

**Elementary Teachers' Perceptions of Teacher-Student Relationships and Associations with
Project Lead the Way**

by

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Abstract

This study is motivated by the primary research question, “Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?” Previous research has attempted to identify predictors that would positively impact teacher-student relationships (TSRs), however few studies have sought to understand associations between TSRs and instructional styles. The purpose of this mixed methods sequential explanatory study was to explore associations between the teacher participants’ perceptions of their TSRs and their use of the PLTW curriculum. The two-phase investigation obtained quantitative results from a 19-item online survey of 83 elementary teachers in a public school district and then followed up with interviews of nine purposefully selected individuals. A mixed regression analysis of the quantitative data from the present study found that teachers from the PLTW-trained group had significantly lower STRS-SF scores ($B = -2.713$, $\beta = -.287$, $t = -2.625$, $p < .05$). The equation explained about 14 percent of the variance in STRS-SF scores ($R^2 = .139$, $\text{Adj. } R^2 = .095$). Two meta-inferences were developed from four themes that emerged from a line-by-line analysis of the qualitative interview data. Overall, this study found that the quantitative and qualitative strands of data combined to show that significantly lower STRS-SF scores within the PLTW group related to a supplanting of the teacher’s role as facilitator and a limitation of opportunities for student-centered instruction.

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Chapter 1: Introduction

My teachers are going to like me this year.

–Adolescent boy, Overheard walking into a store in late summer

Many teachers know they must first motivate and inspire their students through positive interactions before they can become better learners (Murray & Pianta, 2007; Pianta, 1994; Settanni et al., 2015). As the beginning of the school year approaches, they put the final touches on their classroom decorations and consider what the year will be like with this new group of students. The first few days of school usually consist of presenting the classroom’s expectations and building relationships (Wells & Reeder, 2022). Within a few days, however, teachers are faced with “weak administrative structures, student behaviors, [and] uncompromising district practices” that present obstacles to relationship-building in classrooms (Holmes et al., 2019, p. 27). Discouragements such as these can lead to teacher burnout and attrition because educators begin to feel as though they have no influence in the school. One of the oldest English proverbs still in use today states, “You can lead a horse to water, but you can’t make it drink” (Martin, n.d.). Some educators would argue that they are “flogging a dead horse” anyway (Jackson, 2018), and the need for drinking water is long gone (Tsang et al., 2022). Regardless, they were never interested in filling vessels of water. An ancient Greek philosopher is often quoted as saying, “the correct analogy for the mind is not a vessel that needs filling, but wood that needs igniting” (Plutarch, 1992). How do teachers perceive their relationships with students when they feel ineffective in lighting the fires of learning?

A recent longitudinal study has explored teachers’ perceptions of job demands, job resources, teacher burnout, depressed mood, job satisfaction, and motivation to quit (Skaalvik & Skaalvik, 2020). The researchers found that “job satisfaction was positively associated with self-

perceived accomplishment and negatively associated with emotional exhaustion” (p. 611). Considering these data, we can infer that teachers’ perceptions are important, and their perceptions of accomplishments in their classrooms could impact their feelings of job satisfaction. Another study regarding teachers’ perceptions by Prewett et al. (2019) found that “teachers’ perceptions of their student relationships were related to students’ perspectives” (p. 81). Based on this data, we might wonder how teachers’ perceptions of their relationships with students are associated with other aspects of the classroom experience.

Teachers understand that learning cannot happen without the necessary prerequisites in place that provide for physiological needs, safety, and the need to belong (Maslow, 1968). Students often seek to fulfill this need for belonging through a relationship with a teacher or other caregiver, and many teachers develop an awareness of this need through their experiences with children (Bowlby, 1969/1982; Murray & Pianta, 2007). As Murray and Pianta (2007) posit, “This awareness is derived from the common experience of direct interactions with students who respond positively to increased personal attention and support from teachers” (p. 105). The present study seeks to understand more about how to foster healthy teacher-student relationships (TSRs) for the benefit of instruction. Therefore, teachers’ use of a potential exemplar of problem-based learning (PBL) called Project Lead the Way (PLTW) will be explored to look for associations between instructional styles and TSRs. Project Lead the Way (PLTW) is an organization that provides curricula and training to assist teachers in facilitating PBL activities within theme-based modules. PLTW instruction will be presented in the present study as a potential exemplar of the PBL instructional style.

President Theodore Roosevelt is often credited as saying, “Nobody cares how much you know until they know how much you care,” but how does a teacher show that s/he cares

(Dickinson State University, n.d.)? Most teachers care about their students and the subjects they teach. However, they might find it difficult to communicate to their students how much they care (Zlatic et al., 2014). One night, just a few days prior to the beginning of a new school year, I was walking into a local store when I overheard a boy telling the woman with him, “My teachers are going to like me this year. I’m going to be good. I’m going to be funny. My teachers are going to like me!” His hope and enthusiasm touched my heart, and his words continue to remind me about one of our students’ most persistent needs: love and belonging (Maslow, 1968). Instead of wondering if they are liked by their students, perhaps teachers should be asking, “Do my students know that I like them?”

Every relationship experienced between a teacher and a student is different and contingent upon multiple variables, so studies related to these phenomena may appear complicated. Ghasemi (2022) states, “As a context-dependent phenomenon, the teacher–student relationships (TSR) remain an under-researched field” (p. 201). However, the positive outcomes associated with healthy TSRs have warranted a growing number of studies that seek to better understand the ways teachers and students interact (Koca, 2016; Poling et al., 2022). A search for “teacher-student relationship” on the online repository called “ProQuest,” shows an increase in the number of studies being conducted on the subject in recent years. Between 1998 and 2002, there were only 88 theses and dissertations related to TSRs, however, in the past four years (2020-2024) there have been 265. Using the same search query: “teacher-student relationship” on Google Scholar, a total of 11,500 papers were found to be published since 2022.

Relationships matter, but the goal of educators must be student learning. How can teachers provide for students both academically and socio-emotionally? Are there any associations between TSRs and teachers’ instructional styles? A recent study with university

students showed a positive direct effect between PBL and student engagement (Umar & Ko, 2022). PBL is a student-centered instructional style that challenges collaborative groups of students to solve real world problems (Alacapinar, 2008; Almulla, 2020). When teachers employ PBL instruction, they conduct themselves as facilitators or guides instead of lecturers (Hall & Miro, 2016). Considering the social nature of the PBL style, does PBL have an effect on TSRs? Hugerat (2016) studied 458 ninth-grade students in Israel and found that the students' perceptions of TSRs was significantly more positive following PBL-style science instruction. However, more work should be done to study PBL and TSRs in the primary grades (Pianta, 1994; Settanni et al., 2015). Organizations such as Project Lead the Way (PLTW) provide curricula and training for teachers who seek to employ an inquiry-based instructional style. The "PLTW Launch" elementary curriculum is one potential exemplar of the PBL instructional style. Do teachers who seek to use this type of instructional style have different perceptions of their relationships with students?

Statement of the Problem

Of the various dichotomies used to differentiate styles of instruction, perhaps one of the most well-known is the difference between teacher-centered versus student-centered education. Student-centered classrooms provide scaffolding for students while they devise their own plans and strategies for solving problems based on their own background knowledge and collaborative conversations (Gu et al., 2015; Vygotsky, 1978). Van de Walle et al. (2018) state, "In learner-centered classrooms, teachers begin *where the students are—with the students'* ideas. Students are allowed to solve problems or to approach tasks in ways that make sense to them" (p. 7). Educators who seek to centralize their students in the learning environment often choose to employ an inquiry-based style of instruction (Kang & Keinonen, 2018). Problem-based learning

(PBL) is one of these styles which challenges collaborative groups of students to solve problems with the help of a more knowledgeable facilitator (Roopashree, 2014; Vygotsky, 1978). In elementary schools, PBL is used more often to teach mathematics and science than other subjects (Merritt et al., 2017). Proponents of inquiry-based mathematics tout its ability to provide opportunities for productive struggle; a degree of rigor “between scaffolding and support” (Blackburn, 2018). According to The National Council of Teachers of Mathematics, “An effective teacher provides students with appropriate challenge, encourages perseverance in solving problems, and supports productive struggle in learning mathematics” (Leinwand et al., 2014, p. 11).

Kolb (2015) states, "learning is by its very nature a tension and conflict-filled process" (p. 41). Although productive struggle has shown to be effective for young learners, it is worth noting that the discomfort of the struggle could lead to discouragement in the classroom. Many teachers find it difficult to transition from a direct instruction model to one that gives students control over their own learning (Nariman & Chrispeels, 2016). Also, many teachers view students' struggles negatively; perceiving their difficulties in math as warning signs instead of opportunities to learn (Warshauer, 2015). This is concerning because if teachers perceive that inquiry-based instruction, such as PBL, has a negative association with classroom relationships, they may choose to abandon the practice.

Purpose of the Study

The purpose of this mixed methods sequential explanatory study was to determine if there were associations between the teacher participants' perceptions of their teacher-student relationships and their training and use of the Project Lead the Way curriculum. Project Lead the Way (PLTW) is an organization that provides curricula and training to assist teachers in

facilitating PBL activities within theme-based modules. PLTW instruction will be presented in the present study as a potential exemplar of the PBL instructional style. The investigation obtained quantitative results from a 19-item online survey of 83 elementary teachers in a public school district and then followed up with nine purposefully selected individuals to allow them to explain those results more in depth through a line-by-line analysis of their qualitative interview data. This study sought to improve our understanding of elementary teachers' perceptions of their relationships with students. Specifically, the purpose was to further understand if elementary teachers who used PLTW perceived their relationships differently from other elementary teachers that may or may not have encouraged productive struggle and/or student-centered problem solving in their classrooms. Although there are a growing number of studies that explore TSRs and instructional curricula such as PLTW, few seek to better understand the interaction between the two. Fewer still focus on the perceptions of those who teach one of our youngest and most impressionable populations: elementary students.

Research Questions

The primary research question asks, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" A better understanding of how elementary teachers relate to their students may lead to progress as we look for ways to improve TSRs in all elementary school classrooms. Four sub-questions which relate to the primary research question are listed below:

1. Are teachers' beliefs about PBL associated with their perceptions about teacher-student relationships?
2. Is Project Lead the Way (PLTW) professional development associated with differences in teachers' perceptions of their relationships with students?

3. Is the implementation of PBL in teachers' classrooms associated with differences in teachers' perceptions of their relationships with students?
4. Is teacher experience associated with differences in teachers' perceptions of their relationships with students?

I constructed four sub-questions based on four independent variables (IV) to investigate the explanatory power of instruction styles on teachers' perceptions of teacher-student relationships (TSRs). These four sub-questions were designed to explore PLTW (a potential exemplar of the PBL instructional style) as a predictor of teachers' perceptions of TSRs, which is the dependent variable (DV). The present study includes survey questions that provide data to inform a profile for someone who could be referred to as a PBL-friendly teacher. PBL instruction, therefore, is referred to in this study as that which is self-reported by teachers to be in congruence with their 1) beliefs, 2) professional development (specifically PLTW), 3) implementation, and 4) teaching experience in context of questions asked regarding PBL. These four characteristics correspond to the present study's four sub-questions. PBL-friendly teachers can be described as those who self-report that they 1) believe in the efficacy of the PBL instructional style, 2) have participated in PLTW professional development, and/or 3) implemented PBL lessons in their classrooms. Whereas there are overlaps in these self-reported descriptions, each component of this instructional style was analyzed as a predictor in a mixed regression analysis, and I explored associations between the DV and interactions of all four independent variables.

Significance of the Study

Healthy TSRs have been associated with a wide variety of positive outcomes in previous studies (Hamre et al., 2013). Rudasill (2010) found associations between positive TSRs and

prosocial behavior at school, and other researchers have used TSRs to predict academic performance (Birch & Ladd, 1998; Hamre & Pianta, 2001). Some studies have attempted to identify predictors that would positively impact TSRs (Cook et al., 2017; Driscoll & Pianta, 2010; Gehlbach et al., 2016), however, more research should be done to develop a better understanding of these factors. Considering the wide-ranging influence TSRs could have on academic achievement, socioemotional wellbeing, and classroom behaviors, an investigation about teachers' perceptions of TSRs is in order.

A growing number of classrooms employ some type of inquiry-based style of instruction such as PBL that challenges the students to solve problems within collaborative groups (Almulla, 2020). However, teachers face many challenges relative to PBL instruction and the facilitation of the students' activities (Nariman & Chrispeels, 2016). Although educators increasingly acknowledge productive struggle as a necessary component of quality education, Murdoch et al. (2020) argue that its implementation requires the presence of a particular type of relationship to be effective. Similarly, Pianta et al. (2016) argue that positive teacher-student interactions are an indispensable element of quality education. Presently in the field of education, TSRs and PBL are two burgeoning behemoths; so, the question, "Are they friend or foe?" begs for an interesting response.

Chapter 2: Review of the Literature

Introduction

The growing body of research literature regarding teachers' perceptions of TSRs provides an impetus for further study. Perceptions of kindergarten teachers have been predictive of academic and behavioral outcomes through eighth grade (Hamre & Pianta, 2001). Also, positive or negative relationships with teachers may be associated with positive or negative outcomes for some students (Ansari et al., 2020; Decker et al., 2007; Murray & Pianta, 2007). Therefore, it is important to explore possible associations between teachers' perceptions of TSRs and various classroom variables to benefit future research that might determine which factors have significant associations with these relationships.

Teachers are hired to teach, and since the primary responsibility of teachers is to provide instruction to students, it is important to examine how various styles of instruction fit into the students' educational environment. One way to do this is to examine the impact of teachers' instructional styles on their perceptions of teacher-student relationships. Differences in instructional styles correlate with different outcomes (Heatly et al., 2015; Scott & Gage, 2020). Previous studies found associations between instructional practices and student achievement (Heatly et al., 2015; Scott & Gage, 2020). Teachers choose their instructional practices for different reasons (Gottfried & Ansari, 2019; Shirrell et al., 2019). Various factors, including school support infrastructures, on-the-job interactions, and student absenteeism impact teachers' decisions about instructional practices (Gottfried & Ansari, 2019; Shirrell et al., 2019), but the primary goal of most teachers is student success (Cutler, 2018). Regardless of their reasons for adopting particular instructional styles, teachers' decisions about their instructional practices have consequences beyond student achievement (Müller et al., 2018). A study by Müller et al.

(2018) found that teachers' instructional practices were associated with peer influences on disruptive classroom behavior. Their study showed that when teachers separated students into groups based on their abilities, there was an increase in peer influence on disruptive behavior in the classroom (Müller et al., 2018). If teachers' decisions about instructional practices such as ability grouping can be associated with student behaviors, then instructional practices such as those characterized as PBL might also be associated with other social factors such as teacher-student relationships.

Teacher-student relationships are important, and this study seeks to explore teachers' perceptions of them in different instructional settings. Instructional practices can be proactively planned and executed by teachers to enhance the educational experience (Maye, 2013). If certain instructional styles are found to be associated with positive teacher-student interactions, then these pedagogical frameworks should be leveraged for the benefit of the whole learning environment. The confluence of benefits stemming from well-planned instruction and positive TSRs might have compounding advantages (Cook et al., 2017; Gehlbach et al., 2016). Studies have shown that when interventions, such as increasing positive teacher-student interactions and sharing similarities between teachers and students improve TSRs, student achievement improves as well (Cook et al., 2017; Gehlbach et al., 2016).

Teacher Beliefs and Perceptions

Teachers make decisions based on their beliefs, and their beliefs are associated with student outcomes (Sabarwal et al., 2022). Multiple studies indicate that student outcomes are associated with teacher beliefs (Sabarwal et al., 2022; Schmid, 2018). A 2018 study conducted by Dr. Regula Schmid found that teachers of academically successful students had similar beliefs. Qualitative data was collected from teachers of a student population that consistently

scored ten percent above average on the California Standards Test in English language arts (Schmid, 2018). Schmid (2018) found that “participating teachers believed that all students could and would learn, and that this learning was a reflection on the teachers” (p. 4). Other researchers (Boyd & Ash, 2018) posit that teachers’ beliefs influence their instructional practices in mathematics. Thus it is reasonable to hypothesize that teacher beliefs could be associated with instructional practices characterized as PBL. This study will test a sample of teachers to explore associations between teacher beliefs about PBL and their perceptions of TSRs. Boyd and Ash (2018) state, “Teacher beliefs are a significant influence on their classroom practice and are relatively difficult to change despite the efforts of teacher educators and policy makers” (p. 215). The relative stagnation of teacher beliefs as a characteristic lends itself well to this study which tests predictors for their associations with teachers’ perceptions of TSRs.

Teachers’ perceptions have been described as “mental representations” (Ghasemi, 2022, p. 202), and they can be influenced by their beliefs (van Uden et al., 2013). This study seeks to explore possible correlations between teachers’ perceptions of TSRs and their beliefs about instructional styles characterized as PBL. Ghasemi (2022) used a qualitative design to study the perceptions of teachers regarding factors that might influence TSRs. After conducting semi-structured interviews with 17 participating teachers in Iran, the data were analyzed and codes were developed. Consequently, three general themes were discovered regarding teachers’ perceptions of factors that influence TSRs: “Effective Classroom Techniques, Effective Contextual Factors, and Participants’ Attributes and Behaviors” (Ghasemi, 2022, p. 206). Ghasemi (2022) states, “As the first and important theme, the teachers emphasized effective classroom techniques as the most effective and primary mechanisms available to develop positive motivation with students early in the academic year” (p. 210). The present study

specifies PLTW as the “classroom technique” to be isolated as an independent variable for the investigation. Therefore, I will explore possible associations between teachers’ perceptions of TSRs and teachers’ beliefs, professional development, and implementation of PLTW as a potential exemplar of PBL. My selection of teachers’ perceptions of TSRs as a focus of this exploration is predicated on the idea that positive TSRs are a necessary component of quality education (Pianta et al., 2016).

Teacher-Student Relationships

Relationships between teachers and students lie at the heart of education (Friesen, 2017; Woodard, 2019). Positive teacher-student relationships (TSRs) have been associated with enhanced student engagement (Quin, 2017). According to Quin (2017), who analyzed 46 published studies from psychology, education, and social science databases, quality TSRs were associated with enhanced engagement in school. TSRs also support healthy social-emotional development in children, which can benefit social skills, increase academic achievement, and help promote student resiliency (Rimm-Kaufman & Sandilos, 2010). Hill and Jones (2018) used statewide administrative data to find evidence that increasing student-teacher familiarity improved academic achievement in elementary schools. Their study focused on a population of third, fourth, and fifth graders in North Carolina and found that students who were assigned to the same teacher for a consecutive year received small but significant test score gains (Hill & Jones, 2018).

Though much of the available research tends to explore the benefits of TSRs (Goble & Pianta, 2017; Hill & Jones, 2018; Rimm-Kaufman & Sandilos, 2010; Sparks, 2019), there are also studies that seek to make these relationships stronger (Cook et al., 2017; Gehlbach et al., 2016). For example, a study from 2016 evaluated the influence of positive and negative

interactions on students' classroom behavior (Cook et al., 2017). Teachers in six elementary and middle school classrooms were trained to focus on the positive behaviors of their students and deliver verbal praise on a regular basis in the classroom. With the aid of an electronic device called a MotivAider®, teachers were reminded to provide positive statements or gestures to students approximately every five minutes. By increasing the ratio of positive-to-negative teacher-student interactions to 5:1, they were able to note significantly fewer disruptive behaviors in the classroom, which resulted in higher academic engagement when compared with students in the control group (Cook et al., 2017). Another study explored the possibility of enhancing teacher-student relationships by revealing five similarities teachers and students shared with each other, such as desired friendship qualities and sports interests (Gehlbach et al., 2016). The researchers examined the relationships of 315 ninth graders and 25 teachers with a 6-item scale to measure students' perceptions of their degree of similarity to their teachers. Students in the treatment group were given a "get-to-know-you survey" including 28 items such as "which class format is best for student learning" (p. 345). Using the survey data, the researchers developed feedback sheets for the students in the treatment group with a list of five commonalities they shared with their teacher. Students in the control group received feedback sheets about their similarities with students from another school. The intervention of the feedback sheets increased the degree to which students in the treatment group perceived themselves to be similar to their teachers. It also appeared to raise the course grades of typically underserved students and close the achievement gap at the school by over 60%. Considering the apparent benefits of such a brief intervention regarding TSRs, more studies should be developed to explore the influence of various factors in the school environment that could contribute to positive or negative TSRs.

