Teaching Physics while Female: A Phenomenological Study of Female High School Physics Teachers

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TEACHING PHYSICS WHILE FEMALE: A PHENOMENOLOGICAL STUDY OF FEMALE HIGH SCHOOL PHYSICS TEACHERS

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education

by

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I HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER MY SUPERVISION
BY Hope Strickland ENTITLED Teaching Physics While Female: A Phenomenological Study of Female
High School Physics Teachers BE ACCEPTED IN PARTIAL FULFILLMENT OF THE
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The lived experiences of female high school physics teachers were researched in this study with the aim of gaining a better understanding of their decisions to remain in the classroom or to leave the teaching profession. To allow the participants to describe their background and teaching experiences, as well as the meaning they found in them, a transcendental phenomenological approach was used during this research. To create a richer representation of the phenomenon, fourteen women ranging from 0-31 years of experience teaching high school physics were interviewed for this study. The data from the interviews was analyzed through the lens of Vroom’s (1964) Expectancy Theory and Hazari et al.’s (2010) Physics Identity model, which formed the theoretical framework for this research. An iterative analysis of the data resulted in the three major themes of self-efficacy, values, and support. Self-efficacy, the most significant theme, was a result of the confidence the women earned from overcoming obstacles and conquering their initial feelings of inadequacy. Values, the second most significant theme, was characterized by the value women placed on relationships with their students. Other values important to the participants included their students’ growth as well as maintaining a work-life balance for themselves. Support, the third most significant theme, centered on support from mentors during high school, college, and student teaching. Also important was the support
provided by colleagues and school organizations. Implications of this study include informing female high school physics teachers about the necessity of maintaining a growth mindset, honoring their personal values, and supporting each other. Implications for high school leaders include the importance of implementing practices such as providing common planning periods, establishing mentorship programs, and thoughtfully considering the schedules and responsibilities of first year teachers. Implications for school district leaders include the value of creating content specific professional learning communities (PLCs) for physics teachers and providing them with meaningful professional development opportunities. Importantly, this research also provided the women in the study the opportunity to tell the story of their lives in their own words and to reflect upon the meaning they found in their work.
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Chapter 1: Introduction

Many industrialized countries including the United States struggle to recruit and retain qualified teachers, especially in hard-to-staff subject areas such as science and math (Aragon, 2016). Because high school physics has a particular importance in predicting the postsecondary success of students who major in science, technology, engineering, and mathematics (STEM), it is imperative to recruit and retain qualified high school physics teachers (Krakehl et al., 2020). Recruiting and retaining female high school physics teachers specifically is of the utmost importance since a lack of female role models may be one reason for the gender differences found in high school physics students’ academic performance (Lawton et al., 2021).

This research study used a qualitative research approach to conduct a phenomenological study of female high school physics teachers to gain a better understanding of their lived experiences. The findings of the research were then analyzed to discover factors that may influence the women’s decision to remain in the classroom or to leave the profession. The findings also helped provide a voice for the women who have experienced the phenomenon of teaching physics while female.

Statement of the Problem

The importance of an accessible and quality Science, Technology, Engineering, and Mathematics (STEM) education has been a recurring theme for decades in the United States (Farfan, 2020). With alarm bell events such as Sputnik in the 1950s, the Nation at Risk report in the 1980s, and competition in the global market economy of the 2000s, the American education system has long been tasked with improving its students’
performance in STEM fields (Tytler, 2020). A particularly troubling component of the STEM crisis is the underrepresentation of women in STEM careers (Waite & McDonald, 2019). Despite decades of research on the problem of STEM gender disparity, many industrialized countries such as the U.S. show little growth in the equitable representation of women in STEM (Smith, 2011).

The issue of gender disparity in STEM has been found to be even more significant in STEM fields such as physics (Wulf et al., 2018). For example, in 2017, 60% of the bachelor’s degrees in biology were earned by women, but only about 20% of the bachelor’s degrees physics were earned by women as shown in Figure 1 (National Science Foundation, 2017).

**Figure 1**

*Number of Bachelor's Degrees Earned in Physics, Classes 1982-2017*

![Graph showing number of bachelor's degrees in physics from 1982 to 2017.](image)

*Note.* Although the number of earned physics bachelor’s degrees has increased significantly over the past 35 years, from approximately 4,500 to 8,500; the number of
bachelors’ degrees earned by women has increased by a much smaller amount, from approximately 500 to 1,800 (Portie & Ivie, 2019).

An example of this disparity can also be found in higher education careers, where only 8% of full professors are women (Ivie et al, 2013) and approximately 20% of doctorate degrees in physics are earned by women as shown in Figure 2.

**Figure 2**

*Percent of Physics Bachelor's and PhDs Earned by Women, Classes of 1977-2017.*

*Note.* Although the percentage of physics bachelors and PhDs earned by women has increased over the past 35 years, they both hover at around 20% (Portie & Ivie, 2019).

Although historically educators have sought to create more gender equity in physics by changing young women’s attitudes towards physics as a field of study (Ziegler, 2013), results of research conducted during the last two decades document that social factors may have a more significant effect on the development of young women’s
physics identity (Wulf et al., 2018). In the process of developing a physics identity, a student comes to see herself as a physics person and feels seen by others as a physics person (Kane, 2012). A stronger physics identity has been associated with better academic performance in physics, which then in turn further strengthens a student’s physics identity (Seyranian et al., 2018).

Gender stereotypes in physics are particularly problematic for young women (Leslie et al., 2015) because they limit what female students believe they can achieve and may also limit their interest in what they consider a male centric field (Diekman et al., 2013). For example, stereotypes about women’s competence in certain fields such as physics can impair girls’ academic performance in that field (Good & Harder, 2008). Gender stereotypes may also increase the sense of isolation young women can feel in the physics classroom and can create a feeling of disconnect in young women by highlighting the overrepresentation of young men in the classroom (Wulf et al., 2018).

The presence of a female instructor in the classroom may help to buffer some of the negative experiences of being a female in a male-dominated field such as physics. Findings from researchers such as Seyranian et al. (2018) showed that women enrolled in a physics course with a female instructor showed positive gains in performance and persistence at the end of the term. In studies such as the one conducted by Dasgupta and Asgari (2004), young women who took math and science courses with female professors were more likely to report more interest and a greater anticipation of success in STEM fields.

A young woman’s high school experience has been shown to be a predictor of her decision to pursue a degree in a STEM field such as physics in college (Hazari, et al.,
2017). This factor, coupled with the role model effect that female teachers can have on young women, highlights the important influence that a female high school physics teacher can have on a young woman’s future in STEM. Yet there is a dearth of research focused on recruiting and retaining female high school physics in the United States (Hazari et al., 2007).

Recruitment programs aimed at preparing qualified candidates for high school teaching such as the Physics Teacher Education Coalition (PhysTEC) have been found to be successful (Scherr et al., 2014), but their efforts have not delineated between male and female candidates (Physics Teachers Education Coalition). The problem of retaining high school physics teachers has not been the subject of in-depth research, and no evidence of research focusing on retaining female high school physics teachers specifically was found in a thorough review of research literature.

The review of the research literature about the retention of female high school physics teachers was completed using the Wright State library data bases Academic Search Complete, Academic Search Premiere, Applied Science & Technology, Education Research Complete, ERIC, Science Reference Center, and Women Studies International. The search engine Google Scholar was also used to locate research articles. The search terms “retention”, “female physics teachers”, and “women physics teachers” were used for Wright State data bases as well as Google Scholar. After multiple searches using different combinations of the key terms, no research was found concerning the retention of female high school physics teachers.

The lack of research in the retention of female high school physics teachers is surprising since maintaining qualified and effective teachers in the classroom has been
found to be a key factor in the successful science education of high school students (Ronfeldt, 2012) and the major contributor to the shortfall of qualified science teachers in high schools (Ingersoll, 2003; Ingersoll & Perda, 2010).

**Rationale**

The rationale for this study was to fill the gap of research about why female high school physics teachers decide to remain in the classroom or to leave the profession. A phenomenological research approach was employed to capture the experiences of women who teach or have taught high school physics and provide them with the voice they may have been denied in the past. The findings of this proposed research will be useful to researchers and practitioners to inform their practices in the retention of female high school physics teachers through school and district wide interventions.

**Research Questions**

The research for this dissertation focused on describing the phenomenon of being a female high school physics teacher. Of important concern was identifying the rationale for their career status decisions to leave the profession or remain in the classroom. To develop a comprehensive phenomenological study of the experiences of female high school physics teachers, the central question researched was: What is the experience of teaching high school physics like for women?

To fully answer the central research question, the following specific research questions were answered in this study:

1. What are the lived experiences of female HS physics teachers who decided to leave the classroom?
2. What are the lived experiences of female HS physics teachers who remain in the classroom?

3. What organizational practices seem to support the retention of qualified HS female physics teachers?

**Significance of the Study**

The research for this dissertation consisted of a phenomenological study conducted to describe the experiences of female high school physics teachers to reveal factors affecting their career decisions. It is significant because women who are engaged in the important work of teaching high school physics have a wealth of experiences and a unique perspective that have seemingly not been voiced in the past. There is little evidence that female high school physics teachers have ever been asked directly to tell their story of why they chose their profession, what they experience in the classroom, and importantly, why they stay there or choose to leave. By allowing women to freely share their thoughts, feelings, and opinions, their voice will be heard and acknowledged. The knowledge gained from this research will also be of value in helping to address the issue of gender inequality in the high school physics classroom.

**Local Context**

The participants in this study were either former or current high school physics teachers in public schools in the Midwest and Middle South regions of the United States. These regions were chosen due to the researcher’s connections to schools and teachers in her home state of Ohio and her current residence in Tennessee. To create a rich description of the phenomenology of teaching high school physics as a woman,
participants from a wide variety of ages and years of teaching experience were included in the study. These years of teaching experience fell into the three basic categories of 1) new teachers with less than five years of experience, 2) mid-career teachers with five to 15 years teaching experience, and 3) veteran teachers with over 20 years of experience.

The participants’ range of ages and experiences created an additional context to the proposed research aside from their gender. As some feminist scholars have noted, age has been a neglected concept in social analysis, which makes the use of terms such as female inadequate in understanding of the complexity of women’s lives and work (Rousmaniere, 2021). The everchanging social, political, and educational environment guarantees that the experiences of teaching high school physics may be very different for a 25-year-old woman than they are for a 65-year-old.

**Conceptual Framework**

The conceptual framework for the study was based on factors that influence female high school physics teachers’ career decisions and therefore determine their career status of either actively teaching, retired, or having left the profession. Specifically, the conceptual framework represents how the relationship between a female high school physics teachers’ physics identity, lived experiences, and the organizational factors of their school affect their career status.

**Physics Identity**

Physics Identity, or the view of oneself as a “physics person”, is determined by the following four factors: recognition by others as a physics person, performance on physics focused activities, interest in the subject, and competence in understanding the
major concepts of physics (Hazari et al., 2010). Physics Identity has been associated with various positive outcomes such as increased academic performance in physics (Seyranian et al., 2018) and a greater willingness for high school students to continue their study of physics in college (Hazari et al., 2010). Physics Identity has also been shown to positively influence the likelihood of entering a science occupation (Stets et al., 2016). For these reasons, a female high school physics teacher’s Physics Identity is a factor in her decision to become a physics teacher and may continue to be a factor in her decision to remain one.

Lived Experiences

Lived experiences refer to the backgrounds of the participants in the study and include factors such as age, race, education, gender identity, years of teaching experience, marital status, and job placement. Because older teachers have been found to be less likely to quit the profession than their less experienced colleagues (Chambers Mack et al., 2019), the lived experience of age may influence career status. Other lived experiences such as marriage have also been shown to have a positive effect on job satisfaction and commitment (Dinc & Kocyigit, 2017). Teachers’ perceptions of their career developed during their life experiences before teaching may also influence their longevity in the classroom (Coper & Davey, 2011).

Organizational Factors

Organizational factors are characteristics of school organizations such as administrative support, teacher cooperation, the effectiveness of principals, and principal-teacher race/gender congruency (Nguyen, 2021). Some of the organizational factors that
may also influence teachers’ job satisfaction include increasing testing and accountability pressures, lack of administrative support, lack of opportunities for advancement, and dissatisfactions with working conditions (Carver-Thomas & Darling-Hammond, 2017). Fresko, Kfir, and Nassar (1997) determined that among teachers, the only direct prediction of their job commitment was job satisfaction. Therefore, organizational factors that affect teachers’ job satisfaction may also influence their career status.

Because a teacher’s Physics Identity, lived experiences, and the organizational factors of their school all influence teachers’ career decisions; they also contribute to their career status. The following figure represents the relationship of these three components:

**Figure 3**

*Conceptual Framework for Research of Female High School Physics Teachers*
Limitations of the Study

Limitations of the study included the composition of the participant sample. Many of the participants shared similar ethnicities and backgrounds, which yielded a more limited viewpoint of the phenomena. Importantly, only one of the participants made the decision to leave the teaching profession, while the other participants remained in the classroom. More diversity among the participants in the sample would have resulted in richer research results.

Background and Role of Researcher

I am a former high school physics teacher with 22 years of experience in the classroom and eight years of experience as a high school administrator. The purpose of this study is of particular interest to me as I considered leaving the classroom for many reasons over the years. The personal struggles that caused me to contemplate quitting included feelings of inadequacy as a physics content expert as well as the mistreatment, disrespect, and microaggressions I experienced from my male colleagues.

These experiences have contributed to the evolution of my worldview from an initially post positivistic paradigm into a feminist perspective. Feminist researchers see gender as a basic organizing principle that shapes the conditions of their lives (Creswell & Poth, 2008). Since this research is focused on the phenomenology of being a female high school physics teacher, a feminist lens is particularly appropriate. A feminist research perspective also focuses on identifying and valuing women’s subjective experience (Marshall, 1997a), which is the goal of this phenomenological study.
Definition of Relevant Terms

- **Female:** having a gender identity that is the opposite of male (Merriam-Webster Dictionary, n.d.).

- **Woman:** an adult who lives and identifies as female (Cambridge Dictionary, n.d.).

- **Organizational factors:** characteristics of school organizations such as administrative support, teacher cooperation, the effectiveness of principals, and principal-teacher race/gender congruency (Nguyen, 2021).

- **Physics identity:** the view of oneself as a “physics person”. Physics identity is determined by recognition, performance, interest, and competence (Hazari et al., 2010).

- **Career status:** a teacher’s current professional condition. Examples of career status include pre-service, currently teaching, leaving the profession, or retired (Richardson & Watt, 2014).

- **Expectancy theory:** a cognitive psychology theory based on the notion that individuals expect certain outcomes as a result of their actions and place specific value on those outcomes (Vroom, 1964).

- **Stereotype threat:** occurs when individuals feel at risk of confirming a negative stereotype about their social group (Steele & Aronson, 1995).

- **Imposter syndrome:** phenomenon occurring among high achievers who are unable to internalize and accept their success (Clance & Imes, 1978).

- **Gender matching:** occurs when a teacher’s gender is aligned to his or her students (Chen et al., 2020).
Organization of the Study

A thorough review of relevant research literature was conducted with the aim of exploring possible answers to the research questions. Gaps in the existing research were then identified and used to inform the theoretical framework and methodology of the study. Foundational to the research methodology were open ended interviews of current and former female high school physics teachers. The interview questions were based on Seidman’s (2019) method of phenomenological inquiry and focused on the participants’ background, current experiences, and the meaning they found in both. The results of the interviews were then analyzed to reveal factors affecting the teachers’ career decisions.
Chapter 2: Literature Review

For several decades there has been a growing concern that the United States does not produce enough STEM majors to remain globally competitive (Sass, 2015). Of additional concern is the gender disparity found in STEM fields; particularly in physics, where despite decades of slowly increasing participation, women still receive only 20% of the bachelor’s degrees awarded (Hodapp & Hazari, 2015). Unfortunately, this disparity has not decreased in recent years although STEM fields such as biology, chemistry, and mathematics have shown significant improvements (Blue et al., 2019).

Because girls most often make their college and career decisions during high school, it is an ideal time to foster their interest and confidence in physics (Hazari et al., 2017). It is also a time when a lack of female physics role models may negatively influence girls’ decision to pursue physics at the college level (Lawton et al., 2021). For these reasons, female high school physics teachers may be in the unique position of serving as role models for girls while they are in the process of deciding if physics is a viable option for their future.

The research literature reviewed in this chapter focused not only on the gender disparity found in physics and the impact of high school in girls’ college and career decisions, but also on the issues female physics teachers may experience in their roles. It also outlined the theoretical framework that may provide insight into the reasons that women decide to become high school physics teachers and whether they remain in the classroom or leave the profession. Lastly, a review was conducted of research focused on efforts to recruit and retain female high school physics teachers.
Theoretical Framework

Discovering the motivations behind why women choose to teach high school and remain in the classroom is fundamental to this proposed research. The theoretical framework used to shed light on these motivations is based on Vroom’s (1964) Expectancy Theory as well as Tajfell’s (1978) Social Identity Theory as ultimately adapted by Hazari et al.’s (2010) theory of Physics Identity. This theoretical framework provides insight into both why women choose teaching high school physics as a career as well as why they persist in the profession.

Expectancy Theory

Vroom’s (1964) Expectancy Theory of Motivation, or simply Expectancy Theory, is based on the premise that individuals make decisions based on their expectation of the best outcome according to their personal values. It is proposed in this study that female high school physics teachers make career decisions according to how closely their professional outcomes align to their expectations. If the experience of teaching high school lines up with the women’s expectations, they will remain in the profession; but if it does not, they will leave the classroom.

The first component of the Expectancy Theory as established by Vroom (1964) is expectancy, which is a belief concerning the likelihood that a particular act will be followed by a particular outcome (Natemeyer & Hersey, 2011). The second component is instrumentality, which is the thought that if an individual performs well, then a valued outcome will come to that individual (Soupir-Fremstad, 2013). The third component is valence, which is the strength of an individual’s preference for a particular outcome. Outcomes can be classified into two levels depending on their immediacy (Natemeyer &
Hersey, 2011). In an organizational setting, first level outcomes may include money, promotion, or recognition, and have no actual value by themselves (Vroom, 1964). They are only valuable when they are translated into second level outcomes such as food, clothing, shelter, entertainment, and status (Natemeyer & Hersey, 2011).

According to Vroom (1964), motivation is a product of the three components of expectancy, instrumentality, and valence as represented by the following model.

**Figure 4**

*Expectancy Theory of Motivation Model*

![Diagram](image)

*Note.* This diagram represents the relationship between expectancy, the belief that a specific outcome will occur, instrumentality, the performance necessary to bring about the outcome, and valence, the value placed on the outcome (Vroom, 1964). Expectancy Theory is based on the notion that individuals expect certain outcomes as a result of their actions and that they prefer specific outcomes according to their personal values (Natemeyer & Hersey, 2011). When applied to the context of an organization such as a school, Expectancy Theory can be used as an explanation for the motivation of employees such as teachers. Specifically, teachers will be motivated when they are confident of what they can achieve, value the outcome of their efforts, and believe their reward aligns to the promises made by the organization (Soupir-Fremstad, 2013). In this
proposed research, increased motivation will be characterized by a female high school physics teacher’s decision to remain in the classroom.

**Identity Theories**

Social Identity Theory (Tajfel, 1978; Tajfel & Turner, 1979) is based on the premise that individuals define their own identities according to social groups, and that these identifications work to protect and bolster self-identity. Gee (2000) expanded on Tajfel’s (1978) Social Identity Theory by defining identity in terms of being recognized as a certain “kind of person”. Carlone and Johnson (2007) incorporated Social Identity Theory into the development of their model of Science Identity, which represents the extent to which individuals identify themselves as a science person.

Carlone and Johnson’s (2007) model of Science Identity is based on three overlapping dimensions of competence, performance, and recognition. A fourth dimension, interest, was added by Hazari et al. (2010) during the development of their model for Physics Identity. This dissertation research proposes that female high school physics teachers’ career decisions are influenced by their Physics Identity. The stronger a woman’s Physics identity is, the more likely she will choose teaching high school physics as a career, and the more likely she will be to remain in the classroom.

**Science Identity.**

Carlone and Johnson (2007) recognized the socially constructed nature of identity when they developed their model of Science Identity which accounts for how women make meaning of science experiences as well as how society affects those meanings. Carlone and Johnson’s model of Science Identity, which can be used to represent how
strongly an individual identifies with being a science person, is constructed of the three interrelated dimensions of competence, performance, and recognition; and according to the following figure:

**Figure 5**

*Science Identity Model*

*Note.* This model of Science Identity was developed by Carlone & Johnson (2007) and represents the relationship between performance, recognition, and competence in science in determining science identity. The performance component is based on social performance of relevant scientific practices such as ways of speaking and using tools. The recognition component is determined by how much an individual recognizes oneself or is recognized by others as a science person. The competence component is based on knowledge and understanding of science content. Science Identity is also influenced by the racial, ethnic, and gender identities of the individual.
As with other identities, Science Identity arises out of the constraints and resources available in an individual’s immediate environment. For example, the participants in Carlone and Johnson’s (2007) research reported that their Science Identity was shaped by experiences such as “weed out” classes (freshman science) where only the most successful students excelled and therefore became known as “science people”. As aspiring scientists, the participants reported relying on the judgement and invitation of practicing scientists throughout every phase of the educational and career journey (Carlone & Johnson, 2007). As a result, the participants, who were women of color with either undergraduate or graduate degrees in science, were not free to develop their own Science Identity. Instead, it was shaped by larger and more pervasive definitions of “science people” derived from historical and social legacies (Carlone & Johnson, 2007).

The recognition component of Science Identity was shown to be the most significant factor in the science pathways of the women participating in Carlone and Johnson’s (2007) study. Recognition, as it pertains to science identity, is partially determined by the external validation of others. In fact, the women in the study were only able to develop their science identity when they were recognized by people whose acceptance mattered to them as a science person. Conversely, they reported interruptions in their science careers when others failed to recognize them as promising or legitimate science students (Carlone & Johnson, 2007). The importance of recognition by others for women who are developing a Science Identity was also reflected in the work of Lewis (2003) who proposed that the development of a science career is a social process where aspiring female scientists rely on the judgment and acceptance of practicing scientists throughout every phase of their educational and professional journey.
Physics Identity.

