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A Qualitative Case Study of the Influence of Action Research on the Teaching Practices of Novice Secondary Mathematics Teachers

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ACCEPTANCE

This dissertation, A QUALITATIVE CASE STUDY OF THE INFLUENCE OF ACTION RESEARCH ON THE TEACHING PRACTICES OF NOVICE SECONDARY MATHEMATICS TEACHERS, by TERESA INGRAM JACKSON, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

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A QUALITATIVE CASE STUDY OF THE INFLUENCE OF ACTION RESEARCH ON THE TEACHING PRACTICES OF NOVICE SECONDARY MATHEMATICS TEACHERS

by

TERESA INGRAM JACKSON

Under the Direction of Christine D. Thomas

ABSTRACT

This qualitative case study was a means to examine the experiences of novice mathematics teachers as they progressed through the implementation cycle of action research in their graduate coursework and the subsequent effects of the experiences on their teaching practices during their clinical experience. An action research course for novice mathematics teachers can help them develop the pedagogical skills they need to succeed in their classrooms (Ulvik, 2014). Despite a wealth of literature on action research, there has been little study of how the experiences in an action research course can influence the teaching practices of novice secondary mathematics teachers during their coursework and clinical experience. Kolb's experiential learning theory and the National Council of Teachers of Mathematics' eight effective teaching practices served as the conceptual underpinnings for this study. The research questions were: (a) How do the experiences in an action research course influence the teaching practices of mathematics teachers? and (b) How do the action research experiences align with Kolb's experiential learning theory? Four novice secondary mathematics teachers in a master's degree program participated in this study. Data collection included interviews, observations, lesson plans, participants’ journals, synchronous discussions, action research proposals, digital dossiers, a survey, and the action research syllabus. Qualitative data analysis of the journals, synchronous discussions, literature reviews, and action plans resulted in three themes: (a) engagement in action research cultivated novice mathematics teachers’ sense of community and collaboration for sharing effective strategies that became evident in their classroom instruction, (b) exploring and unpacking scholarly literature through action research strengthened the pedagogical content knowledge of novice mathematics teachers and promoted their use of evidence-based practices, and (c) reflective journaling in action research resulted in novice mathematics teachers having the capacity to assess the effects of their teaching on student learning. These themes describe the influence of the action research experiences on the teaching practices of novice mathematics teachers. The findings show that an action research course embedded in a teacher preparation program during the coursework and clinical experience can positively impact the teaching practices of novice mathematics teachers.

INDEX WORDS: Action research, mathematics teaching practices, experiences, reflective practices

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DEDICATION

This dissertation is dedicated to my son, Brandon Darrle Jackson, my sister, Vanesa Ingram, my father, Robert Ingram, my grandmother, Dorothy Ingram, and my great grannie, Cellie Mae Butler. These people are forever in my heart.

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1 THE PROBLEM

More than 4 decades ago, Johnson and Johnson (1984) stated, “We are in a period of educational crisis, with a wide discrepancy between the instructional methods used in schools and those verified by research as most effective” (p. 2). Although there has been significant progress in understanding how students learn mathematics, teachers in college methods courses continue to seek improvement in classroom instruction (Sutton & Kruegar, 2002). Sutton and Kruegar (2002) stated, “The most direct route to improving mathematics achievement for all students is through better mathematics teaching” (p. 26). The existing literature shows that teachers who become reflective practitioners provide better teaching (Shandomo, 2010). “This view of teachers as reflective practitioners implies that teachers become active knowledge producers as they continuously address problems of practice, they encounter to meet the learning needs of all of their students” (Darling-Hammond, 2006). Teachers can learn about the practical values and theories useful for informing everyday actions through reflective practices (Shandomo, 2010).

Some research has focused on reflective practices as an essential part of teacher preparation programs (Akbari, 2007; Conley et al., 2010; Griffiths, 2000; Jacobs et al., 2011; Killen, 2007), and action research has become a commonplace method in those programs (Hine, 2013). Action research enables novice teachers to develop knowledge directly related to their classrooms, become better decision-makers, and become more reflective about their teaching (Cohen & Alroi, 1981; Conroy, 2014; Noffke & Zeichner, 1987). A form of self-reflection, action research is a teacher-led, reflective method of progressive problem-solving to better understand and improve how teachers address challenges and solve problems (Burbank, 2003). There is an abundance of literature on action research; however, little has addressed the influence of an action research course in a teacher preparation program on the teaching practices of novice teachers during their coursework and clinical experience of teaching mathematics.

Research Questions

This investigation of the influence of an action research course on the teaching practices of novice mathematics teachers was guided by the following questions and subquestions:

1. How do the experiences in an action research course influence the teaching practices of novice mathematics teachers?
    a. In what ways did the teachers engage in experiences in the action research course?
    b. How did the action research become evident in their teaching practices?
2. How do the action research experiences align with Kolb's experiential learning theory?

Purpose

The goal of this study was to investigate the influence of an action research course in a teacher preparation program on the teaching practices of novice teachers. This study was a semester-long investigation of what occurred in an action research university course for mathematics and science novice teachers. The study focused on how the novice teachers engaged in the experiences of the action research course and the influence of those experiences.

In this study, the operationalized definition of experience was active participation in the activities of an action research course that caused the participants to alter or contribute to their knowledge, opinions, or skills (Vaughan, 2020). The novice mathematics teachers' experiences in the action research course correlated with the activities in the course syllabus: (a) journal, (b) engage in synchronous discussions, (c) write a literature review, and (d) create an action plan.

Significance of the Study

This study provided insight into novice mathematics teachers' experiences of the implementation cycle of action research in their graduate coursework and its effects on their teaching practices during their clinical experience. This study could contribute to the body of knowledge on reflective educators during their college coursework and clinical experience. More specifically, novice mathematics teachers could use this study to gain direct knowledge of classroom teaching practices, promote reflective practices, and take charge of their craft (Wright, 2020). The study also provided awareness of mathematics methods courses and how action research enables reflection and the implementation and improvement of effective teaching practices, resulting in the genuine transformation of classroom practice. Finally, teachers, teacher researchers, and math instructional coaches could use the study's results to apply action research as professional development to improve practice and student achievement.

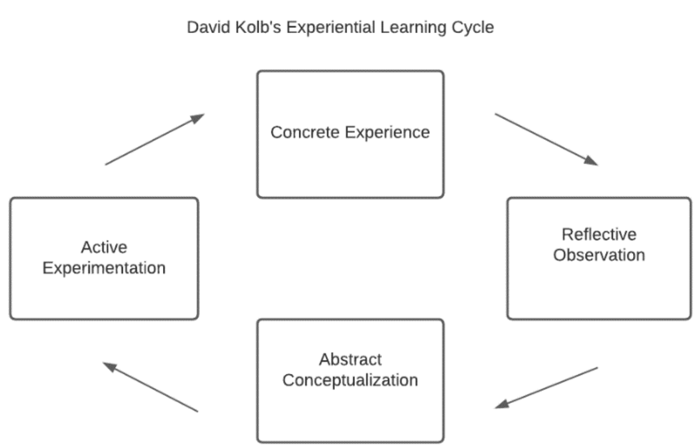
Theoretical Foundations and Conceptual Framework

In this study, "experience" meant active participation in an action research course that could cause the alteration of or contribute to the participants' knowledge, opinions, or skills (Vaughan, 2020). However, experience can also be a theoretically grounded concept. Examining how the novice teachers engaged in the action research course resulted in the use of Kolb's experiential learning theory to ground the study. Kolb's learning theory focuses on the fundamental concepts of having and reflecting on an experience (Kolb & Fry, 1975) and, therefore, direct participation in the learning experience (Kolb, 2014).

Kolb synthesized the works of Dewey, Lewin, and Piaget to develop a holistic model of the experiential learning theory (ELT). The ELT is a "comprehensive theory which offers the foundation for an approach to education and learning as a lifelong process and which is soundly based in intellectual traditions of philosophy and cognitive and social psychology" (Zuber-Skerritt, 1992, p. 98). Kolb (1984) defined learning as "the process whereby knowledge is created through the transformation of experience" (p. 38). Additionally, the scholar proposed that knowledge results from both grasping and transforming an experience (Hedin, 2010). "Grasping an experience refers to the process of taking in information, and transforming experience is how individuals interpret and act on that information" (Passarelli & Kolb, 2012, p. 6). The two dialectical stages of grasping experiences are concrete experience and abstract conceptualization; the dialectical stages of transforming experiences are reflective observation and active experimentation (Kolb, 1984). Kolb suggested that learning results from the resolution of creative tension among the four learning stages. Learning occurs in a cycle or a spiral, in which the learner touches all stages sensitive to the learning situation (McLeod, 2017; see Figure 1).