The present study seeks to explore associations between teachers' perceptions of TSRs and other classroom factors such as teachers' instructional styles and years of experience. Recent studies within the past five years indicate that TSRs are associated with various behaviors and emotions of students in K-12 classrooms (Endedijk et al., 2022; Froiland et al., 2019; Roorda et al., 2019). Roorda et al. (2019) explored associations between TSRs and the behavioral and emotional engagement of 476 seventh grade students and found that they self-reported to have less favorable relationships with the teachers of their most difficult subjects. These findings indicate that perceptions of TSRs can have multiple associations with various classroom factors that might affect student success.

Froiland et al. (2019) surveyed 1,961 ninth-twelfth grade students with a Likert-type scale that measured their sense of belonging in relation to their teachers. They also used two other scales to measure students' sense of happiness and their level of satisfaction regarding their basic psychological needs. These researchers found that TSRs were significantly associated with happiness when psychological need satisfaction was a mediating factor. In summation, they report, "the current study suggests that meeting psychological needs through positive teacher–student relationships is a promising path toward happiness, in addition to intrinsic motivation to learn, academic engagement, and achievement" (p. 866).

A meta-analysis of empirical studies related to teacher-student relationships was conducted by Endedijk et al. (2022). The authors sought to explore "the association between teacher–student relationship quality and peer relationship quality" (p. 398). They included 297 studies in the meta-analysis and found a moderate to strong association between teacher-student relationships and peer relationships. The authors add, "More important, longitudinal findings

suggest that the teacher–student relationship affects peer relationships more strongly than the other way around” (p. 400).

Theoretical Background

The present study is structured from a perspective of the intersection between two theoretical frameworks: attachment theory and Experiential Learning Theory. First, a description of John Bowlby’s (1969/1982) attachment theory will help conceptualize the bonds between teachers and students and to explain the phenomenon that could have bearing on elementary teachers’ perceptions of their relationships with students. Most of the recent studies related to TSRs use attachment theory as a framework, especially when the students are preadolescents (Koca, 2016). An understanding of attachment theory is also critical to properly contextualizing Pianta’s (2001) instrument that will be used to assess teachers’ perceptions of TSRs (i.e. The Student Teacher Relationship Scale – Short Form). This is followed by a description of David Kolb’s (2015) Experiential Learning Theory (ELT), which guides my conceptualization of the instructional component of this study.

Attachment Theory

In the present study, relationships are defined as sustained connections between two or more people involving multiple social interactions (e.g. teacher and student). These connections provide a basis for this exploration into teachers’ perceptions of TSRs. John Bowlby (1969/1982) defines attachment behavior as “seeking and maintaining proximity to another individual” (p. 195). Attachment theory helps explain attachment behaviors that can be observed in relationships such as those observed between mothers and their children or within other relationships between children and their caregivers (Bowlby, 1969/1982). Much of Bowlby’s (1969/1982) conceptual framework has its origins in evolutionary biology. He cites Konrad Lorenz’s (1935) studies of

imprinting in goslings and ducklings, stating, "...in many species of bird attachment behaviour comes quickly to be focused on a particular object, or class of objects..." (Bowlby, 1969/1982, p. 167). Influenced by Lorenz (1935), he felt compelled to look for similar behaviors in mammals. Reflecting on his prior thinking, he posits, "Once Lorenz's experiments were repeated and his findings verified, it was natural to consider whether attachment behaviour in mammals and in man himself develops in a comparable manner" (Bowlby, 1969/1982, p. 211). In reference to his bold hypothesis, the researcher confidently states, "There is now substantial evidence that it does so" (Bowlby, 1969/1982, p. 211). One of Bowlby's colleagues at the Tavistock Institute of Human Relations, Mary Saltei Ainsworth (1967), made close observations of infant-mother interactions in Uganda and agreed that attachment is indeed a human characteristic. Her work on attachment and loss is acknowledged and quoted often in his writings (Bowlby, 1969/1982). One such statement even seems to credit her for being the first to observe the phenomenon: "By being present and making the observations herself Ainsworth may be expected to have recorded the earliest signs of attachment" (Bowlby, 1969/1982, p. 202).

By the time the second edition of *Attachment* was published in 1969/1982, Bowlby was convinced that human infants experience something akin to imprinting. He states, "...so far as can be seen at present, the development of attachment behaviour in human infants, though much slower, is of a piece with that seen in non-human mammals. Much evidence supports that conclusion and none contradicts it" (Bowlby, 1969/1982, p. 222). Attachment theory continues to gain credibility as recent studies provide evidence that attachment behaviors in the formative years of human life are predictive of future outcomes (Ansari et al., 2020; Janssen et al., 2021).

Persistence of Attachment Throughout Life

According to Bowlby (1969/1982), “attachment behaviour is exhibited strongly and regularly until almost the end of the third year” (p. 204). However, as children progress toward the preschool years and kindergarten age, behaviors such as crying and clinging tend to wane, and most four and five-year-olds can be comfortable leaving a parent to go play with other children for a while. This does not mean that attachment behavior disappears as humans age. Behaviors change as a person ages and adapts to different environments and social settings, however, Bolby (1969/1982) asserts, “attachment behaviour continues as a dominant strand in his life” (p. 207). Not only does attachment persist into and throughout adulthood, Bowlby (1969/1982) says, “[it] affects behaviour in countless ways” (p. 207). Emphatically, he continues, “That attachment behaviour in adult life is a straightforward continuation of attachment behaviour in childhood is shown by the circumstances that lead an adult's attachment behaviour to become more readily elicited” (Bowlby, 1969/1982, pp. 207-208). In fact, he writes that it is “usual” for attachment behavior to persist into adult life (p. 234).

Internal Working Models (IWM)

Bowlby (1969/1982) contends that as children develop and interact with parents and other caregivers, they construct “working models” of their own “internal worlds” (p. 354). These mental models form a representation of how a child sees the world, makes plans, and relates to others (Bowlby, 1969/1982). Ghasemi (2022) uses Bowlby’s (1969/1982) concept of IWM to define teachers’ perceptions as “mental representations” (p. 202). Bowlby’s (1969/1982) concept of the internal working model (IWM) suggests that the relationships children have when they are young affect their future behaviors. Attempting to describe the inner workings of a developing toddler’s mind, he writes,

a child is busy constructing working models of how the physical world may be expected to behave, how his mother and other significant persons may be expected to behave, how he himself may be expected to behave, and how each interacts with all the others (Bowlby, 1969/1982, p. 354).

Therefore, attachment theory holds that the IWM in the mind of a person constitutes a mental framework based on past interactions within social environments (Koca, 2016). Consequently, the IWM is gradually constructed from the child's beliefs about caregivers' behaviors (Koca, 2016). Koca (2016) states, "Over time, these beliefs develop into a theory of self that influences the child's working model for future relationships" (p. 100).

Experiential Learning Theory

Just as relationships matter, experiences also matter (Kolb, 2015). In contrast to the teacher-centered practice of direct instruction, inquiry-based instruction is student-centered and experiential (Eltanahy & Forawi, 2019; Kang & Keinonen, 2018; Kolb et al., 2014). When teachers use inquiry-based instruction such as PBL, students are given a thought-provoking question to solve with a collaborating group of their peers. The absence of teacher-led lectures disassociates inquiry-based instruction from the more traditional, direct instruction model because students are encouraged to seek their own multiple paths to a solution. Through the process of working through tasks, students construct knowledge by learning from their experiences. After summarizing the learning models of Dewey, Lewin, and Piaget, David Kolb (2015) states, "The common theme in all these models is that all forms of human adaptation approximate scientific inquiry..." (p. 44). Based on the emphasis given to inquiry within the framework of ELT, this research study will incorporate the inquiry-based PLTW curriculum as a potential exemplar of PBL to be explored within a sample of teacher participants. Professional

development, teachers' beliefs, and implementation of instructional practices will be used in the study as predictors to look for associations with teachers' perceptions of TSRs.

PBL is compatible with Experiential Learning Theory (ELT; Kolb, 2015; Kolb et al., 2014) because it is student-centered and based on a constructivist epistemological perspective. Building on the work of John Dewey (1938) and others, David Kolb (2015) has synthesized the ideas of many educational psychologists into a concise set of models and characteristics that places experience at the center of the learning process (Kolb, 2015). Kolb (2015) integrates similarities in the learning theories of Dewey, Lewin, Piaget, and others to define experiential learning with a set of characteristics, such as "learning involves transactions between the person and the environment" (Kolb, 2015, p. 45). This concept, of course, is markedly different from those of theorists such as Bandura & Walters (1963) because it deemphasizes the social aspect of learning by describing it as part of the "environment." Setting ELT apart from traditional mindsets, Kolb (2015) states,

The casual observer of the traditional educational process would undoubtedly conclude that learning was primarily a personal, internal process requiring only the limited environment of books, teacher, and classroom. Indeed, the wider "real-world" environment at times seems to be actively rejected by educational systems at all levels (p. 45).

ELT gives more emphasis to the process of scientific inquiry than social interactions, however, it does recognize the importance of socialization. On this point, Kolb writes, "...learning spaces extend beyond the teacher and the classroom. They include socialization into a wider community of practice that involves membership, identity formation, transitioning from novice to expert through mentorship..." (p. 290).

Lev Vygotsky (1997) is listed as one of ELT's "foundational scholars" (Kolb, 2015, p. 23) because of his ideas regarding social constructivism (Kolb, 2015, p. 26). Vygotsky (1978) describes mentorship as a relationship between a novice and a "more knowledgeable other" (MKO) who provides scaffolding within a "Zone of Proximal Development" (ZPD; p. 84). In his words, "...what is in the zone of proximal development today will be the actual developmental level tomorrow - that is, what a child can do with assistance today she will be able to do by herself tomorrow" (p. 87). Kolb (2015) agrees with Vygotsky (1978) on the benefits of scaffolding by mentors, stating, "Scaffolding provides the structure and support necessary to progressively build knowledge" (p. 27). However, Kolb (2015) is also critical of Vygotsky's (1978) theory, suggesting that his reasoning was on a "unilinear cognitive track" (p. 226). Regarding the concept of ZPD, Kolb (2015) writes, "Vygotsky's famous example...where a more developed consciousness aids a lesser developed consciousness seem[s] one-way and unilateral" (p. 226). Although Kolb (2015) deemphasizes the social dimension as only one aspect of the environment, he acknowledges the learner's interaction with it, saying, "learning is conceived as a transaction between the person and the environment" (p. 288).

The Intersection of Attachment Theory and Experiential Learning Theory

According to ELT, "social" is merely one dimension of "learning space," which also consists of psychological, institutional, cultural, and physical dimensions (Kolb, 2015, p. 288). Therefore, through the theoretical lens of ELT, learning is not merely social, but much more complex. It is "a theoretical perspective on the individual learning process that applie[s] in all situations and arenas of life..." (p. xx). With the inclusion of the word "individual" in his statement, Kolb (2015) implies that social connections are nonessential at least in some learning contexts (p. xx). Attachment theory, on the other hand, is a lens through which we see the

ubiquitous nature of social connections; illuminating the antecedents and consequences of early human relationships (Colley & Cooper, 2017). So, why should we attempt to peer through both lenses as though we could see opposing viewpoints at once? Can we use attachment theory and ELT simultaneously to better understand teachers' perceptions of TSRs? It is possible to integrate attachment theory (AT) and ELT if we are using theoretical lenses that are bifocal.

Benjamin Franklin is credited with the invention of bifocal glasses, which combine two different lenses to help a person see objects both near and far away (Letocha, 1990). If someone is nearsighted, but also struggles to read print up close, bifocal lenses help the person to see in both situations by simply looking up and down while toggling from concave to convex lenses. Using both AT and ELT lenses, we can study teachers' perceptions of TSRs both near to the teacher and farther away.

Bowlby (1969/1982) describes attachment as "seeking and maintaining proximity to another individual" (p. 195), and he states that "exploratory behaviour and play" is "antithetic to attachment" (p. 237). Therefore, attachment behaviors and exploratory behaviors are directly opposed, but we must see both categories of behaviors to have a well-rounded understanding of teachers' perceptions of TSRs. From the perspective of ELT, this should not be a problem, for Kolb (2015) states, "Learning requires abilities that are polar opposites" (p. 42). To accomplish the task of seeing both attachment and exploratory behaviors, we can use the bifocal lenses of AT and ELT. We will use the AT lens to view the desire of the child to maintain proximity to the caregiver so that we can see the world that is near to the teacher. Contrariwise, a child's exploratory behavior can be seen through the ELT lens, which focuses on "the experiences of the learner" (p. 38). Kolb (2015) defines learning as "the process whereby knowledge is created

through the transformation of experience” (p. 49). These experiences are manifested in the exploratory behaviors of the children (Bowlby, 1969/1982).

Exploratory Behaviors

Piaget (1962), one of ELT’s “foundational scholars” (Kolb, 2015, p. 23) describes exploratory behaviors using words such as “investigation” and “play” (Piaget, 1962, pp. 51, 95). In his book *Play, Dreams and Imitation in Childhood*, he writes, “Finally, with the socialisation of the child, play acquires rules or gradually adapts symbolic imagination to reality in the form of constructions which are still spontaneous but which imitate reality” (Piaget, 1962, p. 87). “Investigation of new objects,” he writes, is generally initiated by “novelty,” i.e. “sounds and movements which are new to the child” (Piaget, 1962, p. 51). Bowlby (1969/1982), who couples “exploratory behavior and play” (p. 237), contends that both attachment and exploration are important classes of behavior, stating that they can “occur and progress together in harmony” (p. 237). Kolb (2015) agrees, positing, “Individuality and relatedness in experiential learning theory are poles of a fundamental dialectic of development” (p. 53). Whereas AT explores dyadic relationships, ELT examines the individual learner in an environment of dynamic experiences. Kolb (2015) writes, “...my aim for experiential learning theory was to create a model for explaining how individuals learn and to empower learners to trust their own experience and gain mastery over their own learning” (p. 53). Therefore, as the learner begins to elicit exploratory behaviors and attachment behaviors are inhibited, the ELT lens helps us to see the individual in an environment of experiences that are consequential to the earlier attachment paradigm. According to Bowlby (1969/1982), behavior of each of these classes “varies greatly in intensity from moment to moment, and behaviour of any one class may for a time be absent altogether”

(p. 237). Therefore, it is necessary to use both AT and ELT when studying teachers' perceptions of a variety of behaviors in elementary classrooms.

Attachment and Experience in View of Teachers' Perceptions of TSRs

Attachment theory emphasizes the influence of primary caregivers on the perceptions of children in their care, but it does not discount the influences of others who are "of much importance also" (Bowlby, 1969/1982, p. 207). Teachers are not typically parents of their students, but they certainly exert a powerful influence, thus they are sometimes referred to as "subordinate attachment-figures" (p. 205). People often develop attachments "towards groups or institutions other than the family," such as schools, and Bowlby (1969/1982) states, "it seems probable, the development of attachment to a group is mediated, at least initially, by attachment to a person holding a prominent position within that group" (p. 207). Teachers' perceptions of their relationships with students may not reflect the true power of their influence. According to Bowlby (1969/1982), "During adolescence a child's attachment to his parents changes. Other adults may come to assume an importance equal to or greater than that of the parents..." (p. 207). A study of teachers' perceptions of their relationships in the classroom is important because, as Bowlby (1969/1982) states, "Once a child has become strongly attached to a particular figure, he tends to prefer that figure to all others, and such a preference tends to persist despite separation" (p. 222).

As prominent figures in elementary classrooms, teachers will witness a variety of attachment and exploratory behaviors in their students (Bowlby, 1969/1982). Attachment theory and Experiential Learning theory will provide explanatory power for the benefit of theoretical analysis when a study is conducted on teachers' perceptions of TSRs. Security is a prerequisite for learning, and teachers can provide a secure base for students in a classroom scenario (Colley

& Cooper, 2017; Maslow, 1968). Heather Geddes (2017) explains why healthy attachment in the classroom can lead to benefits for students: “There is convincing evidence that links ‘secure enough’ attachment experience to a capacity to adapt to school and to respond to the demands of academic learning in the social setting of the classroom” (p. 41). A teacher who provides support for students can effectively challenge them to venture out and explore new concepts.

Subsequently, students will be more likely to engage in exploratory behavior if they have developed a trusting relationship with a teacher who provides a secure base to which they can return.

Problem-Based Learning (PBL)

PBL is an instructional style that is gaining attention by researchers and being used more than ever in classrooms all over the world (Hall & Miro, 2016; Merritt et al., 2017; Zhang et al., 2009). Various teaching professionals, such as biomedical educators (Jiménez-Saiz & Rosace, 2019) and police officer training facilitators (Shipton, 2022) use the problem-based technique to prepare trainees before they enter their respective fields. Almulla (2020) used a 23-item, Likert-type questionnaire to survey 124 university teachers about their use of the PBL approach to engage students. His study sought to determine if there were correlations among any of “five main aspects of the PBL approach: collaborative learning (CL), disciplinary subject learning (DSL), iterative learning (IL), and authentic learning (AL), which, in turn, produced student engagement” (p. 2). Almulla’s (2020) findings indicate that there was an overall favorable view among university professors regarding PBL and its ability to promote student engagement in learning. However, these findings may not reflect the views of elementary teachers, and this study seeks to explore the perceptions of elementary teachers regarding their relationships with students.

Dole et al. (2017) collected interview data from 36 PBL teachers who had experience teaching elementary and middle school students. The goal of their study was to examine the impact of PBL on student learning and motivation. Analysis of online questionnaires, telephone interviews, and field notes collected during classroom observations resulted in three main themes: learning attitudes, learning behaviors, and learning preferences. Under the theme of learning attitudes, teachers reported that PBL influenced students to develop positive attitudes toward learning and improved academic mindsets. Regarding learning behaviors that had been impacted by PBL, teachers listed motivation, engagement, creativity, perseverance, and divergent thinking. Finally, Dole et al. (2017) states that two key learning preferences of PBL students were autonomy and collaboration. Incidentally, since PBL students prefer collaboration, it is reasonable to hypothesize that an instructional style characterized as PBL might be associated with a social factor such as TSRs; the dependent variable in the present study.

In elementary schools, PBL is used more to teach science and math than with the other subject areas (Merritt et al., 2017). Tsybulsky and Oz (2019) conducted a qualitative study of 17 Israeli preservice science teachers during their practicum at an elementary school. The researchers collected interview data, reflective reports, lesson plans, and observations while the preservice teachers practiced implementing PBL science lessons with elementary students (Tsybulsky & Oz, 2017). During the first semester of their practicum, 14 of the 17 preservice teachers were frustrated and described difficulties regarding issues such as “time management and disciplinary problems” (p. 268). However, by the time the teaching students had reached the midpoint of their practicum, most of their reflections had become more positive. The authors of the study state, “...the student teachers began to feel that they were making progress in the process of working on projects and that they could see the advantages of this pedagogical

approach. At this stage, they were experiencing a sense of success” (p. 269). The present study surveyed teachers after the teacher participants had taught for at least one semester so that they would have had time to work through some of the difficulties associated with using the PLTW curriculum at the beginning of the year. The study by Tsybulsky and Oz (2017) highlights the evolving nature of teachers’ perceptions that tend to be influenced by their educational experiences with students.

Navy and Kaya (2020) studied prospective elementary teachers who developed PBL units to integrate STEM and other subjects such as literacy. Their study found that PBL can be an effective approach for integrating STEM into elementary curricula (Navy & Kaya, 2020). The prospective teachers in the study by Navy and Kaya (2020) listed several benefits to the use of PBL while teaching STEM, such as “the integrated approach allows students to make connections across subject areas” (p. 226) and “the integrated STEM approach promotes student engagement and deeper learning” (p. 227). However, they admit that “overall, integration of mathematical concepts was limited” (Navy & Kaya, 2020, p. 229). This is a significant limitation of their project because The National Council of Teachers of Mathematics recommend high level tasks that require critical thinking and problem solving to allow students to develop number sense that is useful in higher level mathematics courses and real-life applications (Leinwand et al., 2014).