Hazari et al. (2010) added the component of interest when they adapted Carlone and Johnson’s (2007) Science Identity model into their model of Physics Identity. Their revised model, as shown in Figure 6 below, includes four components instead of the three proposed by Carlone and Johnson (2007). The four components of Hazari et al.’s (2010) model of physics identity include recognition, competence, performance, and interest. The component of interest was not included in Carlone and Johnson’s (2007) model of Science Identity.

Figure 6

Physics Identity Model

Note. Hazari’s (2010) model of Physics Identity includes the four components of recognition, performance, competence, and interest. The recognition component is determined through recognition by others as being a “physics person”. The performance
component refers to an individual’s belief in his/her ability to perform required physics tasks. The competence component is determined by one’s belief in his/her ability to understand physics. The interest component is based on a desire or curiosity to think about and understand physics.

Hazariet et al.’s (2010) model of Physics Identity expanded the focus of Carlone and Johnson’s (2007) science identity research to include concepts of self-recognition. Instead of relying on purely external validations, their Physics Identity model includes internal conceptualizations of who a person perceives her/himself to be (Potvin & Hazari, 2013).

In their initial study of 3,694 first year college students in 34 randomly selected colleges and universities, Hazari et al. (2007) found that Physics Identity was much higher for males than females. This finding may help explain the underrepresentation of women in physics since a higher science identity has been shown to positively influence the likelihood of entering a science occupation (Stets et al., 2016). Further research of college students revealed that students who were interested in helping people and working with others in their future occupations tended to have much lower physics identities (Monsalve et al., 2016). Since women have reported a greater preference for helping others (Wegemer & Eccles, 2019), this may help explain the discrepancy between the physics identity of male and female college students (Monsalve et al., 2016).

A larger scale study of freshman college students showed that males had much higher self-perceptions than females in the performance and competence dimensions of Physics Identity and reported more recognition and interest than females (Lock et al., 2013). Of the four components of physics identity, recognition and interest were shown
to be the strongest predictors of choosing a career in physics; and recognition seemed to be more important for women than men (Lock et al., 2013).

Since a higher physics identity has been associated with various positive outcomes such as increased academic performance in physics (Seyranian et al., 2018) and a greater willingness for high school students to continue their study of physics in college (Hazari et al., 2010), it is important for young women to receive adequate recognition from their high school instructors. Bottomley et al. (2021) found that women completing undergraduate degrees in physics reported receiving less recognition as a physics student from their college instructors, families, and friends compared to men (Bottomley et al., 2021). The gender disparity in perceived recognition reported by female college students is important as it may be contributing to women’s under-representation in physics (Bottomley et al., 2021)

**Gender Disparity in Physics**

Gender disparity continues to be an issue in the field of physics. Despite decades of slowly increasing enrollment, women still receive only about 20% of the physics bachelor’s degrees in the United States (Hodapp & Hazari, 2015). The gender disparity found in undergraduate physics degree completion is in stark contrast to the fact that women are approaching equality with men in fields such as business and law (Diekman et al., 2010). Among the STEM fields, physics continues to reflect the lowest representation by women. For example, in 2017, women earn nearly 60% of undergraduate degrees in the biological sciences, but only about 20% in engineering, computer science, and physics (National Science Foundation, 2017).
As shown in Figure 7 below, a longitudinal study conducted of women earning bachelor’s degrees in STEM fields from 1984 to 2016 provided more detail in the gender disparity found in physics compared to other STEM disciplines. The study revealed that the percentage of women graduating with degrees in biological science grew from 47% to 60% over three decades, and the percentage of women earning a degree in chemistry grew from 35% to 47%. A slight decline in the percentage of women earning mathematics degrees was indicated by drop from 45% to 43% over that time. A much larger decline was shown in computer science, where the percentage fell from 37% to 18%. Although slowly improving, the percentage of women earning undergraduate degrees in fields of engineering and physics continued to represent the greatest gender disparity. The percentage of women graduating with bachelor’s degrees in engineering increased from 15% to 21%, showing a growth of 6%. The gender disparity in physics continued to be the most pronounced, with the percentage of women earning bachelor’s degrees in physics increasing from 15% to 18%, a growth of only 3% over the 32 years that the data was collected (National Center for Educational Statistics, 2016).
Figure 7

Percent of Women Earning Bachelor's Degrees in STEM Fields, 1981-2016

Note. This graph represents the percentage of bachelor’s degrees earned by women in a variety of STEM fields. Except for engineering, the percentage of bachelor’s degrees in physics earned by women was consistently lower than all other STEM fields (National Center for Educational Statistics, 2016).

The root cause of the gender disparity in physics is complex and can include factors such as isolation, a ‘chilly’ classroom climate, stereotype threat, self-efficacy, and
imposter syndrome (Doucette & Singh, 2020). Women can experience the challenge of isolation if most of the members of their cohort, lab, or department are male, which may lead to being excluded from informal forms of support such as study groups (Rosa & Mensa, 2016). The isolation women may feel in their physics laboratories and classrooms may also contribute to the ‘chilly climate’ women encounter in many university physics departments (Dresselhaus et al., 1995). A ‘chilly climate’ includes such phenomena as lack of encouragement, diminishing remarks on a person’s academic performance, inappropriately drawing attention to a person’s gender or sexuality, and even sexual harassment (Rolin, 2008).

Stereotype threat is a phenomenon that occurs when a stereotype about an individual’s social, racial, or gender group can provide a potential explanation for poor performance (Smith, 2004, Steele, 1997; Steele & Aronson, 1995). The root cause of stereotype threat is an individual’s fear of confirming negative stereotypes about themselves (Doucette & Singh, 2020). Therefore, when an individual is in a situation where a negative stereotype exists about his or her group, the concern of conforming to the stereotype interferes with the individual’s performance (Keller & Dauenheimer, 2003; Smith, 2004). As a result, members of negatively stereotyped groups, such as female physics students, can find themselves reinforcing the very stereotype they are threatened by. This is supported by stereotype threat research which illustrated that individuals who are targets of a negative performance related stereotype tend to perform in a stereotype-consistent manner (Keller, 2002). For example, in a study of high school students in an introductory physics course, male students performed better than females when solving
physics problems that had been identified as being more difficult to solve for females than males (Marchand & Taasoobshirazi, 2013).

Self-efficacy is a person’s belief that they can succeed in a particular activity or course (Bandura, 1977). Physics self-efficacy, the belief that an individual can succeed in physics, has been shown to impact students’ engagement, learning, and achievement in physics courses (Sawtelle et al., 2012; Cavallo et al., 2004). Unfortunately, societal stereotypes and biases internalized by female students over their lifetime can impact their self-efficacy when they take a physics course (Cwik & Singh, 2021). In research conducted with 10,000 undergraduate students, Kost-Smith (2011) found that women entered introductory college physics courses with a lower physics self-efficacy than men, and that this difference increased by the end of the course. In similar studies, female students reported a 52% greater decrease in physics self-efficacy than male students at the end of an algebra-based introductory physics course (Cwik & Singh, 2021) and a 70% greater decrease than males in a calculus-based course (Nissen & Shemwell, 2016).

The term imposter syndrome was created by Clance and Imes in 1978 to describe highly successful women who have difficulty recognizing their own achievements and feel as though they were imposters in their careers. It is characterized by the belief that one’s accomplishments are not the result of genuine ability, but from luck, hard work, or charisma (Langford & Clance, 1993). In a long-range survey of female physics graduate students conducted by the American Institute of Physics, women who scored higher on an indicator of imposter syndrome also reported a greater likelihood to consider leaving the field of physics (Ivie et al., 2016).
Prior research has also shown that boys have an advantage in physics experiences outside of school which can account for perceptions of higher competence as well as higher performance in physics (Hazari et al., 2008). For example, boys have more exposure and experience with toys and objects that align with the traditional physics curriculum than girls do (Lubinski & Benbow, 2006). Girls have been found to lose interest in physics at early ages (Baker & Leary, 2003; Jones et al., 2000). Some of the disengagement is accounted for by early childhood play (Wulf et al., 2018). Specifically, a lack of real-world connections and personally relevant content have been found to result in young women disliking physics (Hazari et al., 2010).

Another factor that may contribute to the lack of women in physics is a misalignment between women’s personal values and the characteristics usually associated with the study of physics. For example, the construction of physics as a masculine field (Gonsalves, 2014) has been shown to impede many young women’s identification with physics by challenging their construction of femininity (Archer et al., 2017). Research has established that physics continues to be constructed as masculine, which deters girls from pursuing the subject as a college major or career (Francis, et al., 2017). This concept reflects a more modern paradigm which has shifted away from focusing on individual ability differences as a cause of gender discrepancies in STEM and towards social cognitive factors such as self-efficacy, social identity, and expected outcomes (Fouad & Santana, 2017). This shift has taken place in large part due to the discovery that there is no fundamental disparity in STEM achievement between boys and girls (U.S. Department of Education, 2012).
Another social cognitive paradigm that can be used to explain the gender disparity in physics is role congruity theory. According to role congruity theory, individuals select specific roles, such as occupational or family roles, that fulfill important values or goals (Diekman & Eagly, 2008). For example, women are more likely than men to have communal goals that are defined by collaboration with others or helping others (Diekman et al., 2011) and a meta-analysis of job attribute preferences showed that the largest gender difference is due to women’s greater preference for helping other people (Wegemer & Eccles, 2019). Similarly, altruistic occupational values are also more strongly associated with females than males (Weisgram et al., 2010) and girls who perceive science to be consistent with altruism tend to show interest in scientific careers (Weisgram & Bigler, 2006). Conversely, the field of physics can be perceived as affording fewer opportunities for young women to achieve communal goals such as altruism (Diekman et al., 2010; Diekman et al., 2011) which may lead them to rule it out as a career option (Diekman et al, 2010). Eccles and Wang (2016) found that perceived occupational altruism not only accounted for some of the gender difference in STEM careers, but it was also a more significant predictor of STEM choices than other factors such as self-concept of math ability, math achievement, and number of math course taken.

Perceived occupational altruism may help explain the reason why more women choose STEM fields other than physics. For example, the greater the value women place on occupations they perceive as helping others, the greater their preference for health-related careers, even controlling for their expectations of success in science (Eccles, 2007). Not surprisingly, the science related fields with the greatest influx of women are
health, biology, and medical sciences (HBMS) (Snyder et al., 2009), which are often perceived to be more aligned with the pursuit of communal goals than math physics, engineering, and computer science (MPECS) (Diekman et al., 2015). Findings from a study conducted by Wegemer and Eccles (2019) revealed that females were many times more likely to choose and HBMS field over MPECS due to their occupational altruistic values.

**Impact of High School on Girls’ Interest in Physics**

Unlike college, there is little gender disparity in the composition of students enrolled in high school physics (Hodapp & Hazari, 2015). As of 2019, approximately 50% of high school physics students are female and this percentage has remained relatively stable for the past two decades (Porter & Ivie, 2019). Because each educational transition can create a loss of interest in STEM careers for girls (National Academy of Science et al., 2007), the best opportunity to decrease gender disparity in physics at the university level occurs during a young woman’s high school experience (Hodapp & Hazari, 2015).

High school is usually the last place where women participate in physics at equal numbers and, importantly, the first time when they are making serious decisions about their future. It is the first time that physics is clearly delineated as a subject with a dedicated course and may offer the first opportunity for students to explore physics at a deeper level with a teacher who can provide support. The temporal equity found in high school physics classes, coupled with looming college and career decisions, creates a unique environment for young women to consider studying physics at the university level.
The importance of high school is reflected in data showing that most students who pursue STEM careers make that choice during their high school years (Schneeweis & Zweimuller, 2012). More specifically, in international studies, most female physicists reported that they became attracted to physics and decided to study it further in high school (Ivie & Guo, 2006; Lock, et al., 2013). In a study conducted by Hodapp & Hazari (2015), most college undergraduate physics students reported becoming interested in physics careers in high school and not earlier. Their research revealed that female students are attracted to physics careers during high school at rates more than double to those attracted during middle school or college (Hodapp & Hazari, 2015). In a similar study, the largest growth in an interest in physics occurred between the first year of high school and the start of college (Hazari et al., 2017). These results reflect just how formative the high school years are for attracting female students to careers in physics.

While high school is often when young women are attracted to the study of physics, it can also be the time when they grow disinterested. The underrepresentation of women found in all levels of physics often become obvious as early as high school (Lawton et al., 2021). High school experiences can also bring about a loss of confidence and science identity to young women, which may result in a decreased interest in STEM fields such as physics. This is reflected in a longitudinal study conducted in 2019 that showed the percentage of female students who believed that men were better than women in science and mathematics jumped from 15% in ninth grade to 25% in 11th grade (Sansone, 2019). Although these findings were not disaggregated according to specific STEM disciplines such as physics, they did reveal the decrease in overall STEM self-efficacy that girls can experience during their high school years.
Young women may become disinterested in physics during high school for several reasons. The historical dominance of males in physics translates into educational practices by defining what physics content and methods are considered suitable for studying in high school physics. Not all of these content domains (e.g., topics such as mechanics and electromagnetism) and instructional strategies (e.g., type and format of problems, labs, contexts) may be conducive to gender equity in terms of performance and interest (Hazari, 2007). In a formal study of high school physics students conducted by McDonnell (2005), most students decided not to pursue physics at the college level as the result of their strongly negative feelings towards their high school physics courses. Their experiences in high school physics classes were described by the students as a series of authoritarian practices which negatively impacted their view of physics as a potential field of study, both psychologically and philosophically. They reported their high school physics experiences as being an exercise in rigidity, where the laws of physics were constantly being confirmed, yet provided no opportunities for free thought (McDonnell, 2005). Interviews with female students from the study also revealed that they often felt overpowered by male students in their high school physics courses and sometime felt like an outsider in their own classroom (McDonnell, 2005).

Other foundational reasons for girls’ decisions to either choose or abandon physics as a career during high school are like those of adult women. Self-efficacy, which is an individual’s perception of their competence, is associated with girls’ achievement and engagement in science (Britner, 2008). Along with self-efficacy, growth mindset is also a predictor of girls choosing to study physics during their senior year of high school (Mackenzie, et al., 2021). Therefore, teaching practices that support the development of a
growth mindset, such as emphasizing the capacity for each student to improve relative to their existing ability in science (Yaeger & Dweck, 2020) have the potential to support girls’ continued participation in physics.

Recognition from high school physics teachers also has a significant effect on predicting women’s intent for a physics career (Hazari et al., 2017). Publicly and privately recognizing ability in female students also helps them develop a physics identity and encourages persistence. In the classroom, recognition can be as simple as calling on a female student or providing positive feedback, both of which enable her to view herself as a member of a physics community (Hodapp & Hazari, 2015). Another strategy for attracting female students to physics in high schools includes engaging their interests by embedding socially and personally relevant content and context such as how physicists work on solving social problems and allowing them the freedom to express their interests and discover emotional ties to physics (Hodapp & Hazari, 2015). During classroom discussions, female students also benefit from an explicit understanding of issues related to women’s under-representation in physics (Hodapp & Hazari, 2015).

If females are well prepared, feel confident, and perform well in introductory high school physics, they may be inclined to study physics further, thereby entering the field in larger numbers and contributing to the diversification and possible reinvention of the field (Hazari, 2007). For this reason, high school physics teachers may have the rare opportunity to impact female students’ physics career interest, even those not previously interested in pursuing science careers (Hazari et al., 2017).
Female High School Physics Teachers

Another reason for gender differences in high school physics may be a lack of female role models (Lawton et al., 2021). Although her study was conducted with middle school math students, Paredes (2014) found that the role model effect was responsible for the increased academic performance experienced by girls with female teachers. Role models are also important as young people may develop an interest in an occupation because they admire an individual with whom they see a resemblance (Lockwood, 2006). Therefore, if female students are exposed to successful women in STEM through their female teachers, they may be inspired to go into these fields (Sansone, 2017). An additional benefit for young women with female high school physics teachers is that their classroom may not resemble the system of oppression responsible for the male dominance found in physics (Pittman, 2010). Also, when young women learn from a female high school physics teacher, they may not experience the bias that the historically male practitioners of science transmit through the traditional teaching of physics (Lederman, 2003).

While matching the gender of high school physics teachers to their students may seem like a natural solution for reducing gender disparity in physics, it has yielded mixed results in practice (Chen et al., 2019). For example, one study found that the number of female faculty in high school science departments had no impact on the choice of a STEM career for either female or male students (Gilmartin, et al., 2007). In contrast, another study of 197 institutions of higher education in the United States found that the percentages of women among undergraduate science or engineering majors and degree
recipients positively correlated with the percentages of women among the faculty in these fields (Sonnert et al., 2007).

Many studies have shown a positive correlation between gender matching female students to their high school physics teachers and a resulting increased interest in physics (Dulce-Salcedo et al., 2022). One such study showed that although the proportion of female math and science teachers at a school has no impact on male students, it has a powerful effect on female students’ likelihood of declaring and graduating with a STEM degree (including physics), and the effects are largest for female students with the highest math skills. These findings suggest that a preponderance of female math and science faculty may be necessary for countering the pervasive gender stereotypes that math and science are masculine domains, especially for the female high school students who score the highest in math (Bottia et al., 2015).

Other benefits of gender matching female students with their physics teachers include an increased comfort with exploring scientific ideas (Morales et al., 2018) and a decreased sense of social identity threat (Herrmann et al., 2016). Another positive outcome of gender matching occurs when female students recognize that their teacher’s gender did not impede her career (Murphy & Taylor, 2012). For girls, a gender role model may not only exhibit the character or charisma that makes them wish to learn from, or grow up to become, but the model can also teach them how to persist as a gender minority, as well as how to counteract gender stereotypes (Chen et al., 2019). Explicit personal discussions regarding issues that women face in pursuing physics may also help female students realize that feelings of inadequacy or discomfort they might have about
physics stem from external norms and pressures rather than from their capabilities, interests, or values (Hazari et al., 2013).

However, direct evidence of any long-term effect of gender-matching is scarce. The gender matching effects on the development of science identity before students enrolled in STEM majors, an important precursor of STEM major choice, career intention, and retention, have not been fully understood (Chen et al, 2019). In fact, the correlation between racial/ethnic and gender matching of students and teachers in middle and high school and STEM major persistence is frequently negative (Sass, 2015). For example, research of undergraduate university physics students did not reveal a positive outcome from gender matching. Students who had men as their high school physics teachers had a higher physics identity compared with those who had women as their first physics teachers. In other words, male physics teachers elevated students’ physics identity, regardless of the students’ gender (Chen et al., 2019). In a similar study, the effect of having a female high school physics teacher on young women’s physics identity was tested and no significant effects were found (Hazari et al., 2013).

Furthermore, research conducted by Betz & Sekaquaptewa (2012) showed that feminine STEM role models weakened future plans to study math among girls who did not identify with STEM. These findings contradict the idea that girls connect better with feminine women. It also suggests that the participants’ reactions to their role models were not driven by perceived dissimilarity. Girls with lower STEM identity rated feminine STEM success as less attainable than gender neutral STEM success. They also rated femininity and STEM as somewhat less compatible than STEM-identified girls did, regardless of the role model, further suggesting that they see feminine women in STEM
as particularly incongruous. Rather than opening these girls’ minds to new possibilities, the feminine STEM role model seemed to close them instead. These results seem to align with the possible effect that stereotype threat can have on girl’s tendency to accept historically feminine stereotypes (Betz & Sekaquaptewa, 2012).

Although role models that defy commonly held stereotypes can inspire, people who disconfirm stereotypes do not necessarily diminish widely held stereotypes. Instead, role models that do not align with existing stereotypes can be or written off as exceptions to the rule (Richards & Hewstone, 2001) or even ostracized (Rudman & Fairchild, 2004). For example, women who excel in stereotypically masculine domains are often subtyped into a less feminine gender category (Heilman & Okimoto, 2007). In order to maintain the stereotype that women are bad at math or science, women who succeed in STEM are instead stereotyped as unfeminine. The feminine STEM role model is a well-intentioned attempt to counter these negative stereotypes but may not work as intended. Instead, feminine STEM role models may seem impossibly successful to others, including young women (Betz & Sekaquaptewa, 2012).

Role models whose success seems unattainable can make students feel threatened rather than motivated, leading to negative self-evaluation and distancing from the role model’s field of success (Lockwood & Kunda, 1997). In light of the unfeminine STEM stereotype, feminine STEM success may seem unexpected and thus unlikely. It may seem even more unexpected (and even less likely) to girls who already do not expect success in STEM. As a result, girls with a low STEM identity may feel the least motivated by feminine STEM role models (Betz & Sekaquaptewa, 2012).
Despite their best efforts, female high school teachers may continue to be on the receiving end of gender bias from a surprising source – their own students. Research into student evaluations of their high school science teachers show that female teachers are rated significantly lower than male teachers by male students in biology, chemistry, and physics; whereas female students underrate female teachers only in physics (Potvin et al., 2008). The gender bias in teacher ratings persists even when accounting for student academic performance, classroom experiences, family support, and teacher effectiveness. Because the findings show that female students rated female teachers lower only in physics, they suggest that students have a discipline-specific gender bias against physics. Such a bias may negatively impact female students and contribute to the loss of females in STEM fields (Potvin et al., 2008). This bias supports Kessels’ (2005) findings that both male and female high school students perceived peers who preferred physics as possessing more masculine and fewer feminine traits. The fact that these students have internalized gender stereotypes in their judgement of others has negative implications for their female peers when they become successful scientists (Potvin et al., 2008).

Further research of the same sample revealed that students with a stronger physics identity show a larger gender bias in favor of male teachers than those with a weaker physics identity. Because students with stronger physics identity are more likely to become members of established physics communities in the future (Potvin & Hazari, 2016) these results may help to explain how gender bias continues to exist in physics. Also, since the bias exhibited here is true for both male and female students at the end of high school or beginning of college, we cannot assume that these biases are present only amongst a cadre of senior scientists who may marginalize women (Moss-Racusin et al.,

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2012). Instead, these attitudes that generally marginalize the competency of women in physics appear to be common amongst participants at the introductory or peripheral stages of physics participation.

Furthermore, biased evaluative feedback structures may be one of the propagators of women’s lower competency beliefs in physics, a result that has been confirmed by many prior studies (Potvin & Hazari, 2016). Prior research has also indicated that female teachers are more susceptible than their male counterparts to negative emotional responses after receiving student evaluations and are more likely to internalize negative feedback as a reflection of their own abilities (Kogan, et al., 2010).