Figure 1

Kolb's Experiential Learning Cycle



Adapted from Passarelli and Kolb (2012)

The first stage of Kolb's ELT is to obtain practical experience by experiencing an activity or event that could contribute to or enable the improvement of the learner's knowledge or abilities (Brailas et al., 2017). An experience could range from an event as simple as a lecture to as serious as a tragic event. Many of these encounters are commonplace in daily lives and thus could occur in professional, personal, or educational settings (Brailas et al., 2017). These “concrete” experiences are the foundation for observations and reflections (Kolb & Kolb, 2005).

After new experiences, the second stage of Kolb’s ELT is reflective observation. In the second stage, the learner reviews and reflects on the experience to create meaning and understanding and make the experience relevant and meaningful (Brailas et al., 2017). This review also enables the learner to extract the most important aspects of the experience and reinforce and clarify concepts and linkages. Next, the learner assimilates and distills the reflections into abstract concepts to derive new implications (Sato & Laughlin, 2018). Thus, reflection is a means of creating new ideas or modifying current ones. These implications result in abstract conceptualization, the third stage in Kolb’s ELT.

In Kolb’s third stage, the learner connects the new experiences to previous knowledge and generalizes the encounter’s key characteristics into enduring concepts or rules. In the fourth stage, active experimentation, the learner puts new knowledge into practice and observes what happens as a result of actions (Menaker et al., 2006). Learning consists of progressing through a four-stage cycle: having a solid experience, observing and reflecting on the experience, analyzing and constructing abstract concepts, and verifying the experience, resulting in new experiences (McMullan & Cahoon, 1979).

The four stages of Kolb’s ELT comprise a learning process that reflects the learner’s experiences and actions. Kolb (1984) viewed learning as a multistage process in which each stage provides support for and flows into the next. A learner can enter the cycle at any stage and engage in its logical progression; however, effective learning only occurs with executing all four stages of the model. As a result, no single stage of the cycle can be a learning technique. In this study, the participants began the cycle at Stage 1 of concrete experiences.

The goal of observing the novice mathematics teachers as they participated in the experiences of the action research course was to know the influence of these experiences on their teaching. The ideal frame to investigate these experiences was Kolb's ELT. The National Council of Teachers of Mathematics (NCTM) eight effective teaching practices was the best frame for investigating effective teaching practices. Founded in 1920, NCTM is the most prominent mathematics educator association and was the catalyst for developing mathematics education standards.

In 2014, the NCTM presented the essential elements of teaching and learning and the actions teachers must engage in to teach effectively and develop mathematics learning for all students. This document presented eight research-based teaching practices for supporting all students' mathematical development:

1. establish mathematics goals to focus on learning,
2. implement tasks that promote reasoning and problem-solving,
3. use and connect mathematical representation,
4. facilitate meaningful mathematical discourse,
5. pose purposeful questions,
6. build procedural fluency from conceptual understanding,
7. support productive struggle in learning mathematics, and
8. elicit and use evidence of student thinking. (NCTM, 2014a, p. 12)

The eight effective teaching practices provide a framework for strengthening the teaching and learning of mathematics.

Summary

The goal of teacher education is to prepare competent novice mathematics teachers entering the field to meet the needs of their students. Therefore, teacher preparation courses should provide novice teachers with the most effective strategies and instruments for developing well-informed professionals aware of their strengths and the impact of their instructional decisions (Sutton & Kruegar, 2002). Developing more reflective practitioners during the clinical experience could be a way to place novice mathematics teachers on a path of deeper learning if they continue to teach (Ngololo & Kanandjebo, 2021). Action research is one strategy for building more reflective practitioners. The goal of action research is to improve existing teaching practices and investigate effective teaching practices, so novice mathematics teachers can identify, prioritize, and address teaching and learning concerns in their classrooms (Sagor, 2004).

2 REVIEW OF THE LITERATURE

This study was a means of investigating the influence of an action research course in a teacher preparation program on the teaching practices of novice mathematics teachers. Action research within teacher education programs has a vital role in preservice teachers' preparation and professional development (Hine, 2013). It is a compelling vehicle for helping teachers improve their teaching (Cochran-Smith & Lytle, 1993). The literature has shown that teachers can benefit significantly from engaging in the process of inquiry and reflection of action research (Schulz & Mandzuk, 2005). However, what remains unclear is whether the experiences in an action research course are means of improving the teaching practices of novice teachers during their coursework and clinical experience. The goal of this study was to examine how novice mathematics teachers engaged in the experiences of the action research course and the influence of those experiences on their teaching practices. This study addressed the following questions:

1. How do the experiences in an action research course influence the teaching practices of mathematics teachers?
    a. In what ways did the teachers engage in the experiences in the action research course?
    b. How did the action research become evident in their teaching practices?
2. How do the action research experiences align with Kolb's experiential learning theory?

This action research-focused study began with a review of the literature on the history and background of action research. Much of the extant literature has focused on the history, innovators, significance in education and teacher preparation programs, and impact of action research on teaching and learning mathematics. Chapter 2 also addresses the limitations and difficulties of action research. Next, there is a presentation of literature on other ways teachers engage in research and their different experiences studying their practices, specifically in mathematics education: in other words, reflective practices and lesson study. The chapter also includes a discussion of Kolb's ELT, this study's theoretical framework. Kolb's ELT provided a foundation to analyze the essence of the participants' experiences.

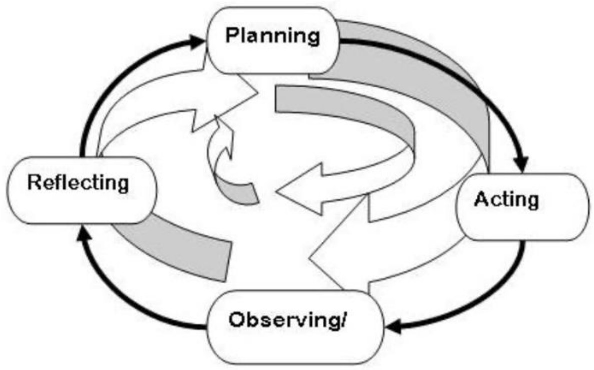
This chapter also addresses the literature on effective mathematics teaching practices. The goal of the study was to research the influence of novice teachers' experiences in an action research course on their effective teaching practices. The NCTM's (2014) eight effective mathematics practices served as a framework to analyze the effectiveness of the teaching practices. This chapter includes a discussion of the history, reform, and standards of teaching and developing mathematics teaching practices and concludes with a summary of the literature review.

History and Background of Action Research

Action research "has its roots in an agenda for social change through practitioner research" (Doerr & Tinto, 2000, p. 404). Lewin, an American social psychologist, introduced the term *action research* in the 1930s and 1940s. Although some scholars came before, Lewin is the one generally credited with constructing the theory of action research. Lewin sought to promote social action through the decision-making and active participation of practitioners in the research process to address community and teaching phenomena (Adelman, 1993). The psychologist focused on raising the self-esteem of minority groups to help them seek "independence, equality, and cooperation through action research" (Adelman, 1993). In social community research in the 1930s and 1940s, Lewin described action research as a spiral of steps (see Figure 2).

Figure 2

Lewin's Action Research Model



Each step consists of planning, acting, and engaging in reconnaissance (or fact-finding) about the result of the action (Kemmis & McTaggert, 1992). Thus, action research theory became a method of acceptable inquiry (McKernan, 1991).

Lewin's action research is a means of conducting a systematic inquiry within a group or organizational phenomena. Action research entails groups discussing problems and deciding how to proceed. After investigating these problems, the members of the group make decisions, monitor and note the consequences, and conduct regular progress checks. The individuals then decide if they have exhausted or fulfilled a strategy or introduced newly perceived problems (Adelman, 1993).

Lewin argued that social scientists, researchers, and practitioners must study groups to understand and change social practices. Researchers should remain on the ground and in the field and interpret data directly from their sources. Lewin's goal was to promote social action and resolve social conflict through the democratic process of action research to examine social situations for improvement (Burnes & Bargal, 2017). Historically, scholars have used action research as a qualitative critical analysis tool to scrutinize social problems and empower participants to understand these problems so that change can occur (Razfar, 2011).

Definition of Action Research

There are many definitions of action research. Action research can be a systematic inquiry that is a "collective, collaborative, self-reflective, and…critical undertaking by participants in phenomenological inquiry to establish meaning" (McCutcheon & Jung, 1990, p. 148). The action research approach varies according to the role, practice, or purpose of inquiry, including in quantitative or qualitative methods (Calhoun, 1993). Scholars first used action research as an inquiry in the social sciences to create social change; later, in education, practitioners engaged in action research as an inquiry to understand practices (Mills, 2018).