Mathematics, at its core, is problem-solving (O’Shea & Leavy, 2013), and it is also a social activity (Franke et al., 2018; Tatsis & Koleza, 2006). Since the PBL approach involves students working together to solve problems, it can satisfy both criteria. As the standards and mathematical objectives in many countries trend increasingly toward a more constructivist approach, a greater need arises for implementation strategies (Leinwand et al., 2014). “Many

mathematical problems are considered too big for individuals to solve in isolation and this necessitates collaborative work which is an important aspect of learning through an emergent constructivist perspective” (O’Shea & Leavy, 2013, p. 5). Project Lead the Way is a program used by many schools to assist teachers in facilitating PBL-style lessons. Its elementary curriculum, referred to as PLTW Launch, is more scripted than ideal PBL curricula. However, it was designed with the intent to introduce students to productive struggle, inquiry, and authentic learning experiences (Teague, 2019; see [Figure 4](#)).

Students who have access to authentic PBL tasks spend more time on task and develop practical skills for solving real-world problems (Drake & Long, 2009). Therefore, PBL is an effective style for teaching any subject (Navy & Kaya, 2020). Mathematics educators are increasingly using PBL to provide their students with opportunities to learn skills that will translate beyond the classroom. The National Council of Teachers of Mathematics offers a practical framework for collaboration and groupworthy task development (Featherstone et al., 2011). However, more can be done to enhance the authenticity of the tasks provided in elementary math classrooms so that the problem-solution paradigm is more meaningful and permanent. Since constructivism is a theory of learning, it must be transferred to the teaching craft in order to be made manifest in classrooms (O’Shea & Leavy, 2013). Teachers can use PBL to ensure that mathematics concepts do not remain in the abstract so that problems can be solved in real-world scenarios.

Project Lead the Way (PLTW)

Project Lead the Way (PLTW) is one of the largest pre-engineering programs in the United States (Hess et al., 2016). Since 1997, this non-profit organization has offered project-based, STEM education to K-12 students in all types of schools (Hess et al., 2016). The present

study includes elementary schools that use the PLTW Launch program, which was designed to introduce K-5 students to PBL. PLTW has been used predominately in high schools to serve as a vehicle for STEM integration and a curriculum base for pre-college engineering education (Nathan et al., 2013). However, scripted programs such as PLTW Launch and Engineering is Elementary (EiE) have also been used in elementary schools to deliberately prepare students for successful careers in STEM (Ralston et al., 2013). Very little assessment of programs such as PLTW Launch and EiE has been conducted, especially at the elementary level (Ralston et al., 2013). Hoefert (2023) used a pre/post-test survey design to measure the degree to which PLTW Launch professional development (PD) would improve elementary teachers' self-efficacy in teaching engineering. However, there is a lack of studies that assess teachers' perceptions of their teacher-student relationships in relation to PLTW PD. The present study conducted an investigation with a sequential explanatory mixed methods design to look for possible associations between PLTW PD and teacher-student relationships.

Chapter 3: Methodology

Introduction

This chapter details the methodology I used to explore possible associations between elementary teachers' perceptions of teacher-student relationships and PLTW. The following sections contain detailed descriptions of the design, the setting, the participants of the study, the methods that were used for sampling, data collection, and the analyses of these data. Limitations of the study will also be considered.

Research Design

To investigate associations between elementary teachers' perceptions of teacher-student relationships and PLTW, I used a study with a sequential explanatory mixed methods design (QUANTITATIVE → qualitative = explanation), which included a quantitative survey followed by qualitative interviews with the priority on the quantitative analysis. This is a common design used in various educational research studies (Li et al., 2015; Wynn, 2023). The qualitative data helped interpret the quantitative findings and extend the range of inquiry to provide validity for a grouping of participants informed by the quantitative analysis.

Even though this study was conducted in two phases (QUANTITATIVE → qualitative), it has been mixed on multiple levels (see [Table 1](#)). The sequential explanatory mixed methods design for the present study can be described as a complementarity design with the purpose of expansion of the quantitative data because phase two of the study seeks to clarify and enhance the results of phase one (Greene et al., 1989). Creamer (2018) states that the mixing, or linking, of both quantitative and qualitative data or strands is central to a mixed methods design. The following sections will explain how the design is integrated by explaining how it is mixed on various levels (see [Table 1](#)).

Table 1*Key Features of this Mixed Methods Study*

Rationale/Purpose	Complementarity		
Priority	Quantitative data		
Timing of Data Collection	Sequential		
Timing of Data Analysis	Sequential		
Mixing	Fully integrated: No		
	Design	x	Sequential explanatory mixed methods. Primary research question is mixed, but sub-questions are quantitative.
	Data collection	x	Nested, purposive, stratified sample of cases from quantitative findings were used for qualitative collection.

Meta-inferences

The purpose of the present study was complementarity because the results of the two-strand, mixed design yielded more results than each of the parts would have provided if conducted separately. I developed meta-inferences from an integration of the findings from the quantitative and qualitative strands by viewing outcomes through the lens of the theoretical framework. The mixed methods design added value to the study because the qualitative data elaborated on the findings from a significant grouping of participants within the quantitative strand.

The qualitative strand explored the study's context to pursue confounding variables by collecting interview data from participants in a variety of locations in the research setting. This

second phase used qualitative data to allow participants from both PLTW and non-PLTW groups to explain their responses to the survey items. The qualitative phase also added value to the study by allowing participants to describe their own experiences with either PBL or PLTW instruction in the context of teacher-student relationships.

Meta-inferences for the present study will be further explained in chapters four and five. In summary, this study found that the quantitative and qualitative strands of data combined to show that significantly lower STRS-SF scores within the PLTW group related to a supplanting of the teacher's role as facilitator and a limitation of opportunities for student-centered instruction.

Research Questions

This study was used to investigate elementary teachers' perceptions of teacher-student relationships to look for possible associations they might have with PLTW instruction. It was hypothesized that there was an association with elementary teachers' perceptions of their relationships with students and their instructional styles that was linear. The primary research question, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" provides a rationale for a mixed methods design because it seeks more than a significant correlation. A quantitative analysis might have been sufficient to identify if there was an association between PLTW instruction and elementary teachers' perceptions of teacher-student relationships (TSRs), however, it could not provide an answer to how PLTW instruction and TSRs were associated. To provide elaboration for how PLTW instruction and TSRs were associated, it was necessary to collect and analyze qualitative data. Therefore, the primary research question provided a rationale for a complementarity mixed methods study because its purpose was to seek elaboration from the results of one method to clarify the results of the other method (Greene et al., 1989).

The sub-questions for the study were used to collect quantitative data in either continuous or categorical forms (see [Table 2](#)). I chose to measure instructional styles using three independent variables, which are briefly described here as 1) PBL beliefs, 2) PLTW professional development, and 3) PBL implementation. I included years of experience as a fourth predictor to measure sub-question four of the study: “Is teacher experience associated with differences in teachers’ perceptions of their relationships with students?” This fourth predictor was included in sub-question four of the study to test its interaction with the other independent variables. The present study explored the predictive relationship of PBL instruction on elementary teachers’ perceptions of their relationships with students, specifically in teachers who were trained in PLTW versus other teachers.

Primary Research Question

Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?

Research Sub-Questions

1. Are teachers’ beliefs about PBL associated with their perceptions about teacher-student relationships?
2. Is PLTW professional development associated with differences in teachers’ perceptions of their relationships with students?
3. Is the implementation of PBL in teachers’ classrooms associated with differences in teachers’ perceptions of their relationships with students?
4. Is teacher experience associated with differences in teachers’ perceptions of their relationships with students?

Table 2*Research Questions, Variables, and Methods for Testing Each*

Research Questions	Variables	Method(s)
Primary	Teachers' perceptions of TSRs and implementation of PLTW	STRS-SF (questionnaire), Interview
Sub-question 1	Teachers' beliefs about PBL	Likert-type item on questionnaire
Sub-question 2	Teachers' professional development (PLTW)	Nominal closed-ended question (yes/no)
Sub-question 3	Teachers' implementation of PBL	Numerical open-ended question
Sub-question 4	Teachers' years of experience	Numerical open-ended question

Note. The research sub-questions helped inform the interview protocols (see [Appendix B](#)).

Setting

The setting of the study was a large school district in the southern United States. This public school district has 31 elementary schools, some of which are classified as Title I because of the high percentages of students who receive free or reduced lunches. There are teachers in at least six of the schools who have had some type of PBL training. Most of the teacher participants (72.3%) chose to remain anonymous. Two of the schools in the present study have been named “STEM-themed” as part of a pilot program of the district. These schools received training and resources for the implementation of STEM-themed, PBL-style instruction called “Project Lead the Way” (PLTW). As part of the PLTW program, teachers received two days of hands-on professional development along with an online curriculum and kits of materials. In contrast with

the other 29 schools, these schools were mandated to teach all the PLTW lessons from at least two modules in their grade level curriculum. They were also required to teach science lessons for 30 minutes per day. Therefore, in the present study, “PLTW training” or “PLTW professional development” generally refers to more than mere teacher training and includes access to otherwise unavailable resources as well as instructional mandates from the district.

Participants

Participants in the study included public elementary school teachers from the southern United States who taught in public elementary classrooms. Teachers could teach any subject as long as they experienced sustained relationships with elementary students throughout the course of the 2022-2023 school year. Participants varied in their beliefs, professional development, and implementation of PBL or PLTW. Their years of teaching experience ranged from one to thirty-one years. If they chose, participants could enter a drawing for a gift card by completing a second survey for an anonymized raffle at the conclusion of the first Qualtrics survey.

Sampling

Quantitative Phase

Convenience sampling was used to select public elementary teachers who taught in kindergarten through sixth grade classrooms within the same district where I was employed as a math coach (Mertler, 2019; Schwandt, 2015). Permission was granted from the district’s superintendent to request further permission from the administrators of each school. Once I received permission from the administrator of a school, s/he sent an email with a recruitment letter and a link to the Qualtrics survey.

I used G*Power software to calculate a minimum sample size necessary for determining the practical and statistical significance of the study’s quantitative data. The average effect size

($r = .28$) taken from a meta-analysis of educational research by Prewett et al. (2019) sufficed as a high estimate for an effect size in the calculation. Using the a priori calculator for linear multiple regression with an alpha level (p) of 0.05, four predictors, and a desired power level of 0.80; the software determined that the minimum sample size for the study should be between 48 and 85 participants, based on a small, anticipated effect size of 0.15-0.28. Sawilowsky (2009) recommended a revision to Cohen's (1988) rules of thumb for interpreting effect sizes. Traditionally, most educational researchers use Cohen's (1988) definitions of small, medium, and large effect sizes as $d = 0.2$, 0.5 , and 0.8 , respectively; however, Cohen himself suggested that these interpretations should be flexible (Sawilowsky, 2009, p. 598). Recently, educational researchers have obtained very large ($d = 1.2$) and huge ($d = 2.0$) effect sizes, and these studies must be considered for contextualization of other educational research (Sawilowski, 2009).

Purwanto et al. (2021) compared the results of quantitative research data processing using software such as Statistical Package for the Social Sciences (SPSS). Using various data processing programs, they analyzed the questionnaire data of quantitative, educational research with a small sample size of 40 participants. The researchers found that SPSS was able to complete a regression analysis with three variables to determine the influence of the independent variables on the dependent variable. After testing the coefficient of determination, Purwanto et al. (2021) found moderate to strong effect sizes (r^2) ranging from 0.324 to 0.642, meaning that the influence of the independent variables on the dependent variables accounted for 32%-64% of the variance. Their study showed that a regression analysis can be calculated using SPSS for a small sample ($n = 40$) to obtain a medium effect size. The present study also collected data from a questionnaire to explore correlations, however it incorporated five variables, and it obtained

smaller effect sizes. I set a recruitment goal of greater than 40 participants before the study began.

Effect sizes vary depending on study design and context, so this power analysis took studies into consideration that focused on possible correlations with teacher-student relationships in educational settings (Endedijk et al., 2022; Prewett et al., 2019). Endedijk et al. (2022) conducted a meta-analysis of teacher-student relationship research that included 297 studies and 1,475 unique effect sizes. Specifically, these researchers wanted to further understand how teacher-student relationships may affect peer relationships (Endedijk et al., 2022). At the conclusion of their meta-analysis, they estimated that the overall association between teacher-student and peer relationships was $r = .28, p < 0.001$, which they interpreted as “a relatively large effect” (p. 382). The sample sizes in their study ranged from 24 to 150,822 students per sample. In a study conducted by Prewett et al. (2019), which also explored correlations between teacher-student relationships and other factors, only ten teachers were included in the sample along with 336 students. The researchers conducted a five-step hierarchical multiple regression analysis to predict teacher-student relationship closeness (Prewett et al., 2019). Model 1 of their analysis had a coefficient of $R^2_{\text{adj}} = 0.12$, however, Model 5 included all variables and accounted for 58% of the variance at $R^2_{\text{adj}} = 0.58, p < 0.001$ (Prewett et al., 2019, p. 78).

The present study did not obtain a large effect size such as those obtained in studies by Endedijk et al. (2022) and Prewett et al. (2019), however I was able to reject the null hypothesis for research sub-question two: “Is PLTW professional development associated with differences in teachers’ perceptions of their relationships with students?” Since there are very few studies that seek to understand associations between teacher-student relationships and instructional styles, I preferred to be conservative regarding estimates of effect sizes. Therefore, the average

effect size ($r = .28$) taken from the meta-analysis by Prewett et al. (2019) sufficed as a high estimate for an effect size for the present study. Using an estimated effect size of 0.28, the G*Power calculator recommended a minimum sample size of at least 48 participants.

Recruitment

To recruit participants from each of the 31 schools in the study setting, an email was sent to each principal describing the nature of the study and its purpose as well as documentation of IRB approval from the university (see [Appendix D](#)). As permission was granted from the administrator of each school, a survey was emailed to each teacher along with a request for their enrollment in the study. Since I was a math coach in the district, and was acquainted with the other math coaches, I asked them to assist me in announcing the opening of the survey. One item of the survey provided an opportunity for participants to anonymously enroll in a raffle for a gift card.

Qualitative Phase

The next to last item of the online Qualtrics survey asked, “Would you like to volunteer to answer interview questions via Zoom videoconferencing? The researcher will purposefully select volunteers based on their responses to the questionnaire so that he can unpack complexities in the data.” Participants who decided to volunteer for the interview submitted their email addresses so that they could be contacted. These were the only participants in the study who did not remain completely anonymous because they submitted their email address contact information. Using this email address, I was able to link qualitative data in the second phase of the study to corresponding quantitative data from the initial phase.

I used purposive sampling to select participants for the qualitative phase of the present study (Teddlie & Yu, 2007). This is because I needed the participants to explain their data from

the initial quantitative phase. The quantitative analysis revealed a statistically significant grouping of teacher participants that had lower STRS-SF scores on average than the other teachers. This group was referred to as the PLTW group because those teachers reported on the questionnaire that they had received PLTW training prior to taking the survey. The other teachers reported that they had not had PLTW training, even though they may have had some other type of PBL or STEM training. Of the 83 participants who completed the online questionnaire in the quantitative phase, there were 21 volunteers for interviews (25.3%). I constructed a table to analyze these participants' data for the purpose of stratified purposive sampling. After selecting ten teachers from ten different schools with a wide variety of STRS-SF scores (56-71) from both PLTW and non-PLTW groups, I sent them emails using the contact information they supplied on the questionnaire in the initial quantitative phase. Nine of the ten teachers (90%) responded that they would participate in the online Zoom interviews, and I scheduled each one separately at their most convenient times (see [Table 3](#)). This group of nine teacher participants comprised a nested, stratified, purposive sample for the qualitative phase of the study. At the conclusion of the interview period, three of the nine participants (33%) had received PLTW training according to their self-report. The cells with participant data from the PLTW-trained group (Participants 7, 8, and 9) are shaded to emphasize a contrast between the two groups.

Table 3*Stratified Purposively Selected Nested Sample of Participants for the Qualitative Phase*

Participant	STRS-SF ^a	PBL Beliefs ^b	PLTW	PBL Implementation	Years Experience	Title I	Report Card ^c	School Enrollment	Volunteer
1	56	5	N	5	16	N	77	104	Y
2	61	5	N	8	4	Y	77	604	Y
3	71	5	N	5	7	Y	80	906	Y
4	70	4	N	0	21	Y	77	664	Y
5	65	3	N	0	21	Y	67	510	Y
6	59	3	N	0	6	N	82	728	Y
7	61	5	Y	3	6	Y	69	551	Y
8	57	3	Y	3	3	N	84	564	Y
9	65	5	Y	20	1	Y	70	306	Y
10	69	4	N	2	23	N	86	537	N

^a Student-Teacher Relationship Scale – Short Form score. ^b Using a five-point Likert-type rating scale from 1 (‘Not at all true of me’) to 5 (‘Very true of me’), participants rated the item “I believe that PBL is an effective instructional style.” ^c School Report Card scores from 2024.

Methods**Data Collection***Quantitative Phase*

This sequential explanatory mixed methods study collected quantitative data from teachers to determine if there were associations between the teacher participants’ perceptions of their teacher-student relationships and their use of the Project Lead the Way curriculum. Teachers’ perceptions of teacher-student relationships were measured with a 15-item, five-point Likert scale (see [Appendix A](#)), and four questions were added to the Student-Teacher Relationship Scale-Short Form (STRS-SF) questionnaire to collect quantitative data for the research sub-questions (see [Appendix C](#)).

The present study hypothesized that there is a linear relationship between teachers’ perceptions of TSRs and PLTW as a potential exemplar of the PBL instructional style. This hypothesis was theoretically predicated on the basis of that instructional style’s emphasis on

student-centered instruction and its integration of productive struggle (Murdoch et al., 2020; Warshauer, 2015). Using a sequential explanatory mixed methods design, I began by measuring teachers' perceptions of TSRs and analyzed it as a dependent variable (DV) compared to four predictors: teachers' beliefs about PBL, teachers' professional development of PBL (PLTW), teachers' self-reported implementation of PBL in their classrooms, and teachers' years of teaching experience (see [Table 2](#)). The study's primary research question emphasized the DV, while the sub-questions outlined each one of the four independent variables (IV). The sub-questions provided a way to measure the degree to which PLTW instruction occurred in context with the teacher-student relationships. Sub-questions 1-3 specifically referred to teachers' beliefs, professional development (PLTW), and their implementation of PBL-style lessons so that metrics could be applied to the quantitative analysis. For example, questions one and three provided numerical responses from participants based on a Likert-type item and an open-ended numerical response item. Question two requested a "yes" or "no" response which was effect coded (-1, 1) for quantitative analysis. The overall goal of the study with these sub-questions was to gain metrics that could quantify the levels of PLTW as a potential exemplar of the PBL instructional style that reportedly existed in the context of the teachers' relationships with students.

Qualitative Phase

After obtaining quantitative results from a 19-item online survey of 83 elementary teachers, I followed up with nine purposefully selected individuals (see [Table 3](#)) to allow them to elaborate on those results more in depth through a line-by-line analysis of their qualitative interview data. In the second phase of the study, I conducted face-to-face semi-structured

interviews of teachers to help interpret the findings from the quantitative analysis (see [Table 2](#) and [Appendix B](#)).

Saturation

The nested sample used in the qualitative phase for the collection of interview data consisted of two groups: those who self-reported that they had participated in PLTW training and those who self-reported that they had not participated in PLTW training. The primary purpose of the qualitative phase was to allow the interview participants to explain their survey responses. Therefore, the questions for the interview protocol emerged from the quantitative data taken from the surveys (see [Appendix B](#)). Saturation in the qualitative phase consisted primarily of collecting answers to these questions. As more and more interviews were conducted, and participants' responses offered less and less new information, saturation occurred (Teddlie & Yu, 2007).

After analyzing the quantitative data and discovering that there were two significantly different groups, I wanted to investigate the primary differences between these two groups (PLTW-trained and the non-PLTW groups). I developed a nested, stratified sample of cases from participants who had participated during the initial quantitative phase (see [Table 3](#)). Both groups were represented in the nested sample, and they answered the questions I had prepared for their groups. Multiple members of each group answered their respective questions until the quantitative data had been elaborated on and less and less new information emerged.