**Teachers’ Career Decisions**

Fresko, Kfir, and Nassar (1997) determined that among teachers, the only direct prediction of their job commitment was job satisfaction. Some of the most important factors that lead to teachers’ job satisfaction are support from colleagues and positive interpersonal relationships with fellow teachers and administrators (Butt et al, 2005; Van Maele & Hutte, 2012). Other factors that lead to increased job satisfaction among teachers are ethical leadership (Dinc & Kocyigit, 2017), meaningful professional development (Pederson & West, 2017), and the ability to make decisions in their classroom and school (Achinstein and Ogawa, 2011).

Conditions that may lead to teachers’ job dissatisfaction include stress from growing workloads and the increasing focus on assessments (Dacres, 2019). The stress teachers experience has only increased due to the COVID-19 pandemic (Diliberti et al., 2021). Other factors contributing to job dissatisfaction among teachers are lack of support
from school leadership (Carver-Thomas & Darling-Hammond, 2017) and student discipline issues (Mondal et al., 2011).

**Teachers who Stay**

Teachers’ decisions to remain in the classroom may be influenced by a variety of factors. Some studies suggest that satisfaction with working conditions produces a positive influence on teachers’ retention (Bozeman et al., 2013). Researchers have also concluded that the main source of job satisfaction for teachers does not originate from salary, but from interpersonal relationships that teachers experience with administrators, other teachers, and students (Butt et al, 2005; Van Maele & Hutte, 2012). Teachers’ satisfaction with school working conditions has also been shown to influence both job satisfaction and retention (Borman & Dowling, 2008; Weiss, 2002).

An important component of working conditions for teachers is the leadership of their school. Ethical leadership has been shown to be a positive influence on overall job satisfaction and commitment for teachers (Dinc & Kocyigit, 2017). Ethical leaders are defined as those who demonstrate ethical behavior, consider the wishes of others, act impartially and without prejudice, and advocate fairly the rights of employees (Zhu, May, & Avolio, 2004). Leadership practices have been found to be even more strongly tied to high school teachers’ motivation and satisfaction compared to those who teach at other levels such as college professors (Marston, 2010).

In addition to relationships with administrators, colleagues, and students, professional development opportunities are important to teacher satisfaction and commitment (Pederson & West, 2017). Unfortunately, teachers often describe professional development in school districts as short and inadequate (Kraft et al., 2018).
Professional development is particularly important to new teachers, who are more likely to struggle in the classroom. Without adequate support and guidance, they are more likely to lose commitment to the profession and leave teaching altogether (Smith & Ingersoll, 2004).

Support from colleagues is another important factor in teachers’ decision to remain in the classroom. High school teachers who reported having supportive colleagues were found to be less likely to feel emotionally exhausted and cynical, and reported higher levels of professional efficacy (Kahn et al., 2006). In research conducted of high school teachers by Newton (2017), the top reason provided for job satisfaction was the presence of strong, positive relationships with departmental colleagues. In fact, teachers that perceive the school climate to be collaborative, supportive, and positive have a lower likelihood of quitting (Billingsley, 2004).

The freedom to manage problems in school and classroom settings has been associated with higher satisfaction in teachers (Pearson & Moomaw, 2005). In fact, teachers’ satisfaction can be determined by their perceived control and support within the job (Landy & Conte, 2013). A study conducted by Hausman and Goldring (2001) found that teachers are more committed when they feel they have authority over decisions within the classroom and in the school. Achinstein and Ogawa (2011) found that teachers report a greater sense of job satisfaction when they are not made to adhere to restrictive curricula and pedagogical practices that inhibit their ability to enact the professional roles that drew them to the profession.

Other factors that contribute to teachers’ decision to remain in the classroom are less esoteric. Marriage as a demographic variable has shown to have a positive effect on
overall job satisfaction and affective commitment (Dinc & Kocyigit, 2017). In addition, teachers who are the breadwinners for their family are more inclined to continue teaching (Cooper & Davey, 2011). Teachers are also more likely to stay if they perceive their job both as relatively better paid and as offering greater job security when compared to other types of work (Coper & Davey, 2011).

**Teachers who Leave**

For teachers who decide to leave the classroom, low job satisfaction was found to be the most significant contributor to their decision (Billingsley, 2004). In recent years, levels of satisfaction have fallen amongst teachers and have been linked to profound changes in their profession (Smithers & Robinson, 2003). Some of these profound changes reported by teachers include increasing testing and accountability pressures, lack of administrative support, dissatisfactions with lack of opportunities for advancement, and dissatisfactions with working conditions (Carver-Thomas & Darling-Hammond, 2017). Student issues such as disrespectful attitudes, lack of academic progress, and discipline events can also cause teacher dissatisfaction with their school environment and lead to higher rates of attrition (Mondal et al., 2011).

Occupational stress is another factor in teacher attrition, and teachers who report feeling stressed daily or weekly are likely to also report leaving the profession (Billingsley, 2004). Teacher stress and burnout has also been attributed to minimal pay, unsatisfactory work conditions, increased emotional exhaustion, expanded workload, and lack of support from administrators (Dacres, 2019). School location also impacts stress, with teachers from schools in urban communities reporting higher stress levels than other regions (Haberman, 2007). Lack of cohesion among colleagues can lead to dissatisfaction
in the workplace environment (Billingsley, 2004) which can lead to teachers being susceptible to low morale and stress-related problems (Tatar, 2009).

The adjustments that teachers were forced to make during the COVID-19 pandemic may have also contributed to their job dissatisfaction. The levels of stress and burnout experienced by teachers increased during the pandemic (Diliberti et al., 2021), raising concerns about a potential increase in teacher turnover and future teacher shortages (Goldberg, 2021). Research conducted with 5,500 teachers across America revealed that more teachers have considered leaving the profession or retiring during the pandemic (Zamarro et al., 2022). Approaching retirement age, having to change instructional modes, and heightened concerns about job burnout appear to be important predictors of the probability of teachers considering leaving or retiring (Zamarro et al., 2022).

**New Teachers**

New teachers are particularly vulnerable to burnout and work-related stress and are more likely to abandon the profession than teachers with more experience (Chambers Mack et al., 2019). Research literature suggests that newer teachers deal with a significant amount of stress and multiple studies have shown that in America, approximately one-half of new teachers quit within their first five years of teaching and 20-30% quit within the first three years (Boe et al., 2008). It has been postulated that new teachers can become mired in an anxiety ridden survival type stage during the first three years of their careers and fail to bond to the school community, which can cause them to abandon teaching (Hampden-Thompson, et al., 2008). In a longitudinal study of high school physics teachers, years of teaching experience was found to be a predictor of
retention, with newer teachers being more likely to leave the classroom than more experienced ones (Palermo et al., 2022; Palermo, 2022).

**Alternatively Certified Teachers**

Teachers who obtain their teacher certification through an alternative pathway seem to be less likely to remain in the classroom than those who graduated from a traditional teacher education program. Research indicated that teachers with alternative certification were more than twice as likely to consider quitting the profession compared to teachers certified by traditional methods (Chambers Mack et al., 2019). For many teachers, alternative pathways to teacher certification can lead to high levels of stress. When coupled with inadequate professional development, stress often leads to ineffective performance as a teacher (Carver-Thomas & Darling-Hammond, 2017).

**Mid-Career Teachers**

Compared to younger teachers, mid-career stage teachers are less likely to decide to leave the profession (Shakrani, 2008). This may be explained by the theory that after approximately fifteen years in the classroom, teachers may enter a career disengagement stage where they lack the confidence to change occupations or are unwilling to jeopardize pension arrangements (Cooper & Davey, 2011). It is also the time when some teachers report feeling overlooked and that their career has plateaued due to their age (Cooper & Davey, 2011). As a result, they may feel stuck, trapped, and even institutionalized in their careers as teachers (Cooper & Davey, 2011).

Not all mid-career teachers are unsatisfied with their career status, however. Studies on teacher job satisfaction revealed that the following seven factors affect job satisfaction: school climate, key stakeholders, support and training, participation in
school management, student/school programs, professional development, and employment terms (Menon & Athanasoula-Reppa, 2011). When compared to newer teachers, experienced teachers report significantly higher job satisfaction in two of the identified dimensions: key stakeholders and participation in school management (Menon & Athanasoula-Reppa, 2011).

**Female Teachers**

Significant factors affecting teachers’ career status include the value driven decisions women may make to support their family, school, and colleagues. For example, the availability of flexible working practices and school holidays can make teaching a family-friendly career for women with children (Richardson & Wyatt, 2005). Additionally, research by Dinc & Kocyigit (2017) showed that female teachers’ affective commitment was positively influenced by their job satisfaction. Namely, employees with a high emotional bond to their job felt compelled to do their best because they feel a strong emotional attachment to their organization and work.

In research conducted with African American female teachers, three overarching themes were identified as reasons for remaining in the classroom: to be a positive role model, to deter negative stereotypes, and to support other teachers (Samuels et al., 2021). The same participants reported their reasons for leaving included underappreciation by administration and parents, constant doubts about their own competence, and a lack of professional learning and development (Samuels et al., 2021).

Further research into the reason why female teachers leave the classroom may be warranted since the group most likely to leave the teaching profession in the next two years comprises women between the ages of 30 and 39 (Newton, 2017). An
unmanageable workload and a sense of disillusionment were the reasons this
demographic provided for their decision to leave (Newton, 2017). Overwhelm was also a
reason women gave for their reason for considering leaving the classroom and they
reported struggling daily to keep up with expectations placed upon them such as lesson
plans, test scores, classroom management, regulation of emotions, and the appearance of
competency (Gillespie & Thompson, 2021).

COVID related stress may also contribute to female teacher attrition. The results
from a recent study of educators showed that women reported higher levels of stress and
work-life balance challenges than their male counterparts (Leo et al., 2022). Further
analysis revealed that the gender disparities in work-life balance challenges were related
to the higher stress women experienced from work and COVID-19 rather than childcare
responsibilities (Leo, 2022).

In a study by Cooper and Davey (2011), narrative accounts were collected of
female teachers who had considered leaving the profession but remained teaching at
midlife. The study’s findings show that far from being a discrete event, a decision about
occupation change was revised and revisited throughout their career span. These
decisions were constrained by a variety of embedding issues including social and family
roles, as well as work experiences. Occupational embeddedness was also perceived in
different ways, ranging from positive narratives of subsequent reconciliation to remaining
in teaching, to negative accounts associated with perceptions of being unable to leave a
demanding profession (Coper & Davey, 2011).
Female STEM Teachers

Research into career decisions of female STEM teachers revealed that there were not significant gender differences in job satisfaction (Pederson & West, 2017). There were, however, reported differences between men and women in their perspectives and experiences. The female participants reported being more certain about their choice to become a teacher and planned to stay in their positions longer. They also reported experiencing less open communication with administrators than the male STEM teachers and were less likely to report that principals commended them for a job well done. The female STEM teachers also reported less cooperation among the staff in their department and school and reported more student behavioral problems (Pederson & West, 2017).

Huang and Fraser (2009) also studied science teacher’s perceptions of the school in environment in Taiwan and found that female science teachers experienced higher levels of work pressure than men in similar positions, even controlling for teachers’ backgrounds and school characteristics. The greater work pressure reported by the female science teachers may be due to the negative impact of the job’s long hours on household duties and child rearing (Huang & Fraser, 2009).

Recruitment and Retention of High School Physics Teachers

The combination of experienced teachers leaving the classroom and new entrants not persisting through their first few years of teaching has created a dire future for the teaching profession (Newton, 2017). The crisis is even more evident in the STEM subjects, where teacher turnover must be low in order to maintain successful and effective STEM programs (Hansen, 2014). For these reasons there is an increasing
recognition of the need to understand not only what leads to teacher turnover, but also what helps keep teachers in the classroom (Ng & Feldman, 2007).

**Recruitment**

In a recent annual survey of school districts, the need for physics teachers was found to be greater than nearly any other subject area (American Association of Employment, 2020). One anecdotal reason for this shortage may be the fact that most colleges and universities with secondary education programs prepared an average of zero physics teachers over a three-year time period (Meltzer & Otero, 2014; U.S. Department of Education, 2022). Numerous remedies have been attempted to alleviate the shortage of well-trained physics teachers. They range from national to local policies and programs and include such approaches as emergency certifications and out of field assignment to fill vacancies, alternative certification programs, and tapping nontraditional candidate pools such as paraprofessionals, retired military, and career changers. Universities and school districts have also joined the efforts to address the shortage of qualified physics teachers by providing scholarships, granting student loan forgiveness, awarding signing bonuses, and establishing partnerships between school districts and teacher preparation institutions to meet staffing needs (Singh et al., 2010).

One of the most accessible potential sources of recruits is science and engineering undergraduates who have not yet completed their degree (Singh et al., 2010). Revamping the introductory physics course for undergraduates is a significant intervention that has been shown to increase students’ interest in majoring in physics (McDermott, 2006). A survey of college physics majors revealed that the students were under the impression that teachers make less money than they actually do. Correcting that impression may
provide one of the easiest ways to recruit more teachers in the difficult to fill STEM teaching positions (Marder et al., 2018).

Physics departments in some universities have also taken a lead role in creating opportunities for fostering interest in teaching. For example, the UTeach program at the University of Texas at Austin has been successful in forging a partnership with the School of Education to provide a degree in science and a teaching certification simultaneously (Singh et al., 2010). The University of Colorado at Boulder has also developed an effective and adaptable model that both improved the education of introductory physics students and increased the numbers of talented physics majors becoming certified to teach physics (Otero et al., 2010). Termed the Learning Assistant program, it provides undergraduate students opportunities as teaching assistance in college physics courses to cultivate their interest in K-12 teaching (Otero et al., 2010). An evaluation of the Colorado Learning Assistant model revealed that it has increased the pool of well-qualified K-12 physics teachers by a factor of approximately three, engaged scientists significantly in the recruiting and preparation of future teachers, and improved the introductory physics sequence so that students’ learning gains are typically double the traditional average (Otero et al., 2010).

Perhaps the largest scale efforts to recruit qualified high school physics teachers is the Physics Teacher Education Coalition (PhysTEC). With funding from the National Science Foundation, PhysTEC has offered grants, staff support, and professional development to over 60 institutions of higher education during the last 20 years (PhysTEC, 2022). PhysTEC partners with the American Association of Physics Teachers and ensures that 100% of its participants graduate with a physics-related degree. This is
in comparison with data collected by the American Physical Society showing that only 43% of new secondary physics teachers have a physics-related degree (White, 2018).

In 2013, an independent study was conducted on the sustainability of PhysTEC sites after project funding ended. The study sought to measure the extent to which programs have been sustained to identify what features should be prioritized for building sustainable physics teacher preparation programs (Scherr et al., 2017). About half of the programs were found to have increased both the number of physics teachers educated per year and funding for physics teacher preparation (Scherr et al., 2017). Aside from this evaluation of PhysTEC, systematic research on physics teacher education programs in the US has been rare (Scherr & Chasteen, 2020).

Retention
Research by Ingersoll (2001) indicated that schools’ staffing problems are not primarily due to teacher shortages in the technical sense of an insufficient supply of qualified teachers. Rather, the data indicate that schools staffing problems are primarily due to excess demand resulting from a “revolving door” where large numbers of qualified teachers depart their jobs for reasons other than retirement (Ingersoll, 2001). Stemming the loss of well-qualified teachers by improving conditions in schools to support excellent teaching would help reduce the need for new teachers (Marder, et al., 2018). In fact, teacher turnover currently accounts for about 88% of the annual demand for new teachers (Darling-Hammond et al., 2018). Moreover, the data show that the amount of turnover accounted for by retirement is relatively minor when compared to that associated with other factors, such as teacher job dissatisfaction and teachers pursuing other jobs. (Ingersoll, 2001).
Ingersoll (2001) also concluded that popular education initiatives, such as teacher recruitment programs, will not solve the staffing problems if they do not also address the organizational sources of low teacher retention (Ingersoll, 2001). Gui (2019) found that the principal’s role in building a positive school culture, along with the principal’s behaviors, practices, and leadership capacity significantly affect teacher satisfaction and retention. Darling-Hammond et al. (2019) also recommends supporting retention through practices such as economic incentives, teacher residencies, grow your own programs, support and mentoring for novice teachers such as seminars, coaching and mentoring, reduced workloads, collaborative planning time, and extra classroom assistance (Darling-Hammond et al., 2018).

When surveyed about staffing needs, principals reported that teachers in the shortage areas of special education, mathematics, science, bilingual education, and world language are most difficult to retain (Darling-Hammond et al., 2018). Some researchers suggest retention is the major contributor to the shortfall of qualified science teachers in high schools (Ingersoll, 2003; Ingersoll & Perda, 2010). Maintaining qualified and effective teachers in the classroom has been found to be a key factor in the successful science education of high school students (Ronfeldt, 2012).

U.S. national staffing surveys have shown that teachers of mathematics and science are more likely to leave their school or the teaching profession than teachers in other fields (Carver-Thomas & Darling-Hammond, 2017). While it is true that science teachers have other career options that their colleagues in the humanities may not, the principal reason they leave is job dissatisfaction (Hampden-Thompson, et al., 2008). Chronically high rates of new and experienced science teacher attrition and the findings
of new large scale mentoring programs indicate that administrators should adopt new approaches (Pirkle, 2011). A disproportionate number of science teachers retire during early middle age for other opportunities, perhaps as a result of having lost the sense of being valued for their contributions within the academic community (Snyder & Dillon, 2010).

Analysts have hypothesized that mathematics and science teachers are more likely to leave at higher rates because they are more likely than other teachers to have alternative career options in the business and technological sectors, often with higher salaries (Ingersoll & May, 2010). There has been little empirical research on where mathematics and science teachers go after departing from teaching, although most teachers report leaving for a better paying job with less stress (Ingersoll & May, 2010). Moreover, little is known about which aspects, conditions, policies and characteristics of district and schools are related to mathematics and science teacher turnover (Ingersoll & May, 2010).

Compounding the issue is the fact that science teachers of all levels report feelings of isolation from colleagues, and a desire for more input into school decision-making (Roudebush, 2010). Physics and chemistry teachers, in particular, report a lack of professional opportunities for collaboration, advancement, and academic progress (Pirkle, 2011). High school physics teachers in the US are often in a position of isolation, particularly in urban schools where access to physics is relatively limited (Nehmeh & Kelly, 2018). In interpretive phenomenological research conducted by Nehmeh & Kelly (2018) of physics teachers in urban schools, the teachers reported pervasive feelings of isolation, poor self-efficacy, limited professional agency, and a desire for pedagogical
collaboration. They also reported a lack of administrative support and meaningful feedback and mentoring, which led them to seek their own networks for planning curriculum, instruction, and laboratory experiences (Nehmeh & Kelly, 2018).

**Summary and Implications of Literature Review**

The theoretical framework for this research was centered on Vroom’s (1964) Expectancy Theory of Motivation as well as the model of Physics Identity developed by Hazari et al. (2010). Expectancy Theory was particularly appropriate for this research since motivation for teaching physics corresponds to expected outcomes that may or may not occur. The model Physics Identity was integral to the phenomenological study of female high school physics teachers because the women’s own physics identity may factor into their persistence in teaching physics.

The research literature reviewed revealed possible reasons for the gender disparity found in the field of physics as well as the importance of high school in young women’s decisions to consider physics as a college major and career option. The effects of having a female high school physics teacher on a young woman’s interest in physics was explored through the literature, as were the issues female high school physics teachers experience because of their gender. The factors that may influence teachers’ decision to remain in the classroom or not are also important to this dissertation research since they contribute to an understanding of what the participants in this study may be experiencing as well as how those experiences affect their career choices.

This review of the literature revealed that although there has been a good deal of research into the recruitment of high school physics teachers, there has been seemingly
no research into recruiting female teachers specifically. Similarly, the nominal research into the retention of high school physics teachers does not seem to include any focus on retaining women. An extensive search of the literature also did not reveal any research that included asking female high school physics teacher directly what their experiences are and why they have decided to remain in the classroom or to leave the profession. Consequently, this literature review reveals a gap in the current research that can be filled by a phenomenological study of the experiences of teaching physics while female.
Chapter 3: Research Methods

To understand the perspective of female high school physics teachers, I conducted a phenomenological study of their lived experiences. First, I interviewed 14 individuals who identified as women who are either currently teaching high school physics or have taught it in the past. The women ranged in age from 22-58 years old, with 0-31 years of experience teaching high school physics. Two of the women interviewed had just completed their student teaching and were preparing to begin their first year of teaching independently.

Using Seidman’s (2019) phenomenological approach to interviewing, I asked the participants three open-ended questions. The first question focused on the participants’ background leading up to teaching high school physics, the second question focused on their current or former experiences teaching high school physics, and the third question focused on the meaning the participants found in their lived experiences. Each interview was conducted virtually, and the subsequent recording was used to create a transcript, which was cleaned up and returned to the participant for review. When the participants returned the member-checked transcripts, I used NVivo (2022) software to open code the data. I then performed axial coding to group the initial codes into broader categories based on their commonalities (Marshal et al., 2022). Three major themes emerged from the data, which I then used to answer the study’s three research questions and to create a narrative of the phenomenon of being a female high school physics teacher.
Research Questions

The primary goal of this research was to describe the phenomena of being a female high school physics teacher. Because phenomenological research is based on descriptions of experiences and not explanations of those experiences (Moustakas, 1994), the research questions for this study focused on the participants’ direct, lived experiences with the phenomena of being a female high school physics teacher. Therefore, the central research question of the research was the following: What is the experience of teaching high school physics like for women?

Phenomenological research is also grounded in questions that give direction and focus to a meaning (Moustakas, 1994). The focus of this research was to reveal factors that may contribute to the retention of female high school physics teachers in the classroom. Another research goal was to identify practices that learning organizations such as schools and school districts could employ to increase the retention of female high school physics teachers. As a result, the specific research questions were as follows:

1. What are the lived experiences of female HS physics teachers who decide to leave the classroom?
2. What are the lived experiences of female HS physics teachers who remain in the classroom?
3. What organizational practices seem to support the retention of qualified HS female physics teachers?
Research Design Overview

In researching the issues involved in understanding the experience of teaching high school physics for women, I designed a research approach that is capable of both capturing its complexity and communicating it in a cohesive manner. A qualitative research design was most appropriate since it involves communicating multiple perspectives, identifying various influential factors, and creating a more holistic representation of a situation (Creswell & Poth, 2018). Of the major qualitative research approaches, a phenomenological study was the most closely aligned to the research questions since phenomenology is a methodology designed to describe the common meaning for several individuals of their lived experiences of a phenomenon (Creswell & Poth, 2018). The central phenomenon of focus in this study was the lived experiences of female high school physics teachers.