The goal of action research is to conduct scholarly inquiry to produce an understanding of practices and the situations in which they occur (Kemmis & McTaggert, 1992). Action research is a trusted approach for self-studying one's practices in a situation. In the United States, scholars have developed action research as a method of inquiry over the last century (Altrichter et al., 2002).

Innovators of Action Research in the Field of Education

Social scientists have applied action research. In the 1950s, Corey applied Lewin's concept of action research to education, arguing that traditional research done mainly by researchers occurred outside the public school and thus had little influence on school practice. Corey (1953) said, "The value of action research is to determine the extent to which findings lead to an improvement in the practices of the people engaged in the research" (p. 9). Thus, the scholar was the first to use action research to seek to improve practices in school.

In the 1960s, action research "suffered a decline in favor because of its association with radical political activism" (Stringer, 1999, p. 9). In addition, there were concerns about its rigor and the training of those leading it. However, action research reemerged in the 1970s under Stenhouse and Elliott in Britain (Jaworski, 1998).

Another action research innovator, Stenhouse sought to use educational research to strengthen teachers' professional judgment (Kirkwood & Christie, 2006). Stenhouse argued that effective curriculum development of the highest quality is based on teachers' capacity to take a systematic action research stance to their teaching. The idea is that the curricular requirement should inspire teachers' research, through which the teachers progressively increase in understanding their teaching.

Stenhouse's colleague, Elliott, earned international recognition for his role in developing the theory and practice of action research within education and training. Elliott wanted teachers to be collaborators rather than observers. The scholar saw educational action research as "empowering," enabling teachers to critique the curriculum structures they used to shape their practices. Furthermore, Elliot wanted teachers to have the power to negotiate change within the educational system (Water-Adams & Nias, 2003). Succinctly, the goal of action research is to improve practices, the understanding of practices, and the situations in which the practices occur (Carr & Kemmis, 1986).

Action Research in Education

Action research in education is a systematic process of studying real school or classroom situations to improve the quality of the educative process (Henson, 1996; Johnson, 2012; McTaggart, 1997). Mills (2018) defined action research as "any systematic inquiry conducted by teacher researchers, principals, school counselors, or other stakeholders in the teaching and learning environments to gather information about how their particular schools operate, how they teach, and how well their students learn" (p. 10). The goal of action research in education is to enhance the lives of the students and professionals who work within the educational system (Hine, 2013).

When teachers engage in action research, the questions they ask and the improvements they pursue vary depending on the problems and situations in the research settings (Burnaford et al., 1996). Through action research, teachers have a “chance to shape what happens in their classrooms and relate what they believe with what they practice” (Burnaford et al., 1996, p. 58). Educators are insiders who explore improvements in areas they consider important, and the people who conduct action research determine its goals. Therefore, action research is a process of pursuing improvement in practical situations (Altrichter et al., 2002).

Henson (1996) explained that teachers who engage in research could achieve various positive changes in themselves and others and increase their commitment to developing various teaching strategies. Teachers can also experience an openness toward learning something new and reflect on their practices (Johnson, 2012). According to Johnson (2012), teachers can meet the needs of their students by implementing effective practices. Action research workshops could replace ineffective traditional teacher in-service training and teacher professional development activities. The training sessions can occur “over multiple sessions, provide active learning activities that allow teachers to manipulate ideas, enhance their assimilation of the information, and align the concepts presented with the current curriculum, goals, or teaching concerns” (Johnson, 2012, p. 22).

Action Research Within Teacher Preparation Programs

Action research has an important role in university courses for preservice and in-service teachers. Action research can be a means of building a further basis for professional development (Ulvik, 2014). Teachers familiar with action research due to teacher preparation programs are more likely to use the tool in their careers (Ponte et al., 2004). Of course, not all teachers in a teacher preparation program conduct action research in the fullest sense with explicit, systematic data collection and analysis (Kosnik & Beck, 2000). However, if teachers are to teach informed, they should use the strategies of action research to gain knowledge for their practice.

Integrating action research as a significant component of teacher education programs could enable teachers to develop new knowledge of their classrooms and expand their pedagogical repertoires (Henson, 1996). When teachers use action research, they can embrace the challenges, advantages, and rewards to improve teaching practices (Kosnik & Beck, 2000). Teachers can become better decision-makers and more reflective about their teaching (Cohen & Alroi, 1981; Noffke & Zeichner, 1987). Additionally, they can use the components of reflection (e.g., identifying and analyzing problems, gathering, organizing, and interpreting information, and making reasonable interpretations and judgments of one’s practices) to become more thoughtful practitioners (Ross, 1987).

Studies of preservice and in-service teachers in teacher education programs have shown similar conclusions about using action research to foster strong inquiry habits and promote critical reflections to effect changes to teaching practices. Conroy (2014) explored how to use action research to promote or encourage reflection among preservice teachers in a teacher preparation program. Twenty preservice teachers participated in a 4-week action research training before their practicum, developing and executing an action research study following the training module’s guidelines. The teachers identified a research interest or problem; designed, implemented, and evaluated an intervention; and reflected on the process.

The collected data included an initial questionnaire, a daily reflective journal, an interview with a faculty member, and a follow-up written questionnaire (Conroy, 2014). After analyzing and coding the data, Conroy (2014) found that the teachers learned how to solve instructional dilemmas through action research. Further, action research enabled the teachers to discover and apply new ideas to their teaching practices, frame and reflect upon the interventions to determine their value, and develop themselves as reflective practitioners who sought to improve student learning.

In a similar study, Hagevik et al. (2012) used a multiple case method and a cross-case comparison to determine commonalities and differences among 20 middle-grade interns to explore how they planned, conducted, and reflected on their teaching practices as a result of action research. Data collection was from multiple sources: “Written action research reports, digital PowerPoint presentations, reflections in the written research paper, an open-ended qualitative survey, and the researcher’s journal documentation of informal conversations and reflective discussions with the interns” (Hagevik et al., 2012, p. 678). The findings showed that action research enabled the interns to reflect critically on their experiences during the year-long practicum, become more reflective and think about teaching differently, learn how to work together, and learn from the actions of other interns. Additionally, Hagevik et al. found the importance of daily reflections and how they enable teachers to develop more transformative practices as they engage in action research.

Junor Clarke and Fournillier (2012) studied an action research project integrated into a mathematics method course in a teacher preparation program for preservice secondary school mathematics teachers to investigate their teaching practices. Furthermore, the two instructors, the pedagogical methods instructor, and the action research methods instructor carried out an action research study on their own course teaching. The study included four aspiring secondary school mathematics teachers. The data included statements of educational philosophy, transcripts of focus group interviews, action plans, reflection memos, online discussions, and final action research projects.

After data analysis and coding, Junor Clarke and Fournillier (2012) found that preservice secondary school mathematics teachers learned about historical pedagogical views, their struggles with old and new mathematical concepts, and their struggles with theory and practice. The participants reflected on their comfort and needs for better practice in urban classrooms due to the action research project, discussed their viewpoints and experiences in class, received comments from peers and instructors, and gained knowledge through microteaching. Furthermore, the participants reflected on specific teaching strategies to determine what they could do differently for better results. Additionally, they shared their reflections and class summaries of current and old literature on mathematics education readings with their peers and the two instructors. The pedagogical methods instructor and the action research methods instructor also learned about the historical views of pedagogy and the old and new mathematics standards, technology, classroom culture, expectations, and cognitive demands within and across their classrooms. In addition, the instructors found ways to adjust their teaching approaches, strategies, and techniques, sharing their new knowledge with their students. The preservice secondary school mathematics teachers and teacher educators reflected at both levels and used the outcomes to make necessary modifications, resulting in effective practices.

Action research is a way to effectively prepare novice teachers for their complex roles as educators. Qualitative researchers acknowledge the complexity of the classroom learning environment; accordingly, qualitative data methods in action research can be a means of adjusting the curriculum content, the delivery of the content, and teaching practices to improve student learning (Sax & Fisher, 2001). Action research allows teachers to implement practices from an informed stance. Using action research, teachers can understand what occurs in the classroom and identify the changes needed to improve teaching and learning.

An action research project can occur with positivist (quantitative), interpretive (qualitative or constructivist), or mixed methods (Calhoun, 1993). There is no right way to undertake action research in education. The key distinguishing criterion for action research is that the researcher always gets directly involved in the situation. Undertaking a unit in action research methodology provides novice teachers with a systematic, reflective approach to addressing areas of need within their respective domains (Holter & Frabutt, 2011).