Instrumentation

The Student-Teacher Relationship Scale - Short Form

The Student-Teacher Relationship Scale - Short Form (STRS-SF), developed by Dr. Robert C. Pianta (2001), was used to collect data for the dependent variable (DV) that described

elementary teachers' perceptions of TSRs (University of Virginia, 2022; see [Table 2](#)). The questionnaire is strongly based on the theoretical framework of attachment theory (Tsigilis et al., 2018). It can be administered to individuals in about five to ten minutes (Pianta, 2001). Quantitative data collected by the STRS-SF was used to investigate the primary research question. The STRS-SF is a 15-item survey that measures a teacher's perceptions of their relationship with one of their students using five-point, Likert-type items. These items are used to measure closeness (eight items) and conflict (seven items) dimensions of the TSR based on teachers' self-reporting (Pianta, 2001). I directed participants to choose the first student listed on their roster for the first class on their schedule for a regular school day. This method of selection is essentially block randomization because it limits each teacher's focus to one student per classroom whereas the students have already been blocked into classes by age (Kang et al., 2008). The teacher participants had already been grouped in these classifications as well, considering there is one teacher per classroom. It was important to specify a student number on the roster so that teachers did not make their own selection when they considered a student during the survey completion. If teachers self-selected a student to think about while they answered the questions on the STRS-SF, their bias might have influenced them to choose a student with which they believed they had a positive relationship. This study used a quasi-experimental design, and it was important to randomize the teachers' experiences as much as possible to limit errors of measurement from group to group, especially since classification variables such as grouping by age result in weaker interpretations of the data (Roberts & Russo, 1999). As Roberts and Russo (1999) state, "If subjects have not been randomly allocated to groups, then any differences between groups may be because of the way in which people were allocated to them, rather than the experimental treatment" (p. 70). Therefore, we should assume

that grouping students by age will result in confounding variables that complicate the analysis of the data.

Permission was granted by Dr. Robert C. Pianta (University of Virginia, 2022) to disseminate the STRS-SF (Pianta, 2001) using a web-based tool called Qualtrics. Dr. Pianta responded to an email request on August 23, 2022 saying, “Thanks for your interest - yes, please use the STRS as you plan.” There are four sub-questions that were explored with survey items attached to the STRS-SF questionnaire (see [Appendix C](#)). A web-based survey tool called Qualtrics was used to collect responses from teachers about their beliefs, professional development (PLTW), implementation of PBL, and years of experience. Items related to these four predictors were added to the STRS-SF questionnaire and distributed together within a single Qualtrics survey to collect continuous and/or categorical variables for quantitative analysis. The first of these items related to the sub-questions was a Likert-type item to measure teachers’ beliefs in the effectiveness of the PBL instructional style. Sub-question two, “Is PLTW professional development associated with differences in their perceptions of their relationships with students?” was measured with an item to collect a “yes/no” categorical variable: “Have you participated in ‘Project Lead the Way’ training?” The other two sub-questions were measured with items that collected continuous variables: “Approximately how many PBL activities have you facilitated this school year?” and “Including the current school year, how many years of teaching experience do you have?”

Reliability and Validity

The 15-item STRS-SF is a short form of the 28-item STRS developed by Pianta “to measure a teacher’s perception of his or her relationship with a particular student” (Pianta, 2001, p. 1). The original STRS measured “relationship patterns in terms of conflict, closeness, and

dependency” (Pianta, 2001), however the short form has eliminated the “dependency” dimension and its associated items (Pianta, 2001). Pianta’s conceptual framework of TSRs (1999) was based on the two primary dimensions of teachers’ experiences: conflict and closeness. Later, Pianta (2001) included a third dimension on the original STRS he referred to as “dependency,” stating that it “reflects the extent to which teachers vary in their experiences of negotiating and supporting autonomy in their relationships with particular students” (p. 4).

Pianta (2001) tested the reliability of the STRS within an elementary school context using a test-retest method with a subsample of 24 kindergarten teachers and found significantly strong ($p < .05$) estimates of reliability over a four-week period for each dimension: Conflict, .92; Closeness, .88; Dependency, .76; Total, .89. He also used Cronbach’s (1951) alpha method to calculate estimates of internal consistency, and he noted that the reliability estimate for the Dependency factor was lower than the estimates for both Conflict and Closeness: “For the total normative sample, internal consistency reliability estimates for the Total scale as well as for the Conflict and Closeness subscales were high. However, reliability for the Dependency subscale was not as high” (.64; Pianta, 2001, p. 21).

The STRS has been used in many research studies over the past 30 years, so there have been numerous opportunities to test the validity of its outcomes in various educational studies (Pianta, 2001; Tsigilis et al., 2018). Exploratory factor analysis (EFA) has been used to assess its construct validity and found that “only item 28...was found to load on two factors (i.e., both conflict and closeness)” (Pianta, 2001, p. 25). Pianta (2001) used Pearson product-moment correlations between the three subscales and the Total scale score, and all the correlations were statistically significant. Though he states that these correlations indicate “a moderate-to-strong degree of association in expected directions among the scale and subscales,” he admits that there

are “lower correlations between Dependency and the other STRS Total scale and subscales,” stating that this “may be due to the low number of items comprising the Dependency subscale” (Pianta, 2001, p. 27). Tsigilis et al. (2018) suggest that the items related to the Dependency subscale may have lacked the validity of the other items because of their sensitivity to “cultural differences” in its construct (p. 416). They agree that EFA results have been strong, but confirmatory factor analysis (CFA) does not support the original three-factor structure (Tsigilis et al., 2018, p. 415). In conclusion, “using the adapted version of the STRS seems to be more appropriate in terms of sound psychometric properties and a more thorough measurement of the Dependency subscale” (Tsigilis et al., 2018, p. 417).

Based on the recommendation of these researchers and the extant literature regarding Pianta’s instrument, the present study used the results of the STRS-SF for its quantitative analysis. More recent studies have chosen to use this adapted version of the STRS which leaves out the items associated with the Dependency subscale (Settanni et al., 2015; Tsigilis & Gregoriadis, 2008). The STRS-SF is an adapted version, and Dr. Pianta himself recommends using the short form (University of Virginia, 2022). This study used the STRS-SF to explore teachers’ perceptions of TSRs along the dimensions of Conflict and Closeness. I tested the data with Chronbach’s alpha to determine if there was consistency between the items on the scale.

Semi-Structured Interviews

For the qualitative phase of data collection, I used an interview protocol that was developed cooperatively with my dissertation committee (see [Appendix B](#)). The questions included in the protocol were derived from the research questions and the outcomes of the survey in the initial quantitative phase. I conducted nine interviews, which took an average of 12

minutes each. All the interviews were recorded and transcribed on Zoom software, and the video files were stored on Auburn's cloud storage.

Credibility

All the questions for the interview protocol were reviewed and discussed by the dissertation committee following the initial phase of the present study. I used member checking to test the credibility of the qualitative data. Creswell and Miller (2000) describe "member checking" as "taking data and interpretations back to the participants in the study so that they can confirm the credibility of the information and narrative account" (p. 127). After developing themes and meta-inferences from the qualitative data, I sent them via email to all nine interview participants for their review.

Data Analysis

Quantitative Phase

Analysis of the STRS-SF and Other Independent Variables

In the initial phase of the study, I collected quantitative data with an online Qualtrics survey. Most of the survey consisted of 15 items from The Student-Teacher Relationship Scale by Dr. Robert C. Pianta (2001). A grouping of participants referred to as “PLTW” was informed by the significant difference in groups determined by a quantitative analysis of the dependent variable. Using a multiple linear regression model, I tested the hypothesis and analyzed the quantitative data using SPSS (v. 28.0) software.

The dependent variable for the present study was teachers’ perceptions of TSRs, and the STRS-SF was used as the primary quantitative measure. The STRS-SF scoring guide was used to score the STRS-SF questionnaires (Pianta, 1992). Each of the 15 items on the scale falls under one of two factors: Closeness or Conflict. Items 1, 3, 4, 5, 6, 7, 9, and 15 are classified under the Closeness dimension and items 2, 8, 10, 11, 12, 13, and 14 are classified under the Conflict dimension. The participants were prompted to answer each question with a rating on a scale of 1-5, with 1 meaning *definitely does not apply*, 2 meaning *not really*, 3 meaning *neutral, not sure*, 4 meaning *applies somewhat*, and 5 meaning *definitely applies*. Each completed survey was given a subscale score for both Closeness and Conflict, which was a mean of the included items. Item number 4 was reverse-scored because it included negative wording: “This child is uncomfortable with physical affection or touch from me” (Pianta, 1992). Subscale scores were used as separate dependent variables at times during the analysis, but mostly they were used together as one dependent variable to determine if there were any correlations with the independent variables in the study.

This study investigated the explanatory power of multiple independent variables, so it used a multiple regression model to test the hypothesis (Kahane, 2008). Since the independent variables included both continuous and categorical (binary) variables, I also referred to the quantitative analysis as a mixed regression model. The sample mean was subtracted from the continuous independent variables to calculate centered variables. This grouped the variables around a sample mean of zero to provide for a more meaningful interpretation of the analysis. SPSS (v. 28.0) software was used to analyze the quantitative data collected by the online Qualtrics surveys. The investigation used hypothesis testing to determine if there were any correlations between one or all four of the independent variables and the dependent variable. Therefore, the sample regression function was as follows:

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + e_i.$$

After replacing the variables with labels, the regression function is more descriptive:

$$TSR_i = a + b_1(BELIEFS_i) + b_2(PLTW_i) + b_3(IMPLEMENTATION_i) + b_4(YEARS_i) + e_i.$$

The response rate is included in chapter four. It was calculated by dividing the number of respondents to the survey by the total number of invitations sent via email:

$$\text{RESPONSE RATE} = \text{RESPONDENTS/TOTAL INVITATIONS}$$

Descriptive statistics for the independent variables (i.e. teacher beliefs about PBL, professional development in PLTW, implementation of PBL, and years of experience) show frequencies and percentages, and for the STRS-SF measurement; mean, standard deviation, skewness, and kurtosis are included for each of the 15 survey items (see Tables [4](#), [10](#), and [11](#)).

The STRS-SF was tested for internal consistency using Cronbach’s alpha (Cronbach, 1951). Taber (2018) states, “Alpha is commonly reported for the development of scales intended to measure attitudes and other affective constructs,” so it was appropriate for this measure of

teachers' perceptions of TSRs (p. 1275). Given that the STRS-SF only has two constructs, Cronbach's alpha was a sufficient test to determine if there was consistency between the items on the scale (Taber, 2018).

Qualitative Phase

Following the analysis of the quantitative data, I constructed an interview protocol and code book with 15 a priori codes through collaboration with members of my dissertation committee. The codebook contains the code, type of code, definition, and at least one exemplar for each (see [Appendix E](#)). I conducted, recorded, and transcribed semi-structured interviews using Zoom online software. The recordings and transcriptions were saved on Auburn University's cloud server. The qualitative data collected were subjected to a line-by-line analysis as I examined them for patterns and themes. I combined all nine interview transcripts into one PDF file to facilitate the coding process. Then, I opened the document with Microsoft Edge and used the "Add text" feature to insert the a priori codes in the margins adjacent to the transcript lines. Creswell and Poth (2018) state, "In this loop, forming *codes* or *categories*...represents the heart of qualitative data analysis" (p. 189). Thematic analysis of qualitative data is consistent with other recent studies of teacher-student relationships in elementary schools around the world (Hildenbrand & Arndt, 2016; Kasimi & Höl, 2023; Peng & Cao, 2021; Thornberg et al., 2022).

Interpretation of the Data Analysis

After the data sets from the STRS-SF and the semi-structured interviews had been analyzed, I compared the results of both the quantitative and qualitative data analyses. The qualitative interview data was used to interpret the quantitative results. I drew conclusions based on the output from the data analysis calculated with SPSS (v. 28.0) and numerous quotations from multiple teacher participants.

According to Almeida (2018), the sequential explanatory mixed methods design is advantageous when it is “guided by a theoretical perspective” (p. 146). This study’s primary theoretical perspective was Bowlby’s (1969/1982) attachment theory, and the data analysis was interpreted through that lens. The STRS-SF was designed by Dr. Robert C. Pianta, based on attachment theory (Bowlby, 1969/1982), so the quantitative instrument I used is based on the same theoretical perspective. The items on the survey were designed to measure the teachers’ perspective of the level of closeness or conflict in the teacher-student relationship (TSR). Before participants completed the STRS-SF items, they were asked to consider the student in their class that was first on their roster for the first class of a regular school day. Interview participants were given the same directions, so they could further explain various aspects of their relationship with the same student from the STRS-SF questionnaire. Qualitative data from the semi-structured interviews added depth to the quantitative data from the STRS-SF questionnaire and was coded so that I could show the themes that developed during the analysis.

Sub-question two of the present study asks, “Is PLTW professional development associated with differences in teachers’ perceptions of their relationships with students?” The categorical variable for sub-question two is designed to provide a measure of PBL professional development, but it is limited to participation in “Project Lead the Way” (PLTW) training. This is because it was the only clear way to measure PBL professional development in this research setting. Teachers in the PLTW group were provided with materials and online curriculum access to teach inquiry-based lessons, and they were given mandates to teach at least two modules of the curriculum in the 2022-2023 school year. After completing the quantitative data collection and analysis and finding that teachers who had been trained in PLTW professional development self-reported lower STRS-SF scores on average than the other teachers in the study, it was

important for me to select interview participants from both teachers with and without professional development in PLTW. A thorough interpretation of the quantitative data was only possible after qualitative data had been collected from both groups. At the conclusion of the quantitative data collection period, 21 of the 83 respondents (25.3%) reported that they had received PLTW training. Considering the importance of gathering input from both PLTW and non-PLTW groups, I purposively selected interview participants with and without PLTW training to form a nested, stratified sample.

Positionality

I served as a math coach for a Title I school in the setting for the study. Our district had decided that we would become a STEM-themed school in a zone among other schools that would have other themes. Our faculty was being trained as “Project Lead the Way” (PLTW) teachers and facilitators, and I wanted to know if this experience would associate with teachers’ perceptions of their teacher-student relationships. A brief conversation with one of our area directors revealed that our district had an interest in this research study. Therefore, I worked to obtain permission to gain access to all our 31 elementary schools for the purpose of comparing data from elementary teachers who self-reported using PLTW instruction versus other elementary teachers.

The context of the present study reflects the pragmatist paradigm under which I worked throughout the investigation. The study’s mixed methods design was based on the practical need to explain its quantitative outcomes. Throughout the process of investigation, I was driven by a desire to know if there were associations between TSRs and instructional styles. Since I worked within the research setting, I believed that knowing more about these associations would benefit my understanding of TSRs in elementary school settings.

Limitations

The present study had several limitations. My position as a math coach at one of the participating schools influenced me to have a considerable amount of bias. Math coaches in my district were trained to help teachers promote productive struggle in their classrooms, so I had a vested interest in the implementation and success of its practice. Also, my base school was a STEM-themed school, and we were implementing PLTW that year in kindergarten through fifth grade. I had a personal affinity for PBL because I used it for years when I was a classroom teacher. I worked with my dissertation committee to develop my interview protocol, but I felt that I still needed to bracket my biases toward PBL when I was conducting interviews and analyzing the data.

I used a well-known survey tool called the Student-Teacher Relationship Scale–Short Form (STRS-SF; Pianta, 2001). However, it must be noted that the STRS-SF is a Likert-type scale that was used to collect teachers’ self-reported data. Participants had the option to answer interview questions in a face-to-face session with the researcher. I conducted only nine interviews due to time constraints and lack of participation.

Key components of the present study were the independent variables associated with the teachers’ training and implementation of PLTW instruction. However, most of the teachers who had received PLTW training were new to that curriculum and instructional practice, and some of them were novice teachers. A confounding variable might have been the teachers’ frustrations due to lack of experience with a new initiative from the district. Therefore, it was important to include the teachers’ years of experience to look for correlations with their perceptions of TSRs.

Finally, the study only represented one district, and all the teachers shared the same cultural and departmental expectations. Since the district is relatively large and consists of 31

schools, the sample included teachers from a diversity of communities. However, many of the PLTW-trained teachers could have been from the two STEM-themed schools in the research setting. This nested structure is a limitation of the study's design because it may violate the assumption that the predictors are independent variables. For example, the quantitative data suggest that teachers who received PLTW professional development self-reported lower STRS-SF scores than the other teachers. However, if some of these teachers were from the same schools, this difference could be attributed to a confounding variable.

Chapter 4: Results

The findings of this sequential explanatory mixed methods study answer the research questions through the analysis and integration of both quantitative and qualitative data. Creswell and Clark (2007) refer to this approach to a mixed methods study as an explanatory design in which data from the qualitative study assist in explaining the initial results of the quantitative study. More recently, Almeida (2018) has adopted the term “sequential explanatory design” to describe this methodology (p. 143). With this approach, the quantitative data must be analyzed before the qualitative data is collected and analyzed (Almeida, 2018). The sequential explanatory mixed methods design used in this study was also used by Akram et al. (2021) and Azmat and Ahmad (2022). In this chapter, quantitative findings are shared, followed by the qualitative findings.

Response Characteristics

Quantitative Phase

I sent a recruitment email to 31 elementary school principals in a single public school district in the southeastern United States. A link to the questionnaire was contained in the body of the email, and the principals were asked to forward the invitation to their faculty members (958). Eighty-three participants (8.7%) completed the questionnaire and 23 (27.7%) of these participants expressed an interest in participating in an interview to further explain their responses to the questions on the STRS-SF survey.

Qualitative Phase

During the qualitative phase of recruitment, ten volunteers were purposively selected for interviews, and nine participants responded affirmatively (90%). This nested, stratified sample of cases comprised 10.8% of the total sample and 39.1% of the sample of volunteers.

Findings

Quantitative Phase

I used a mixed regression analysis to investigate the explanatory relationship of teachers' beliefs and implementation of PBL instruction as well as years of experience on teachers' perceptions of their relationships with their students, specifically in elementary teachers trained in Project Lead the Way (PLTW) versus other teachers. This analysis corresponds with four predictors from the independent variables found in the research sub-questions: 1) Are teachers' beliefs about PBL associated with their perceptions about these relationships? 2) Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students? 3) Is the implementation of PBL in teachers' classrooms associated with differences in their perceptions of their relationships with students? 4) Is teacher experience associated with differences in their perceptions of their relationships with students? See [Table 4](#) for frequencies and descriptive statistics. The following assumptions were made for the mixed regression analysis: a) the predictors of teachers' beliefs and implementation of PBL instruction are not fixed variables, b) there is some measurement error with both predictors due to self-reporting, and c) the relationship is theoretically linear. The residual plot of the dependent variable (see [Figure 1](#)), which is comprised of the STRS-SF scores, indicated potential heteroscedasticity, with compression of residuals at the upper end of the predicted values. These scores are also negatively skewed (see [Figure 2](#)).