More specifically, this research was a transcendental phenomenological study of the lived experiences of female high school teachers. Transcendental phenomenology, as developed by Husserl (1931), is a philosophical approach to qualitative research that seeks to understand human experience (Moustakas, 1994) and focuses less on the interpretation of the researcher and more on the lived experiences of the participants (Creswell & Poth, 2018). The methodology of transcendental phenomenology as outlined by Moustakas (1994), made it a particularly effective approach for this research. This methodology consists of epoche, transcendental-phenomenological reduction, and imaginative variation. The process of epoche, which refers to setting aside preconceived understandings and judgments to view the phenomena with a fresh perspective (Moustakas, 1994), was crucial to this research since I have an extensive experience with
the phenomena of being a female high school physics teacher. Completing a transcendental-phenomenological reduction was also fundamental to the research’s goals since it required me to create connections and structures of meaning from the participants’ experiences from an open-minded vantage point (Moustakas, 1994). Imaginative variation, the final component of transcendental methodology, also aligned well with the overall purpose of this research as it is the process by which multiple, varying experiences and meanings are synthesized into a unified description of a phenomena (Moustakas, 1994).

To capture the lived experiences of the women, I interviewed them using open-ended questions grounded in the philosophical tradition of phenomenology. Phenomenological interviewing is based on the assumption that there is a structure and essence to shared experiences that can be narrated to describe the meaning of a phenomenon that several individuals share (Marshal et al., 2022). I also incorporated Seidman’s (2019) phenomenological inquiry method, which consists of an in-depth and open-ended, three-part interview about the participants’ past, present, and essential experience with the phenomenon. Seidman’s (2019) interviewing method, which focuses on understanding the lived experience of people and the meaning they make of that experience instead of evaluating or testing hypotheses, aligns with the transcendental phenomenological approach which is sets aside preconceived ideas to allow the true meaning of the phenomena to naturally emerge (Moustakas, 1994).
Study Participants

Researcher Description

I chose the focus of this research primarily because of my lived experiences as a former female high school physics teacher. I am a former public-school teacher with 22 years of experience teaching high school physics. Throughout that time, I frequently considered leaving the classroom for another profession and often felt that no one was aware of or concerned about my experiences. Because of my past experiences, I was eager to hear the stories of other female high school physics teachers and to provide them with the opportunity to speak their truth that I never felt I had. As a result, I chose the research methodology of transcendental phenomenology since its design allows participants to tell their story in their own words (Creswell & Poth, 2018).

After leaving the classroom to become a school administrator for several years, I returned to teaching high school physics when I moved from Ohio to Tennessee. My first teaching position in Tennessee was as a replacement for a young woman who taught high school physics for one year, and then left for a job in electrical engineering. I was curious as to why she left the teaching profession so early on in her career and wanted to find out what her experiences were that caused her to quit.

Now that I have returned to a high school leadership position, I also wanted to identify factors that could help reduce the attrition of female high school physics teachers. I was concerned about the gender disparity found in the physics teachers in my school and in my school district and wanted to gain insight into why women make the decision to either remain in the classroom or to leave the teaching profession.
My own experiences with physics were overwhelmingly negative during high school and college and although I loved the subject, I often thought of changing majors. At times, the only reason I did not abandon the study of physics was because one of my scholarships stipulated that if I didn’t graduate with a physics degree and teach high school physics for four years, I would have to repay it. Even though I went on to earn a bachelor’s and a master’s degree in physics, I never developed a true Physics Identity during my college years. This may have been due to the lack of support and even discouragement I received from my overwhelmingly male physics professors. As an undergraduate, all my physics professors were male and in graduate school all but one of my physics professors were male. Although I enjoyed positive and productive relationships with my fellow students, I also felt a bit isolated by the fact that I was one of only a handful of female undergraduate physics students and the only female student in my graduate physics program.

When I became a teacher, I grew to love and appreciate physics, much more so than I did as a college student. This was probably because in order to explain physics concepts clearly and comprehensibly to my students, I had to better understand them myself and be able to connect them to real life applications for my students. Not surprisingly, I found my Physics Identity increasing with each year of teaching because I felt that I truly was helping my students become better physics thinkers and problem solvers through my instruction.

Although teaching high school helped me develop a stronger Physics Identity, teaching was not always what I expected it to be. In alignment with Vroom’s Expectancy Theory (1964), I chose to become a high school teacher because I had certain
expectations of what the job would be like, and the reality did not always meet up to those expectations. Aside from the usual issues of classroom management problems, an ever-increasing workload, and the pressures of standardized assessments, I also experienced a good bit of negativity and what I now realize was mistreatment by my male colleagues.

During my first teaching position I was frequently patronized and even ridiculed by the school’s other physics teacher, who was male. Even after teaching high school physics for two decades, I was still subjected to sarcastic comments and exclusionary treatment by other male physics teachers during district wide professional development meetings in my last position. As a result of these experiences, I often thought of leaving the classroom and entering the private sector as a research scientist or technical writer. I eventually did take a different career path by becoming a high school administrator, which is my current position.

Because I have spent most of my career as a high school physics teacher, I was concerned about allowing my own experiences to influence the results of this research. I wanted the participants to share their experiences freely and authentically and did not want to view the results of their interviews through the lens of my perspective. For these reasons, I chose a transcendental phenomenological research approach because its methodology required the practice of epoche, also known as bracketing or setting aside the researcher’s own experiences to have a fresh perspective on the phenomenology being studied (Moustakas, 1994).

I also employed a feminist approach to inquiry in this research. The lack of voice that female high school physics teachers have historically possessed made the use of a
feminist research approach particularly appropriate due to its critical and emancipatory aims for women ( Marshal et al., 2022). Because a feminist inquiry approach incorporates the recognition of multiple intersections of identity ( Marshal et al., 2022) aside from gender, it is also aligned to the research’s theoretical framework of the role of Physics Identity in women’s career decisions. Additionally, a feminist approach supports my perspective as a former high school physics teacher since feminist inquiry proposes that reflexivity is the key to authentic research where subjectivity is embraced instead of shunned ( Marshal et al., 2022). A feminist inquiry approach also aligns with the transcendental phenomenology conducted since that particular methodology allows the women to use their own words to describe their experiences without predetermined constraints (Moustakas, 1994).

**Participants or Other Data Sources**

The participants for this research consisted of 14 former and current female high school physics teachers in various stages of their careers. To include a diverse set of perspectives, I interviewed teachers from a variety of backgrounds, school settings, career stages, and years of experience, ranging from zero to two years of experience to decades spent in the classroom. The participants ranged in age from 22-58, all identified themselves as women, and described their ethnicities as White, Asian, Asian Indian, and Latine.

The proposed participant sample was five to 10 teachers, depending on the point of occurrence for data saturation, when the sample patterns repeat and little more can be gained from further data collection (Saumere & Griven, 2008). The actual participant sample consisted of 14 teachers because data saturation was not achieved during the first
several interviews. Also, several of the participants referred colleagues as prospective participants, and four of those referrals were added to the sample due to their unique experiences. Research into the participants’ local context such as demographics, marital status, and years of teaching experience was also conducted to provide a richer context and thick description of each of the participants. See Table 4, *Demographics of Participants*.

**Researcher-participant Relationship**

There was a relationship between myself and the participants in that four of the 14 research participants knew me before their interview. Because I wanted to research factors that may influence a woman’s decision to remain in the classroom, I interviewed one of my college classmates since she has been a high school physics teacher for almost three decades and plans to teach until retirement. Because I also wanted to research factors that may influence a woman’s decision to leave the classroom, I also interviewed the young woman whose high school physics teaching position I replaced when I moved to Tennessee from Ohio six years ago. She taught for one year before leaving the classroom to work as an electrical engineer and provided a perspective on why female high school physics teachers may leave the classroom early on in their career. I also interviewed two former colleagues who taught physics in schools I worked in before moving to my current position.

Because I employed the phenomenological practice of bracketing (van Kaam, 1966) with each and all the participants in the sample, I was able to suspend my preconceived thoughts and possible biases about these three women’s experiences and focus on the phenomenon (Peoples, 2021). A possible benefit of knowing these women
as colleagues before the interviews is that they may have shared a sense of trust and rapport with me.

**Participant Recruitment**

**Recruitment Process**

Participants were recruited through social media messages to former classmates and colleagues as well as emails to teachers in school districts throughout Ohio and Tennessee. As shown in Table 1, the recruitment process spanned almost four months. Participants were compensated for their time with a $25 Amazon gift card after each interview was completed.

**Table 1**

**Participant Recruitment Timeline**

<table>
<thead>
<tr>
<th>February 2023</th>
<th>March 2023</th>
<th>April 2023</th>
<th>May 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 7: IRB approval granted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>February 20: email sent to “Rachel” requesting interview.</td>
<td></td>
<td></td>
<td>May 20: emailed four more teachers from AAPT membership roster. One response from “Mandy”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May 24: sent follow up email to 13 teachers from AAPT membership roster. No responses.</td>
<td></td>
</tr>
</tbody>
</table>
**Participant Selection**

I used a combination of purposeful sampling and convenience sampling to select participants in this research. Purposeful sampling, or intentionally sampling a group of people that can best inform the researcher about the research problem (Creswell & Poth, 2018), was used to ensure that participants with a variety of teaching experiences were included. This was important since years of teaching experience was one of the factors in teacher attrition identified by the review of research literature. Purposeful sampling was also ideal for this phenomenological study since the participants were selected for their contribution to the understanding of the phenomenon (Klenke, 2016). Convenience sampling was also employed when I contacted a former college classmate and former colleagues. Referrals by initial participants and a fellow doctoral candidate were also examples of convenience sampling used in this research. Participants were also recruited and selected by utilizing the member list from the American Association of Physics Teachers (AAPT), an organization of which I am also a member. A stratified purposeful sampling approach was also used where participants of various years of teaching experience were selected to in order make comparisons among the participants (Miles & Huberman, 1994).

Participant inclusion criteria required that participants identify as female and have at least one year of experience teaching (or have student taught) physics in a high school located in the U.S. Initially I planned to select only public-school teachers as participants because unlike teachers in private schools, they are governed by the same federal laws and share similar working conditions. Because only 28 prospective participants were identified and the response rate was only 50%, the public-school criteria was discarded.
and women teaching physics in private schools were also included. Exclusion criteria included teachers who identify as male or who I supervise or evaluate in my current position as an assistant principal, for ethical reasons.

**Data Collection**

**Procedure**

I recorded the participants virtual interviews with their permission and transcribed them with fidelity. I also took comprehensive field notes during the interviews which included observational, methodological, and theoretical notes; as well as records of any data analysis decisions (Marshal et al., 2022). I also used data about the women’s local context such as their demographics in order triangulate the information from the interviews.

**Collection of Data**

Data were collected during virtual interviews conducted during evenings and weekends, depending on the participants and researcher’s work schedule, as shown in Table 2.
### Table 2

**Participant Interview Timeline**

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>Interview Date</th>
<th>Interview Time</th>
<th>Interview Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patty</td>
<td>March 4, 2023</td>
<td>8:00 am</td>
<td>88 minutes</td>
</tr>
<tr>
<td>Yvonne</td>
<td>March 8, 2023</td>
<td>7:30 pm</td>
<td>72 minutes</td>
</tr>
<tr>
<td>Rachel</td>
<td>May 21, 2023</td>
<td>4:00 pm</td>
<td>65 minutes</td>
</tr>
<tr>
<td>Lauren</td>
<td>May 2, 2023</td>
<td>4:30 pm</td>
<td>51 minutes</td>
</tr>
<tr>
<td>Megan</td>
<td>May 11, 2023</td>
<td>4:00 pm</td>
<td>28 minutes</td>
</tr>
<tr>
<td>Paula</td>
<td>May 18, 2023</td>
<td>6:30 pm</td>
<td>29 minutes</td>
</tr>
<tr>
<td>Wendy</td>
<td>May 20, 2023</td>
<td>8:00 am</td>
<td>82 minutes</td>
</tr>
<tr>
<td>Victoria</td>
<td>May 20, 2023</td>
<td>3:00 pm</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Olivia</td>
<td>May 25, 2023</td>
<td>3:30 pm</td>
<td>44 minutes</td>
</tr>
<tr>
<td>Mary</td>
<td>May 25, 2023</td>
<td>6:00 pm</td>
<td>68 minutes</td>
</tr>
<tr>
<td>Brenda</td>
<td>May 27, 2023</td>
<td>9:00 am</td>
<td>84 minutes</td>
</tr>
<tr>
<td>Mandy</td>
<td>May 27, 2023</td>
<td>3:00 pm</td>
<td>68 minutes</td>
</tr>
<tr>
<td>Phyllis</td>
<td>May 29, 2023</td>
<td>6:30 pm</td>
<td>37 minutes</td>
</tr>
<tr>
<td>Mandy</td>
<td>June 2, 2023</td>
<td>3:00 pm</td>
<td>38 minutes</td>
</tr>
</tbody>
</table>

All participants chose to be interviewed from their home instead of their classroom. Data was then collected through interviews using the following protocol.

First, the participants were contacted via email which included a pleasant greeting and an explanation of the proposed research along with the researcher’s telephone number and an invitation letter attachment (Appendix B). A follow up was sent a week later if no response was received from the perspective participant. After the participant
confirmed her interest, she was emailed the informed consent for research participation form (Appendix C). I then used Calendly, a scheduling software, to set up the participant interviews (Calendly, 2023). After receiving the consent form from each participant, I emailed her a link to the interview Calendly page, which displayed the available interview times and dates. Each participant was then able to schedule her interview based on her availability. I also maintained a comprehensive audit trail of the recruitment and selection process to assure trustworthiness and transparency.

The data were collected through a series of three open-ended interview questions, each focusing on a different aspect of the phenomena of being a woman teaching high school physics. Each part of the three-part interview lasted approximately 20-30 minutes, resulting in approximately 60-90 minutes of data collection per participant. If follow up questions are deemed necessary after the initial interview, the participant was contacted, and the ensuing data was collected via email. Asking follow up questions to gain clarity is a member checking strategy that was implemented to increase the trustworthiness of the study results. The data collection process spanned a 13-week time period, from March 2, 2023 through June 2, 2023.

Prior to interviewing the participants, I completed the first step of the bracketing process by writing a full description of my own experiences as a female high school physics teacher. This initial bracketing step was completed to gain an understanding and awareness of my experiences to set them aside from those of the participants (Klenke, 2016). The participant interview questions aligned with the phenomenological interview practices as outlined by Seidman (2019) which entails asking the participants about their past experiences with the phenomenon, their recent experiences with the phenomenon,
and their reflections on the meaning of the phenomenon. Therefore, the data collection took place as a three-part interview process that centered on exploring the experiences of the participants in the context of their life history and offering them the opportunity to reflect on the meaning of that experience (Marshall et al., 2022). In essence, the first part of the interview focused on the history of the participant’s experience with the phenomenon, the second part focused on their present experiences, and the third focused on the meaning the participant gained from those experiences (Marshall et al., 2022).

Applying this phenomenological interview approach, the following three open-ended interview questions were asked of the participants.

1. Tell me some of your background that led you to become a physics teacher?
2. What are/were your experiences as a high school physics teacher?
3. When you think about what you have shared, what meaning do you find in your experiences?

Since reflexivity is crucial in qualitative interviewing (Seidman, 2019), the participants’ responses to the three-part interview at times elicited the need for further probing questions. In anticipation of asking these probing questions, I prepared the following list of follow up questions that I used with participants who needed support providing details during their interview answers. These questions were designed to add more detail to the participants’ responses and were used with all participants. They did not change over the course of the interviews.

1. Could you clarify what you mean by that statement?
2. Can you give me an example?
3. What were you thinking/feeling at the time?
In addition to the above three questions, I added the following questions after the second participant was interviewed. They were added to make a connection between the theoretical frameworks of expectancy Theory (Vroom, 1964) and Physics Identity (Hazari et al, 2010).

1. Were your experiences teaching high school physics what you expected?
2. Do you feel more like a “physics person” from your experiences?

After the interviews were completed in June, all participants were also emailed the following questions about their demographics for triangulation purposes.

1. What is your age?
2. What is your ethnicity?
3. What is your marital status?
4. If you have children, how many do you have, and what are their ages?
5. Where have you taught and how long have you taught there? (Please include all teaching positions).
6. Do you have tenure? If so, when did you earn it?

**Recording and Data Transformation**

The interviews were all conducted virtually using the Webex videoconferencing application (Webex, 2023) and the resulting transcripts were saved as Microsoft Word files. As a backup, the interviews were also recorded using a voice recorder (Sony, 2023).

**Analysis**

I analyzed the results of the interviews using the method outlined by Moustakas (1994) and Giorgi (2009) in which the interview transcripts are read for a sense of the whole, meaning units are determined, and a description of the phenomenon is
written. The data analysis process spanned almost three months, as seen in Table 3, and included nine coding iterations. During each iteration, the data was reorganized into more meaningful categories that addressed the research questions of why female high school physics teachers leave the classroom (RQ1), remain in the profession (RQ2), as well as what learning organizations can do to increase retention (RQ3). By the conclusion of the data analysis, I identified three major themes that were used to create a narrative of the phenomena of being a female high school physics teacher.

**Data-Analytic Strategies**

The phenomenological method of analysis developed by Moustakas (1994) was utilized when analyzing the data from this study. This method consisted of the following sequential processes: identifying significant statements from the interviews and grouping them into themes, creating a textural and structural description of the experiences, and writing a composite description of the phenomenon (Creswell & Poth, 2018). More specifically, this analysis method was completed by following the data analysis steps outlined by Peoples (2021) as follows:

1. Read the individual interview transcripts in its entirety to discern the participants’ complete story. Deleted any irrelevant or unnecessary information including repetitive statements or filler words such as um, uh, or you know.
2. Created preliminary meaning units while concentrating on the research topic. A meaning unit is the allocation piece of data that reveals a feature or trait of the phenomenon being investigated (Giorgi, 2009).
3. Broke down the preliminary meaning units into final meaning units or themes for each interview using a deepened understanding of each participant’s description.
4. Synthesized final meaning units into situated narratives under each interview.
   Repeated for each participant.

5. Synthesized situated narratives into general narratives, integrating major themes of participants.

6. Generated a general description of the phenomenon.

The unit of analysis consisted of each participant’s transcript and the coding categories were not developed a priori, but instead emerged from the analysis through open coding (Marshall et al., 2022). NVivo (QSR International, 2022) software was used to aid in coding and theme development. The initial, open coding of the data was revised eight additional times as meaning units were organized and consolidated into themes and subthemes outlined in Chapter 4 and found in the final codebook found in Appendix B. I served as the primary coder of the data and sample coding of one participant’s interview was completed by a peer acting as a critical friend to increase trustworthiness.

Methodological Integrity

The use of open-ended questions allowed the participants to speak freely about their experiences, which provided a rich array of data about the phenomenon. Follow-up questions were also asked to gain clarity or detail about data relevant to the study’s research questions. Since I am passionate about the research subject matter and have years of personal experience with it, I took care to separate my feelings and opinions from the participants’ results by bracketing. Bracketing, also known as epoche, is the practice of revealing personal experiences, biases, and preconceived ideas to maintain a fresh perspective from the vantage point of a “pure or transcendental ego” (Moustakas, 1994).
I also kept a reflexive journal during the data collection and analysis process to reflect on my own biases, personal experiences, and values that could be a factor in this phenomenological study (Creswell & Poth, 2018). I reviewed these reflexive entries throughout the study to further understand how my own experiences were woven throughout the process and findings of the study. As an additional measure in the epoche process, I created reflective journal notes after each interview to increase my level of metacognition and ability to make clear observations (Moustakas, 1994). I also employed the practice of memoing throughout the data collection and analysis process to document my thought processes and decision making. The memos, which are short phrases, ideas, or important concepts (Marshall & Rossman, 2018, p.188), helped create an audit trail of my decision-making process during the data analysis.

The findings from the data analysis were grounded in evidence such as participants’ quotes, excerpts from interview responses, and transparent description of the researcher’s engagement in data collection through an extensive audit trail. The results of the data analysis served to fill the gap identified by a review of current research literature about gender inequities in physics, namely the lack of research into female high school teachers. The results of the data analysis also served to provide a voice for female high school physics teachers as they communicated the phenomena of their lived experiences.

Phenomenology relies primarily upon coherence of interpretation of the data and its findings are only valid to the extent that they resonate with the experiences of those who have experienced the phenomenon in question (Klenke, 2016). For this proposed research, trustworthiness was ensured through practices such as collaboration with
participants and member checking (Marshall et al., 2022). Member checking procedures for this research included repeating participants’ statements for confirmation during the interview as well as returning the participants’ interview transcripts and requesting that they check them for accuracy. Each participant returned the transcripts with either no revisions or very minor revisions that were a result of transcription. The descriptive summary of each participant included in the results chapter was also returned to the participant as a member checking practice. Resulting feedback from each participant was used in their final descriptive summary.

Trustworthiness was also supported through the implementation of practices such as peer debriefing with critical friends (Marshall et al., 2022). Claims made during the data analysis such as theme and narrative development were supported through documentation such as reflexive journal notes, an extensive audit trail, and the bracketing of my thoughts and experiences. I also implemented checks on the utility of my findings in relation to the aims of the research by continually focusing on the study’s research questions throughout the data analysis process. Trustworthiness was also enhanced through the richness of the data and close collaboration with the participants (Marshall et al., 2022).

The timeline of each significant analysis procedure can be found in Table 3.