The Impact of Action Research on the Teaching and Learning of Mathematics

Traditionally, mathematics education researchers have focused on university staff and others with approved qualifications (Lerman, 1990). Most of the research at universities has addressed teaching and learning practices in schools. However, there has been a general trend toward using practice-based research methods to address problems in practice (Wright, 2020). Practitioner-based research is action research conducted by practitioners, people whose primary education and training are not research methodology (Campbell, 2011). Practitioner-based research can be a challenge to established practices (Myhill, 2015) and could impact a teacher's understanding of the theory of mathematics teaching and its enactment in practice (Betts et al., 2017). Teachers who engage in practitioner-based research can learn about the "teaching and learning process and about mathematics in ways that empower them to better meet the needs of their students" (Crawford & Adler, 1996, p. 1596). The "experience of engaging in systematic inquiry about mathematics practice appears to be changing mathematics teachers' views about research and practice" (Manfra, 2019). Moreover, teachers can become learners through the experience of conducting action research studies in mathematics classrooms (Wright, 2020).

In an action research study, Segal (2009) sought to understand the claims about the benefits of action research. Forty-five teachers completed their master’s degrees in mathematics education at a Northern Rocky Mountain land-grant university, conducting an action research project as their capstones. The author examined the effectiveness of action research by studying the group of graduates and gathering qualitative and quantitative data through surveys and interviews.

Segal (2009) analyzed the participants’ data collection methods, instrumentation, and data analysis procedures for their action research. For example, one participant focused the action research study on curbing the school’s level of violence and misconduct. In the analysis, Segal used Calhoun’s (1994) five-phase evaluation cycle: (a) selecting an area or problem of collective interest, (b) collecting data, (c) organizing data, (d) analyzing and interpreting data, and (e) taking action. The author used the evaluation cycle to collect data on the participants’ action research methods. Data from interviews, journals, writings, and field notes showed the action research experiences provided valuable insight into solutions for instructions and defining teacher roles and responsibilities. The study found that action research projects contributed to preservice teacher development in the teaching field.

Price (2001) explored how 11 teacher candidates in action research courses used the approach as a springboard to develop pedagogy in mathematics instruction and understand their students’ learning and pedagogical content. The college instructor emphasized the four course domains of developing dispositions of action and inquiry, relationships with students in schools and knowledge of the students, an understanding of pedagogical content knowledge, and an understanding of the centrality of issues of democracy and social justice. The instructor derived the knowledge domains from scholarships, including the NCTM, National Board for

Professional Teaching Standards (1992), and the Interstate New Teacher Assessment and Support Consortium (1993).

The course goal was to ensure that the action research work would be similar to teaching (Price, 2001). Price (2001) sought to understand the students' course experiences by collecting different forms of data. These included transcripts of audiotapes of classroom conversations, questionnaires administered at the beginning and end of the course, preservice teachers' and their students' action research journals, informal interviews with teacher candidates, videotapes of classroom work, and school, district, and state policy documents. After collecting the data, Price analyzed the different kinds of change the participants experienced: change on a personal level, change in what they knew and could do, and the types of agents of change they thought they were becoming and hoped to be. Price then examined the participants' experiences of action research and noticed distinct patterns. The researcher found that most participants used action research to pursue particular pedagogical interests, and a few used action research to strengthen their confidence in areas of weakness; however, one participant did not find action research helpful to her development as a teacher. Price used these three distinct patterns to analyze the relationship between action research and an understanding of pedagogy. The findings showed the commitment to action research in a preservice teacher education program needed to be situated in learning to teach carefully. Providing a framework preservice teachers can use to understand teaching practices via a purposeful, systematic, and intentional exploration of practice could have a positive effect on children's lives.

Beckett, a third-grade teacher, used action research to examine error patterns among third-grade students learning subtraction with regrouping (Beckett et al., 2011). Beckett et al. (2011) defined error patterns as the misconceptions and erroneous understandings that students make when learning new mathematical concepts. Students often incorrectly apply the procedures for one mathematical concept to another. For example, when multiplying fractions, some students approach the problem by finding a common denominator because they initially learned that step as the process for adding fractions with unlike denominators (Van de Walle et al., 2010).

Beckett found numerous articles on error patterns in mathematics but few articles on using error patterns in mathematics and as a means of instruction (Beckett et al., 2011). In the action research project, the teacher wanted to investigate whether this approach could enable students to develop subtraction comprehension with regrouping. The process commenced with background readings about common error patterns in subtraction, after which Beckett started formulating ideas about how her students could identify error patterns.

Initially, Beckett administered a 20-problem pretest of two-digit subtraction to determine common errors (Beckett et al., 2011). As a result, Beckett found that highlighting error patterns with subtraction was a way to help students with subtraction. The teacher used the findings to instruct the students differently, making them responsible for identifying errors when solving subtraction problems. Beckett learned this instruction method by using action research, which provided the opportunity to reflect on teaching practices and help students become proficient at solving subtraction problems. Thus, action research could be a way to address specific student needs, target classroom topics, keep teachers current, and discourage ineffectual methods.

Limitations and Difficulties in Action Research

There is “clear evidence that action research is a valuable exercise for teachers to undertake” (Hine, 2013). However, the approach has problems and limitations. Teachers might not have the choice to be change agents in their schools (Fullan, 1991), and even if they choose to be, they might not have the capacity, confidence, expertise, or time to conduct action research to improve their practices (Robson, 2002). According to Hadfield (2004), sustainability is the most challenging limitation to conducting action research at schools, as the lack of motivation or resources could compromise the research.

Another hurdle to action research is the "methodology, or lack thereof, depending on which side of the epistemology divide one stands" (James & Augustin, 2018). The debate about action research as a method of inquiry could lead some to avoid this approach. There have also been some concerns about teachers' capacity as researchers. Mockler and Groundwater-Smith (2015) stated that action research results could challenge practitioners' beliefs and perceptions about themselves; therefore, they might avoid pursuing action research. Mockler and Groundwater-Smith also stated that "these unhappy truths can stimulate reflection and provide a catalyst for rethinking and recasting practice" (p. 606). However, despite the limitations and challenges, action research can provide substantial evidence.

Other Approaches to Teachers Studying Their Practices

The research on reflective practices and lesson studies in mathematics education has shown the importance of teachers reflecting on their practices (Katwijk et al., 2019). Reflective practice is a term used in mathematics education to describe the action of reflecting on one's actions to engage in a continuous learning process (Kaminski, 2003). Reflective practice consists of evaluating practices attentively and inertly while paying close attention to the practical values and beliefs used to guide everyday behaviors.

Dewey, the most well-known American educator of the 20th century, used reflection to find ways to enhance instruction (Everett, 2013). Dewey led the way in teacher education (Griffiths, 2000; Osterman & Kottkamp, 2004). According to Dewey, instructors needed more than an education on successful methods. The educator advocated for assisting teachers with developing attitudes and habits of mind that enable them to become more conscientious about their work. According to Yang (2009), many teachers do not naturally reflect; it is assumed is that teachers reflect on their actions automatically (Griffiths, 2000). However, Yang indicated the need for teachers, particularly novice teachers, to have opportunities to reflect.

Models of reflective practices have resulted in several frameworks of reflective teaching. Schon produced the influential framework of reflective practices popular in mathematics education. Schon discussed reflection in action and reflection on action, noting that the former happens during an occurrence and the latter occurs after an event (Everett, 2013). According to Schon, reflection in action enables teacher practitioners to “respond to the variables of the immediate context, which involves thinking in the thick of things or on one’s feet” (Everett, 2013). Teachers consciously think about what they are doing while doing it and take appropriate action. On the other hand, reflection on action is the retrospective contemplation of practice to uncover the knowledge used in a teaching situation via analysis and interpretation of the information obtained in the research process. Reflective practitioners can consider how they could have handled certain teaching situations differently and what knowledge would be helpful for improving teaching practices (Burns & Bulman, 2000).

Reflective practices resulted in a framework or theory called the reflective teaching model comprising the components of planning, teaching, and debriefing. In the planning sessions, teachers think about how students interact with the content taught and how they can use instructional strategies to get students excited about the content (Fontenot et al., 2002). The instructors must become adept at responding to unanticipated student questions and facilitating discourse. In the debriefing sessions, teachers analyze their teaching and compare how they planned to teach the lesson to how they actually taught it.

Developed in Japan, lesson study is a method for teachers to examine their practices. In a lesson study, teachers get together to plan and develop research lessons, directing their work by identifying an issue and developing a lesson to solve the problem (Lewis, 2016). While one teacher teaches, the others watch and critique the lesson. The teachers then use the group members' reflection and evaluation to revise the lesson. Next, another member teaches the revised lesson while the others assess, reflect, and share the outcomes. The process occurs repeatedly. Reflection also occurs to enhance the teachers' capacity to look into their practices and improve their lessons with the strategies obtained during the research (Gutierez, 2015). The main purpose of lesson study is to gain deeper insights into the problems that teachers identify in their classrooms, as well as to propose and test potential solutions (Gutierez, 2015). In other words, lesson study is a means of integrating practical, significant insights into a problematic aspect of teaching.