Figure 1

Residual Plot of the Dependent Variable (STRS-SF Scores)

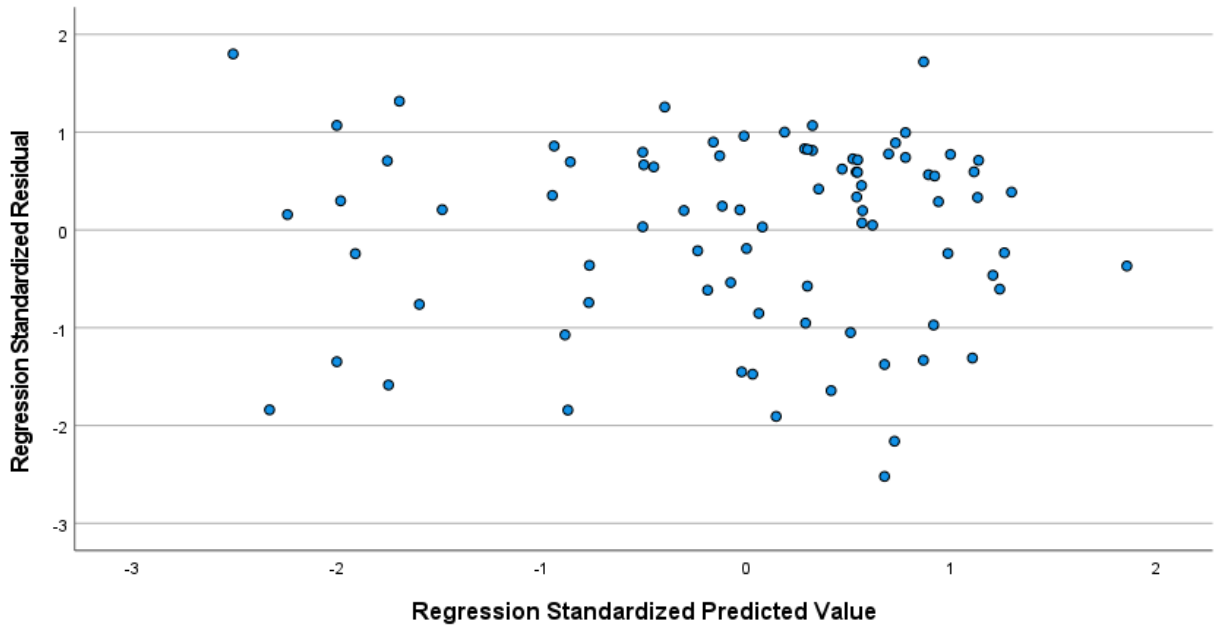


Figure 2

Histogram of the Dependent Variable (STRS-SF Scores)

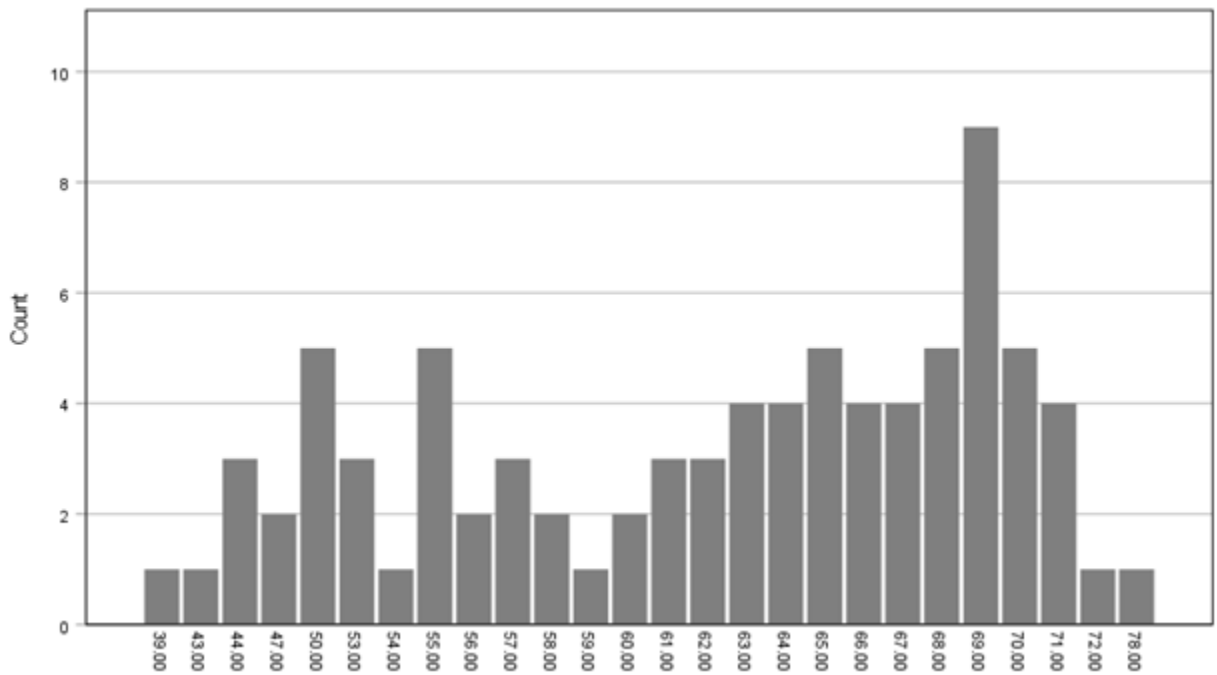


Table 4*Frequencies and Descriptive Statistics for the Independent Variables*

Sub-question #	Independent Variable	<i>M</i>	<i>SD</i>	<i>N</i>
1	PBL Beliefs	3.77	0.992	83
2	PLTW PD	-0.49	0.875	83
3	PBL Implementation	2.95	5.816	83
4	Years of Experience	13.42	8.521	83

The unstandardized prediction equation for the mixed regression is as follows: STRS-SF Scores = 59.696 + (.421) (BeliefsCentered) + (.423) (ImplementationCentered) + (.184) (ExperienceCentered) + (-3.081) (PLTW_EC) + (-.001) (PLTWxExperience) + (-.302) (PLTWxBeliefs) + (.363) (PLTWxImplementation). See [Table 5](#) for frequencies and descriptive statistics.

Table 5*Frequencies and Descriptive Statistics for the Mixed Regression Analysis*

	<i>M</i>	<i>SD</i>	<i>N</i>
STRS-SF Scores	61.48	8.271	83
BeliefsCentered	0.00	0.991	83
ImplementationCentered	0.00	5.816	83
ExperienceCentered	0.00	8.521	83
PLTW_EC	-0.49	0.874	83
PLTWxExperience	-1.61	8.365	83
PLTWxBeliefs	0.12	0.984	83
PLTWxImplementation	0.82	5.757	83

I calculated a Pearson point-biserial parametric test in SPSS (v. 28.0) to measure the relationships between the PLTW categorical predictor and the continuous predictors because the PLTW variable is binary. I also calculated Pearson's correlation coefficients to show comparisons of all the continuous predictor correlations using Pearson product-moment tests.

Teachers in the PLTW group had fewer years of experience on average ($r = -.219, p < .05$), and teachers who believed in the efficacy of PBL reported that they implemented more PBL activities on average ($r = .300, p < .01$; See [Table 6](#)).

Table 6

Correlations for Predictors (N = 83)

	PBL Beliefs	PBL Implementation	Years of Experience
PLTW PD	.135	.163	-.219*
PBL Beliefs	1	.300**	-.029
PBL Implementation	.300**	1	-.102
Years of Experience	-.029	-.102	1

* $p < .05$. ** $p < .01$.

Interactions between the independent variables were run using SPSS (v. 28.0) to test the primary research question: “Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?” In the present study, instruction consists of four components, which are expressed in four research sub-questions involving: 1) beliefs, 2) professional development (PLTW), 3) implementation, and 4) years of experience. The overall regression equation (Model 3) was statistically significant ($F_{7, 75} = 2.254, p < .05$). The equation explained about 17 percent of the variance in scores on the Student-Teacher Relationship Scale - Short Form (STRS-SF; Pianta, 2001; $R^2 = .174$, Adj. $R^2 = .097$). Research sub-question two, “Is PLTW professional development associated with differences in teachers’ perceptions of their relationships with students?” was tested with a grouping of PLTW-trained teachers versus teachers who received no PLTW training. The interaction of teachers’ beliefs about PBL with a grouping of PLTW-trained teachers was not a

statistically significant predictor of teachers' perceptions of teacher-student relationships ($B = -.302$, $\beta = -.036$, $t = -.276$, $p = .783$). Likewise, the interaction of teachers' implementation of PBL with a grouping of PLTW-trained teachers was not a statistically significant predictor of teachers' perceptions of teacher-student relationships ($B = .363$, $\beta = .253$, $t = 1.729$, $p = .088$). Finally, the interaction of teachers' years of experience with a grouping of PLTW-trained teachers was not a statistically significant predictor of teachers' perceptions of teacher-student relationships ($B = -.001$, $\beta = -.001$, $t = -.008$, $p = .994$). Therefore, I did not calculate separate regression equations per group. The two groups shared common regression coefficients (PBL beliefs, PBL implementation, and years of experience). Model 3 showed PLTW status was a significant predictor of STRS-SF scores ($B = -3.081$, $\beta = -.326$, $t = -2.834$, $p = .006$). PBL beliefs, PBL implementation, years of experience and the interaction were not significant predictors. Because there was no significant interaction, the two groups shared a common regression coefficient (see [Table 7](#)). Consequently, I removed the interaction terms from the equation to test if there were different intercepts between variables (Model 2).

Table 7*Regression Coefficients*

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>Sig.</i>	Collinearity Statistics	
	<i>B</i>	<i>SE</i>	β			Tolerance	VIF
1 (Constant)	61.482	.895		68.666	<.001		
BeliefsCentered	.365	.952	.044	.383	.702	.910	1.099
ImplementationCentered	.142	.163	.100	.872	.386	.901	1.110
ExperienceCentered	.225	.106	.232	2.120	.037	.990	1.011
2 (Constant)	60.142	1.003		59.942	<.001		
BeliefsCentered	.593	.923	.071	.642	.522	.902	1.109
ImplementationCentered	.189	.158	.133	1.191	.237	.890	1.124
ExperienceCentered	.168	.105	.173	1.607	.112	.947	1.056
PLTW_EC	-2.713	1.034	-.287	-2.625	.010	.924	1.082
3 (Constant)	59.696	1.087		54.907	<.001		
BeliefsCentered	.421	1.094	.050	.385	.701	.641	1.561
ImplementationCentered	.423	.210	.298	2.017	.047	.506	1.977
ExperienceCentered	.184	.129	.190	1.424	.158	.622	1.608
PLTW_EC	-3.081	1.087	-.326	-2.834	.006	.833	1.200
PLTWxExperience	-.001	.129	-.001	-.008	.994	.645	1.550
PLTWxBeliefs	-.302	1.094	-.036	-.276	.783	.650	1.540
PLTWxImplementation	.363	.210	.253	1.729	.088	.516	1.938

The reduced model (Model 2) was also statistically significant ($F_{4, 78} = 3.152, p < .05$).

The equation explained about 14 percent of the variance in STRS-SF scores ($R^2 = .139$, Adj. $R^2 = .095$). In the reduced model, PLTW status was a statistically significant predictor ($B = -2.713, \beta = -.287, t = -2.625, p < .05$). Although the relationship between PLTW status and PBL beliefs, PBL implementation, and years of experience was constant across both groups, teachers who had been trained in PLTW self-reported lower STRS-SF scores ($M = 57.33, SD = 8.563$) on average than the other teachers in the study ($M = 62.89, SD = 7.746$).

I also conducted a simple linear regression with each of the four predictors separately to test their explanatory power with the dependent variable (STRS-SF scores). PLTW status was a statistically significant predictor ($B = -5.554$, $\beta = -.294$, $t = -2.765$, $p < .05$), and years of experience was also a statistically significant predictor ($B = .214$, $\beta = .221$, $t = 2.036$, $p < .05$).

Pianta's (2001) STRS-SF scale was designed within the framework of attachment theory (Bowlby, 1969/1982) to measure teachers' perceptions of their overall relationships with students. More specifically, the 15 Likert-type items are divided into two constructs: "Closeness" and "Conflict." The STRS-SF is a modified version of the original, 28-item STRS, which had three constructs: "Closeness," "Conflict," and "Dependency."

Solheim et al. (2012) used CFA to examine the validity of the original, three-factor version of the STRS in a preschool community sample ($N = 925$). After finding the original version to be unsatisfactorily confirmed, they modified the scale so that it would show better concurrent validity. Due to potentially poor psychometric properties of some of the items on the original scale (items 6, 12, and 21), the discriminant validity of two of the three constructs was only partially confirmed. Solheim et al. (2012) hypothesized that items on the original STRS may have contained "ambiguous" content (p. 259). These items are not included in the STRS-SF, and therefore were not used in the present study. Solheim et al. (2012) determined the discriminant validity for the closeness construct versus the other two constructs was good, and none of the items on the STRS-SF were discussed as having poor psychometric properties. Aboagye et al. (2019) used CFA to verify the factorial validity of the two-factor STRS-SF that was used in the present study and found both the closeness and conflict constructs to be valid and reliable.

For the present study, the STRS-SF showed acceptable internal consistency reliability with an overall Chronbach’s alpha coefficient of 0.765 as calculated by SPSS (v. 28.0) software. The closeness and conflict factors demonstrated Chronbach’s alpha coefficients of 0.721 and 0.893 respectively (Taber, 2018). The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy showed a relatively high value (0.789) and Bartlett’s Test of Sphericity was significant ($p < .001$), which indicated that a factor analysis would be useful (see [Table 8](#)).

Table 8

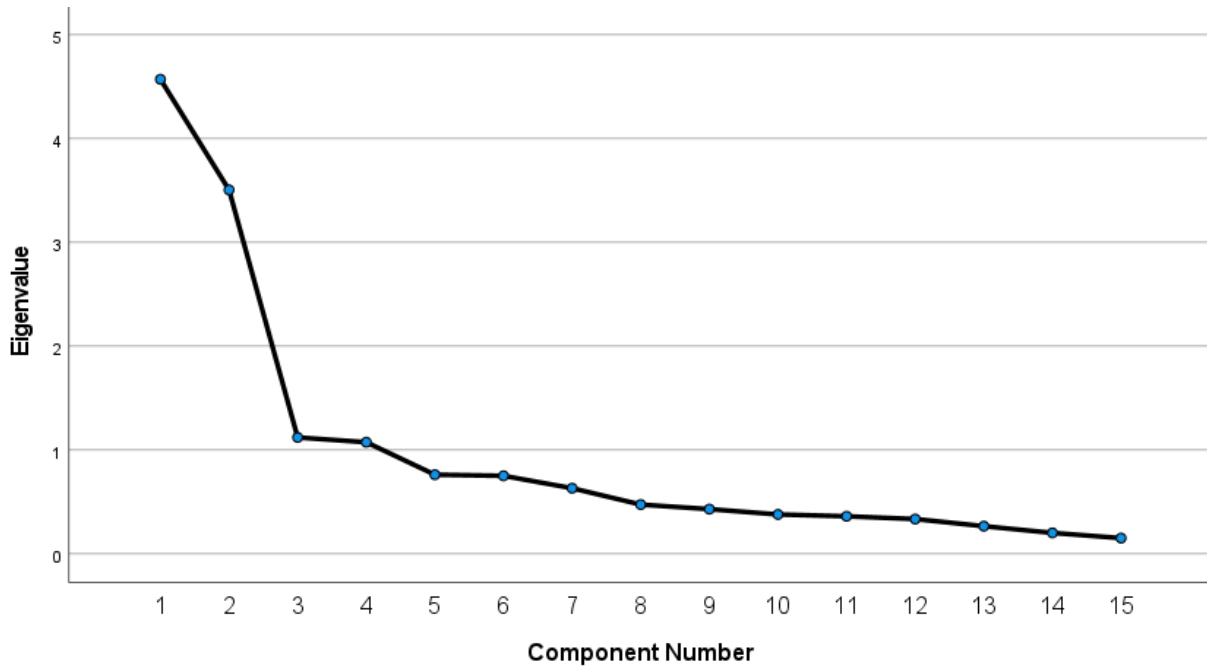
KMO and Bartlett’s Test

<hr/>		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.789
Bartlett’s Test of Sphericity	Approx. Chi-Square	562.073
	df	105
	Sig.	< .001
<hr/>		

I conducted a confirmatory factor analysis (CFA) to measure the discriminant validity of the 15 items on the STRS-SF to determine if each item would correspond with its a priori construct i.e., closeness or conflict. The scree plot of the eigenvalues shows there are two factors with eigenvalues well over 1.0 that explain the greatest percentage of the variance in items one through fifteen on the STRS-SF scale (see [Figure 3](#)).

Figure 3

Scree Plot of Eigenvalues



Using a rotational method with Kaiser normalization in SPSS (v. 28.0), items 2, 8, 10, 11, 12, 13, and 14 correlated most closely with Factor 1 (see [Table 9](#)). These items were originally designed to measure the conflict construct. Items 1, 3, 5, 6, 9, and 15 correlated most closely with Factor 2 (see [Table 9](#)). These items were originally designed to measure the closeness construct. However, items 7 and 4 did not show high correlations with Factors 1 or 2 and correlated with Factors 3 and 4 respectively. Descriptive statistics (mean and standard deviation) and normality (skewness and kurtosis) for each of the 15 items were examined, and they are included in [Tables 10](#) and [11](#). Skewness did not meet the recommended threshold on items one (skew = -2.543, $SE_{skew} = .264$) and six (skew = -2.534, $SE_{skew} = .264$), and the same items were leptokurtic (9.382₁, 5.849₆), indicating abnormal distributions (Hopkins & Weeks, 1990).

Table 9*Rotated Component Matrix^a*

Item and Construct	Component			
	1	2	3	4
#12 CONFLICT	.874			
#13 CONFLICT	.828			
#11 CONFLICT	.817			
#14 CONFLICT	.768			
#08 CONFLICT	.725			.283
#02 CONFLICT	.723			
#10 CONFLICT	.717			
#06 CLOSENESS		.854		
#05 CLOSENESS		.805		
#03 CLOSENESS		.711		
#01 CLOSENESS		.571	.326	
#07 CLOSENESS			.850	
#15 CLOSENESS		.313	.803	
#09 CLOSENESS		.554	.612	
#04 CLOSENESS				.890

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

^a. Rotation converged in 6 iterations.

Table 10*STRS-SF Score Descriptive Statistics for the Conflict Construct*

		Item 2	Item 8	Item 10	Item 11	Item 12	Item 13	Item 14
<i>N</i>	Valid	82	83	83	82	83	83	83
	Missing	1	0	0	1	0	0	0
<i>M</i>		1.98	1.71	2.02	2.05	2.06	1.71	1.98
<i>SD</i>		1.100	0.957	1.158	1.405	1.374	1.195	1.352
<i>Skewness</i>		1.077	1.471	1.208	.925	1.076	1.726	1.136
<i>Kurtosis</i>		0.274	1.695	0.559	-.784	-.230	1.839	-.181

Table 11*STRS-SF Score Descriptive Statistics for the Closeness Construct*

		Item 1	Item 3	Item 4	Item 5	Item 6	Item 7	Item 9	Item 15
<i>N</i>	Valid	83	83	83	83	83	83	82	83
	Missing	0	0	0	0	0	0	1	0
<i>M</i>		4.63	4.34	1.82	4.55	4.81	4.34	4.18	4.22
<i>SD</i>		0.676	0.753	1.038	0.703	0.480	1.062	0.931	1.060
<i>Skewness</i>		-2.543	-1.002	1.313	-1.277	-2.534	-1.655	-1.035	-1.520
<i>Kurtosis</i>		9.382	0.690	1.397	0.230	5.849	1.832	0.263	1.791

Qualitative Phase

I collected qualitative data from interview participants to help interpret the quantitative data from the questionnaire and to answer the present study's primary research question: "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" The qualitative phase of this study is focused on the findings from the primary research question. The quantitative data showed a significant difference between the mean STRS-SF scores of teachers who had received PLTW PD ($M = 57.33$, $SD = 8.563$) and teachers who had not received PLTW PD ($M = 62.89$, $SD = 7.746$). In the present study, teachers who had been trained in PLTW self-reported lower STRS-SF scores

on average than the other teachers in the study. This quantitative finding led to a need for qualitative data to help interpret the difference between groups for the purpose of answering the primary research question. After being prompted by questions from the semi-structured interviews (see [Appendix B](#)), participants were able to describe in their own words their experiences with PLTW and/or other PBL instruction. They further explained how they believed their instruction impacted their relationships with students.

This study seeks to better understand TSRs by searching for possible associations between teachers' relationships and PLTW instruction. An analysis of the quantitative data showed that the results of item one, "I share an affectionate, warm relationship with this child," are negatively skewed ($skew = -2.543$, $SE_{skew} = .264$) and leptokurtic (9.382). Using a five-point Likert-type rating scale from 1 ('Definitely does not apply') to 5 ('Definitely applies'), participants in both PLTW and non-PLTW groups largely agreed that their relationships were affectionate and warm ($M = 4.63$, $SD = .676$). Using a five-point Likert-type rating scale from 1 ('Not at all true of me') to 5 ('Very true of me'), participants rated the item "I believe that PBL is an effective instructional style," with a mean score of 3.77 ($SD = .992$). Of the 83 participants that completed the survey, 53 (63.85%) of them gave a favorable opinion of PBL instruction ('Applies somewhat' or 'Very true of me') and 22 (26.51%) were "Neutral, not sure." Since the PLTW and non-PLTW groups were not differentiated by these data (see [Table 12](#)), the qualitative data were analyzed to assist in elaborating on the differences between the two groups.