### Table 3

**Data Collection and Analysis Process**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Description</th>
<th>Timeline (2023)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection</td>
<td>Conducted virtual interviews via Webex. Created reflexive notes and memos.</td>
<td>March 4 – June 2 (26 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data management</td>
<td>Downloaded transcripts from Webex. Created a file for each interview transcript.</td>
<td>June 3 – June 9 (8 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data cleanup</td>
<td>Formatted transcripts as narratives. Read transcripts and edited them for accuracy using Webex audio recording.</td>
<td>June 10 – July 8 (34 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Member Checking</td>
<td>Participants provided feedback about the accuracy of their transcript.</td>
<td>July 9 – August 1 (18 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial coding</td>
<td>Uploaded final transcript files to NVivo 14.0. Open coded each transcript to create preliminary meaning units.</td>
<td>August 2 – 18 (24 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theme Development</td>
<td>Organized and consolidated codes. Developed final meaning units (themes).</td>
<td>August 19 - November 6 (28 hours)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Narrative Creation</td>
<td>Created description of each participant and synthesized final meaning units into situated narratives. Synthesized situated narratives into general narratives. Generated a general description of the phenomenon.</td>
<td>November 6 -12 (36 hours)</td>
</tr>
</tbody>
</table>

### Limitations

Limitations of this study included the level of diversity among the research participants. Of the 14 participants, one was Latine, one was Asian and White, one was Asian Indian American, and 11 were White. The women self-identified their racial and
ethnic background when they answered the open-ended question “What is your ethnicity?”, which was one of the follow-up demographic questions sent to each participant. To recruit women of color as participants, I reached out to the teacher education chairs of two historically Black universities in central Tennessee. Although both chairs were eager to help with my research, they were not aware of any African American female alumni from their universities who taught high school physics teachers. Unfortunately, this underrepresentation of Black women in physics is documented in research that showed in 2016, only 3% of bachelor’s degrees in physics were earned by Black women (Dickens, 2020).

Another limitation of the study occurred from the fact that at the time of the study, only one participant had left teaching for another profession. This limitation may have arisen from the study’s participant recruitment methodology. The participants were recruited by methods such as my professional connections with former colleagues and classmates, referrals by other participants, and by contacting current members of the American Association of Physics teachers. As a result, it was very difficult to locate women who were not currently teaching at the time of the study. This limited the findings in support of research questions one, which focused on the lived experiences of female high school teachers who left the classroom.

Ethical Considerations

This research was conducted according to international Review Board (IRB) protocols. The information collected from the participants in this study was protected through several confidentiality protocols. Each participant was assigned a pseudonym and the list connecting the participants names to their pseudonym was kept in a locked
file separate from the research data. When the study was completed and the data analyzed, the list connecting the participants names to their pseudonyms was destroyed. The participants’ data was stored on an encrypted flash drive and an encrypted, cloud-based storage system. Personally identifiable information such as the teachers’ names was re-coded to protect the participants’ identities. The audio recording of each interview was transcribed and after transcribing was completed and verified, the recording was destroyed.

Additional ethical considerations included in this research occurred as a result of extensive member checking with participants. Each participant was provided with a copy of their interview transcript and was given the opportunity to correct any errors before the transcript was coded. Participants were also given final approval of their descriptive summary included in the research results. As an extra measure, the complete dissertation will be shared with each participant, so they can see the final product of the research they were such an integral part of.
Chapter 4: Results

This chapter summarizes the analyses and results of the study, which was conducted as a qualitative transcendental phenomenology. This research approach was particularly appropriate for understanding human experience (Moustakas, 1994) as it allowed the lived experiences of the participants to emerge unfettered from interpretation by the researcher (Creswell & Poth, 2018). The fourteen women interviewed in the study represented a wide range of backgrounds and experiences, which they described by answering three open-ended questions in accordance with the phenomenological approach to interviewing (Seidman, 2019). The interview questions focused on the women’s past experiences that lead up to their teaching career, their past and current experiences with teaching high school physics, and the meaning they found in those experiences.

The participants’ responses were then analyzed using the phenomenological method of analysis developed by Moustakas (1994), by first identifying significant statements from the interviews and then grouping them into themes (Creswell & Poth, 2018). The three major themes that emerged from the data, in order of significance, were self-efficacy, values, and support. The major theme of self-efficacy included the themes of feeling inadequate, overcoming obstacles, and earned confidence. The major theme of values encompassed the themes of relationships with students, work-life balance, students’ growth, and teaching is important work. The major theme of support included the themes of colleagues, mentors, and organizational support.

The themes and their significant representative statements were then used to create a textural and structural description of the participants’ experiences and to write a
composite description of the phenomenon (Creswell & Poth, 2018). The findings of this research were also used to address the following three research questions:

RQ1: What are the lived experiences of female HS physics teachers who decided to leave the classroom?

RQ2: What are the lived experiences of female HS physics teachers who remain in the classroom?

RQ3: What organizational practices seem to support the retention of qualified HS female physics teachers?

Setting

The 14 participants were interviewed virtually using the Webex teleconferencing application. The participants selected their own interview times and locations, and all participants chose to be interviewed during weekday evenings or weekend mornings and afternoons as shown in Table 2. All participants chose to be interviewed from their home, which allowed them to speak more freely without the concern of a student, colleague, or supervisor overhearing their conversation.

Participant Demographics

All 14 participants were women of varying characteristics such as marital status, number of children, and years of experience teaching high school physics. Their characteristics are represented in Table 4.
### Table 4

**Demographics of Participants**

<table>
<thead>
<tr>
<th>Interview Number</th>
<th>Pseudonym</th>
<th>Age</th>
<th>Ethnicity</th>
<th>Marital Status</th>
<th>Number of Children</th>
<th>Years of Teaching Experience</th>
<th>Tenured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wendy</td>
<td>54</td>
<td>White</td>
<td>Married</td>
<td>2</td>
<td>31</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Mandy</td>
<td>28</td>
<td>White</td>
<td>Engaged</td>
<td>0</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Pamela</td>
<td>31</td>
<td>White</td>
<td>Married</td>
<td>2</td>
<td>8</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Yvonne</td>
<td>34</td>
<td>White</td>
<td>Married</td>
<td>1</td>
<td>1</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Phyllis</td>
<td>58</td>
<td>Asian Indian American</td>
<td>Married</td>
<td>2</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Mary</td>
<td>46</td>
<td>White</td>
<td>Married</td>
<td>2</td>
<td>19</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Victoria</td>
<td>22</td>
<td>Asian and White Single</td>
<td>0</td>
<td>0</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Rachel</td>
<td>48</td>
<td>White</td>
<td>Married</td>
<td>5</td>
<td>27</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>Patty</td>
<td>50</td>
<td>White</td>
<td>Married</td>
<td>2</td>
<td>29</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>Paula</td>
<td>32</td>
<td>White</td>
<td>Married</td>
<td>1</td>
<td>5</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Olivia</td>
<td>22</td>
<td>White</td>
<td>Single</td>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>Lauren</td>
<td>40</td>
<td>White</td>
<td>Married</td>
<td>2</td>
<td>17</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>Megan</td>
<td>35</td>
<td>White</td>
<td>Single</td>
<td>0</td>
<td>9</td>
<td>No</td>
</tr>
<tr>
<td>14</td>
<td>Brenda</td>
<td>35</td>
<td>Latine</td>
<td>Single</td>
<td>0</td>
<td>5</td>
<td>No</td>
</tr>
</tbody>
</table>

*Note.* The women self-identified their racial and ethnic background when they answered the open-ended question “What is your ethnicity?”, which was one of the follow-up demographic questions asked of each participant.
Description of Each Interview Participant

**Wendy.** "Wendy" is a 54-year-old White woman with 31 years of experience teaching high school physics. Her theater background led her to study acoustics in college, which required a physics degree. The prospect of "hardcore physics studying" in graduate school did not appeal to Wendy, but the idea of teaching did. She applied for and was accepted into the newly formed Teach for America program and started her teaching career in Arkansas. She went on to teach at a private school, completed grad school and earned her teaching license. Wendy has been teaching at her current school for 25 years.

**Mandy.** "Mandy" is a 28-year-old White woman with five years of experience teaching high school physics. She accepted her first (and current) position with the understanding that she would be teaching biology. However, one month before school started, she was asked to teach AP Physics 1, physics, conceptual physics, and physical science instead. Determined to a good job, Mandy worked hard in her new role as a physics teacher and finished her first year with her students earning the second highest pass rate on the AP Physics I exam in her large school district.

**Pamela.** "Pamela" is a 31-year-old White woman with eight years of teaching experience, five of which are in teaching high school physics. As the daughter of a military employee who moved his family frequently for his job, Pamela grew up appreciating the consistency and structure that school provided. While she was working on her master's degree and student teaching, Pamela was hired at the same school as a long-term sub for the school's physics classes and then taught physics there for another four years before moving to another state and accepting a position teaching math.
**Yvonne.** "Yvonne" is a 34-year-old White woman with one year of experience teaching high school physics. Her initial career plans included becoming a music journalist, but she developed an interest in physics after taking an introductory course in college. She continued to take more physics courses and eventually enrolled in a teacher education program designed specifically to prepare STEM teachers. After doing some substitute teaching, she took a job teaching high school physics, AP Physics I, and AP Physics C as her first teaching position. At the end of that year, Yvonne left teaching to work in the engineering field and has no plans to return to the classroom.

**Phyllis.** "Phyllis" is a 58-year-old Asian Indian American woman with five years of teaching experience. A former environmental engineer, Phyllis described her entrance to teaching as "backdoored" through an alternative teaching license after gaining experience as a substitute teacher and an adjunct professor at a local community college. She taught physical science for several years before teaching AP Physics.

**Mary.** "Mary" is a 46-year-old white woman with 19 years of experience teaching high school physics. She majored in physics in college because it was her favorite high school class and the only subject she found challenging. During graduate school, Mary discovered she did not enjoy physics research and with the encouragement and support from her advisor, transferred to the education department and completed a licensure program while earning her master's degree. Although Mary has found success and meaning in her experiences teaching high school physics, she plans to change careers in the future, and has started the process of becoming a principal.

**Victoria.** "Victoria" is a 22-year-old Asian and White woman who recently completed her student teaching experience and is currently in her first year of teaching
high school physics. She discovered her love for physics during high school and although she struggled with the material, loved the challenge it provided. Victoria majored in physics in college and participated in a teacher education program designed specifically to prepare STEM teachers.

Rachel. "Rachel" is a 48-year-old White woman with 27 years of teaching experience, six of those in high school physics. She always wanted to be a teacher and decided as a senior in high school that she wanted to be a math teacher. After ten years of teaching math, Rachel completed a physics licensure program through a local college and education service organization and started teaching physics the following year.

Patty. "Patty" is a 50-year-old white woman with 29 years of experience teaching physics. She knew she wanted to be a teacher as a child and became interested in teaching science in high school. She majored in physics and chemistry in college where she benefitted from the support of an encouraging professor. Patty has taken up the mantle of mentoring future female high school physics teachers during their student teaching experiences and also serves as a support to her colleagues.

Paula. "Paula" is a 32-year-old white woman with five years of experience teaching subjects such as biology, chemistry, and AP Environmental Science. Last year was her first year teaching physics, specifically AP Physics C, a rigorous calculus-based course. Paula is a member of the Knowles Teachers Initiative, a national fellowship supporting early-career STEM teachers.

Olivia. "Olivia" is a 22-year-old white woman who recently completed her student teaching experience with “Patty” as her mentor, who she credits with providing the support and encouragement she needed to complete her physics degree and become a
teacher. Olivia recently accepted a position teaching physics at a local high school and is currently in her first year of independent teaching.

**Lauren.** "Lauren" is a 40-year-old white woman with 17 years of experience teaching physics. She calls herself an "accidental physics teacher" because she originally intended to teach biology but was asked to also teach physics as a part of her first job. She recalls feeling unprepared to teach physics initially but found motivation in her enjoyment of the content and her desire to help her students.

**Megan.** "Megan" is a 35-year-old white woman with nine years of experience teaching math and science, including four years of teaching physics and AP physics. She began her career teaching biology but was soon asked to teach physics after the school's physics teacher quit. Three years later, she relocated to another state to teach physics and AP Physics where she soon developed an appreciation for the content and the opportunity for growth it provided her students.

**Brenda.** "Brenda" is a 35-year-old Latine with five years of teaching experience teaching high school physics. She completed a bachelor's and a master's degree in physics and conducted physics research as both an undergrad and a graduate student. She credits the support from a college advisor as fundamental in the completion of her education and prides herself in providing similar support to her students. Brenda's immigration status was a factor in her path to becoming a high school physics teacher since, at the time, many teacher licensure programs did not accept students who were not citizens. She did successfully complete a licensure program and currently teaches physics in a high school with students from predominantly Hispanic backgrounds.
Findings

Analysis of the participants’ interview data yielded the three major themes of self-efficacy, values, and support. These themes were developed from the initial open coding of the data through an iterative process of continually finding patterns, commonalities, and differences until theoretic categories were established (Marshall & Rossman, 2018, p.243). Nine coding iterations were completed to reveal the most accurate and complete relationships between the major themes and their more specific themes and subthemes.

I completed the initial three coding iterations by organizing the meaning units, or codes, according to the interview questions as outlined by Seidman’s (2019) phenomenological inquiry method. However, these interview questions, while designed to provide the participants with the opportunity to speak freely and authentically about their lived experiences as a female high school physics teacher, did not align with the three fundamental research questions. During the fourth coding iteration I began to organize the codes according to their relevance to the research questions and soon discovered that they began to fall under four major themes of supports for teaching, personal values, relationships, and confidence.

During the fifth coding iteration, I began to make connections between the data and the two major theories forming the theoretical framework for this research; Vroom’s (1964) Expectancy Theory and Hazari et al.’s (2010) model of Physics Identity. The sixth and seventh round of coding focused on condensing codes into more meaningful units that addressed the three research questions. After completing the eighth coding iteration, I created a conceptual diagram representing the relationships between the themes based on their relative significance to the data. It was during this step that I realized the major
theme of relationships referred to relationships with students specifically and belonged in the major theme of values.

During the ninth, and final iteration, I revisited each major theme, theme, and sub-theme and compared their representative codes to eliminate redundancies and categorization errors. During this step I discovered that the significance of the major themes shifted in relation to each other as a result of finalizing the codes into their correct themes and sub-themes. In the process of completing these nine coding iterations, I condensed the original 163 codes into three major themes, ten corresponding themes, and 34 specific sub-themes. Each round of coding created a more cohesive and meaningful representation of the phenomenon of being a female high school physics teacher.

Of the three major themes (self-efficacy, values, and support) that emerged from the data, self-efficacy was the most important to the participants’ lived experiences. All fourteen women reported feelings of inadequacy in college and during their first position teaching high school physics, both of which caused them to doubt their abilities. However, the participants reported a powerful ability to overcome obstacles such as their feelings of inadequacy. As shown in Table 6, the data revealed almost twice the number of references to overcoming obstacles than to feelings of inadequacy. As a further testament to the women’s ability to overcome obstacles, the most significant theme of self-efficacy was the confidence the participants earned through facing their fears and experiencing success in the classroom. As Table 6 shows, the participants referred to their earned confidence more than twice as often as they did their feelings of inadequacy. This relationship shows that the women resolved their feelings of inadequacies by
Values was the second most significant major theme of the data after self-efficacy. As shown in Table 5, the participants referred to their values twice as often as they did the major theme of support. Analysis of the data revealed that the participants placed the highest value on their relationships with their students. As Table 8 shows, the participants referenced the importance of student relationships with a significantly higher frequency than the other three values, showing that they value their relationships with their students above all. Work-life balance was the next most important value to the participants, followed by fostering their students’ growth and the value they placed on teaching as important work.

The third major theme of support exemplifies how important it was for the participants to feel supported in their roles as high school physics teachers. As shown by Table 10, they referenced the support of mentors more frequently than they did colleagues, which highlighted the significant impact mentors had on the participants’ lived experiences. The participants referred to their colleagues as the next most important source of support after mentors. Table 10 shows that the participants also referenced, but to a lesser degree, the support they received from their school organization.

The relationships between the three major themes and their resulting ten themes that all emerged from the data are shown in Figure 8. The size of each circle represents the relative significance of the major theme or theme, with the larger circles representing the more important. The arrows found in Figure 8 show connections between the themes, as revealed from the analysis of the data.
Figure 8

Relationships between Major Themes and Themes
Table 5

Major Themes and Participant Reference Frequencies

<table>
<thead>
<tr>
<th>Major Theme</th>
<th>Definition</th>
<th>Number of Participants</th>
<th>Total References to Major Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy</td>
<td>The belief that the participants have in their qualifications and abilities to teach high school physics.</td>
<td>14</td>
<td>319</td>
</tr>
<tr>
<td>Values</td>
<td>How the personal and professional values of female high school physics teachers affect the satisfaction and meaning they find in their work.</td>
<td>14</td>
<td>230</td>
</tr>
<tr>
<td>Support</td>
<td>The extent to which female high school physics teachers feel valued for their abilities and supported in their work.</td>
<td>14</td>
<td>113</td>
</tr>
</tbody>
</table>

**Self-Efficacy**

Self-efficacy, or the belief that the participants have in their qualifications and abilities to teach high school physics, was the most significant major theme that emerged from the data. Included in the major theme of self-efficacy were the three themes of feeling inadequate, overcoming obstacles, and earned confidence, as shown in Table 6. The data for these three themes of self-efficacy were also organized according to more specific sub-themes as shown in Table 6.

Analysis of the data showed that participants detailed the theme of feeling inadequate with descriptions of negative experiences with physics in college, reservations about not having physics background to teach the subject, feeling unsure of their abilities, and struggling with imposter syndrome. Representative quotes from participants about feeling inadequate are found in Table 7.
Despite feeling inadequate about their abilities at times, the participants referenced an impressive ability to overcome obstacles such as teaching during the COVID-19 pandemic, school culture challenges, and student issues. They also described possessing the quality of “grit”, which helped them overcome obstacles such as the challenges they faced during their first year of teaching and the necessity of having to teach themselves the physics content before they presented it to their students. Representative quotes from participants about overcoming obstacles are found in Table 7.

The most significant theme of self-efficacy is the confidence that the participants earned by moving past their feelings of inadequacy and overcoming the obstacles associated with teaching high school physics. They described their earned confidence through the sub-themes of personal and professional growth, increased Physics Identity, and an overall enjoyment of teaching physics. Analysis of the data revealed that the enjoyment the participants found in teaching physics was as a result of their comfort with not being a content expert, the appreciation for physics they grew to have, and experiencing success with effective pedagogy such as inquiry-based learning and Modeling Instructional practices. Representative quotes from participants are found in Table 7.
Table 6

*Themes and Sub-Themes for the Major Theme of Self-Efficacy*

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Files</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling Inadequate</td>
<td>Feelings of inadequacy as a high school physics teacher.</td>
<td>13</td>
<td>68</td>
</tr>
<tr>
<td>Imposter Syndrome</td>
<td>Feeling like a fraud as a high school physics teacher.</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>College Experiences</td>
<td>Struggles mastering physics content in their college classes.</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Physics Background</td>
<td>Did not take enough physics in college to prepare them for teaching high school physics.</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Unsure of Abilities</td>
<td>Feeling unsure of their abilities to teach high school physics.</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Overcoming Obstacles</td>
<td>Overcoming obstacles associated with teaching high school physics.</td>
<td>14</td>
<td>110</td>
</tr>
<tr>
<td>COVID-19</td>
<td>Effect COVID-19 had on teaching of high school physics.</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>First Year Teaching</td>
<td>Challenges experienced during the first year of teaching high school physics.</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Grit</td>
<td>How &quot;grit&quot; has been a factor in overcoming obstacles associated with teaching high school physics.</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Teaching Myself Physics</td>
<td>Teaching/reteaching themselves physics content to be able to teach it to their high school students.</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>School Culture Challenges</td>
<td>Challenges resulting from changing school cultures due to issues such as students' personal technology, parental pressure, and mandated initiatives.</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Student Issues</td>
<td>How they navigated behavioural, cultural, and gender issues related to their students.</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Earned Confidence</td>
<td>Confidence gained from facing challenges and experiencing success as a high school physics teacher.</td>
<td>14</td>
<td>141</td>
</tr>
<tr>
<td>Enjoy Teaching Physics</td>
<td>Enjoyment of teaching high school physics.</td>
<td>12</td>
<td>75</td>
</tr>
<tr>
<td>Not a Content Expert</td>
<td>Comfort and acceptance of not being a physics content expert in their classroom.</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Appreciate Physics</td>
<td>Participants describe how they have come to appreciate physics as a subject matter.</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Pedagogy</td>
<td>Participants describe their instructional practices of teaching high school physics.</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>Increased Physics Identity</td>
<td>How teaching high school physics has strengthened their physics identity.</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Growth</td>
<td>Participants describe experiences where they experienced growth as teachers and human beings.</td>
<td>13</td>
<td>45</td>
</tr>
</tbody>
</table>

Quotes from the participants that represent the themes and sub-themes of self-efficacy are found in Table 7.
Table 7

Representative Quotes from the Major Theme of Self-Efficacy

<table>
<thead>
<tr>
<th>Theme/Sub-Theme</th>
<th>Representative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative College Experiences</td>
<td>“You would have these guys who were getting hundreds on tests, and it was like, how? I want to learn this material, but it takes me so much effort to learn it. I just felt so dumb sometimes.”</td>
</tr>
<tr>
<td>Not Enough Physics Background</td>
<td>“I do feel a bit fraudulent because I didn’t have a lot of undergrad credits for physics. I wasn’t a physics major. I never got my master’s in physics. I feel as if I'm not as smart as everybody else because I’m lacking those degrees.”</td>
</tr>
<tr>
<td>Imposter Syndrome</td>
<td>“At first, I did not feel like a physics person. I felt like a biology person trying their best to figure out the physics”.</td>
</tr>
<tr>
<td>Unsure of Abilities</td>
<td>“I went to the AP College Board training, and I felt like a complete idiot the entire time, because I had no idea what anyone was talking about around me. Even though I tried to study, I had absolutely no idea”.</td>
</tr>
<tr>
<td>COVID-19</td>
<td>“COVID kind of blew the whole world apart and when we taught hybrid, you'd have one group every other day and give stuff to the other group to do at home and nobody did their stuff at home. And I remember this perpetual state of confusion like what day is it? What group am I seeing today?”</td>
</tr>
<tr>
<td>First Year Teaching</td>
<td>“I ended up surviving the first year. I kind of hated it, but I was like, all right, I'm going to tough it out. I can do this.”</td>
</tr>
<tr>
<td>Grit</td>
<td>“I have an incredible amount of persistence and grit. I don't quit things. Once I start, I'm going to dig in and do what it takes to finish”.</td>
</tr>
<tr>
<td>Had to Teach Myself Physics</td>
<td>“I learned the content as much as I could, and then I went into my first year teaching. I was very transparent with the kids about the fact that hey, I'm learning this with you.”</td>
</tr>
<tr>
<td>Comfortable with not Being a Content Expert</td>
<td>“So, I got better at drawing boundaries and showing them that yes, I can be wrong, but I am still the teacher. You may be better at this than me at some point, and that's ok. It was both extremely frustrating and pretty empowering to do that.”</td>
</tr>
<tr>
<td>Grown to Appreciate Physics</td>
<td>“So yeah, physics wasn't my primary certification, but I ended up here and I love it and I'm doing it. And it makes my day every day.</td>
</tr>
<tr>
<td>Increased Physics Identity</td>
<td>“I think this year, even as hard as it was, validated the fact that hey, I am the physics person I said I was”.</td>
</tr>
<tr>
<td>Personal and Professional Growth</td>
<td>“I basically took the hardest science class we have and made it mine and put my mark on it as a teacher. I'm really proud of that. I'm proud of myself as a teacher. I'm proud of myself as a person.”</td>
</tr>
</tbody>
</table>
Values

Analysis of the data revealed that the next most significant major theme was values, or how the participants’ personal and professional values affected the satisfaction and meaning they found in their work. As shown in Table 8, the participants placed the highest value on the relationships they have with their students, referencing student relationships more frequently than any other value. In fact, 12 of the 14 women responded that building relationships with their students was the most meaningful aspect of their lived experiences as a female high school teacher. As Table 8 shows, the participants described the value they placed on relationships with their students through with the more specific sub-themes of connections with students, nurturing students, and serving as a role model for their students.