Teachers engage in experiences to investigate and improve their practices, even if the inquiry approaches include different terminology. In this study, the novice mathematics teachers' experiences in the action research course connected to the activities in the course syllabus. Therefore, Kolb's ELT was the lens used to study these events during their participation in the course. Kolb's ELT facilitates a comprehensive examination of how learners acquire knowledge through experiences.

Kolb's Experiential Learning Theory

Kolb (1984) based the ELT on the idea that an individual creates knowledge by transforming an experience. The scholar proposed that knowledge results from the combination of grasping and transforming an experience (Hedin, 2010). “Grasping an experience refers to the process of taking in information and transforming experiences is how an individual interprets and acts on that information” (Kolb, 2014, Location No. 1541). Learning follows from resolving creative tension among four learning stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Concrete experiences are the basis for observation and reflection with which the learner directly engages (Kolb & Kolb, 2005); reflective observation occurs after having new experiences (Brailas et al., 2017). The individual assimilates and distills reflection into the abstract concepts used to draw new implications for action (Sato & Laughlin, 2018), thus resulting in active experimentation. The experience in this stage “allows the learner to apply the new knowledge and learn how to improve the future process and how the learning will continuously be revised and reshaped through experimenting” (Chan, 2012, p. 406).

Kolb’s ELT (1984) indicates that “learning is the process whereby knowledge is created through the transformation of experiences” (p. 38). The experience “comes first, and learning is the byproduct of the direct experience” (Brailas et al., 2017). In this study, Kolb’s ELT was the philosophy used to examine how the knowledge developed through the teachers’ experiences resulted in effective teaching practices.

Research Literature on Effective Mathematics Teaching Practices

Teaching and learning mathematics are involved, active, and complex processes (NCTM, 2000). Learning mathematics consists of successively collecting ideas and building more in-depth and refined understandings (NCTM, 2000). The experiences that teachers provide are how students learn mathematics. Thus, students’ knowledge of mathematics, their ability to problem-solve, and “their confidence in and disposition toward mathematics are all shaped by the teachings they encounter in school" (NCTM, 2000, pp. 16–17). Although effective teaching has a positive impact on student learning, there are no easy strategies for "helping all students learn or for helping all teachers become effective" (NCTM, 2000, p. 17). Teachers must have a deep understanding of the mathematics they teach (Ball et al., 2008) and draw on that knowledge with pliability in their teaching tasks (NCTM, 2000). Also, effective teaching requires reflection and continual pedagogical efforts for improvement.

The Beginning of Reform in Mathematics Education

Reform in mathematics education occurred in the early 1980s in response to a back-to-basics movement in the 1970s. The dominant instructional strategies of much of the 1970s in U.S. classrooms focused on basic skills (Howson et al., 1981). The perception was that teachers were ill-equipped for the instructional demands of New Math, the first reform movement in the 1960s. Thus, the belief was that well-designed instructional materials were a way to overcome any teacher's deficiencies in content knowledge (Hekimoglu & Sloan, 2005). The back-to-basics movement showed that there were no teacher-proof mathematics curricula or curricula designs to ensure that every teacher who used the products would have the same results (Erlwanger, 1973). As a result, the mathematics education community "was faced with the challenge of developing a curriculum to bring effective mathematics instruction into the K–12 classrooms" (Hekimoglu & Sloan, 2005). Subsequently, educators made problem-solving an essential component of the mathematics curriculum (Van de Walle et al., 2016). Piaget and other psychologists helped shift the focus from mathematics content to how students learn mathematics best.

Recommendations for School Mathematics Education From the National Council of Teachers of Mathematics

Founded in 1920, the NCTM is the largest mathematics organization for professional mathematics educators. The goal of the NCTM is to present a responsible and knowledgeable viewpoint of the educational mathematics program's directions (NCTM, 1980). In 1980, the NCTM published a report entitled *An Agenda for Action: Recommendations for School Mathematics of the 80s,* presenting eight recommendations for improving mathematics teaching and learning:

> (a) problem-solving should be the focus of school mathematics in the 1980s, (b) basic skills in mathematics be defined to encompass more than computational facility, (c) mathematics programs take full advantage of the power of calculators and computers at all grade levels, (d) stringent standards of both effectiveness and efficiency be applied to the teaching of mathematics, (e) the success of mathematics program and student learning be evaluated by a wider range of measures than conventional testing, (f) more mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accommodate the diverse needs of the student population, (g) mathematics teachers demand of themselves and their colleagues a high level of professionalism, and (h) public support for mathematics instruction be raised to a level commensurate with the importance of mathematical understanding to individuals and society. (p. 1)

In *An Agenda for Action*, the NCTM (1980) provided new directions in mathematics education later categorized as national standards. Problem-solving, along with new instructional practices, was the recommended focus of school mathematics in the 1980s. The report addressed the (a) counterproductive nature of requiring students to master skills without allowing them to participate in challenging problem-solving tasks, (b) that difficulty with paper and pencil calculations would not cause interference with the learning of problem-solving strategies, and that (c) access to calculators and computers throughout the school mathematics program is a way to make problem-solving available to students without basic skills. The NCTM suggested that problem-solving could be a way to promote meaningful learning and teaching of mathematics. The problem-solving process can facilitate learning mathematics and encourage students to develop logical reasoning skills and remain accountable for their learning (Stanic & Kilpatrick, 1989). The NCTM also suggested new ways of teaching mathematics, suggesting that teachers should use (a) diverse instructional strategies, materials, and resources, such as individual or small-group work and large-group work; (b) manipulatives to illustrate or develop a concept or skill; (c) discovery and inquiry-based learning; and (d) technology, such as overhead projectors, videos/audio tapes, computers, televisions, films, and slides. Although *An Agenda for Action* received little attention, it was the NCTM's "most prominent and powerful policy document and laid the groundwork for a major reform effort that launched the move toward professional standards for the mathematics education community" (Gates, 2003, p. 741).

The Need and Development for Mathematics Education Standards for K–12 Classrooms

The need for mathematically literate workers, lifelong learners, minorities in science and technology careers, and informed citizens capable of understanding issues in a technological society indicated the importance of teaching mathematics standards in the 1980s and 1990s (NCTM, 1989). The standards movement in mathematics education began with the NCTM's (1989) *Curriculum and Evaluation Standards for School Mathematics* (*Curriculum and Evaluation Standards*), presenting a vision for mathematics teaching and learning that differed significantly from traditional practices (Groth, 2013). With traditional practices, teachers focused on using algorithms and manipulating expressions as precursors to solving problems, overlooking the concern that knowledge often emerges from the problem.

The *Curriculum and Evaluation Standards* addressed the mathematics topics requiring less or increased attention (NCTM, 1989). For example, in algebra for Grades 5–8, the standards indicated the need for “more attention to using a variety of methods to solve linear equations and informally investigate inequalities and nonlinear equations” (p. 70) and “less attention to memorizing procedures and drilling on equation solving” (p. 71). For algebra for Grades 9–12, the standards suggested “more attention to the use of real-world problems (p. 126) and “less attention on word problems by type, such as coin, digit, and work” (p. 127).

The NCTM’s (1989) *Curriculum and Evaluation Standards* also presented the need for more attention on historically neglected areas (e.g., statistics, probability, and discrete mathematics) nonexistent in the present school mathematics curricula. This recommendation focused on the need to devote more attention to neglected areas and change school curricula based on society’s evolving needs. The standards also suggested that the school curriculum should include technology as a tool for helping students understand the conceptual underpinnings of mathematics. In the document, the NCTM focused on the components needed for high-quality mathematics education, introducing 54 standards for three grade bands (Grades K–4, Grades 5–8, and Grades 9–12) and an evaluation section. These standards were the first step in school mathematics reform.

Curriculum and Evaluation Standards presented 14 curriculum standards for Grades 9–12:

> (a) mathematics as problem-solving, (b) mathematics as communication, (c) mathematics as reasoning, (d) mathematics connections, (e) algebra, (f) functions, (g) geometry from a synthetic perspective, (h) geometry from an algebraic perspective, (i) trigonometry, (j) statistics, (k) probability, (l) discrete mathematics, (m) the conceptual underpinnings of calculus, and (n) mathematical structure. (NCTM, 1989, p. 123)

As in the *Agenda for Action*, the standards indicated the need for problem-solving as the central focus of the mathematics curriculum. *Curriculum and Evaluation Standards* indicated that mathematical problem-solving, reasoning, communication, and connections should be prevalent throughout the entire mathematics program, with the context provided in the concepts and skills learned (NCTM, 1989). The NCTM (1989) indicated that students could gain mathematical power via exposure to the experiences presented in the standards (see Table 1).