Tables [12](#) and [13](#) show a comparison of the means and standard deviations between the PLTW-trained group and the Non-PLTW group for phase one, quantitative and phase two qualitative. A comparison of these data shows similarities and differences between four variables. Both groups in each phase show similar means for teachers' beliefs in the efficacy of

PBL. However, the PLTW-trained group is comprised of teachers who self-reported the implementation of more PBL activities, fewer years of teaching experience, and lower STRS-SF scores. These characteristics of the data were consistent for both phases.

Table 12

Means and Standard Deviations for the Variables within Each Group in Phase One, Quantitative

Variable	PLTW-Trained		Non-PLTW	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
PBL Beliefs	4.00	0.949	3.69	1.001
PBL Implementation	4.57	4.894	2.40	6.034
Years of Experience	10.24	7.880	14.50	8.520
STRS-SF Scores	57.33	8.563	62.89	7.746

Table 13

Means and Standard Deviations for the Variables within Each Group in Phase Two, Qualitative

Variable	PLTW-Trained		Non-PLTW	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
PBL Beliefs	4.33	1.155	4.17	0.983
PBL Implementation	8.67	9.815	3.00	3.464
Years of Experience	3.33	2.517	12.50	7.765
STRS-SF Scores	61.00	4.000	63.67	6.055

After consulting with my dissertation committee, I developed a codebook with 15 a priori codes and conducted a line-by-line analysis of the qualitative data by memoing in the margins of the transcripts. Saturation was reached as less and less new information was provided by the purposively selected interview participants. I developed four themes based on a synthesis of the codes and memos I added to the interview transcripts. In the latter part of this chapter, I will list these themes and explain how they support responses to the present study’s primary research question.

Primary Research Question:

Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?

Theme 1: Participants' Definitions of PBL

The survey I used to collect data in the quantitative phase did not provide participants with an operational definition of PBL. The PBL instructional style has been referred to as project-based learning and/or problem-based learning in a variety of educational settings, and the literature is ambiguous about its definition. According to Merritt et al. (2017), PBL has yet to take on a single, widely accepted, universal definition. Therefore, it was important to begin data collection in the qualitative phase with an opportunity for participants to provide their own definitions of PBL. To this end, the interview protocol for both the non-PLTW and PLTW-trained groups began with the question, "How do you define PBL?" For the benefit of comparison, [Table 14](#) shows a summary of the interview participants' responses to this question alongside their STRS-SF scores from the quantitative phase. Participants one through six were from the non-PLTW group, and participants seven through nine were from the PLTW-trained group. The cells with participant data from the PLTW-trained group are shaded to emphasize a contrast between the two groups.

Table 14*Phase Two Participants' Initial Responses to, "How do you define PBL?"*

Participant	Initial Response to, "How do you define PBL?"	STRS-SF Score
1	"Project-based learning"	56
2	"Tell me what those letters mean."	61
3	"Establishing a goal or some type of project. Trying to have them figure out a problem."	71
4	"Is it the same as project-based learning?"	70
5	"It's what people create for teachers to help students' kind of self-discovery."	65
6	"Can you clarify?"	59
7	"Using real world projects to help students learn."	61
8	"Problem-based learning, right?"	57
9	"Learning through hands-on experiences."	65

Interview participants from the stratified purposive sample provided a variety of definitions for PBL, including references to projects and problem-based descriptions. Some participants, such as Participant Three, integrated their descriptions to include both projects and problem-based activities and explained how they could be used together. Participant Four referred to PBL as "project-based learning," but s/he added, "It could be like an experiment or group work where they had to work together to solve the problem."

Comparison of Responses from Non-PLTW and PLTW-Trained Groups. Two of the participants from the non-PLTW group did not have definitions of PBL (2 and 6), however, all the PLTW-trained participants in the sample gave coherent descriptions of their perceptions of PBL.

Theme 2: Context Dependent Efficacy of PBL

After they had provided a definition of PBL, participants in both the non-PLTW and PLTW-trained groups answered the question, “Do you believe that problem-based learning is an effective instructional style?” Most of the participants answered in the affirmative, which expanded the quantitative data from the survey item, “I believe that PBL is an effective instructional style” ($M = 3.77, SD = .992$). However, almost every participant from the nested, stratified sample of interview participants modified their response with a conditional phrase, such as “...if you can relate it to life skills” or “...as long as it has the proper support” (see [Table 15](#)).

Interview participants from both groups that had varying STRS-SF scores commented that the efficacy of PBL was dependent upon the context of the learning environment. Participants 1, 2, 3, 5, 7, and 9 placed at least part of the responsibility on teachers, claiming that PBL efficacy depends on teachers’ knowledge, planning, and support. Participants Four and Six posited that PBL efficacy depends on students’ proficiency in foundational skills.

Comparison of Responses from Non-PLTW and PLTW-Trained Groups. Participant Four had used (non-PLTW) PBL years ago in another state, and s/he said it worked well with those students because they “were above and beyond what the state standards were.” However, when I asked how s/he would react if s/he found out s/he would be using PLTW next year, s/he said, “I would kind of be terrified.” S/he continued, “I have so many on tier 2 and tier 3 reading and math that come to me a year or two below.” Participant Eight was in the PLTW-trained group, and s/he would most likely agree with Participant Four about the need for PBL students to be proficient in foundational skills. I asked, “Please tell me your experience with Project Lead the Way,” and s/he said, “Hated it.” I asked, “Okay, can you tell me why?” S/he replied, “It was not developmentally appropriate by any means.” S/he elaborated by saying that the students “could not comprehend or articulate what it was and what they were doing.” [Table 15](#) shows the difference in scores between Participant Four (70) and Participant Eight (57) that might be explained somewhat by the fact that Participant Eight was required to use PLTW even though s/he thought it was “not developmentally appropriate.”

Table 15

Initial Responses to, “Do you believe that problem-based learning is an effective instructional style?”

Participant	Initial Response	STRS-SF Score
1	“Yes...if you’re knowledgeable about the standards...”	56
2	“I think it is if you can relate it to life skills.”	61
3	“It’s very effective as long as it has the proper support.”	71
4	“To a degree, but...you’ve got to have the foundations for reading and math.”	70
5	“I only believe it’s effective when students are in a safe environment.”	65
6	“With my higher language proficiency kiddos, I can probably do that.”	59
7	“Yes. Letting students see stuff in the real world.”	61
8	“Not by itself. No. I feel like a little bit. Yeah.”	57
9	“I’m not sure. I think that there’s a balance of direct instruction, but also needing to discover...”	65

Theme 3: Implementation of PBL and/or PLTW

The primary research question explored associations between PLTW and TSRs, so the interview protocols included questions to help collect data about teachers’ implementation of PLTW and/or other PBL lessons. The mean number of PBL activities implemented by teachers in the study was three, and the median number was 1.5. These numbers ranged from zero to 45. The present study did not find a significant difference between teachers with high, medium, or low implementation of PBL activities. PLTW-trained teachers offered descriptions of PBL implementation that were different from those who were not trained in PLTW, even though there were some similarities between the teachers’ beliefs about the efficacy of PBL. Consider from

Theme 2 that participants 1, 2, 3, 5, 7, and 9 in the qualitative phase placed at least part of the responsibility on teachers, claiming that PBL efficacy depended on teachers’ knowledge, planning, and support. These teacher-participants explained that their experiences were different because of the ways they implemented PBL lessons in their classrooms. When asked about their implementation of PBL or PLTW, they described different experiences between groups. Overall, the PLTW-trained teachers described a scripted program, comprised of step-by-step instructions that were designed to be followed in sequence. In contrast, teachers from the non-PLTW group described experiences that were more student-centered and flexible (see [Table 16](#)).

Table 16

Differences in Implementation of PBL between non-PLTW and PLTW-Trained Groups

Participant	Response Regarding Style of Implementation	STRS-SF Score
1	“Because of the student choice part, they were able to choose and pursue their own interest with it.”	56
2	“We did a project where they bought a Thanksgiving meal, and they had a budget.”	61
3	“Authentic engagement with the kids. They usually buy in because it’s a product of their own work.”	71
4	“We were given the projects that we had to do, and we had the rubrics that went with it.”	70
5	“It’s really student led.”	65
6	“I could...give them a problem and say, ‘Okay, work together. See what you can come up with, and we’ll work it together afterwards.’”	59
7	“You literally have to follow it to a T in order to get what you need to get out of it.”	61
8	“You know, we had it planned out. Like, we had slides for it.”	57
9	“Project Lead the Way has been very helpful, especially with step instruction.”	65

Comparison of Responses from Non-PLTW and PLTW-Trained Groups. All

participants had some experience with PBL, but the STRS-SF scores from the PLTW-trained group were significantly lower. Therefore, it was important for me to learn what might distinguish PLTW from other PBL implementational styles. Participant Seven told me that s/he had provided non-PLTW PBL activities for students before introducing them to PLTW. I asked her/him to explain the difference between how s/he implemented PLTW compared to the other lessons. Two main differences were present in the interview data: the timing of hands-on activities and student choice.

Regarding PLTW, Participant Seven said, “It didn’t really get into what we really needed to do the hands-on part until later on.” S/he said the students had been “super excited” about a racecar project they had done because “they could put their hands on it. It was something they could actually do, and they could take ownership of it.” In the PLTW module s/he used, called “Life Cycles and Survival,” there is an introductory story, three activities, and two culminating projects. This teacher would have preferred an engaging, hands-on activity at the beginning of the module.

According to Participant Seven, another key difference between PLTW and other PBL activities was the emphasis or lack of emphasis on student choice. S/he believed that students preferred to jump right into hands-on activities as opposed to listening to a story or discussing topics with a teacher. Referring to PLTW, s/he said, “You have to follow it to a T, and they have specific, you know, PowerPoints for specific stories that you have to read to reach your objective.” According to Participant Seven, the PLTW lesson sequence supplanted her role as facilitator and made it difficult to center her instruction around students’ needs. Contrasting other PBL activities s/he had facilitated with PLTW, s/he said, “We were more involved, so the kids

were more involved. It wasn't like always the video, always the story. It might just be, 'Hey, this student's having a party...Let's help them plan their party.'"

Theme 4: Instructional Impact on Teacher-Student Relationships (TSRs)

The primary research question for the present study is, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" The quantitative phase of the study showed a statistically significant correlation, so the qualitative phase has been designed to explain how PLTW is associated with TSRs. A nested sample of stratified cases included a mixture of non-PLTW and PLTW-trained teachers from nine different schools and various grade levels (K-5). Each of the nine participants were asked, "Do you think using problem-based learning (or Project Lead the Way) impacts your relationships with students?" Every participant in the nested sample confirmed that they perceived PBL or PLTW to have some type of impact on TSRs (see [Table 17](#)).

Table 17

Initial Responses to, “Do you think using problem-based learning (or Project Lead the Way) impacts your relationships with students?”

Participant	Initial Response	STRS-SF Score
1	“Yeah. They would be like, ‘You’re the teacher that does the cool experiment.’”	56
2	“I think it does.”	61
3	“I think it does impact the relationships.”	71
4	“I think so.”	70
5	“Oh yes, most definitely because it helps develop that relationship.”	65
6	“They would get frustrated.”	59
7	“Yes.”	61
8	“Just frustrating. It made me feel more frustrated towards them.”	57
9	“Absolutely. Yes.”	65

The qualitative data provides evidence that the rigid structure of the PLTW format supplants the role of teacher as facilitator and limits opportunities for student-centered instruction in the learning environment. The following examples reveal how the PLTW-trained teachers may have perceived their relationships with students differently than the non-PLTW teachers. Regarding PLTW, Participant Seven said, “It was really more hands-off with teachers. It was kind of like we put that in the, you know, hands of the person that was, you know, kind of teaching us.” I asked, “Is it fair to say that your role as facilitator was sort of farmed out to Project Lead the Way?” S/he responded, “I honestly think that was the main difference.” Later, I asked, “In your opinion, was Project Lead the Way too structured?” S/he responded, “Yes. My

teaching styles aren't just like going down a list of directions. I tailor my teaching to my kids, and there wasn't really a way to tailor it to the kids.”

Participant Seven's comments were similar to another participant's comments who had taught students using PLTW (Participant 8). Participant Eight in the nested sample from the PLTW group mentioned the restrictive nature of PLTW's structured curriculum and its impact on TSRs. Participant Eight used two separate PLTW modules to teach kindergarten students about weather and recycling, and she felt pressure to follow the program correctly. S/he said at one point, “Apparently, we didn't do it right.” S/he did not feel that s/he could adapt the lessons to meet the students' needs, saying, “I was like, ‘How are they going to do that?’ I'm looking at it very realistically, like, this is just not right.”

Comparison of Responses from Non-PLTW and PLTW-Trained Groups. Participant Nine had an above average STRS-SF score for the PLTW group (65; $M = 57.33$, $SD = 8.563$), but s/he had a different perspective on the implementation of PLTW and its impact on TSRs. When asked if PLTW impacted relationships with students, s/he replied, “Absolutely. Yes.” However, s/he explained that the relational impact of the PLTW lessons was associated with students' mindsets about learning from mistakes. “They were allowed to trust me more as they made mistakes,” s/he said. “We worked through it, and they were able to see my reactions to their mistakes.” In Participant Nine's classroom, the teacher maintained the role of facilitator despite the rigid structure of the curriculum because s/he worked through the modules alongside the students.

Since the qualitative phase of the present study sought to explain the quantitative findings using purposive sampling of stratified cases, participants from both groups with high and low STRS-SF scores were questioned. Participant One had an STRS-SF score that was well below

the average for the non-PLTW group (56; $M = 62.89$, $SD = 7.746$). This was the lowest score of all in the nested sample of the qualitative phase. Seeking to understand why this score might be so low, I asked, “What kind of group did you have last year? Was that a group you were more likely to use PBL with?” S/he responded, “Last year had to be very tight. Safety issue. I actually had kids that were physically aggressive with one another, so the PBLs I worked with them were shorter.” This response explains that the STRS-SF score for that teacher might reflect a case where students were unusually disruptive to the learning environment.

Participant Three had an STRS-SF score that was well above the average for the non-PLTW group (71; $M = 62.89$, $SD = 7.746$). This was the highest score of all in the nested sample of the qualitative phase. S/he used PBL activities, but none of them were the PLTW exemplars used in this study. I asked why s/he thought implementing PBL impacted relationships, and s/he responded, “It’s more emotional because of the different times you’re having to agree, disagree, and truly be involved. They like seeing that from the teacher, and they see that you’re actively trying to help them accomplish their goals.” In contrast to Participant Seven and Participant Eight from the PLTW group, Participant Three was completely involved in the entire PBL activity, making collaborative decisions, and working to accomplish team goals. This level of involvement was so ingrained that s/he described it as “emotional.”

Summary of Results

The primary research question for this sequential explanatory mixed methods study explored associations between elementary teachers' perceptions of teacher-student relationships and PLTW instruction. A mixed regression analysis of the quantitative data found a significant difference in Student-Teacher Relationship Scale-Short Form (STRS-SF) scores between elementary teachers who had received Project Lead the Way (PLTW) professional development and those who had not. PLTW is a research-based program designed to provide students with opportunities to collaboratively solve problems in grades PreK-12 classrooms. PLTW professional development trains teachers how to facilitate problem-based learning (PBL) activities in their classrooms. The STRS-SF is a survey that allows a teacher to rate his/her relationship with one of his/her students with 15 Likert-type items along two constructs: closeness and conflict. A scoring guide written by the author of the scale directed me how to assign one numerical score to each teacher-student relationship (TSR). This STRS-SF score was the basis for the dependent variable in the study.

A mixed regression analysis of the quantitative data from the present study found that teachers from the PLTW-trained group had significantly lower STRS-SF scores. I used a semi-structured interview protocol (see [Appendix B](#)) to conduct nine semi-structured interviews with PLTW-trained and non-PLTW-trained teachers to help interpret the difference in STRS-SF scores between the two groups. Through a line-by-line analysis of the qualitative data and memoing in the margins of the transcripts, four themes were developed. Saturation was reached as less and less information was provided by the stratified purposive sample of participants, and the following themes were generated: Participants' Definitions of PBL, Context-Dependent Efficacy of PBL, Implementation of PBL and/or PLTW, and Instructional Impact on Teacher-

Student Relationships. I explained how each of these themes respond to the primary research question and link the qualitative interview data to the quantitative data taken from the STRS-SF.

Chapter 5: Summary and Conclusions

The Purpose of the Study

The present study explored elementary teachers' perceptions of their relationships with students through the lens of attachment theory (Bowlby, 1969/1982). To better understand these relationships, I studied a sample of teachers to look for possible associations between teachers' perceptions of their teacher-student relationships and their instructional practices. Classroom instruction has been generally categorized as either teacher-centered or student-centered, and various approaches to instruction under these categories may have relational implications.

One of the most widely accepted approaches to student-centered instruction is usually referred to as problem-based learning (PBL). This methodology is an inquiry-based, constructivist approach that prioritizes student discovery of concepts rather than direct instruction delivered by the teacher. Elementary PBL teachers are typically trained to facilitate learning in classrooms by allowing their students to solve challenging problems in collaborative groups of their peers.

Project Lead the Way (PLTW) is an organization that provides curriculum and training to PreK-12 PBL and STEM teachers in the United States. The primary research question for the present study asked, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" In the sample for the present study, two of the 31 schools received funding and support for PLTW training, and 21 of the 83 survey respondents (25.3%) reported that they had received PLTW training. The difference in professional development opportunities between the PLTW-trained teachers and the non-PLTW teachers provided an opportunity to explore associations between these instructional differences and teacher-student relationships between the two groups.

The primary research question for the present study was “Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?” This question helped organize the mixed methods study in such a way that the perceptions of the teachers could be measured through self-reporting in response to a 19-item questionnaire. Survey scores of teacher perceptions from 15 items of the questionnaire were used as a dependent variable and tested for correlations with four predictors. One of those four predictors was teachers’ beliefs about PBL. I wanted to know if teachers’ perceptions about TSRs had any correlations with teachers’ beliefs about PBL. So, sub-question one of the present study asked, “Are teachers’ beliefs about PBL associated with their perceptions about teacher-student relationships?”

Much of the available literature tends to explore the benefits of TSRs (Goble & Pianta, 2017; Hill & Jones, 2018; Rimm-Kaufman & Sandilos, 2010; Sparks, 2019). However, this study sought to better understand TSRs through their associations with other factors, especially instructional styles. I hypothesized that PLTW teachers would perceive their relationships with students differently because of their student-centered methodology predicated upon their beliefs about student learning. This includes, but is not limited to, the facilitation of productive struggle in challenging problem-solving exercises (Leinwand et al., 2014; Warshauer, 2015). Four independent variables were studied quantitatively to provide metrics for analyzing data about teachers’ instructional styles for the primary research question. An analysis of the present study’s quantitative data did show a significant difference between the perceptions of PLTW-trained teachers and other teachers. Recent literature argues that the implementation of productive struggle requires the presence of a particular type of relationship to be effective (Murdoch et al.,

2020). Part of the explanatory work in the qualitative phase was trying to determine how these relationships might be different.

The Study

I employed a sequential explanatory mixed methods design to generate both quantitative and qualitative findings in two phases. Four sub-questions were asked to assist in the exploration of the independent variables: PBL beliefs, PLTW professional development, PBL implementation, and years of experience. I used a survey tool (STRS-SF) based on attachment theory to collect quantitative data from 83 participants about their perceptions of teacher-student relationships (DV) and instructional styles (IV). Twenty-one of the 83 teachers (25.3%) had received PLTW professional development, and three of those teachers participated in semi-structured interviews during the qualitative phase of the study. Six teachers who had not received PLTW training were interviewed as well. I subjected all the interview transcripts to a line-by-line analysis and used a priori codes to generate patterns and themes.