Second only to their relationships with students was the value participants placed on work-life balance. In fact, nine of the 14 teachers referenced work-life balance as an issue that was important to their professional and personal lives. Of the four sub-themes associated with work-life balance found in Table 8, the participants most frequently referenced the heavy workload associated with teaching high school physics and its effect on their emotional and physical well-being. Motherhood and the toll that teaching high school physics has on their personal life was also referenced by the participants as issues affecting work-life balance.

Another value that was important to the participants was their students’ academic and personal growth. As shown in Table 8, the teachers found meaning in helping their students develop their thinking and problem-solving skills as well as teaching them that they can “do hard things”. Of equal importance to the participants was the value they
placed on teaching as important and meaningful work. Five of the teachers referenced
that they wanted to be a teacher since childhood and three of the women referred to
teaching as a calling instead of mere profession. The value the participants placed on the
importance of teaching was reflected by the fact that 10 of the 14 women had specific
expectations of teaching before they entered the profession.
### Table 8

**Themes and Sub-Themes for the Major Theme of Values**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Files</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationships with Students</td>
<td>The relationships female high school physics teachers have with their students as human beings and as learners of physics.</td>
<td>14</td>
<td>84</td>
</tr>
<tr>
<td>Connections with Students</td>
<td>Participants describe making connections with their students that strengthen their teacher-student relationships.</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>Nurturing Students</td>
<td>Finding meaning in nurturing and supporting their students.</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>Role Model for Students</td>
<td>Finding meaning in serving as role models for their female students.</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>Students’ Growth</td>
<td>Importance of helping their students grow academically and personally.</td>
<td>13</td>
<td>41</td>
</tr>
<tr>
<td>Developing Students’ Thinking and Problem-Solving Skills</td>
<td>Finding meaning in helping students develop better thinking and problem-solving skills.</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Teaching Students They Can Do Hard Things</td>
<td>Finding meaning in teaching students that they can do persevere through difficult tasks.</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Teaching is Important Work</td>
<td>Value placed on teaching as a profession.</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Always Wanted to Be a Teacher</td>
<td>Lifelong desire to be a teacher.</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Expectations of Teaching</td>
<td>Expectations of teaching beforehand.</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>Teaching is a Calling</td>
<td>Teaching is a calling and has more meaning than other careers.</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Work Life Balance</td>
<td>Work life balance associated with teaching high school physics.</td>
<td>9</td>
<td>63</td>
</tr>
<tr>
<td>Health and Well Being</td>
<td>The effect of teaching on physical health and emotional wellbeing.</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Heavy Workload</td>
<td>Description of the heavy workload associated with teaching high school physics.</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Motherhood</td>
<td>How having children affected teaching experience.</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Toll on Personal Life</td>
<td>Participants describe how teaching high school physics has taken a toll on their personal life.</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>
Quotes from the participants that represent the themes and sub-themes of values are found in Table 9.

**Table 9**

*Representative Quotes from the Major Theme of Values*

<table>
<thead>
<tr>
<th>Theme/Sub-Theme</th>
<th>Representative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connections with Students</td>
<td>“The fact that I'm a teacher who comes from the same background as a lot of these students and that I understand their culture, their background, where their parents are coming from, it's sometimes so much easier for me to connect with them on that level.”</td>
</tr>
<tr>
<td>Nurturing Students</td>
<td>“My job as a teacher is to be there for them the best I can within reason, to make sure that they feel safe and welcome.”</td>
</tr>
<tr>
<td>Role Model for Students</td>
<td>“I’m showing them that this is a possible trajectory for you coming out of this community and what it could mean to become a STEM professional, or someone working in education. That's the other, big take away from me that's so important in my role as a teacher.”</td>
</tr>
<tr>
<td>Developing Students' Thinking and Problem-Solving Skills</td>
<td>“We use physics as the vehicle, but we really teach problem solving. To me, the most important thing that I teach is giving them the tools they need to think and to problem solve and to tinker.”</td>
</tr>
<tr>
<td>Teaching Students They Can Do Hard Things</td>
<td>“I think the meaning for me is showing the kids that I can – and they can – do hard things, whether they're male or female.”</td>
</tr>
<tr>
<td>Teaching is Important Work</td>
<td>“I'm not rolling in money, and it's never really been about that. It's always been about the fact that this is a purpose, this has meaning.”</td>
</tr>
<tr>
<td>Expectations of Teaching</td>
<td>“I would say that teaching is what I expected it to be. In terms of physics, I didn't expect to come into a content area where I had no idea what I was doing and having to learn it all. That was not expected at all.”</td>
</tr>
<tr>
<td>Teaching is a Calling</td>
<td>“I feel like it's definitely more than a job for me. It's a calling, it's my calling.”</td>
</tr>
<tr>
<td>Health and Well Being</td>
<td>“Because of the amount of pressure and stress I experienced, I still have nightmares where I am teaching a class that I didn't prep for, and I have no idea what I am supposed to be doing with these children.”</td>
</tr>
<tr>
<td>Heavy Workload</td>
<td>“Being able to not bring work home every single day would be amazing. It would be really great to have more work - life balance.”</td>
</tr>
<tr>
<td>Motherhood</td>
<td>“I felt like I was missing out on too much. I could either do an okay job teaching, or I could do better at being a mom.”</td>
</tr>
<tr>
<td>Toll on Personal Life</td>
<td>“I’m at a point where I recognize that I have neglected relationships in the past - friendships, romantic/personal, and familial relationships, because I've been so focused on work.”</td>
</tr>
</tbody>
</table>
Support

Support, or the extent to which the participants felt valued for their abilities and supported in their work, was the third most significant major theme that emerged from the data. Mentors, colleagues, and organizational support were revealed to be the primary sources of support for the participants, and therefore formed the themes found within the major theme of support, as shown in Table 10. Of these three themes, mentors were referenced the most frequently, perhaps due to the impact they had on the participants’ career during formative experiences such as high school, college, and student teaching. The role of mentors was so significant that all 14 participants reported that the presence, or lack of, a mentor was an important component of their lived experience as a female high school physics teacher.

The participants also found their colleagues to be an important source of support, although not as significant as the support of mentors. Many of the women reported that unsupportive colleagues added the stress and pressure they felt during their first year of teaching. On the other hand, several women acknowledged the positive effect that supportive colleagues have on experiences as a high school physics teacher. The participants also found, to a lesser degree, support from organizations such as the American Modeling Teachers Association. They also referenced the importance of the support from Professional Learning Communities (PLCs) within their school and district because they were often the sole physics teacher in their building.
Table 10

Themes and Sub-Themes for the Major Theme of Support

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Files</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleagues</td>
<td>How colleagues have (or have not) supported participants in their teaching.</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>Mentors</td>
<td>How mentors have provided support in different stages of their careers</td>
<td>12</td>
<td>58</td>
</tr>
<tr>
<td>College</td>
<td>Support received during college experiences.</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>High School</td>
<td>Support received in high school.</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Student Teaching</td>
<td>Support (or lack of support) received during student teaching.</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Organizational Support</td>
<td>Support they received from school organizations such as administrative support, PLCs, and professional development.</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Administrative Support</td>
<td>Support they received from school administrators.</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Support they receive through effective professional development.</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Professional Learning Communities (PLCs)</td>
<td>The importance of PLCs to prevent isolation.</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Quotes from the participants that represent the themes and sub-themes of support are found in Table 11.
### Table 11

*Representative Quotes from the Major Theme of Support*

<table>
<thead>
<tr>
<th>Theme/Sub-Theme</th>
<th>Representative Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleague Support</td>
<td>“I think the people you work with are very important. That's probably what's kept me in it right now.”</td>
</tr>
<tr>
<td>College Mentors</td>
<td>“I think that having all the interest in physics in the world would not have helped me get into and through a master's program without that support from those people”</td>
</tr>
<tr>
<td>High School Mentors</td>
<td>“I had an incredible physics teacher in high school, for both regular physics and then AP Physics B. She was a young woman who looking back was probably my age now, in a similar life stage to me now when I was her student.”</td>
</tr>
<tr>
<td>Student Teaching Mentors</td>
<td>‘Being surrounded by and interacting every day with a really great woman in physics definitely helped. It helped my confidence, and it helped me realize what I could be doing better.’</td>
</tr>
<tr>
<td>Administrative Support</td>
<td>“I feel like when you have admin that fully support you and back you, it's so good. I have worked in schools where I don't feel like the admin was supportive and I hated it. It was just toxic.”</td>
</tr>
<tr>
<td>Professional Development</td>
<td>“Being trained by the American Modeling Teachers Association and being a part of their list servs have always been an important part of my career. My experience is that a lot of women do appreciate community, and that's one community for me.”</td>
</tr>
</tbody>
</table>

### Findings on Research Question One

RQ1: What are the lived experiences of female HS physics teachers who decided to leave the classroom?

Research question one focused on the lived experiences of female high school physics teacher who have made the decision to leave the classroom for another profession. Although at the time of the study only one participant in the sample had quit teaching high school physics, several other participants expressed a desire to leave the classroom but felt that financial realities and family responsibilities prevented them from
doing so. Wendy was one of these participants, and described her situation as the following, “I have kids to get through college and a house with a good size mortgage, and I’m kind at the point where I can’t do something else, I can’t switch schools without taking a massive pay cut. Even though these last couple of years I have felt like I’m just getting through, I’m too tired to investigate other options.”

The most influential factors in the participants’ desire to leave the classroom fell under the major themes of support and values. When the women did not feel adequately supported in their efforts to grow and develop in their abilities to teach high school physics, many reported feelings that they wanted to leave the profession. The participants also shared that they felt like leaving when the reality of teaching high school physics did not seem to align with their personal values such as helping others or having a family.

All 14 participants reported that inadequate support from colleagues and administration has caused them to consider leaving the classroom at some point in their careers. Often the women found themselves being the “singleton”, or the only physics teacher in their school, which meant that there were no other readily available teachers to collaborate with about physics content or pedagogy. Lauren described the effects of teaching in isolation by saying “I think that’s part of the reason we lose physics teachers so quickly. If you don’t have a support system of any kind in the building, it makes it very difficult.” Even when there were other physics teachers in their school, support from their colleagues was not guaranteed. As one of only three female physics teachers in a large school district with 11 high schools, Lauren stated that “I don’t think the male physics teachers realize that they come off as unapproachable, but they are”.

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The first year of teaching seemed to be particularly challenging for the participants in this study. Several women shared that a lack of support from colleagues who were unwilling to share resources or expertise during that year caused them to seriously consider leaving the classroom. Lauren described the lack of support she received during her first year of teaching this way, “I went in blind, and it was horrifying. Everybody knows the first year of teaching is the worst, but the first year of teaching and not having very supportive people around just added to that. I had to make everything from scratch. Nothing was ever offered to me, no help or advice.”

Another significant influence on the participants’ decision or desire to leave the classroom was a misalignment between their personal values and the realities of teaching high school physics. Wanting to or actually leaving a profession because it does not fulfill expectations based on personal values is grounded in Vroom’s (1964) Expectancy Theory, a major component of this research’s theoretical framework. Expectancy theory predicts that individuals are motivated to repeat actions if they result in expected outcomes based on the individual’s personal values. The theory also predicts that if expected outcomes do not occur as a result of an action, individuals will not continue to repeat that action (Vroom, 1964).

Yvonne, the only participant who actually left the classroom, explained how her expectations of teaching did not match up to its realities, which caused her to make the decision to leave. In her words:

No one really sugarcoats how awful that first year will be or how hard teaching is, so I knew it was going to be hard, and sometimes it hurts my pride to say that I just taught one year, and I got out of it. I had hoped that I could have tried more,
but I just wasn't worth it to me. There were too many things that were challenging about it. That was something that I could not do at that time in my life.

The participants also expressed a value conflict arising from the heavy workload and ever-increasing expectations associated with teaching high school physics. They reported that their personal relationships as well as their physical and emotional health have been negatively affected by the challenge of creating and maintaining a healthy work life balance, which often caused them to consider leaving the classroom. Brenda, who has been teaching high school physics for five years, explained her wish for a better work-life balance by saying “I am career orientated and want to do my job well, but I recognize that I’ve been putting in insane hours and I’m tired.” She also commented that she feels like she’s in a constant state of “When do I get to live?” due to her job’s heavy workload. Brenda also expressed that establishing a healthy work-life balance is more difficult for female teachers because “there’s a certain sense that as a woman, and as a teacher, you’re expected to give more of yourself than a man or someone in a different profession.”

The major theme of self-efficacy also played a role in the women’s thoughts of leaving the classroom due to the often significant obstacles they had to overcome, especially during their first year of teaching. Most of the participants (nine out of the 14) were not physics majors and described how difficult it was to add “teaching myself physics” on top of the steep learning curve associated with the first year of teaching high school. Paula recounted her experience with this issue by stating “I put everything I had
into studying physics and actually learning it so I could teach. It was painful; there were a lot of tears, a lot of grabbing the textbook and screaming why?”

**Findings on Research Question Two**

RQ2: What are the lived experiences of female HS physics teachers who remain in the classroom?

Research question two focused on the lived experiences of female high school physics teachers who have remained in the classroom. The overwhelming majority (13 out of 14) of the participant sample have chosen to continue teaching despite the challenges and ensuing thoughts of quitting addressed in research question one. Their rationales for remaining in the classroom include all three of the major themes of the research results: support, values, and self-efficacy.

All fourteen participants reported that support from their colleagues and administration was fundamental to their decision to remain in the classroom. Most of the women also shared that they would not have been able to face the challenges of their first year of teaching without the support of their colleagues. After describing her first year of teaching as “hanging on by a thread”, Mary explained how important the role of supportive colleagues was in her decision to remain in the classroom by recounting that “the three other physics teachers in the building took me under their wing, so I had mentors.” She also described the added benefit of organizational support during that pivotal first year by saying “the principal was so supportive, and teacher professional development was really strong, so I feel like I lucked out having some great ways to help me develop as a teacher.”
The support of colleagues and mentors continued to be important for the participants long after their first year of teaching. As Phyllis described, “the reason I’ve been so successful is that our science department is very collaborative, and we help each other”. Wendy also referred to the power of support from her fellow teachers by saying: I’ve had some incredible colleagues along the way. I have a group of women that we call “the sci gals” that are incredibly smart and dedicated to teaching. We’re all married and mothers, so we have a lot of common frustrations and tribulations. They are some of the women I respect and lean on the most.

The participants’ personal values also played an important role in their decision to remain in the classroom. According to Vroom’s (1964) Expectancy Theory, personal values form the basis of expectations, and individuals are motivated to repeat action when they result in their expectations being met. This theoretical framework helps to explain why the participants remained in the classroom where their value-driven expectations were being met.

Several women shared that they kept coming back to the classroom each year because teaching high school physics fulfilled their desire to help others. Patty expressed the desire to help her students by remaining in the classroom as follows, “I feel very good about the number of kids I’ve helped. If you think about the number of kids you see in a year and multiply that by 29, that's a lot of kids.”

Teaching high school physics also provided the participants with a vehicle by which they could help their students develop better thinking and problem-solving skills, which they valued. When asked what meaning she found in her lived experiences as a high school physics teacher, Wendy responded that “in the beginning, I would have said
the meaning is that kids need to know physics. Now, it's that kids need to learn how to think and work with each other. To persevere and find ways to solve problems.”

Importantly, the participants found value in their opportunities to teach their students that they “can do hard things” through the study of physics. Patty described it as:

If someone would go on to be a physicist or an engineer, that's great. I would love that. But really, it's just about hoping that they all think and that they'll try something that's hard and understand the joy that comes out of conquering that. There's so much self-satisfaction and joy that comes out of doing something hard and knowing that you figured it out.

Several of the women expressed that physics was the only subject that provided their students with these specific growth opportunities, and therefore found teaching high school physics to be rewarding and a profession that they wanted to continue in. Mary expressed this sentiment as follows, “I wouldn't be any other teacher than a physics teacher. I highly value the ability or the chance to teach kids how to think, how to reason, and how to be approach things logically.”

When asked what meaning they found in their experiences as high school physics teachers, 13 of the 14 participants cited the value they placed on building positive relationships with their students as the most meaningful aspect. They also reported that it was these relationships with their students that kept them going when they felt like quitting. Victoria explained her feelings about building relationships during her student teaching experience as follows:

“I'm getting to know them as a person and getting to know their lives, and helping them on their paths how to be a better person, or a better thinker, or
somehow, help them with future obstacles they might have. Being a part of that definitely has a lot of meaning to me.”

Lauren, a participant who has been teaching high school physics for 17 years, reported that her job has met her value-driven expectations in some ways, but not in others, and she is comfortable with that. She also shared that her valued expectations have shifted over time from focusing on content towards building relationships with her students. She said “I feel like the relationship I have with my kids makes it so much more worthwhile. You know, it's not what I thought it was going to be, but not in a bad way.” She finds inspiration and satisfaction from her role as a high school physics teacher and has adjusted her expectations as she gained more experience in the classroom. She summed it up by saying, “I still feel like I did when I first started out and was bright eyed and bushy tailed. Yeah, maybe I'm a little more cynical, but I also know a lot more now than I did then.”

Many of the participants also shared that they viewed themselves as a role model for their female students and therefore it was important for them to stay in the classroom where they could continue to set an example for their students. Rachel described her desire to be a role model for her students by the following:

I do think about the young women in my classes, and I think it's really important for me to be a role model for women to say you can do this, too. You know, women can be good at math. Women can be good at physics. Women can be confident. Women can be problem solvers. Women can be scientists.

Many of the participants reported that their growing sense of self-efficacy was another motivating factor for remaining in the classroom. Self-doubt and experiences
with imposter syndrome at the beginning of their career were cited by many participants, but their confidence grew as they conquered the content and experienced success in the classroom. Brenda described her gained confidence by stating “I wouldn't say killing it. I'm not going to say I'm the best teacher, but I feel like every single year I get better at my job, and I can see the growth.”

Many of the women reported that the “grit” associated with the self-efficacy theme of overcoming obstacles kept them from leaving the classroom. Megan explained by saying “Maybe it’s the tenaciousness that women tend to have more than men that has kept me going.”

Most of the women in this study expressed that this personal growth was an important motivation for continuing to teach high school physics. Megan described the personal growth she witnessed in herself and her students with the following:

Seeing that personal growth in myself, and in my students, as they went from regular physics with me to AP physics with me, it was really inspirational. That may not be quite the right word, but it was encouraging. It was really encouraging to see that who we are right now isn't who we have to be forever. You know, we, all of us are absolutely capable of change.

Another significant component of the theoretical framework for this research is the concept of Physics Identity, or the identification of oneself as a physics person (Hanzari, et al, 2010). The participants in this study shared their physics identity has changed as a result of teaching high school physics. Most of the participants reported that their physics identity increased through teaching, and provided that a better understanding of the content because of teaching was one of the significant reasons for
this growth. In Mandy’s words, “because I try to make physics visible to my students, it's become visible to me. So yeah, I would say my physics identity has definitely increased since starting just because I understand it so much better.”

Sometimes the participants reported that their physics identity increased by teaching the subject because they did not initially have a strong background in physics. Megan described this as the following “at first, I did not feel like a physics person. I felt like a biology person trying their best to figure out the physics. But I think by the end of my first year, I absolutely saw myself as a physics person.” Other participants, such as Olivia, were physics majors but still found that teaching the subject increased their physics identity, perhaps through their increased self-efficacy. Olivia said the following about her physics identity after completing student teaching: “It’s still weaker than it probably should be, but it definitely got a little stronger.”

**Findings on Research Question Three**

RQ3: What organizational practices seem to support the retention of qualified HS female physics teachers?

The focus of research question three was identifying the organizational practices that seem to support the retention of qualified female high school physics teachers. Support is an important organizational factor in retaining female high school teachers as evidenced by the fact that all the participants reported that a lack of support from colleagues and administration caused them to consider leaving the classroom at some point.
Support for female high school physics teachers can take the form of Professional Learning Communities (PLCs), where teachers of similar content collaborate on lesson planning, pedagogy, and assessments. Many participants in this study, such as Lauren, reported that it was difficult to form PLCs because they were often the only physics teacher in their school building. Lauren described the importance of PLCs as a source of support by saying “That's the thing I didn’t like about my previous district. Zero support. They don’t encourage PLCs. I was the only teacher in the building, I was the only one who specialized in my content area.” In cases such as Lauren’s, school administration and teacher leaders such as the science department chair could connect the physics teachers in their building with other physics teachers in the district to form a PLC.

Support can also take the form of meaningful professional development, which many of the participants cited as beneficial to their instructional practices and sense of professionalism. Mary describes the positive effects of professional development as follows:

There's nobody in my building for me to really work with physics wise, but being trained by the American Modeling Teachers Association and being a part of their list servs has always been an important part of my career. My experience is that a lot of women do appreciate community, and that's one community for me. It's been beyond just colleagues because as a physics teacher, you would have to be in a pretty big school to have another physics teacher to collaborate with.

