interest and further student outcomes?	Predictions: Make a prediction for each question. Not optional. Students will be more interested with the material since they are able to make a personal connection rather than use rote memorization and no interest in the topic. I will be able to further refine case studies for the benefit of student interest by making them more relatable and understandable for high schoolers to grasp difficult concepts. This refinement will make them more likely to be used in the future to improve student outcomes.	Data: Data you'll collect to test predictions. Student Flipgrid (think-aloud) responses Teacher journaling	What were your results? Comment on your predictions in the box below. Were they correct? Record any data summaries as well. Prediction was correct. Students were very interested with the material and that could be directly observed by me. Flipgrid responses showed a high interest toward using case studies over lecture/note taking. Two students prefer to do notes in addition to the case studies to help gain more of a basic knowledge. Prediction was correct. Results were better than expected. Through journaling, I discovered ways in which I could improve case studies further for Cycle 2. I learned that the amount of student interaction drastically improved through the use of case studies. Students were able to retain information much better than with note taking and the students seemed interested in the subject matter. This was demonstrated through their questioning and critical thinking amongst themselves.
4) ACT Describe modifications and/or decisions for the next cycle; what Prior to introducing the next unit on Evolution, begin with a "story" or case study to spark interest; however, after day 1, complete 10-15 minutes of notes to provide a basic understanding of the content by focusing on new vocabulary. Shorten the case study since most are written for college courses. Rather than popcorn reading, allow students to read amongst themselves in their small groups in order to remain on task. Once everyone has completed reading the case, have a small whole-group discussion in order to ensure comprehension of what the case has introduced.		3) STUDY What did you learn? Students had a much higher interest in the subject matter through the use of case studies when compared to topics where notes and lecture were used. I was surprised at the amount of interaction between their peers as well as the curiosity that they demonstrated through the use of deeper thinking questioning. Students wanted to know more. They left with a better understanding of the T shades of skin color and how melanin plays a role in those shades. They also touched on our next topic of evolution by learning that the various shades of skin color are a direct result of humans moving further away from the equator which is what causes less melanin to be produced by the skin. Through this first cycle, I discovered that the college-level case studies can be a bit long; however, as a whole, case studies were favored amongst the students over lecture and note taking. Lastly, I discovered that the students were able to retain the information much easier through the use of case studies since it made it more relatable to real life which in turn increases interest and makes them want to learn more.	

Appendix E PDSA Cycle 2

PDSA Form			
Test Title:	Exploring New Teaching Practices: Refining the Use of Case Studies to Increase Student Interest in Biology	Date:	3/21/2022-3/28/2022
Tester:	Monica Graziani	Cycle #:	2
What Change Idea is being tested?	If further refining of case studies will increase student interest in biology	Driver:	
What is the overall goal/hypothesis you are testing?	Increase student interest in Biology by incorporating refined case studies into the curriculum to make the material more relatable		

<p>1) PLAN Details : Describe the who/what/where/when for the test. Include your data collection plan.</p> <p>I plan to continue to use case studies in place of only lecture/note-taking to improve student engagement and learning outcomes in biology to teach a difficult concept of evolution to students of the freshman honors biology class. This PDSA will occur one week after Cycle 1 data collection and will include change ideas from Cycle 1. Data will be collected from student Flipgrids (think-alouds), direct observation by teacher, and a teacher journal.</p>	<p>2) DO Briefly describe what happened during the test.</p> <p>Students began the unit by being introduced to a case study that pertained to heredity and how it pertains to skin color. They were presented with a "story". They asked each other questions, argued amongst their groups, and had a vested interest in how the case study ended. Students completed small assignments as the case unfolded and submitted their answers post class discussion. At the end of the case study (unit), students completed a Flipgrid, using the video platform as a think-aloud while answering prompts regarding the case study and what they learned. I completed a teacher journal during and after each day's lesson to record observations and findings.</p>
<p>Questions: Questions you have about what will happen. What do you want to learn?</p> <p>Will students be more interested with the concept of evolution if a case study is used rather than a lecture/notetaking pedagogical method?</p> <p>Will refinements such as shortening the case study, using popcorn reading, and pre-defining novel vocabulary increase students' interest in honors biology?</p>	<p>Predictions: Make a prediction for each question. Not optional.</p> <p>Students will be more interested with the material since they are able to make a personal connection rather than use rote memorization and no interest in the topic.</p> <p>Students will remain on task and better understand the content matter than in Cycle 1 with the minor refinements.</p>
<p>Data: Data you'll collect to test predictions.</p> <p>Student Flipgrid (think-aloud) responses</p> <p>Teacher journaling</p>	<p>What were your results? Comment on your predictions in the box below. Were they correct? Record any data summaries as well.</p> <p>Prediction was correct. Students were very interested with the material and that could be directly observed by me. Flipgrid responses showed a high interest toward using case studies over lecture/note taking. Students were able to stay on task, complete all assignments successfully and stated an overwhelming approval for the use of the refined case studies for difficult topics.</p> <p>Prediction was correct. Results were better than expected. Through journaling, I discovered ways in which I could improve case studies and implemented the theory of improvement. I learned that the amount of student interaction drastically improved through the use of case studies and even more so during Cycle 2. Students were able to retain information much better than with note taking and the students seemed interested in the subject matter. This was demonstrated through their questioning and critical thinking amongst themselves.</p>

<p>4) ACT Describe modifications and/or decisions for the next cycle; what</p> <p>For Cycle 3, it would be beneficial to <i>design</i> a case study independently for my students. Knowing each individual learning style is a benefit to creating a successful case study. I will also be able to take control of the wording of the content matter as well as have more direction in how the students should go about being introduced to the topic.</p>	<p>3) STUDY What did you learn?</p> <p>Students had a much higher interest in the subject matter through the use of the refined case studies when compared to topics where notes and lecture were used. I was surprised at the amount of interaction between their peers as well as the curiosity that they demonstrated through the use of deeper thinking questioning. Students wanted to know more. They left with a better understanding of antibiotic resistance and how evolution played a role. Through this second cycle, I discovered that the shortened college-level case studies do a better job of keeping students interested and focused; however, as a whole, case studies were favored amongst the students over lecture and note taking. Lastly, I discovered that the students were able to retain the information much easier through the use of case studies since it made it more relatable to real life which in turn increases interest and makes them want to learn more.</p>
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Appendix F Educator Reflective Journal

1. What did you do today?
 - a. How did the lesson for today begin?
 - b. How did the lesson for today end?
 - c. What did you learn?
 - d. What would you change?
 - e. What factors had a role in your teaching today?
2. What are some things you observed during the data collection?
 - a. Were students engaged more/or less?
 - i. Did the students ask questions?
 - ii. Did the students respond to my questions?
 - iii. Were the students able to relate to the lesson?
 - iv. Was the students' behavior different from during other class periods?
 - b. What were students' overall reactions?
 - c. What were some things you heard students saying to each other during informal conversation?
 - d. Were students more or less likely to complete the assignments associated with the case study?

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