Table 1

Mathematical Power

Ability to explore
Ability to conjecture
Ability to reason logically
Ability to solve nonroutine problems to communicate about and through mathematics
Ability to connect ideas within mathematics and between mathematics and other intellectual activity
The development of personal self-confidence and a disposition to seek, evaluate, and use quantitative and spatial information in solving problems, and in making decisions
Students' flexibility, perseverance, interest, curiosity, and inventiveness

The Emergence of Standards for Teaching Mathematics and Development of Teaching Practices

The mathematics teaching presented in the NCTM’s (1989) *Curriculum and Evaluation Standards* differed significantly from what many teachers experienced as students in their own mathematics classes. Thus, to promote the vision and develop the teaching practices needed to teach mathematics as envisioned, the NCTM (1991) published *Professional Standards for Teaching Mathematics* (*Professional Standards*) as a companion publication. The *Professional Standards* presented a vision for teaching mathematics and implementing the curriculum changes of the *Curriculum and Evaluation Standards*. The later document was also a means of clarifying the NCTM’s vision for school mathematics reform.

In the 1990s, most teachers believed they implemented standards-based teaching methods focused on higher-order thinking. Many of them introduced group work, calculators, and real-world problems, but the teaching practice remained the same (Groth, 2013); there was no connection between the vision of NCTM and what occurred in the classroom. The *Professional Standards* (NCTM, 1991) presented six standards for mathematics teachers and the aspects of mathematics teaching practice in support of the teaching and learning in the *Curriculum and Evaluation Standards* (NCTM, 1989). The 1991 standards included the assumption that what students learn has a fundamental connection to how they learn. The goal of the *Curriculum and Evaluation Standards* was for students to develop mathematical power via teachers’ careful attention to pedagogy and the curriculum.

Professional Standards presented six standards for the teaching of mathematics: (a) worthwhile mathematical tasks, (b) the teacher’s role in discourse, (c) the student’s role in discourse, (d) tools for enhancing discourse, (e) the learning environment, and (f) the analysis of teaching and learning (NCTM, 1991). These standards were the NCTM vision's core dimensions for shaping what occurs in mathematics classes. The NCTM's *Professional Standards* suggested changing the discourse in the classroom to include talk (discourse). According to the NCTM, discourse includes thinking, talking, agreeing, and disagreeing in a classroom between the teacher and the students. The inclusion of talk could enable students to consider and challenge one another's assertions, question the teacher, and use mathematical evidence to convince others of the reasonability of their claims. NCTM's teaching standards included the assumption that the nature of classroom discourse could have a significant influence on what students learn about mathematics. Therefore, creating a learning environment supportive of this type of discourse is a necessity.

The NCTM recommended significant shifts in the mathematics classrooms' environment to move away from mathematical practices that did not contribute to mathematics teaching that enabled student empowerment. *Professional Standards* suggested that educators shift toward fostering a sense of community so that students can express their mathematical ideas, explore, conjecture, invent, problem solve, and reason logically. The document also suggested shifting away from memorizing procedures, finding the right answers, and seeing the teacher as the sole authority for the right answers.

The NCTM *Professional Standards* focused on practice while acknowledging the inherent complexity of practice:

> Good teaching demands that teachers reason about pedagogy in professionally defensible ways within the particular contexts of their work. The standards for teaching mathematics are designed to help guide such reasoning processes, highlighting issues that are crucial

> in creating the kind of teaching practice that supports the learning goals of the *Curriculum and Evaluation Standards.* (NCTM, 1991, p. 22)

The *Principles and Standards for School Mathematics* (*Principles and Standards*; NCTM, 2000) document expanded upon the *Curriculum and Evaluation Standards* and *Professional Standards*, both of which had a significant influence on teaching practices. With *Principles and Standards*, the NCTM (2000a) presented six principles fundamental to high-quality mathematics education: (a) equity, (b) curriculum, (c) teaching, (d) learning, (f) assessment, and (g) technology.

The *Principles and Standards* included the features of high-quality mathematics education. According to the NCTM (2000a), these principles must be “deeply intertwined with school mathematics programs” (p. 12). Although the principles are components essential to a high-quality mathematics experience, the focus was the teaching principle. The teaching principle indicates that “effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well” (NCTM, 2000, p. 370).

The *Principles and Standards* (NCTM, 2000) teaching principle emerged from the important ideas in the *Professional Standards* (NCTM, 1991). The goal of the standards was to address the expectations teachers must meet for multifaceted teaching tasks. The document addressed the importance of mathematical tasks, suggesting a focus on important mathematical ideas that students can find captivating and relevant to real-world experiences and arguing that curricula should be more than tasks (NCTM, 2000). “A curriculum is more than a collection of activities; it must be coherent, focused on important mathematics, and well-articulated across the grades” (NCTM, 2000, p. 14). Similarly, the ideas about teacher and student discourse in the

Professional Standards underlie that teaching principle in the description of a challenging and supportive classroom learning environment. Likewise, with *Principals and Standards*, the NCTM (2000a) further addressed the analysis of teaching and learning presented in the *Professional Standards*, stating, “Opportunities to reflect on and refine instructional practice during class and outside of class, alone and with others are crucial in the vision of school mathematics” (NCTM, 2000, p. 19). Teachers can improve students’ learning by analyzing what students are doing in the classroom (NCTM, 2000).

The *Principles and Standards* (NCTM, 2000) provided a way to focus curricula. The document was a means of building on and combining the messages from the previous standards documents. This document presented standards for four grade bands—PreK–Grade 2, Grades 3–5, Grades 6–8, and Grades 9–12—with ambitious and comprehensive curriculum standards for all students. The first five standards focused on the content goals in number and operations, algebra, geometry, measurement, data analysis, and probability; the next five addressed the processes of problem-solving, reasoning and proof, connections, communication, and representation. The content and processes of focus in *Principles and Standards* reflect society’s needs for mathematical literacy, past practices for mathematics education, teachers’ values, and expectations, mathematics educators, mathematicians, and the general public (NCTM, 2000b). The vision for school mathematics was as follows:

> Imagine a classroom, a school, or a school district where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodation for those who need it. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. The curriculum is mathematically rich, offering students opportunities to learn impotent mathematical

> concepts and procedures with understanding. Technology is an essential component of the environment. Students confidently engage in complex mathematical tasks chosen carefully by teachers. They draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing mathematics in different ways until they find methods that enable them to make progress. Teachers help students make, refine, and explore conjectures based on evidence and use different reasoning and proof techniques to confirm or disprove those conjectures. Students are flexible and resourceful problem solvers. Alone or in groups and with access to technology, they work productively and reflectively, with their teachers' skilled guidance. Orally and in writing, students communicate their ideas and result effectively. They value mathematics and engage actively in learning it. (NCTM, 2000b, p. 3)

The realization of the vision of mathematics teaching and learning in *Principles and Standards* is a work in progress that requires "a strong system of support at both the local and the national levels" (p. 366).

The Eight Effective Teaching Practices

Principles to Actions: Ensuring Mathematical Success for All (*Principles to Actions*; NCTM, 2014a) advanced *Principles and Standards* (NCTM, 2000a). Although necessary for effective teaching and learning, high-quality standards are insufficient (NCTM, 2014a). In other words, NCTM standards alone are not enough. *Principles to Action* (NCTM, 2014a) presented the settings, structures, and guidelines needed for all students to learn. Further, the document addressed the essential elements of teaching and learning, access and equity, curricula, tools and technology, assessments, and professionalism. *Principles to Action* also introduced a united vision of the requirements for educating all students under any standards or in any educational setting.

Teaching mathematics is a complicated endeavor (NCTM, 1991, 2014a). Teachers must know and understand the mathematics they teach (Ball et al., 2008), how their students learn mathematics, and the students' learning progression across grade levels (Daro et al., 2011). Learners should have experiences that enable them to (a) engage with challenging tasks that include active meaning-making and meaningful learning; (b) connect new learning with prior knowledge and informal reasoning and, in the process, address preconceptions and misconceptions; (c) acquire conceptual knowledge and procedural knowledge to meaningfully organize knowledge, acquire new knowledge, and transfer and apply knowledge to new situations; (d) construct knowledge socially, through discourse, activity, and interaction related to meaningful problems; (e) receive descriptive and timely feedback to reflect on and revise work, thinking, and understanding; and (f) develop metacognitive awareness as learners, thinkers, and problem-solvers and monitor learning and performance (NCTM, 2014a). In other words, learners should have the opportunity to develop mathematical power.