Several participants reported that professional development opportunities in their school and district were rarely valuable to their role as a female high school physics teachers, so
involving the teachers in the decision-making process of designing professional development opportunities would be a valuable organizational practice as well.

Another organizational factor that can contribute to the retention of female high school physics teachers is the school’s master schedule. Overloading new female high school physics teachers with several preps during their first year could cause them to become burned out and leave the profession. Wendy, the science department chair at her school, did this practice by the following:

We used to give new teachers the very worst schedule, but I try really hard to give them a couple of courses to get good at before we start switching things around. I also try to give everyone no more than two preps.

Unrealistic demands on teachers such as expecting them to sponsor clubs is another organizational practice that can lead to the attrition of female high school physics teachers. Yvonne, the only participant in the sample who left the classroom for another profession, noted the effect that extra-curricular expectations on her decision to leave the classroom by saying, “preparing for three different classes on top of starting robotics club on top of doing the science fair? That’s just far too much work for a first-year teacher. Even for a ten-year teacher, that’s a lot.”

Work life balance was important to the participants in this study, and an overwhelming workload was cited as a reason for wanting to leave the classroom. Yvonne did leave the classroom and referenced how the heavy workload of her teaching job prevented her from maintaining a healthy work-life balance. She represented her feelings by stating:
It was challenging to juggle the stress and the workload with actual living. And I wanted to live, I wanted to gain experiences. I wanted to be able to go out on the weekends and hang out with my friends. You know, it was just too much from my perspective.

**Summary of Findings**

Although each of the fourteen women who participated in this research shared unique lived experiences, three major themes emerged when I analyzed their interview data. The most significant major theme, self-efficacy, was characterized by the earned confidence the participants gained by overcoming obstacles and conquering their feelings of inadequacy. Values held by the participants comprised the second most significant major theme, with the greatest value being placed on relationships with their students, followed by maintaining a healthy work-life balance. Also of value to the participants were facilitating their students’ growth and the belief that teaching is important work. The third most significant major theme of the data was support, particularly from mentors. Colleagues and school organizations were also found to be sources of support for the participants.

The findings of the data analysis were then used to answer the study’s three research questions, which focused on describing the lived experiences of participants who decided to leave the classroom (RQ1) and those who remained teaching (RQ2), as well as the organizational factors that seemed to encourage their retention (RQ3). Although only one of the 14 participants left the classroom permanently, several of the women stated that they had thought of leaving, especially during their first year of teaching. The most common reasons the participants gave for leaving (or wanting to leave) were a lack of
support, a mismatch between what they valued and the reality of teaching high school physics, and the effect of the obstacles associated with teaching had on their self-efficacy. Conversely, the participants referenced adequate support and an alignment with their values as reasons to remain in the classroom. Lastly, examples of organizational practices that supported retention of the participants in their role as high school physics teachers were revealed. Those practices included creating mentorships, providing meaningful professional development, creating connections through professional learning communities (PLCs), and supporting teachers during their first year in the classroom.

**Trustworthiness**

The participatory nature of qualitative research requires that researchers build rapport and trust with participants. Therefore, researchers must ensure that their interpretations of the data are transparent and trustworthy (Marsh et al. 2022). In fact, trustworthiness in qualitative research encompasses the constructs of credibility, dependability, transferability, and confirmability, as distinct from descriptions of validity and reliability found in quantitative research (Lincoln and Guba, 1985). Of the ten trustworthiness procedures recommended by Marshall et al. (2022), eight were incorporated into this research. Specifically, the trustworthiness procedures I followed in this study were the following: crystallization, comparison, reflexivity, collaboration with participants, member checking, the use of rich data, peer debriefing, and developing an audit trail.

Crystallization, also known as triangulation (Marshall et al., 2022) is a trustworthiness procedure that synthesizes data from multiple sources (Creswell & Poth, 2018). In this research, I used demographic data such as age, ethnicity, and years of
experience from the follow-up questions outlined in Chapter 3 to support the analysis of the interview data. This demographic data was also used during the trustworthiness procedure of comparison when I compared data from teachers based on their years of teaching experience.

The trustworthiness practice of reflexivity includes creating positionality statements and recording self-reflections in field notes (Marshall et al., 2022), both of which I followed in this research by maintaining a reflexive journal that I used throughout the interviewing and data analysis process. Reflexivity also requires that researchers possess self-awareness of their potential biases and predispositions (Klenke, 2016). As a former female high school physics teacher myself, many of the participants’ thoughts and feeling resonated with me, and I had to make sure to set aside my own reactions to focus on their authentic stories. I achieved this through the consistent practice of bracketing (Moustakas, 1994), to set aside my personal biases due to my own experiences.

I collaborated with the participants during their interviews by eliciting their reflection as recommended by Marshall et al. (2022). The participants were also reflective of their words and meaning when they reviewed their interview transcripts and provided final approval. By asking the participants to review their transcript interviews and making resulting revisions, I also employed the trustworthiness practice of member checking (Marshall et al., 2022). Another participant collaboration and member checking procedure I followed was providing the participants multiple opportunities to refine and eventually approve their participant description included in this chapter.
As a former female high school teacher, I was able to establish an “insider” status that helped me build rapport and trust with the participants, which allowed them to share their experiences freely and deeply without fear of judgment. The participants were comfortable providing a great deal of detail in their responses, which resulted in rich data with thick descriptions, a trustworthiness procedure recommended by Klenke (2016).

Trustworthiness was also supported by sample coding of a participant interview by a peer acting as a critical friend (Marshall et al., 2022). The critical friend coding the sample interview was a high school science teacher who recently and successfully completed her dissertation which included the coding of qualitative data. Her open coding differed from mine in that it was more general and contained fewer individual meaning units. The names given to the individual meaning units also differed slightly from mine. For example, the code “liked the content” was used by the critical friend instead to describe a specific meaning unit, while I used the code “grown to appreciate physics”. The critical friend also found the same three major themes that I did but gave them slightly different names. Her theme of “imposter syndrome” was very similar to the major theme of self-efficacy that I found and her theme of “professional learning community” corresponded to my major theme of support. Lastly, her theme of “meaning” was very similar to the major theme of values that I found.

During the data collection and ensuing analysis process, I utilized the trustworthiness practice of developing an audit trail. The audit trail was a transparent record of data through the use of field notes and analytic memos (Marshall et al., 2022). I also maintained a detailed record of the nine coding iterations outlined in this chapter, recording each decision in the audit trail.
Chapter 5: Discussion, Conclusions, and Implications

The aim of this research was to gain insight into why female high school physics teachers remain in the classroom or decide to leave the profession through a study of their lived experiences. It was conducted to fill the gap in research on recruiting and retaining female high school physics in the United States (Hazari et al., 2007). The conceptual framework for the study shown in Figure 9 was based on how the relationship between the participants’ physics identity, lived experiences, and the organizational factors of their school affected their career status. The theoretical framework used to provide insight into the participants’ motivations was based on Vroom’s (1964) Expectancy Theory and Hazari et al.’s (2010) model of Physics Identity.

Figure 9

*Conceptual Framework for Research of Female High School Physics Teachers*
A transcendental phenomenological research approach was employed to capture the experiences of 14 women, all current or former high school physics teachers with varying years of experience. The women were interviewed using Seidman's (2019) phenomenological inquiry method, which consists of an in-depth, open-ended, three-part interview about the participants' past and present experiences with the phenomenon of being a female high school physics teacher, as well as the meaning they give those experiences. In this final chapter, I discuss the findings of the research and its limitations, reflect on the research methodology and impact on the participants, reveal connections between the findings and previous literature, and outline implications for future practice and research.

**Discussion of Findings**

Three major themes of self-efficacy, values, and support emerged from the research when I analyzed the participants’ interview data. Of these three major themes, self-efficacy was the most significant. The participants’ self-efficacy was determined by the earned confidence they gained by overcoming obstacles as well as their initial feelings of inadequacy. The second most important major theme was values, as determined by the participants’ personal beliefs. The women in this study placed the most value on their relationships with their students, followed by a healthy work-life balance. Also of value to the participants were their students’ growth and the importance of teaching as a profession. The third most significant major theme of the data was support. The participants referenced receiving the most support from mentors, followed by colleagues and their school organizations.
I used these major themes, as well as their corresponding themes and sub themes to answer the study’s three research questions. The research questions were designed to shed light onto why female high school physics teachers leave the classroom (RQ1) or continue teaching (RQ2), as well as what organizational factors may support their retention (RQ3).

**Research Question One**

RQ1. What are the lived experiences of female HS physics teachers who decided to leave the classroom?

**Values.**

The major theme of values played a significant role in addressing RQ1. An important reason participants gave for leaving (or wanting to leave) the classroom was a mismatch between their values and the realities of teaching. These results align with a critical component of the research's theoretical framework, Vroom's (1964) Expectancy Theory, which is based on the premise that individuals are not motivated to continue behavior if it does not result in an expected outcome based on their values (Natemeyer & Hersey, 2011).

Yvonne, the only participant who left the classroom, shared that she started her first teaching job with optimistic expectations of helping students appreciate physics and develop their problem-solving skills. However, she quickly realized that those expectations needed to align with the overwhelming workload and pressures associated with teaching. After only two months into the school year, she began considering changing careers. This feeling of being overwhelmed has also been identified by previous
research as a reason women consider leaving the classroom as they struggle to balance teaching demands such as lesson planning, classroom management, regulating their emotions, and maintaining the appearance of competency (Gillespie & Thompson, 2021). This participant left the classroom after one year for an engineering position, which aligns with research proposing that mathematics and science teachers are more likely to leave because they are more likely than other teachers to have alternative career options in the business and technological sectors, often with higher salaries (Ingersoll & May, 2010).

**Support.**

The major theme of support was also integral to answering RQ1. All 14 participants reported that a perceived lack of support from colleagues and administration was the primary reason they considered leaving the classroom at some point in their careers. Their experiences coincide with previous research showing that a lack of support from school leadership is a significant contributor to teacher job dissatisfaction (Carver-Thomas & Darling-Hammond, 2017).

**Self-efficacy.**

The major theme of self-efficacy also addresses RQ1 due to its inclusion of the theme of overcoming obstacles. The challenge of first year teaching was one obstacle that all 14 participants shared. Each participant shared that she considered leaving teaching after the first year when most teachers are particularly vulnerable to burnout and work-related stress (Chambers Mack et al., 2019). Most of the participants also described struggling with learning or relearning physics content during their first year of teaching.
and often feeling isolated as the only physics teacher in the building. This discomfort with professional isolation aligns with research showing that women desire a sense of community in the workplace (Eccles, 2007). The sense of isolation, coupled with a self-perceived inadequate physics content background, caused several participants to experience imposter syndrome, which is linked to a greater likelihood of considering leaving the field of physics (Ivie et al., 2016).

Several participants also cited the obstacles associated with the COVID pandemic as a reason why they considered leaving teaching. They shared that the combination of virtual and hybrid learning changed their working conditions so dramatically that it was disorienting. The women also described that their students' academic behaviors have been permanently and negatively affected by the pandemic and that teaching is more complex and less joyful. These shared experiences align with research showing that American teachers considered leaving the profession or retiring due to the pandemic (Zamarro et al., 2022).

**Research Question Two**

RQ2. What are the lived experiences of female HS physics teachers who remain in the classroom?

**Self-efficacy.**

Many participants reported that their growing sense of self-efficacy in teaching high school physics was a motivating factor for remaining in the classroom. Many participants cited self-doubt and experiences with imposter syndrome at the beginning of their careers. However, their confidence grew as they conquered the content and
experienced success in the classroom. Several participants shared that their Physics Identity and self-efficacy increased by observing their impact on their students, particularly their female students, which aligns with research showing that social factors may significantly affect the development of women's physics identity (Wulf et al., 2018). The teachers participating in this research also modeled for their students that physics self-efficacy, or the belief that an individual can succeed in physics, impacts engagement, learning, and achievement in physics (Sawtelle et al., 2012; Cavallo et al., 2004).

Four of the participants in this research reported that their “grit” was the primary reason for remaining in the classroom because they had reached a point in their careers where it was simply too difficult to make any significant changes. This viewpoint is supported by research showing that compared to younger teachers, mid-career stage teachers are less likely to decide to leave the profession (Shakrani, 2008), perhaps due to financial considerations such as yearly salary increases and their retirement (Cooper & Davey, 2011). One participant specifically shared that she remained in the classroom because she was the primary financial support for her family, a phenomenon supported by previous research on teacher retention (Cooper & Davey, 2011).

Values.

The participants' personal values also played an essential role in their decision to remain in the classroom. 13 of the 14 women reported that building positive and supportive relationships with their students was the most meaningful aspect of their job and kept them motivated when they felt like quitting. The participants' value of nurturing their students is reinforced by research showing that women are more likely than men to
have professional goals defined by collaboration and helping others (Diekman et al., 2011; Wegemer & Eccles, 2019).

Their challenges in learning physics in high school and college caused the participants to understand the importance of supportive relationships with their female students. Several women shared their practices of intentional support and encouragement for the girls in their classroom. These practices included strategies such as calling on female students and providing them with positive feedback, which coincides with actions that enable a student to view herself as a member of a physics community (Hodapp & Hazari, 2015), which may result in a strengthening of their female students' Physics Identity (Hazari, et al., 2010), another theoretical framework of this research.

Many participants also shared that they valued serving as role models for their female students and stated that it was vital for them to stay in the classroom to continue to set an example for their students. Their views are supported by research showing a positive correlation between gender-matching female students to their high school physics teachers and an increased interest and persistence in physics (Dulce-Salcedo et al., 2022; Seyranian et al., 2018). Several participants reported that they found meaning in modeling that achievement in physics is not mutually exclusive to other feminine roles such as motherhood, coinciding with research identifying that a benefit of gender matching female students with their physics teachers included a decreased sense of social identity threat (Herrmann et al., 2016). Many of the participants also reported having frank discussions with their female students and student teachers about their own educational and professional experiences, which lines up with research showing that personal discussions regarding issues that women face in pursuing physics may help
female students realize that the feelings of inadequacy or discomfort they might have about physics stem from external norms and pressures rather than from their capabilities, interests, or values (Hazari et al., 2013).

**Support.**

All fourteen participants reported that support from their colleagues and administration was fundamental to their decision to remain in the classroom. Most of the women also shared that they would only have been able to face the challenges of their first year of teaching with the support of their colleagues. The positive effect of supportive colleagues coincides with research conducted by Fresko, Kfir, and Nassar (1997) that determined the only direct prediction of teachers' job commitment was job satisfaction and that some of the most critical factors that lead to teachers' job satisfaction are support from colleagues and positive interpersonal relationships with fellow teachers and administrators (Butt et al, 2005; Van Maele & Hutte, 2012).

**Research Question Three**

RQ3. What organizational practices seem to support the retention of qualified HS female physics teachers?

**Support.**

Organizational practices beneficial to retaining female high school physics teachers in the classroom fell under the major theme of support. Organizational support, one of the themes found under the umbrella of the major theme of support, was particularly relevant in addressing RQ3. Several of the participants cited a need for Professional Learning Communities (PLCs), organizational structures that support their
collaboration with other high school physics teachers on lesson planning, pedagogy, and assessments. The positive impact of PLCs has been reflected by research conducted on high school teachers by Newton (2017), which revealed that the top reason for job satisfaction was the presence of strong, positive relationships with departmental colleagues.

Many participants in this study reported that it was difficult to form PLCs because they were often the only physics teacher in their school building. This feeling was echoed in research showing that high school physics teachers often reported pervasive feelings of isolation, poor self-efficacy, limited professional agency, and a desire for pedagogical collaboration (Nehmeh & Kelly, 2018). They also reported a need for more administrative support and meaningful feedback and mentoring, which led them to seek their own networks for planning curriculum, instruction, and laboratory experiences (Nehmeh & Kelly, 2018).

Several participants in this research cited the importance of organizational support in the form of meaningful professional development. These participants reported that quality professional development made a significant difference in their self-efficacy and overall job satisfaction. This perspective is supported by research showing that professional development opportunities are important to teacher satisfaction and commitment, in addition to relationships with administrators, colleagues, and students (Pederson & West, 2017). Several participants reported that professional development opportunities in their school and district were rarely valuable to their role as female high school physics teachers, a sentiment reflected in research that showed physics teachers
report a lack of professional opportunities for collaboration, advancement, and academic progress (Pirkle, 2011).

Because all 14 participants reported that their first year of teaching was challenging and caused them to consider quitting, a robust support system for first-year teachers is an organizational factor that may have a significant impact on retention. This factor aligns with Darling-Hammond et al. (2019) recommendations for improving teacher retention through support and mentoring for novice teachers with practices such as seminars, coaching, and mentoring.

Strong support and leadership from the participants' administration were also frequently cited as organizational factors influencing their decision to remain in the classroom. One of the participants also described a lack of support from administrators as the reason they considered leaving teaching. The effect of this lack of administrative support coincides with research conducted by Gui (2019), who found that the principal's role in building a positive school culture, along with the principal's behaviors, practices, and leadership capacity, significantly affects teacher satisfaction and retention.

Limitations of Findings

The most significant limitations of findings from this research resulted from the demographics of the participant sample. One of the study’s three major research questions focused on why female high school physics teachers leave the classroom, yet only one of the 14 participants (Yvonne) had actually did. Although Yvonne was the only participant who quit the profession, several other participants reported that they also wanted to leave the classroom at times, but could not due to financial considerations. As
a result, their experiences were valuable in addressing the research question of why female high school physics teachers leave the classroom. Yvonne also left teaching after her first year, which aligns with research showing that new teachers are more vulnerable to burnout and stress and are more likely to quit during their first year (Mack et al., 2019). Including teachers in the sample who quit after several years of teaching would have enhanced the findings of the research.

Another limitation to the research findings resulted from the level of diversity found in the participant sample. Of the 14 teachers, only three were women of color. These three women included a Latine, an Asian and White woman, and an Asian Indian American woman. (The participants self-identified their ethnicity). Although I made concerted efforts to include women of color as participants, especially African American women, the participant sample was primarily made up of white women. This lack of diversity limited the research findings because they did not include lived experiences of African American women. The phenomenon of being a female high school physics teacher would have had a richer narrative if this research had included more women of color its participant sample.

The geographic location of the participants in the sample also limited the research findings. The participants were all current or former teachers in the states of Ohio and Tennessee, locations chosen because of my professional and personal connections in my home state (Ohio) and my current state of residence (Tennessee). With one exception, the participants were also current or former teachers in schools located in suburban areas or mid-size cities. The results of the findings may have been more insightful and expansive
if they had included participants from other areas of the United States and larger cities or rural areas.

A final limitation to the research findings was the reliance on the professional organization of the American Association of Physics Teachers (AAPT) as a method of participant recruitment. Because I knew four of the 14 participants as former college classmates and colleagues, I was able to easily contact them through social media messages or personal email. Four other participants were referred to me by these initial connections. I located the six other women in the sample by utilizing the AAPT membership list to recruit participants. Including more women who were not members of AAPT would have enriched the findings of this research, especially since two of the participants stated that membership in professional organizations was a source of support.

**Researcher Reflections**

**Personal Reflections on Research Methodology**

Because this study was a phenomenological study, I used Seidman's (2019) phenomenological inquiry method for interviewing which consisted of an in-depth, open-ended, three-part interview about the participants' past, present, and essential experiences with the phenomenon. Although this method allowed the participants to speak freely and create a rich narrative of their experiences, it often made it difficult to connect the resulting data to the three major research questions or to the two theoretical frameworks. Only after nine coding iterations of the interview data did I gain a clear understanding of the major themes of the data (and their corresponding themes and subthemes) and how they addressed the research questions, as well as how they were supported by the theoretical framework.
Spending so much time with the participants’ interview data proved to be a valuable experience, however, since I developed a rich context for the research findings in the process. I also spent a great deal of time bracketing off my own experiences during this extended period of data analysis, which provided me with ample opportunity for self-reflection. Through this self-reflection I found myself coming to terms with my own feelings of inadequacy as a former female high school physics teacher and my lingering resentment towards several of my former male colleagues and administrators.

Interviewing the women in this research was truly one of the most rewarding experiences of my life. I felt honored to have the opportunity to hear their stories in their own words without the constraints of structured questions. I also felt a healthy sense of responsibility to represent their stories with fidelity and experienced a deep sense of community through our member checking procedures when they provided feedback about their transcripts and participant descriptions. Most importantly, I was struck with a deep admiration for the participants and how they overcame the challenges associated with teaching high school physics. As a result, I walked away from this research feeling very proud to have shared similar experiences with this group of strong, intelligent, and caring women. I also gained a strong motivation to make the women proud of research that they were so essential to. Whenever I felt like giving up on completing this research, I thought about the perseverance and grit of the participants and pressed forward. Because as in the words of the participant Megan, “women know that when stuff is hard, we just have to push through it. Because if we don’t, who will?”
**Reflections on Research Participants**

The participants in this research demonstrated a great deal of generosity in sharing their stories with such transparency and authenticity. They were also generous with their time, spending up to 90 minutes of their personal time for their interview after teaching all day and or during the weekend. As a testament to the multiple roles and responsibilities of the women included in this research, participant Laura made a meatloaf for her family during our virtual interview and effortlessly juggled preparing dinner for her family while she reflected on her lived experiences.

Yet despite the sacrifices they made by participating in this research, the women expressed gratitude to be included in the study and thanked me for the opportunity to tell their stories. Additionally, each of the participants expressed their good wishes to me on my research journey and assured me that they would support me by providing any additional information that I needed. Several participants also requested that I send them my final dissertation and expressed how important they found the research topic to be. One of my trustworthiness practices is to send each of the 14 participants a copy of my final dissertation and my hope is that when the women read it, they will be as proud of themselves as I am.

**Implications for other Researchers**

Researchers interested in this study can benefit from my description of how transcendental phenomenology can be used to shed light on pragmatic issues such as the retention of female high school physics teachers. As a result of this study, future researchers can see that providing participants with the opportunity to freely share their experiences can yield answers just as well as structured questions that focus on research
goals. Most importantly, this study may inspire researchers to provide more opportunities for women to tell their stories and know that their voice is being heard but valued.