The Findings

During the initial quantitative phase, I conducted a mixed regression analysis of the STRS-SF scores and found the relationship between PLTW status and PBL beliefs, PBL implementation, and years of experience was constant across both groups. However, teachers who had received PLTW professional development self-reported lower STRS-SF scores on average than the other teachers in the study. This was consistent with other studies that found associations between perceptions of TSRs and instructional styles (Ghasemi, 2022; Hugerat, 2016). A line-by-line analysis of the qualitative interview data resulted in the development of four themes: Participants' Definitions of PBL, Context Dependent Efficacy of PBL,

Implementation of PBL and/or PLTW, and Instructional Impact on Teacher-Student Relationships.

Discussion

I will present a summary of the present study's research questions and their findings before I explain the implications of the results. The primary research question was, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" An analysis of the quantitative measures of teachers' perceptions of their relationships with students found a significant difference between two groups of teachers, indicating that there was some association between teachers' perceptions of TSRs (DV) and at least one of the independent variables (IV). Four sub-questions were used to explore associations between teachers' perceptions of TSRs (DV) and instructional styles (IV). The quantitative findings from the initial sub-questions helped inform meta-inferences for the primary research question, which I will further explain and explore once the individual questions have been examined. I explored the four research sub-questions quantitatively. After explaining the findings of these sub-questions, I will share data to support meta-inferences for the primary research question and make connections to literature.

Research Sub-Question 1:

Sub-question one asked, "Are teachers' beliefs about PBL associated with their perceptions about teacher-student relationships?" to explore correlations between teachers' beliefs about the efficacy of PBL and their perceptions of teacher-student relationships. All 83 participants in phase one, quantitative responded to Likert-type item 16, which states, "I believe that problem-based learning is an effective instructional style." Every participant in phase two, qualitative, nested sample confirmed that they perceived PBL or PLTW to have some type of

impact on TSRs (see [Table 17](#)). In the present study, teachers' beliefs about the efficacy of PBL was significantly correlated with their self-reported implementation of PBL activities ($r = .300, p < .01$). This aligns with studies by Boyd and Ash (2018) and Song and Looi (2012), which found that teachers' beliefs have a significant influence on their classroom practices. However, even though all the participants in the nested sample perceived PBL or PLTW to have some type of impact on TSRs (see [Table 17](#)), the present study found no significant correlations between teachers' beliefs about the efficacy of PBL and their perceptions of TSRs. Also, the interaction of teachers' beliefs about the efficacy of PBL with a grouping of PLTW-trained teachers was not a statistically significant predictor of teachers' perceptions of teacher-student relationships ($B = -.302, \beta = -.036, t = -.276, p = .783$). To be clear, the "beliefs" referenced in Item 16 of the survey were only about the "efficacy of PBL" and not PBL's influence on other factors, such as TSRs.

Participants in this study had an overall belief in the efficacy of PBL, based on the data from the quantitative phase (see [Table 15](#)). However, their positive views of this student-centered methodology did not correlate with their perceptions of relationships with students. The present study did not find evidence for a link between these teachers' beliefs in inquiry-based learning and their perceptions of TSRs. Notwithstanding these data, beliefs about inquiry practices, often associated with PBL, have led to more opportunities for student inquiry (Song & Looi, 2012). A case study by Song and Looi (2012) explored the relationship of teacher beliefs, practices, and student inquiry-based learning in a computer-supported collaborative learning environment and found evidence that different teacher beliefs led to different practices. Ultimately, they concluded that the teachers' beliefs were associated with the amount of opportunities offered for student inquiry in the learning environment (Song & Looi, 2012). While teachers' beliefs about inquiry-based practices such as PBL have been shown to correlate

with their decisions about instructional practices in their classrooms (Song & Looi, 2012), there are no extant studies about how or if these connect with their perceptions of TSRs. Although inquiry-based practices such as PBL may appear more relational because of their student-centered and collaborative nature, the current study did not find a connection between teachers' beliefs about PBL and their self-reported perceptions of TSRs.

The data analysis from research sub-question one helped inform the interview protocols for the qualitative phase to provide data for the primary research question (see [Appendix B](#)). According to the literature, teacher beliefs are associated with perceptions (van Uden et al., 2013) and therefore relate to the primary research question about teacher perceptions. Item 16 from the phase one survey asked, "Do you believe that problem-based learning is an effective instructional style?" The initial findings from this item in the quantitative phase informed a question on the interview protocol in the qualitative phase that asked the follow up question, "Why or why not?"

Research Sub-Question 2:

Research sub-question two asked, "Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students?" Since PLTW purports to be PBL-based curricula, this question about whether teachers had received the training or not could serve as a convenient categorical variable for a measure of PBL professional development. When I initially designed the study, I did not realize that PLTW status would be a significant predictor of Student Teacher Relationship Scale – Short Form (STRS-SF) scores. However, after the quantitative data from phase one had been analyzed, and PLTW status was shown to be a predictor, I needed qualitative data from phase two to help interpret these findings for the primary research question.

Project Lead the Way (PLTW) is an organization that provides curricula and training to PreK-12 PBL and STEM teachers in the United States. In the sample for the present study, two of the 31 schools received funding and support for PLTW training, and 21 of the 83 survey respondents (25.3%) reported that they had received PLTW training. In the context of this study, PLTW professional development involved two days of hands-on PLTW training, access to proprietary PLTW resources, and district-mandated PLTW instruction performed by the PLTW-trained teachers. The difference in professional development opportunities between the PLTW-trained teachers and the non-PLTW teachers provided an opportunity to explore associations between these instructional differences and teacher-student relationships between the two groups.

A significant difference was found between two groups in response to sub-question two: “Is PLTW professional development associated with differences in teachers’ perceptions of their relationships with students?” PLTW status was a statistically significant predictor of STRS-SF scores ($B = -2.713$, $\beta = -.287$, $t = -2.625$, $p < .05$). Teachers who had received PLTW professional development (PD) self-reported lower STRS-SF scores ($M = 57.33$, $SD = 8.563$) on average than the other teachers in the study ($M = 62.89$, $SD = 7.746$). When I conducted a simple linear regression with each of the four predictors separately to test their explanatory power with the dependent variable (STRS-SF scores), PLTW status remained a statistically significant predictor ($B = -5.554$, $\beta = -.294$, $t = -2.765$, $p < .05$). This equation explained about nine percent of the variance in STRS-SF scores ($R^2 = .086$, $Adj. R^2 = .075$).

Other research studies have found significant differences within groups that had received PLTW PD (Nathan et al., 2011; Tolan, 2008). Hoefert (2023) conducted a quantitative study with a pre/post-test survey design to measure the degree to which PLTW Launch PD would

improve teachers' self-efficacy in teaching engineering at the elementary level. He found that PLTW PD was successful in improving elementary teachers' confidence to teach engineering concepts at the elementary level (Hoefert, 2023). Hoefert's (2023) study did not explore associations between PLTW PD and TSRs, however it did show that PLTW PD can be associated with significant differences among elementary teachers.

Research sub-question two was very closely related to the primary research question because it referred specifically to PLTW PD. The findings from sub-question two showed a significant grouping of participants, and the primary research question asked how these groups were different. During phase two, qualitative, participants in the PLTW group were prompted by the statement, "Please tell me about your experience with Project Lead the Way."

Research Sub-Question 3:

Sub-question three asked, "Is the implementation of PBL in teachers' classrooms associated with differences in their perceptions of their relationships with students?" I hypothesized that there would be an association between teachers' perceptions of their TSRs and their implementation of student-centered activities in the classroom. All 83 participants, regardless of their use of PLTW or other activities, responded to Item 18 on the survey in phase one, quantitative: "Approximately how many PBL activities have you facilitated this school year?"

I found that teachers' self-reported implementation of PBL was significantly correlated with their beliefs in the efficacy of PBL ($r = .300, p < .01$). However, I did not find a significant difference between teachers with high or low implementation of PBL activities in relationship to their perceptions of TSRs. Also, the interaction of teachers' implementation of PBL with a grouping of PLTW-trained teachers was not a statistically significant predictor of teachers'

perceptions of teacher-student relationships ($B = .363$, $\beta = .253$, $t = 1.729$, $p = .088$). I conducted a simple linear regression with each of the four predictors separately to test their explanatory power with the dependent variable (STRS-SF scores), but PBL implementation was still not a significant predictor. In the present study, the degree to which teachers self-reported that they facilitated PBL-style activities or PLTW lessons was not associated with their perceptions of TSRs. Perhaps this was due to the wide variety of activities they used in their classrooms that may or may not have been proper exemplars of PBL as defined in the literature (Alacapinar, 2008; Almulla, 2020).

Studies that seek associations between the implementation of STEM, PBL, or scripted programs like PLTW and academic achievement are common in the literature. However, the results of these studies are inconsistent. A sequential explanatory mixed methods study by Wynn (2023) found significant differences in third, fourth, and fifth grade math and science achievement scores from students at public schools in Georgia with STEM integration programs as compared to scores from students in traditional public schools. The schools described as having STEM integration used a scripted program designed by Boston Museum of Science for grades 1-5 called Engineering is Elementary (EiE). Teachers were given a list of suggested units that would integrate best with the state standards. Wynn's (2023) study showed that a scripted STEM integration program could have a positive impact on math and science achievement scores as measured by the Georgia Milestone assessments. However, a systematic literature review by Hess et al. (2016) studied 16 journal articles, 11 dissertations, and 4 theses, and found minimal evidence that PLTW integration improved math and science achievement.

The quantitative data from research sub-question three did not provide any answers to the primary research question. However, the implementation of PBL activities, referenced in sub-

question three, is germane to the question of whether PLTW is associated with teacher-student relationships. This sub-question from the quantitative phase informed questions about the implementation of PBL and/or PLTW activities in the qualitative phase on the interview protocols (see [Appendix B](#)). More will be stated regarding meta-inferences that involve PLTW implementation in the section regarding the primary research question.

Research Sub-Question 4:

Sub-question four, “Is teacher experience associated with differences in teachers’ perceptions of their relationships with students?” was included in the present study to test its interactions with the other variables. It was hypothesized that this variable could possibly add explanatory power to the other predictors if significance was found. A Pearson point-biserial parametric test in SPSS (v. 28.0) showed that teachers in the PLTW group had fewer years of experience on average ($r = -.219, p < .05$; see [Table 6](#)), however, the interaction of years of experience with a grouping of PLTW-trained teachers was not a statistically significant predictor of teachers’ perceptions of teacher-student relationships. I conducted a simple linear regression with each of the four predictors separately to test their explanatory power with the dependent variable (STRS-SF scores) and found that years of experience was a significant predictor of STRS-SF scores ($B = .225, \beta = .232, t = 2.120, p = .037$). This means that, in the present study, teachers’ years of experience did appear to have some influence on their perceptions of TSRs, but it was no more or less significant with PLTW-trained teachers.

A study of pre-K programs by Pianta et al. (2018) found a significant difference in exposure to educational content among classrooms with teachers who had more experience compared to teachers with less experience. This data provides evidence that teachers’ years of

experience can be a significant predictor of instructional differences in young students' classrooms.

My study tested the association of years of experience with teachers' perceptions of TSRs. In 2005, Brekelmans et al. conducted a longitudinal study of 343 teachers with 2-20 years of experience and found that their perceptions of TSRs were relatively stable during their careers. However, their study also showed that teachers' perceptions of their influence grew on average in their first six years of teaching.

The Primary Research Question:

A mixed linear regression analysis was sufficient to answer the present study's four research sub-questions, however, a mixed methods design was needed to answer the study's primary research question: "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" This section will discuss the meta-inferences developed in response to the analyses of both phases of the sequential explanatory mixed methods study. Since each of the four sub-questions and their respective independent variables have been discussed, more emphasis will be given to the qualitative results in this section.

A significant difference was found between two groups in response to sub-question two: "Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students?" PLTW status was a statistically significant predictor of STRS-SF scores ($B = -2.713$, $\beta = -.287$, $t = -2.625$, $p < .05$). Teachers who had received PLTW professional development (PD) self-reported lower STRS-SF scores ($M = 57.33$, $SD = 8.563$) on average than the other teachers in the study ($M = 62.89$, $SD = 7.746$). Much of the work undertaken in phase two was focused on interpreting the differences between those two groups.

Lee et al. (2018) compared the math and science achievement scores from PLTW versus non-PLTW high schools in Texas and found that the PLTW schools had significantly higher scores. However, the present study explored TSRs instead of achievement and used teacher interviews to elaborate on the quantitative data to help interpret the difference between the groups. After using a priori codes and memoing in the margins of the interview transcripts to look for patterns in the qualitative data, four themes emerged: Participants' Definitions of PBL, Context Dependent Efficacy of PBL, Implementation of PBL and/or PLTW, and Instructional Impact on Teacher-Student Relationships. These four themes inform two meta-inferences that provide more information about the primary research question of how PLTW is associated with teachers' perceptions of TSRs.

Meta-Inference 1: Supplanting of the Teacher's Role as Facilitator

As stated in Theme 1: Participants' Definitions of PBL, the three PLTW-trained participants in phase two provided coherent definitions of PBL. Each of them emphasized a hands-on, project-based notion of PBL and referred to their experiences with PLTW when they gave examples. These PLTW teachers also believed in the efficacy of PBL. However, as Theme 2: Context Dependent Beliefs in the Efficacy of PBL showed, they each agreed that the efficacy of PBL depended upon either teacher or student ability. Participants seven and nine believed that PBL could only be effective if teachers were prepared, and participant eight felt strongly that successful PBL students must be proficient in reading and math.

Based on Themes 1 and 2, it would be logical to assume that PLTW would benefit teachers by providing readymade plans and materials for facilitating PBL lessons. However, the teachers in the present study elaborated on the quantitative data by expressing their concerns about the implementation of PLTW and how it affected their roles as facilitators. As Theme 3:

Implementation of PBL and/or PLTW shows, PLTW-trained teachers referred to PLTW as “planned out” and “step instruction,” saying that they had to “follow it to a T.” Participant Seven said that s/he was more involved when s/he facilitated other non-PLTW activities with his/her students. Theme 4: Instructional Impact on Teacher-Student Relationships shows that this lack of involvement is one of the primary differences in the two groups (PLTW vs. non-PLTW). The phase two participant with the highest STRS-SF score (71) reported to have been so involved in non-PLTW PBL activities that s/he described the experiences as “emotional,” saying s/he would “truly be involved.” In contrast, the participant in the phase two stratified sample with an STRS-SF score of 57 said that PLTW put teaching in the hands of the curriculum. These data provide evidence that the PLTW curriculum supplanted the role of facilitator for some participants in the present study. Participant Nine was an exception to this pattern because she developed a way to become more involved as a facilitator while s/he participated in PLTW alongside the students.

The present study asked, “Is PLTW instruction associated with elementary teachers’ perceptions of their relationships with students and how?” Meta-inference 1 has shown that the PLTW-trained elementary teachers in the study did not implement their roles as facilitators in a way that would effectuate and foster relationships with students. Interview participants stated that the curriculum supplanted the role of the facilitator, which certainly would have led to less interactions between teachers and students; interactions that would have had the potential to engender healthier relationships (Cook et al., 2017). Teachers’ perceptions would naturally follow as a result. Genuine PBL is characterized in part by collaboration among students and facilitators (Almulla, 2020; Dole et al., 2017), but scripted programs such as PLTW disrupt these interactions by eliminating the need for the teacher’s side of the relationship. PLTW instruction is associated with elementary teachers’ perceptions of their relationships with students because it

over mediates the interactions between teachers and their students and relegates them to the role of the curriculum's assistant without the capacity to relate through the instructional context.

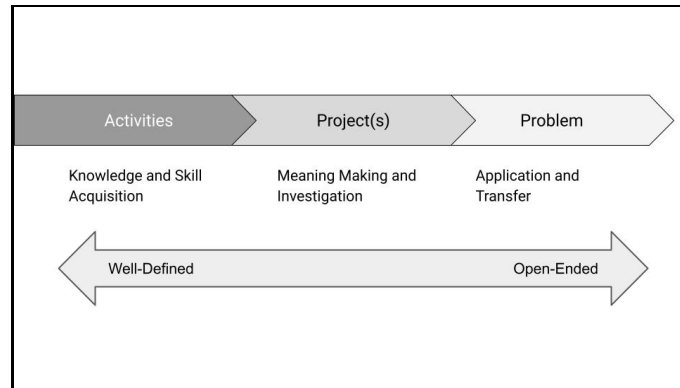
Meta-Inference 2: Limitation of Opportunities for Student-Centered Instruction

Although teachers in the PLTW group possessed coherent definitions of PBL (Theme 1) and believed in its efficacy (Theme 2), their actions (Theme 3) were often guided by the PLTW curriculum in ways that were contrary to their natural inclinations. This dissonance impacted their relationships (Theme 4) because the teachers often relinquished their role as facilitators and allowed the curriculum to guide instruction for the students. The PLTW structure described by the teachers in phase two was more curriculum-centered than student-centered.

Phase two participants in the PLTW group felt that it was difficult to tailor the curriculum to meet the needs of their students. They did not always agree with the PLTW format, and they believed that it was not adaptable. The PLTW Launch curriculum is both project and problem-based, and each unit of study includes Activities, Projects, and ProBlems, referred to as APB (Teague, 2019). A typical module begins with a picture book slide presentation that is designed to engage students in the topic of study. This literature component is followed by three activities, a project, and a problem-based challenge (see [Figure 4](#)).

Figure 4

APB Launch Learning Diagram



Participant Seven in phase two said that s/he would have preferred to begin with projects because the students s/he taught would have been more engaged. Overall, participants in the qualitative phase expressed that they wanted to facilitate activities they believed their students would enjoy as opposed to curriculum-centered activities.

The primary research question for the present study asked, “Is PLTW instruction associated with elementary teachers’ perceptions of their relationships with students and how?” Meta-inference 2 has shown that the PLTW-trained teachers in the study perceived their relationships with students to be hindered by a lack of individualization in the PLTW instructional approach. Gehlbach et al. (2016) showed that relationships between teachers and students can be enhanced when they share common interests, however, most scripted programs such as PLTW are designed to be used with any group of students in the grade level, regardless of their interests. The PLTW approach was associated with elementary teachers’ perceptions of their relationships with students because it was more curriculum-centered than student-centered. Instead of beginning with students’ specific interests, PLTW lessons were designed to match the generic interests of the whole class.

Implications

Recommendations for Practitioners

Analyses of quantitative and qualitative evidence from this mixed methods study led to two meta-inferences: Supplanting of the Teacher's Role as Facilitator and Limitation of Opportunities for Student-Centered Instruction. Teacher-participants expressed their desire to increase student engagement by facilitating lessons that appealed to their students' interests. Those participants who had used the PLTW curriculum described it as a scripted, step-by-step program that accomplished most of the work of facilitation without the need for teacher input. Administrators and PLTW trainers should consider making a way for teachers to adapt the curricula to meet the needs of their students. Evidence from the present study shows that more flexibility in the facilitation of PLTW might provide a greater degree of buy-in from teachers as well as more engagement from students. Perhaps this would benefit teacher-student relationships as well. As an example of this, Participant Nine in the nested sample expressed a more positive view of PLTW because s/he found a way to facilitate the lessons while she worked alongside the students. In her interview, she described her experience with PLTW stating, "we worked through it" and "they were able to see my reactions..."

Meta-inference 1 of the present study posits that the PLTW curriculum supplanted the teachers' role as facilitators in the present study. In these PLTW settings, challenges were posed by the curriculum instead of the teacher-facilitator. Sub-question two: "Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students?" was explored using scores from the STRS-SF scale that rated elementary teachers' perceptions of their relationships with their students. Evidence from a quantitative analysis of these scores showed that there may be an association between PLTW professional development

and elementary teachers' perceptions of relationships with their students. In the present study, teachers who participated in PLTW professional development and taught the lessons to their students rated their perceptions of TSRs lower on average than the other teachers. More time could be spent on preparing teachers to use curricula in a way that is flexible enough to meet students' needs.