To promote deep learning of mathematics, the NCTM (2014) presented the eight mathematics teaching practices. These practices provide a framework for strengthening the teaching and learning of mathematics. The eight mathematics teaching practices are to

1. Establish mathematics goals to focus on learning,
2. implement tasks that promote reasoning and problem-solving,
3. use and connect mathematical representations,
4. facilitate meaningful mathematical discourse,
5. pose purposeful questions,

6. build procedural fluency from conceptual understanding,
7. support productive struggle in learning mathematics, and
8. elicit and use evidence of student thinking. (NCTM, 2014a, p. 12)

Establish Mathematics Goals to Focus on Learning

According to the NCTM (2014a), "Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions" (p. 10). The most notable aspect of the teaching practice is the importance of lesson preparation and lesson reflection (Spangler & Wanko, 2017). According to Mills (2015), lesson preparation and lesson reflection are essential components of effective mathematics teaching.

Teachers can establish goals to set the course for a lesson and guide their decision-making during lessons (Boston et al., 2017). Clear goals should "describe what mathematical concepts, ideas, or methods students will understand more deeply as a result of instruction and identify the mathematical practices that students are learning to use more proficiently" (NCTM, 2014a, p. 12). Clear goals guide teachers' instructional decisions and students' decisions on where to focus their efforts and what to take away from a given lesson (NCTM, 2014a; Spangler & Wanko, 2017; Stein & Meikle, 2017). Goals connected to big mathematical concepts and learning progressions enable teachers to reflect on how to support students as they learn new information in the context of their prior knowledge (Sidney & Alibali, 2013). When teachers consistently refer to the instructional goals, students can better self-assess and focus their learning on the lesson (Henningsen & Stein, 1997).

Teachers who work toward establishing and using goals in mathematics classrooms to focus on learning can set goals to articulate the mathematics learned by the students. Teachers can also identify how the goals fit within the learning progression, refer to the lesson's mathematical purpose, explain how the purpose contributes to students' learning, and use goals to guide lesson planning and instructional decisions (NCTM, 2014a). In conjunction with teachers' actions, students can engage in class discussions by asking questions about what they will learn for the day. The students can use learning goals to remain focused on their progression and improve their understanding of mathematical content and practices, connect prior knowledge to current work, and assess and monitor their understanding and progress toward the learning goals. Although these teacher and student actions are not immediate remedies, they can result in informed teaching. Teachers must have in-depth conceptual knowledge of the mathematics they teach and remain deeply engaged with what and how students learn (Ball et al., 2008; Spangler & Wanko, 2017).

Implement Tasks That Promote Reasoning and Problem-Solving

For decades, the NCTM has recommended that teachers use tasks and problem situations in mathematics classrooms. *An Agenda for Action* (NCTM, 1980) identified problem-solving as the necessary focus of school mathematics in the 1980s. *Professional Standards* (NCTM, 1991) suggested that teachers should use worthwhile mathematical tasks to create opportunities for students to develop mathematical understandings, competence, interests, and dispositions. According to the NCTM (1991), mathematical tasks are "projects, problems, constructions, applications, and exercises in which students engage" (p. 24). Worthwhile mathematical tasks stimulate students to think about particular concepts and procedures, connect them to other mathematical ideas, and apply them to the real world. The NCTM has provided much research on using tasks and problem situations in mathematics to promote mathematical reasoning and problem-solving; however, the use of such tasks and problem situations has not occurred on a national scale (Hiebert et al., 2003; Spangler & Wanko, 2017). Thus, there are “common and overarching obstacles in selecting and implementing tasks that promote reasoning and problem-solving in the work that teachers do daily in teaching mathematics” (Spangler & Wanko, 2017).

According to the NCTM (2014), “Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies” (p. 17). For students to “learn mathematics with understandings, they must have opportunities to engage on a regular basis with tasks that focus on reasoning and problem solving” (p. 23). Tasks that promote reasoning and problem-solving are the first step in helping students understand mathematics, and teachers should use these tasks to draw on students’ prior knowledge and experiences (Cross et al., 2012; Kisker et al., 2012). Tasks should also be a means of encouraging high-level student thinking and reasoning (Spangler & Wanko, 2017). One option for student thinking is to use tasks requiring them to perform procedures; tasks requiring engagement with concepts enable students to make connections and meanings, resulting in a different set of options for student thinking (Stein et al., 2009).

Teachers can implement tasks that promote reasoning and problem-solving by providing opportunities for students to explore and solve problems that enable them to build on their prior knowledge and extend their current understanding (NCTM, 2014a). Tasks with high cognitive demand “provide multiple entry points through the use of varied tools and representation and encourages students to use varied approaches and strategies to make sense of and solve tasks” (NCTM, 2014a, p. 24). Teachers can use various solutions, strategies, tools, and representations to improve students’ thinking capabilities, help students develop and maintain fluency, and explore, reason, draw on, and connect prior understandings and ideas.

Use and Connect Mathematics Representations

"Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem-solving" (NCTM, 2014a, p. 24). Because representations are the channel for communicating students' thinking in mathematics (Spangler & Wanko, 2017), they are critical features of mathematical constructs and actions (NCTM, 2014a). In learning to use representations, such as diagrams or words, to explain their mathematical thinking and make connections among mathematical ideas in various forms, students demonstrate a deeper understanding of the mathematics they are learning.

Teachers can deepen students' understanding of concepts by introducing different forms of representations and selecting tasks that allow students to decide which representations to use to make sense of the problem (NCTM, 2014a). In conjunction with their teachers' actions, students can use multiple forms of representations, such as drawings or diagrams, to demonstrate their mathematical understanding. Moving flexibly through various representations enables students to become successful problem-solvers, understand the power and beauty of mathematics (NCTM, 2000), and grow in their appreciation of mathematics (Lesh et al., 1987).

Facilitating Meaningful Mathematical Discourse

"Effective mathematics teaching facilitates discourse among students to build a shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments" (NCTM, 2014a, p. 29). Discourse consists of more than spoken words; it includes the exchange of ideas through all mediums and methods (Fontenot et al., 2002). The NCTM (2014a) defined discourse as any form of verbal, visual, or written communication. In facilitating meaningful mathematical discourse, teachers enable students to share their ideas, clarify their understanding, construct viable and convincing arguments, develop a language for expressing mathematical concepts, and learn to see things from a different point of view (NCTM, 2000, 2014a).

Discourse is a primary mechanism for developing a conceptual understanding of mathematics focused on tasks that promote reasoning and problem-solving (NCTM, 2014a; O’Connor et al., 2015). Orchestrating discourse that enables reasoning and problem-solving in a lesson is a complex challenge (Boerst et al., 2011; Franke et al., 2007). Smith and Stein (2018) designed five practices for teachers to plan and facilitate meaningful mathematical classroom discussions: (a) anticipating student responses before the lesson, (b) monitoring students’ work on and engagement with the tasks, (c) selecting particular students to present their mathematical work, (d) sequencing students’ responses in a specific order for discussion, and (e) connecting different students’ responses to key mathematical ideas.

Smith and Stein (2018) noted that, through lesson planning,

> Teachers can anticipate likely student contributions, prepare responses and questions they can use while monitoring students’ work, make decisions about how to structure students’ presentations (e.g., what strategies to select and how to sequence them), and plan questions to ask during the discussion to support students in connecting mathematical strategies and ideas in ways that advance the mathematical goals of the lessons.

Teachers can also facilitate meaningful mathematical discourse by engaging students in the purposeful sharing of ideas, reasoning, and approaches with different representations. Allowing students to present and explain their mathematical ideas and reasoning in whole-class discourses or small groups enables them to reflect on their understanding while making sense of and critiquing others' ideas (NCTM, 2014a). Additionally, teachers can make explicit connections to student approaches and reasoning in solving problems so students can identify the similarities and differences of those approaches in solving tasks (NCTM 1991).

Discourse provides opportunities for purposeful talk in the classroom; however, creating a mathematical discourse culture is challenging (NCTM, 2014a). Teachers must establish a culture where all individuals' comments and ideas are valued and respected and ensure that the lesson's central mathematical concepts remain prominent in class discussions (Engle & Conant, 2002). Orchestrating a mathematical discourse requires teachers to decide which approaches to share, how to share those approaches, and which questions to ask to help students connect those approaches and the mathematical ideas driving a lesson. According to the NCTM (2014),

> By anticipating student responses before the lesson, monitoring students' work on and engagement with the tasks, selecting particular students to present their mathematical work, sequencing the responses of students in a specific order for discussion, connecting different students' responses in a specific order for discussion, and connecting different students' responses to mathematical ideas. (p. 30)

To support mathematics learning in the classroom, teachers should allow students to talk, respond, question, and critique their peers' reasoning.