**Implications for Future Practice in Local Context**

**Implications for Female High School Physics Teachers**

Because the most significant major theme of the research data was self-efficacy, women facing the challenges of teaching high school physics should focus on their strengths and accomplishments instead of on their feelings of inadequacies. Recognizing and celebrating evidence of the value they bring to their students each day would be a beneficial practice. Practicing a growth mindset would also be helpful for increasing self-efficacy. Participant Megan summed up this practice in her statement “I’m not looking for huge wins. I’m happy with these small wins. They’re what really keep me going.”

The major theme of values was also of great significance to the participants in this study. Therefore, women teaching high school physics should also identify and acknowledge the values that are important to them and take efforts to fulfill them through their work. The research participants placed the greatest value on relationships with their students, so establishing connections with and nurturing their students may be important practices for female high school physics teachers. Maintaining a healthy work life balance was also very important to the participants in this study, so creating boundaries between their professional and person lives would also be a beneficial practice for women teaching high school physics. Lastly, the participants in this study also valued their students’ growth, particularly their thinking and problem-solving skills and their perseverance through difficult situations. Practices that would support this value are
providing students with a rigorous curriculum and high expectations that require students to challenge themselves, as well as modeling these valued qualities in the classroom.

The major theme of support implies that female high school physics teachers provide the level of support for each other that they themselves would like to have. This support could take the form of collaborating with each other to create resources and assessments, sharing lab equipment, and providing guidance about issues with students or colleagues. Because all of the 14 participants reported that they felt like quitting during their first year of teaching, supporting new teachers is an especially important practice. The participants referred to mentors as their most important source of support throughout their lived experiences, so seeking out mentorship during the first year of teaching or serving as a new teacher’s mentor are valuable practices for women teaching high school physics.

**Implications for High School Leaders**

Because the second most significant major theme of the research results was values, high school leaders must acknowledge the fact that female high school physics teachers are motivated when their professional responsibilities align with their personal values. The participants in this research placed the highest value on the relationships they have with their students so school leadership should create opportunities for their teachers to connect with students and contribute to social-emotional learning practices in their school. A healthy work-life balance was also valued by the participants in this research. School leadership practices that would support this balance include not overloading physics teachers with multiple preps and additional expectations such as sponsoring extracurricular activities, particularly during their first year of teaching when they are
more likely to quit. The participants also valued their students’ growth and an appreciation for the importance of teaching as a profession. School leaders could support these values by acknowledging the professionalism of teachers by providing them with the freedom to develop challenging curriculum and maintain high expectations for their students and themselves.

Support was another major theme of the research results, and school leaders can demonstrate their support of female high school physics teachers through practices such as providing physics teachers with common planning periods to foster collaboration. The first year of teaching is a particularly vulnerable time for a woman teaching high school physics. Therefore, school leaders should establish a strong support system for new teachers through practices such as mentorship programs where they are paired with another, more experienced physics teacher.

**Implications for School Districts**

Because it is a common occurrence for high schools to have only one physics teacher in the building, school districts would be wise to employ practices such as developing district wide PLCs for physics teachers where they can connect and collaborate with each other. The participants in this research also listed meaningful professional development as an important source of organizational support for their teaching. While individual high school leaders may not have the bandwidth to provide adequate professional development opportunities for the single physics in their building, leaders at the district level do. Therefore, important practices for school district leadership include providing meaningful professional development opportunities based
on physics content and pedagogy and involving physics teachers in the design of these opportunities.

**Implications for Future Research**

Including more women of color, particularly African American women, in a future study would be an important focus for future research. Their voice was not captured in this research into the lived experiences of female high school physics teachers and should be included in future research as an essential aspect of the phenomenon. More geographical diversity of participants in future research would also be beneficial. Including participants from rural or larger urban school districts, as well as more teachers from private or charter schools would also contribute to the richness of future research.

Because the participant sample only included one female high school physics teacher who left the classroom, including more teachers who left the profession could provide additional clarity into their decision to quit. Additionally, the participant (Yvonne) left after her first year of teaching, which is the time when teachers are the most likely to quit. It would be valuable to conduct similar research as this study with teachers who quit after several years of teaching or even mid-career to gain insight into their decision to leave.

Another vital research opportunity would be to focus on female high school physics teachers who want to quit but cannot due to concerns about financial security and family obligations. These teachers represent a wealth of knowledge, skills, and expertise that could be utilized in different capacities so that the women could find satisfaction and motivation in their careers.
Because each of the participants reported struggling with self-efficacy and a lack of support during their first year of teaching, it would be valuable to research best practices for creating and maintaining effecting mentorship programs for new teachers. An additional layer would be to research the effectiveness of current mentorship programs in helping retain female high school physics teachers specifically.

Meaningful professional development opportunities were cited by several of the participants as an important source of support. As with the aforementioned mentorship programs for new teachers, research into best practices for professional development designed specifically for female high school physics teachers would be of value, as would studying its effect on their retention.

Although this research focused on the phenomenon of being a female high school physics teacher, it would be of interest to discover whether male and LGBTQ+ high school physics teachers experience a similar phenomenon. Specifically, it would be revealing to compare their answers to the question about the meaning of their experiences. Would they respond similarly to the women, who were motivated personal values as nurturing students? It would also be interesting to discover whether they report struggling with self-doubt and the imposter syndrome at the start of their career and whether they cite the importance of support from their colleagues and administration.

Lastly, because the impetus for this research was the gender disparity found in physics, it would be important to extend this research to the effect that having a female physics teacher during high school has on their female students. Almost all the participants in this research noted that they valued serving as a role model for their female students. For this reason, it would be of value to research whether the participants’
female students shared similar experiences as their teacher who acted as role models.
Specifically, did the young women feel supported by their teachers and view them as mentors? Were they more likely to follow in their teachers’ footsteps and enter physics or teaching physics as a career? It would also be valuable to research whether the participants’ female students experienced an increased self-efficacy and stronger physics identity by having a woman as their high school physics teacher.
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https://phystec.org/highly-qualified-teacher


Appendices

Appendix A: Participant Interview Questions

Part I: Tell me some of your background that led you to become a physics teacher.

Part II: What are/were your experiences as a high school physics teacher?

Part III: When you think about what you have shared, what meaning do you find in your experiences?
Appendix B: Invitation Letter

Date

Hello ____,

I’m contacting you with the hope that you will participate in my dissertation research about female high school physics teachers. This research will provide women with an opportunity to make their voices heard by describing how their backgrounds and experiences have influenced their career.

Participation includes answering three, open-ended questions about your past and current experiences, as well as about the meaning they hold for you. Each interview will take approximately 30 minutes, for a total of 90 minutes of interview time. The transcript of your interview will be returned to you so you can check it for accuracy. As a former female high school physics teacher of many years, I am so excited about this research! Historically women have often been denied the opportunity to speak their truth and I am thrilled to provide this opportunity through my dissertation research.

If you are able to participate, please look at the attached consent form to make sure you have all the information needed to decide. I will be scheduling interviews from January 10, 2023 through June 10, 2023 so if you wish to participate, please let me know a couple of dates/times that work for you and I can confirm a schedule with you.

Thank you so much and I’m really looking forward to hearing your story!

Hope Strickland
INFORMED CONSENT FORM FOR RESEARCH
Teaching physics while female: A phenomenological study of female high school physics teachers

Key Information
Your consent is sought to participate in this research study which focuses on capturing the phenomenon of being a female high school physics teacher. Your participation is voluntary and consists of a series of three open-ended interviews about your experiences teaching high school physics. The interviews can take place in person or virtually at the participant’s discretion. The focus of the first interview is the background and experiences that led you to become a high school physics teacher, the focus of the second interview is your current or former teaching experiences, and the focus of the interview is the meaning that you find in your experiences. Each interview should take approximately 30 minutes, for a total interview time of 90 minutes.

There are no reasonably foreseeable risks to participants in this study and participants may benefit from the opportunity to reflect on their experiences and learn more about themselves.

About This Research Study
You are being asked to participate in a research study. Scientists do research to answer important questions which might help change or improve the way we do things in the future. This consent form will give you information about the study to help you decide if you want to participate. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Hope Strickland, College of Health, Education, and Human Services, under the direction of Dr. Yoko Miura, College of Health, Education, and Human Services, Doctor of Organizational Studies Program Director

Why is This Study Being Done?
The purpose of this study is to understand the phenomenon of being a female high school physics teacher. You were selected as a possible participant because you are a former or current female high school physics teacher. If you agree to participate, you will be one of 5-10 participants taking part in this study.

Taking Part in this Study is Voluntary
You may choose not to take part in this study or choose to leave the study at any time. Deciding to not participate, or deciding to leave the study later, will not result in any penalty or loss of benefits to which you are entitled. You can skip any interview questions that make you uncomfortable and can stop the interview at any time.
What Will Happen During the Study?

If you agree to be in this study, we would ask you to do the following:

- Help determine the time, date, and location of the interviews in coordination with the principal investigator, Hope Strickland
- Participate in three, open-ended interviews and truthfully answer the interview questions truthfully with as much detail as possible
- Double check the interview transcript for accuracy
- Provide feedback on the themes derived from your interview results.

Participation in the study involves the following time commitment: approximately 90 minutes (three, 30 minute open ended interviews)

What are the Risks of Taking Part in the Study?

The study involves the following foreseeable risks or discomforts: possible discomfort when describing negative experiences

In order to assist with the offset of these risks, protection of participants will be provided by discontinuing the interview at the participant’s request. No funds have been set aside by Wright State University to compensate you in the event of illness or injury. However, you are not giving up any legal rights or benefits to which you are otherwise entitled.

What Steps Are Being Taken to Reduce Risk of Coronavirus Infection?

The following steps are being taken to address the risk of coronavirus infection:

Screening: Researchers and participants who show potential symptoms of COVID-19 (fever, cough, shortness of breath, etc.) will NOT participate in this study at this time.

Physical distancing: Whenever possible, we will maintain at least 6 feet of distance between persons while conducting the study.

Mask/Covering: Researchers will wear and participants will be advised to shield their mouth and nose with a cloth face cover or mask during the study, even when maintaining at least 6 feet of distance. Tissues will be available to cover coughs and sneezes.

Handwashing: Researchers and participants will wash hands before/during [activity] or use a hand sanitizer.

Disinfecting materials: When feasible, researchers will clean and disinfect surfaces between participants, using an EPA-registered disinfectant or a bleach solution (5 tablespoons of regular bleach per gallon of water) for hard materials and by laundering soft materials. Disinfected materials will be handled using gloves, paper towel, plastic wrap or storage bags to reduce the chance of re-contamination of materials.
Electronics: Alcohol-based wipes or sprays will be used to disinfect shared touch screens, mice, keyboards, etc. Surfaces will be dried to avoid pooling of liquids.

What are the Potential Benefits of Taking Part in the Study?

The benefits to participation are: The benefits which may reasonably be expected to result from this study include a better understanding and meaning of your role as a female high school physics teacher. We cannot guarantee or promise that you will receive any benefits from this study.

Will I Receive my research results?

You will receive the transcript of your interview via email within five business days of the interview so you can check it for accuracy. We may learn things about you from the study activities which could be important to your health or well-being, such as memories of negative experiences. You may need to meet with professionals with appropriate expertise to help you learn more about your research results. The study team will not cover the costs of any follow-up consultations.

Will I be Paid to Participate in the Research?

You will receive a $25 Amazon gift card as payment for your participation. You will be given this gift card via email.

How Will my Information Be Protected?

The information that you give in the study will be handled confidentially. Your information will be assigned a code number/pseudonym. The list connecting your name to this code will be kept in a locked file separate from the research data. When the study is completed and the data have been analyzed, this list will be destroyed. Your name will not be used in any report.

Your data will be stored on an encrypted flash drive and an encrypted, cloud-based storage system. Personally identifying information will be separated at the conclusion of the interviews. When the study is completed and the data have been analyzed, all code lists linking names to study numbers will be destroyed. This is expected to occur no later than August, 2023. The audio/video recording will be transcribed. The recording will be deleted after the transcription is complete and verified. This process should take approximately five business days. This informed consent form will be kept for five years after the study is complete, and then it will be destroyed.

It is unlikely, but possible, that others responsible for research oversight may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. Organizations, in addition to the Wright State Institutional Review Board (IRB) and research investigators, that may inspect your research records include [if federally funded add Office of Human Research Protections (OHRP), Food & Drug Administration (FDA), and Sponsor, as appropriate.] We will only share your information if law or policy requires us to do so.
Certificates of Confidentiality

To help us protect your privacy, we have a Certificate of Confidentiality from the National Institutes of Health (NIH). With this Certificate, we can’t be forced by a court order or subpoena to disclose information that could identify you in any civil, criminal, administrative, legislative or other proceeding.

There are circumstances where the Certificate doesn’t protect against disclosure of your personally identifiable information:

- when the US government is inspecting or evaluating federally-funded studies
- when information must be disclosed to meet FDA requirements
- if you give someone written permission to receive research information or you voluntarily disclose your study information
- if the researcher reports that you threatened to harm yourself or others
- in cases of child abuse reported by the researcher
- if the investigator reports cases of contagious disease (such as HIV) to the state

You should understand that a Confidentiality Certificate does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. This means that you and your family must also actively protect your own privacy. Finally, you should understand that the investigator is not prevented from taking steps, including reporting to authorities, to prevent serious harm to yourself or others.

Will My Information Be Used for Research in the Future?

Information collected from you may be used for future research studies or shared with other researchers for future research. If this happens, information which could identify you will be removed before any information is shared. Data, without identifying information, will be made publicly available in [state which database], an online database for analysis by other researchers. Results of this study may be presented at conferences, or published in journals, books, and the popular media.

What Financial Interest does the Researcher have?

One or more individuals involved in this study may benefit financially from this study. The Institutional Review Board (an ethics committee that helps protect people involved in research) has reviewed the possibility of financial benefit. The Board believes that the possible financial benefit is not likely to affect your safety and/or the scientific integrity of the study. If you would like more information, please ask the researchers or study staff.

Who Should I Call with Questions?

If you have questions about the research study itself, please contact the Principal Investigator at (937) 684-3751 or hope.strickland@wright.edu. If you have questions
about your rights as a research volunteer or would simply like to speak with someone other than the research team about concerns regarding this study, please contact the IRB at (937) 775-4462 or irb-rsp@wright.edu. All reports or correspondence will be kept confidential.

**You will be given a copy of this information to keep for your records.**

**Statement of Consent**

I have read the above information provided in this form. I have had the opportunity to ask questions and have my questions answered. In consideration of all information provided in this form, I give my consent to participate in this research study. You will be provided with a copy of this form to keep for your records.

Indicate Yes or No:
I give consent to be audio and/or video-taped during this study.
___Yes ___No

I give consent for my identity to be revealed in written materials resulting from this study:
___Yes ___No

I give consent to be contacted for follow-up in this study or future similar studies:
___Yes ___No

*Use the following for Written Informed Consent:*

Signature: _____________________________________________________

Date: __________

Printed Name:

Signature of Person Obtaining Consent:

_________________________________________ Date: ________
Appendix D: Qualitative Analysis Codebook

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Files</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Efficacy</td>
<td>The belief that the participants have in their qualifications and abilities to teach high school physics.</td>
<td>14</td>
<td>319</td>
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<tr>
<td>Earned Confidence</td>
<td>Participants describe the confidence they gained from facing challenges and experiencing success as a high school physics teacher.</td>
<td>14</td>
<td>141</td>
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<tr>
<td>Enjoy Teaching Physics</td>
<td>Participants express their enjoyment of teaching high school physics.</td>
<td>12</td>
<td>75</td>
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<tr>
<td>Comfortable with not Being a Content Expert</td>
<td>Participants describe their comfort and acceptance of not being a physics content expert in their classroom.</td>
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<tr>
<td>Grown to Appreciate Physics</td>
<td>Participants describe how they have come to appreciate physics as a subject matter.</td>
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</tr>
<tr>
<td>Pedagogy</td>
<td>Participants describe their instructional practices of teaching high school physics.</td>
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<td>38</td>
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<tr>
<td>Increased Physics Identity</td>
<td>Participants describe how teaching high school physics has strengthened their physics identity.</td>
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<tr>
<td>Personal and Professional Growth</td>
<td>Participants describe experiences where they experienced growth as teachers and human beings.</td>
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<td>45</td>
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<tr>
<td>Feeling Inadequate</td>
<td>Participants describe their feelings of inadequacy as a high school physics teacher.</td>
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</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Files</td>
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</tr>
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</tr>
<tr>
<td>Imposter Syndrome</td>
<td>Participants describe feeling like a fraud as a high school physics teacher.</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Negative College Experiences</td>
<td>Participants describe their struggles mastering physics content in their college classes.</td>
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<td>14</td>
</tr>
<tr>
<td>Not Enough Physics Background</td>
<td>Participants describe feeling that they did not take enough physics in college to prepare them for teaching high school physics.</td>
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<tr>
<td>Unsure of Abilities</td>
<td>Participants describe feeling unsure of their abilities to teach high school physics.</td>
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<td>15</td>
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<tr>
<td>Overcoming Obstacles</td>
<td>Participants describe overcoming obstacles associated with teaching high school physics.</td>
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<tr>
<td>COVID-19</td>
<td>Participants describe the effect COVID-19 had on their teaching of high school physics.</td>
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<td>14</td>
</tr>
<tr>
<td>First Year Teaching</td>
<td>Participants describe the challenges they experienced during their first year of teaching high school physics.</td>
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<tr>
<td>Grit</td>
<td>Participants describe how their &quot;grit&quot; has been a factor in overcoming obstacles associated with teaching high school physics.</td>
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<td>10</td>
</tr>
<tr>
<td>Had to Teach Myself Physics</td>
<td>Participants describe the process of teaching/reteaching themselves physics content to be able to teach it to their high school students.</td>
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</tr>
<tr>
<td>School Culture Challenges</td>
<td>Participants describe challenges resulting from changing school.</td>
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</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Files</td>
<td>References</td>
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<td>--------------------</td>
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</tr>
<tr>
<td>Student Issues</td>
<td>Participants describe how they navigated behavioural, cultural, and gender issues related to their students.</td>
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<td>30</td>
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<tr>
<td>Support</td>
<td>The extent to which female high school physics teachers feel valued for their abilities and supported in their efforts.</td>
<td>14</td>
<td>113</td>
</tr>
<tr>
<td>Colleagues</td>
<td>Participants describe how their colleagues have (or have not) supported them in teaching high school physics.</td>
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<td>39</td>
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<tr>
<td>Mentors</td>
<td>Participants describe how mentors have supported them in different stages of their careers as high school physics teachers.</td>
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</tr>
<tr>
<td>College</td>
<td>Participants describe the support they received during their college experiences.</td>
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<td>23</td>
</tr>
<tr>
<td>High School</td>
<td>Participants describe the support they received in high school.</td>
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<td>18</td>
</tr>
<tr>
<td>Student Teaching</td>
<td>Participants describe the support (or lack of support) they received during their student teaching experience.</td>
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<td>17</td>
</tr>
<tr>
<td>Organizational Support</td>
<td>Participants describe the support they received from their schools such as administrative support, professional learning communities, and professional development.</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Files</td>
<td>References</td>
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<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Administrative Support</td>
<td>Participants describe the support they received from their school administrators.</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Participants describe the support they receive through effective professional development.</td>
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<td>4</td>
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<tr>
<td>Professional Learning Communities (PLCs)</td>
<td>Participants describe the importance of PLCs to not feel isolated as a female high school physics teacher.</td>
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<td>3</td>
</tr>
<tr>
<td>Values</td>
<td>How the personal and professional values of female high school physics teachers affect the satisfaction and meaning they find in their work.</td>
<td>14</td>
<td>230</td>
</tr>
<tr>
<td>Relationships with Students</td>
<td>The relationships female high school physics teachers have with their students as human beings and as learners of physics.</td>
<td>14</td>
<td>84</td>
</tr>
<tr>
<td>Connections with Students</td>
<td>Participants describe making connections with their students that strengthen their teacher-student relationships.</td>
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<td>30</td>
</tr>
<tr>
<td>Nurturing Students</td>
<td>Participants describe finding meaning in nurturing and supporting their students.</td>
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<td>31</td>
</tr>
<tr>
<td>Role Model for Students</td>
<td>Participants describe finding meaning in serving as role models for their female students.</td>
<td>9</td>
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</tr>
<tr>
<td>Students' Growth</td>
<td>Participants describe the importance of helping their students grow academically and personally.</td>
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<td>41</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
<td>Files</td>
<td>References</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------</td>
<td>------------</td>
</tr>
<tr>
<td>Developing Students' Thinking and</td>
<td>Participants describe finding meaning in helping their students develop</td>
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<td>22</td>
</tr>
<tr>
<td>Problem-Solving Skills</td>
<td>better thinking and problem-solving skills</td>
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<td></td>
</tr>
<tr>
<td>Teaching Students They Can Do Hard Things</td>
<td>Participants describe finding meaning in teaching their students that they</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>can do persevere through difficult tasks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching is Important Work</td>
<td>Participants describe the value they place on teaching as a profession.</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Always Wanted to Be a Teacher</td>
<td>Participants describe wanting to be a teacher since childhood.</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Expectations of Teaching</td>
<td>Participants describe the expectations they had of teaching before they</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>started their career.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching is a Calling</td>
<td>Participants explain how teaching is a calling and has more meaning than</td>
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<td></td>
<td>other careers.</td>
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<tr>
<td>Work Life Balance</td>
<td>Participants describe the work life balance associated with teaching high</td>
<td>9</td>
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<td></td>
<td>school physics.</td>
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<tr>
<td>Health and Well Being</td>
<td>Participants describe the effect that teaching high school physics has had</td>
<td>5</td>
<td>23</td>
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<td></td>
<td>on their physical health and emotional well being.</td>
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<tr>
<td>Heavy Workload</td>
<td>Participants describe the heavy workload associated with teaching high</td>
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<td>school physics.</td>
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<tr>
<td>Motherhood</td>
<td>Participants describe how having children has affected their experience</td>
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<td>teaching high school physics.</td>
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<tr>
<td>Name</td>
<td>Description</td>
<td>Files</td>
<td>References</td>
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<tr>
<td>Toll on Personal Life</td>
<td>Participants describe how teaching high school physics has taken a toll on their personal life.</td>
<td>3</td>
<td>8</td>
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