Administrators should account for teachers' years of experience when they initiate instructional changes. The quantitative data in phase one of the present study showed that teachers in the PLTW group had less experience on average than the other teachers (see [Table 6](#)). Also, a simple linear regression found that years of experience was a significant predictor of STRS-SF scores ($B = .225$, $\beta = .232$, $t = 2.120$, $p = .037$). Studies have shown that teachers face challenges with PBL instruction and the facilitation of the students' activities (Nariman & Chrispeels, 2016; Tsybulsky & Oz, 2019). Even the facilitation of a potential exemplar of PBL such as PLTW could be difficult for novice teachers to manage. O'Dell (2018) investigated the emotions of fourth and fifth grade students while they solved challenging mathematics tasks and found that both positive and negative emotions were displayed, but frustration was observed most frequently. O'Dell noted that when students were given the opportunity to finish solving the problems, their frustrations were often followed by joy. It should be noted that O'Dell's (2018) study was conducted with a small group of students in an afterschool setting, and the present study references general education students during regular school days. Lessons that incorporate productive struggle are often time consuming. Furthermore, if the attachment figure (teacher) is accustomed to using proximity as a primary tool for management, PLTW lessons could introduce situations that do not conveniently fit within the teacher's normal routines. In most PLTW lessons, students work in collaborative groups with their peers, and they often

encounter frustration as they work together to solve challenging problems. Discomfort of the teacher in the learning environment may lead to different perceptions of relationships from the teacher's point of view. Murdoch et al. (2020) state that academic struggles can become "unproductive" and even "destructive" if the teacher-student relationship does not influence the learner to "feel heard" (pp. 659-661). Productive facilitation will require training and experience.

In response to item 15 on the STRS-SF, "This child openly shares his/her feelings and experiences with me," on a scale of 1 ('Definitely does not apply') to 5 ('Definitely applies'), there was a mean score of 4.22 ($SD = 1.06$). The mean score on the STRS-SF was even higher for item 3, "If upset, this child will seek comfort from me" ($M = 4.34$, $SD = .753$). Therefore, teachers in the study generally perceived that they shared a warm relationship with students which resulted in their ability to provide emotional security in the classroom. Meta-inference 1 reveals that participants in the study desired a more active facilitator role. Teachers are the primary attachment figures in their classrooms, and they make most of the managerial and instructional decisions in the learning environment. Many of these decisions are predicated upon their attachment perceptions and behaviors. Meta-inference 2 of the present study posits that teacher participants believed the PLTW curriculum should have been more student-centered. Student-centered classrooms provide scaffolding for students while they devise their own strategies for solving problems based on their own background knowledge and discussions (Gu et al., 2015; Vygotsky, 1978; Van de Walle et al., 2018). If teachers are provided with student-centered strategies that encourage exploration, they can still appreciate their roles as attachment figures and facilitators without abdicating their positions as secure bases. School leaders should take measures to ensure that teachers have balanced perspectives of their roles in the classroom

as secure bases and facilitators of engaging learning experiences that provide agency to students in safe spaces (Kim, 2022).

Recommendations for Future Research

Prior to data collection, I determined that the minimum sample size for the present study should be between 48 and 85 participants, based on a small, anticipated effect size of 0.15-0.28. A total of 83 participants completed the survey and PLTW status was a statistically significant predictor of STRS-SF scores ($B = -2.713$, $\beta = -.287$, $t = -2.625$, $p < .05$). The reduced model (Model 2) was statistically significant ($F_{4, 78} = 3.152$, $p < .05$), and the equation explained about 14 percent of the variance in STRS-SF scores ($R^2 = .139$, Adj. $R^2 = .095$). Future research should be done to repeat the study with a larger sample size under better circumstances. Prior to the collection of the data, the school district I sampled was hit by a devastating cyberattack that left their network idle for weeks. By the time the network was reestablished, teachers were hesitant to reply to emails and click on hyperlinks. If the data collection for the study had not been postponed and compromised by a cyberattack, it is likely that the sample size would have been much larger.

In the present study, four sub-questions were used to explore various aspects of instructional styles, including PBL. I chose not to operationalize the term “PBL” before I collected data from participants in phase one, quantitative. This aspect of the study’s design allowed me to ask the participants about PBL without the risk of influencing their responses with educational literature or my own biases. However, more work could have been done to define and explain PBL to the participants before they responded to any of the survey items. PBL has been difficult to study and discuss among educators. Newman et al. (2004) had similar difficulties with the term “inquiry” in the context of teaching elementary science methods

stating, “because inquiry has been defined in multiple ways, facilitating preservice teachers’ learning and implementation of inquiry in methods courses is complicated” (p. 260). Paolo Freire (1974) describes words as “the essence of dialogue itself” (p. 75), and Kolb (2015) states that “naming something transforms it” (p. 41). Most studies refer to PBL as “problem-based learning” or “project-based learning.” When studying PBL, it is critical to define the term clearly and explicitly for the participants unless the study involves exploring their previously held understandings. Future studies about PBL could broaden our understanding of teachers’ perspectives if the participants in those studies have clear understandings of the PBL instructional style at the outset of the study.

The teachers who participated in the present study appeared to have positive perceptions of PBL based on data from the survey. Sub-question one: “Are teachers’ beliefs about PBL associated with their perceptions about these relationships?” was explored with a survey item which found that most of the participants believed in the efficacy of the PBL instructional style. It would be interesting to see future investigations about participants’ understandings and perceptions of how PBL corresponds with PLTW.

A variation of the present study would measure teachers’ perceptions of teacher-student relationships at the beginning, middle, and end of the year to look for trends in the STRS-SF scores over the course of a school year. Qualitative data from interviews could help explain differences that might appear at different times throughout the school year.

I used a complementarity rationale for my study design. However, future researchers that seek triangulation of their results from the STRS-SF could use the Teacher Relationship Interview (TRI) to collect qualitative data (Pianta, 1999). In previous studies on teacher-student relationships, multiple researchers analyzed the qualitative data of the TRI and compared their

results (Spilt & Koomen, 2009; Stuhlman & Pianta, 2002). Codes were scored numerically, and Pianta's TRI scoring manual was used to calculate scores for each code. Future studies that use a mixed methods approach to explore associations between teacher-student relationships and other variables should use Pianta's TRI scoring manual and multiple coders so that intercoder reliability can be assessed.

The primary research question for the present study asked, "Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?" Note that the dependent variable is a measure of perceptions and not the relationships themselves. A significant difference in the STRS-SF scores of the PLTW and non-PLTW groups in the study suggests that there was some type of correlation between instructional practice and perceptions of teacher-student relationships. It is clear from the data that PLTW has an impact, but it is unclear what elements of the program make that impact, whether it be the curriculum or the professional development or a combination of the two. Future studies should examine this in greater detail. In addition, studies that search for correlations between teachers' perceptions and PLTW professional development would be informative.

Sub-question three: "Is the implementation of PBL in teachers' classrooms associated with differences in their perceptions of their relationships with students?" was measured with one survey item that allowed for an open-ended numerical response. Future studies should consider exploring this question with a multiple-choice item to facilitate a simpler analysis of the quantitative data. Instead of allowing participants to answer the question, "Approximately how many PBL activities have you facilitated this school year?" with an open-ended numerical response, researchers should place quantities in categories and offer four choices to the participant: "none," "1-8," "9-16," and "more than 16." Another option for assessing sub-

question three would be to provide a Likert-type item for the participants so that they could make their selection based on a range of quantities rather than typing a number into an open box.

Examining phenomena such as whether lessons were planned or taken from PLTW, as well as if these lessons were teacher-selected or mandated by administration would be informative; as these nuances would possibly impact perceptions and how instruction is facilitated.

The dependent variable for the present study was a measure of teachers' perceptions of their relationships with students. Future studies should seek to explore the other side of the relationship as well. A survey such as the Student Questionnaire of Teacher Interaction (QTI) could be used to assess students' perceptions of teacher-student relationships (Wubbels, 1993). It would be interesting to compare teachers' perceptions to students' perceptions, especially in PBL classrooms.

Conclusions

There may be a diminishing return on investment in instructional strategies such as PLTW without a commitment to strategic and intentional professional development. Participants in the present study stated that they desired more integral roles as facilitators than they experienced with their administration of PLTW. If elementary teachers attempt to facilitate curricula such as PLTW Launch without proper guidance, their perceptions of their relationships with students could be negatively impacted based on this study. Murdoch et al. (2020) state that academic struggles can become "unproductive" and even "destructive" if the teacher-student relationship does not influence the learner to "feel heard" (pp. 659-661). Student frustrations brought on by productive struggle could be associated with student perceptions of TSRs as well. Roorda et al. (2019) found that 476 seventh grade students had less favorable relationships with the teachers of their most difficult subjects.

The design of this study gave more emphasis to a potential exemplar of PBL (PLTW) than PBL itself. Curricula such as PLTW might serve as appropriate PBL proxies, but they cannot effectively represent PBL as an instructional style. However, perhaps we now have more questions to ask about the role of facilitators in PBL-style instruction and their influence on perceptions of TSRs.

Genuine problem-based learning (PBL) is a student-centered instructional style (Alacapinar, 2008; Almulla, 2020). When teachers employ PBL instruction, they challenge collaborative groups of students to solve real world problems, and they work alongside them as facilitators (Hall & Miro, 2016). This type of learning is social, and it attracts teachers who love to interact with students. Since the PBL approach is student-centered, generally favored by teachers, and promotes collaboration, it is considered socially positive. However, the present study used a potential exemplar of PBL called PLTW that limited the role of facilitators and centered instruction around the curriculum. Resources such as PLTW can be tremendous tools for organizing instruction, but they will never be able to replace the support that teachers can provide. Teachers in the present study expressed their desire to adapt the resources to meet their students' needs because they wanted to fulfill their roles as facilitators. Our students, especially elementary students, will always look to their teachers for support when they struggle at school.

Scripted programs such as PLTW provide structure and convenience, but they fall short of providing genuine, student-centered, problem-solving experiences. We all struggle, and life is full of problems. Educators must decide if schools are places to avoid problems or to learn through them. If life is like a raging sea, should our classrooms be more like submarines or aircraft carriers? The submariner does not see the waves or the storms, but on an aircraft carrier, the sky is the limit. When teachers and students are given the freedom to collaborate in an

environment that encourages learning through experiences, relationships can flourish. The present study has provided evidence of less favorable perceptions of teacher-student relationships in classrooms where PLTW Launch curricula was mandated and utilized by less experienced teachers.

It is encouraging that the elementary teachers in the present study wanted a more student-centered, teacher-facilitated experience. Warshauer (2015) noted that many teachers view students' struggles negatively instead of seeing opportunities for learning. However, PBL is not problem-based learning without problems, and problems will invariably introduce tension into the learning environment. Productive struggle is a necessary component of effective teaching, and all students deserve a quality education (Leinwand et al., 2014; Murdoch et al., 2020).

Kolb (2015) called learning a "tension and conflict-filled process" (p. 41). However, we must not assume that all teachers know how to facilitate productive struggle. Murdoch et al. (2020) make it clear that not all educational struggles are productive, and sometimes they can be destructive. The difference is made by teacher-student relationships. If we prioritize relationship-building in our learning environments, we can foster higher quality teaching. Prioritizing relationship-building does not mean teaching depends on perfect relationships. We must be practical and realistic in our implementation. Murdoch et al. (2020) state, "Rather, building such educational relationships and engaging students in productive struggle are mutually supportive dimensions of reflective teaching practice" (p. 676). Facilitating productive struggle in the classroom can be a means to building healthy relationships just as building healthy relationships can benefit the facilitation of productive struggle.

We travel the same ocean. Storms of life have made some of us bitter, but others are better because of them. Our relationships make a difference in our reactions to life's challenges,

and sometimes relationships are built because there were challenges in the first place. The same is true in the microcosm of the elementary classroom, where some of our most vulnerable population spends a considerable amount of time. The present study asked, “Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?” This mixed methods study has presented evidence that suggests some PLTW-trained teachers with fewer years of teaching experience could have had less favorable perceptions of their teacher-student relationships than other teachers in the study. Future studies should explore associations between teacher-student relationships and inquiry-based instructional styles so that teachers and students can learn how to grow through their struggles together.

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Appendix A

STUDENT-TEACHER RELATIONSHIP SCALE – SHORT FORM

Robert C. Pianta

Child: _____ Teacher: _____
 Grade: _____

Please reflect on the degree to which each of the following statements currently applies to your relationship with this child. Using the scale below, circle the appropriate number for each item.

Definitely does not apply 1	Not really 2	Neutral, not sure 3	Applies somewhat 4	Definitely applies 5
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1. I share an affectionate, warm relationship with this child.	1	2	3	4	5
2. This child and I always seem to be struggling with each other.	1	2	3	4	5
3. If upset, this child will seek comfort from me.	1	2	3	4	5
4. This child is uncomfortable with physical affection or touch from me.	1	2	3	4	5
5. This child values his/her relationship with me.	1	2	3	4	5
6. When I praise this child, he/she beams with pride.	1	2	3	4	5
7. This child spontaneously shares information about himself/herself.	1	2	3	4	5
8. This child easily becomes angry with me.	1	2	3	4	5
9. It is easy to be in tune with what this child is feeling.	1	2	3	4	5
10. This child remains angry or is resistant after being disciplined.	1	2	3	4	5
11. Dealing with this child drains my energy	1	2	3	4	5
12. When this child is in a bad mood, I know we're in for a long and difficult day.	1	2	3	4	5
13. This child's feelings toward me can be unpredictable or can change suddenly.	1	2	3	4	5
14. This child is sneaky or manipulative with me.	1	2	3	4	5
15. This child openly shares his/her feelings and experiences with me.	1	2	3	4	5

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Appendix B

Semi-Structured Interview Protocols

Research Questions	Interview Questions for PLTW Group
Primary Research Question: Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?	Do you think Project Lead the Way had any impact on your relationships with students? Why or why not?
Sub-question 1: Are teachers' beliefs about PBL associated with their perceptions about teacher-student relationships?	How do you define PBL? Do you believe that problem-based learning is an effective instructional style? Why or why not?
Sub-question 2: Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students?	Please tell me about your experience with Project Lead the Way.
Sub-question 3: Is the implementation of PBL in teachers' classrooms associated with differences in teachers' perceptions of their relationships with students?	How often do you assign problem-based learning activities? Why? Is Project Lead the Way (PLTW) problem-based learning (PBL)? How did you implement PLTW? How does that fit with PBL?
Sub-question 4: Is teacher experience associated with differences in teachers' perceptions of their relationships with students?	The quantitative data collected is sufficient.
Research Questions	Interview Questions for Non-PLTW Group
Primary Research Question: Is Project Lead the Way (PLTW) instruction associated with elementary teachers' perceptions of their relationships with students and how?	Do you think using problem-based learning impacts your relationships with students? Why or why not?
Sub-question 1: Are teachers' beliefs about PBL associated with their perceptions about teacher-student relationships?	How do you define PBL? Do you believe that problem-based learning is an effective instructional style? Why or why not?
Sub-question 2: Is PLTW professional development associated with differences in teachers' perceptions of their relationships with students?	Not Applicable for the Non-PLTW Group
Sub-question 3: Is the implementation of PBL in teachers' classrooms associated with differences in teachers' perceptions of their relationships with students?	How often do you assign problem-based learning activities? Why?
Sub-question 4: Is teacher experience associated with differences in teachers' perceptions of their relationships with students?	The quantitative data collected is sufficient.

Appendix C

Part II: Teacher Perceptions Questionnaire

The purpose of this survey is to understand your perceptions of the relationships you have with students in the classroom where problem-based learning (PBL) may or may not occur.

Please rate the following items based on your perception of the teacher-student relationships in your classroom.

Your rating should be on a 5-point scale where **1= not at all true of me** and **5= very true of me**.

Mark one box for each item.

	1	2	3	4	5
I believe that problem-based learning is an effective instructional style.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Have you participated in “Project Lead the Way” training?

- Yes
- No

Approximately how many PBL activities have you facilitated this school year?

Including the current school year, how many years of teaching experience do you have?

Appendix D



COLLEGE OF EDUCATION

CURRICULUM & TEACHING

(NOTE: DO NOT PROVIDE CONSENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMED CONSENT for a Research Study entitled

“Elementary PBL Teachers’ Perceptions of Teacher-Student Relationships”

You are invited to participate in a research study to improve our understanding of teacher-student relationships in problem-based learning (PBL) classrooms. This study is being conducted by Ash Kizer/PhD candidate, under the direction of Dr. Megan Burton in the Auburn University Department of Curriculum and Teaching. You were selected as a possible participant because you are a teacher at a public elementary school and are age 19 or older.

What will be involved if you participate? If you decide to participate in this research study, you will be asked to complete a brief, 19-item, online survey about your perception of teacher-student relationships in your classroom. Access the survey by clicking the blue button below. Your survey responses will refer to the first student on your roster for your first class on a typical day, and your total time commitment for the survey will be approximately 5-10 minutes. At the conclusion of the survey, you will be asked if you would like to volunteer to answer interview questions for approximately one hour via Zoom videoconferencing. The researcher will purposefully select volunteers based on their responses to the questionnaire so that he can unpack complexities in the data. This interview will be recorded and stored on an encrypted drive so that the researcher can analyze it and compare it to the other interviews. All electronic data will be deleted by May 31, 2026.

Are there any risks or discomforts? The only risk associated with participating in this study is a possible breach of confidentiality. To minimize this risk, we will make all questions optional and maintain data on encrypted drives. Teachers’ identities will be anonymous unless they decide to participate in an interview. Information of all interviewees will be kept confidential.

Are there any benefits to yourself or others? If you participate in this study, you can expect to increase public knowledge about teacher-student relationships in PBL classrooms. I cannot promise you that you will receive the benefit described.

Will you receive compensation for participating? To thank you for your time you will be offered verbal and/or written appreciation. You will also have the option to enter your email address into a drawing for a gift card.

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Are there any costs? If you decide to participate, you will not be required to make any investments other than your time.



Your privacy will be protected. Any information obtained in connection with this study will remain confidential. We will protect your privacy and the data you provide by choosing not to collect IP addresses or email addresses with the survey. However, if you volunteer for an interview, you will be asked to supply your email address so that you can be contacted by the researcher. Information obtained through your participation may be used to fulfill an educational requirement.

If you have questions about this study, please contact Ash Kizer at the Jefferson County Board of Education [phone: (205) 379-2241 or email: akizer@jefcoed.com]. You may also contact my academic advisor, Dr. Megan Burton [meb0042@auburn.edu].

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334)-844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. IF YOU DECIDE TO PARTICIPATE, PLEASE CLICK ON THE LINK BELOW. (YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.)

[Click here to provide consent and begin the survey.](#)

 _____ Investigator obtaining consent	<u>1/24/23</u> Date	 _____ Co-Investigator	<u>1/25/23</u> Date
<u>Ash Kizer</u> Printed Name		<u>Dr. Megan Burton</u> Printed Name	

The Auburn University Institutional Review Board has approved this document for use from _____ to _____ . Protocol # _____

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Appendix E

Code Book

Code	Type	Definition	Exemplar
Beliefs	a priori	expression of beliefs	“I think the ones that are behind really enjoy it. And I think it's great for them...” “I only believe it’s effective when students are in a safe environment...”
Imp	a priori	teacher’s implementation of instruction	“We were required to do those each 9 weeks.”
PBL	a priori	problem-based learning	“PBL, it’s different. It’s very different.”
PBL+	a priori	positive statement about PBL	“I feel like it's very effective.”
PBL-	a priori	negative statement about PBL	“We were kind of told that it's not best practices anymore whenever I was in college.”
PBL/PLTW	a priori	differences between PBL and PLTW	“... the books that they wanted us to read...”
PBL=PLTW	a priori	similarities between PBL and PLTW	“I would say so. Yes, cause they're presented with a problem.”
PBL/Lit	a priori	differences between the participant’s definition of PBL and the literature	“It was just more of my opinion on how things were, and there were really no set standards just except for that rubric.”
PBL=Lit	a priori	similarities between the participant’s definition of PBL and the literature	“... It could be like an experiment or group work where they had to work together to solve the problem.” “it’s really student led.”
PLTW	a priori	Project Lead the Way	“Like with Project Lead the Way, even the material leading up to the project is way far over their heads.”

PLTW+	a priori	positive statement about PLTW	“Project Lead the Way has been very helpful, especially with step instruction.”
PLTW-	a priori	negative statement about PLTW	“Hated it. It was not developmentally appropriate by any means.”
TSR	a priori	teacher-student relationship	“My job as a teacher is to get to know my kids and meet them where they are and learn about them.”
> or < TSR	a priori	positive or negative impact on TSR	“...it helps develop that relationship.”