The Use of Posing Purposeful Questions

"Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense-making about important mathematical ideas and relationships" (NCTM, 2014a, p. 35). The practice of posing purposeful questions consists of asking questions to deepen students' understanding of mathematics while providing information about their mathematical thinking (NCTM, 2000a). Purposeful questions require students to do more than provide short answers. For example, in Figure 3, students must discuss the mathematical connections and representations of the mathematical concept of slope.

Figure 3

AP Calculus AB Question

Identifying a Tangent Line Use a graphing utility to graph the function $f(x) = 2x^3 - 4x^2 + 3x - 5$. On the same screen, graph $y = x - 5$, $y = 2x - 5$, and $y = 3x - 5$. Which of these lines, if any, appears to be tangent to the graph of f at the point $(0, -5)$? Explain your reasoning.

(Lawson & Edwards, 2010, p. 96)

Asking these questions could enable teachers to discern what a student understands about the relationship between slope, the tangent line, and the derivative of a function at a point. The productive questions provide students with the opportunity to explain, reflect, and justify their answers. These questions also allow for rich classroom discussions (Spangler & Wanko, 2017).

Asking purposeful questions is challenging, as teachers must resist the urge to talk while focusing on the purpose of the lesson. *Principles to Actions* (NCTM, 2014a) presents four main types of questions:

> a) gathering information—asks students to recall facts, definitions, and procedures; b) probing thinking—asks students to explain, elaborate, or clarify their thinking; c) making the mathematics visible—asks students to discuss mathematical structures and make connections among mathematical ideas and relationships; and d) encouraging reflection and justification—asks students about deeper understandings of their reasoning and actions. (pp. 36–37)

Teachers can use each question to help students develop a better understanding of mathematics (Spangler & Wanko, 2017). Teachers can also help students make important mathematical connections by listening more, talking less, and learning from their students. In turn, students teach themselves important mathematical concepts as they talk more and listen to other students' reasoning and ideas (Wood & Hackett, 2017).

Build Procedural Fluency From Conceptual Understanding

"Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems" (NCTM, 2014a, p. 42). Conceptual understanding and procedural fluency are crucial and connected components of a student's mathematical proficiency (Boston et al., 2017). According to Hiebert and Grouws (2007), "Conceptual understanding consists of "mental connections among mathematical facts, procedures, and ideas" (p. 380). Similarly, Spangler and Wanko (2017) identified conceptual understanding as the ability to explain the relation of mathematical operations or procedures to a physical context or process or to each other. Applying procedures accurately, efficiently, and flexibility, transferring procedures to different problems and contexts, building or modifying procedures from others, and recognizing when one strategy or procedure is more appropriate to apply than another defines procedural fluency (NCTM, 2014b).

Conceptual understanding "must come first and serve as the foundation on which to build procedural fluency" (NCTM, 2014a). The development of students' conceptual understanding through visual models and representations and by drawing on their prior knowledge allows them to build procedural fluency (Boston et al., 2017). Procedural fluency enables students to choose the methods and strategies needed to solve contextual problems, explain their work, and produce efficient answers (NCTM, 2014a). When they receive opportunities to understand when to use a procedure and why and how it connects to conceptual understanding, students can make appropriate decisions when applying the procedure to new situations (Boston et al., 2017).

For students to select the procedures needed to carry out solutions to mathematical problems, “Teachers must support students in building a foundation of a conceptual understanding of mathematics on which rests a set of mathematical procedures” (Boston et al., 2017, p. 49). Teachers can support students in building conceptual understandings by providing opportunities to use their strategies or methods to solve problems and discuss and explain why they are the correct procedures (NCTM, 2014a).

Support Productive Struggle in Learning Mathematics

“Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships” (NCTM, 2014a, p. 48). Productive struggle is a “key feature of teaching that consistently facilitates students’ conceptual understanding” (Hiebert & Grouws, 2007, p. 387). In a productive struggle, students work through a challenging problem to make sense of the problem situation and determine the course of action to take when there is no solution strategy stated or within reach (Boston et al., 2017). Productive struggle in mathematics occurs when students cannot see a clear path to a solution and become frustrated. Teachers must allow students to work through the struggle independently before offering help. By learning how to persevere when facing challenges, students can become independent learners (Blackburn, 2018). Teachers can support productive struggle in the mathematics classroom by anticipating students’ challenges and providing time to struggle with the tasks, asking questions to guide their thinking without doing the work for them (NCTM, 2014a). In the productive struggle, students must ask questions to progress in their understanding of mathematical concepts and persevere in solving challenging problems.

Elicit and Use Evidence of Student Thinking

"Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning" (NCTM, 2014a, p. 53). An essential component of meaningful learning of mathematics is using evidence of students' thinking to guide instruction (Sherin & Lynn, 2019). Teachers must first identify the evidence with a "clear understanding of what counts as an indicator of students' mathematical thinking" (NCTM, 2014a). To acquire evidence of students' thinking during instruction, teachers should listen to students explain or demonstrate their thinking, make sense of students' ideas, and build on that evidence to help students move forward in their thinking (NCTM, 2014a; Sherin & Lynn, 2019).

Teachers must actively look for evidence of students' ideas during instruction (Sherin & Han, 2004; Sherin & van Es, 2008). Among the forms, written evidence can include drawings, diagrams, graphs, symbols, or words; in comparison, verbal evidence includes students' discourses among their peers while working in small or large groups. Teachers can use this evidence to guide or adapt their instruction to meet their students' learning needs (NCTM, 2014a). To begin, teachers must identify the evidence to elicit and use evidence of student thinking to assess, support, and extend learning. Also, teachers must "gather evidence of student understanding at different points during instruction, interpret student thinking, make in the moment decisions on how to respond to students' questions, and then identify the next steps in planning future lessons and designing interventions" (NCTM, 2014a, p. 56).

Teaching is not limited to the eight NCTM (2014a) mathematics teaching practices; however, this core set of research-based, highly effective practices provides a framework for strengthening mathematics teaching and learning. Effective classrooms and learning environments for all students require effective instruction with the mathematics teaching principles. In continuously implementing the eight effective teaching practices, teachers "elicit, value, and celebrate varied approaches and solution paths that student takes to solve mathematics problems, explain their thinking and critique the arguments of others" (NCTM, 2014a, p. 114). Teachers must also include problem-solving tasks to engage students in mathematical reasoning and help them construct viable arguments with their peers. Most importantly, teachers should implement lessons, tasks, and applications to promote a positive disposition toward the study of mathematics.

Studies Using National Council of Teachers of Mathematics Teaching Practices

Studies in mathematics have shown extensive use of the NCTM's effective teaching practices to promote deep mathematics learning. The following discussions on NCTM's effective teaching practices provide a common lens for educators to collectively move toward improved instructional practices to become skilled at teaching and ensure successful mathematics learning for all students. The effective teaching practice of facilitating meaningful mathematical discourse consists of providing students with opportunities to share ideas, clarify their understanding of mathematics, and facilitate meaningful mathematics discourse.

Creating a culture of discourse in the mathematics classroom presents challenges (NCTM, 2014a). Kooloos et al. (2020) investigated changes in the classroom discourse of a secondary school teacher who had no prior experience facilitating meaningful mathematical discourse. Together with the researcher, the teacher collaboratively developed four discourse-based analytic geometry lessons in iterative design cycles comprised of the students' work for a problem and the classroom discourse about their various solution methods. The teacher and researcher chose problems based on textbook tasks; however, they modified the tasks because the students did not receive step-by-step instructions. The goal was for the students to solve the problems and develop their solution methods. Kooloos et al.’s (2020) data collection included four video recordings of classroom discourses, field notes, and two cameras used to capture student talks at specific moments. The videos underwent transcription, and the authors linked the transcripts to specific moments in the video recordings using Atlas.ti software. After data analysis and coding, the study found that more students participated and spoke in the later of the four lessons. The findings also showed that the teacher’s reaction to students’ solution methods changed from “either setting them aside or conforming them [to] making the solution methods the subject of discussion by probing for explanations or asking other students to react” (Kooloos et al., 2020, p. 371). Although the teacher succeeded in building the discussion on students’ ideas and their solution methods, she struggled to make the different solution methods the subject of discussion and help students connect the methods. This study aligned with previous research showing that developing a productive classroom discourse is a complex and long-term process (Hufferd-Ackles et al., 2004; Nathan & Knuth, 2003).

In a study on mathematical discourse, Sherin (2002) explored a middle school teacher’s attempt to implement a discourse community in the mathematics classrooms in an upper-middle-class suburb of the San Francisco Bay Area during the 1995–1996 school year. There was tension between the goal of establishing a classroom environment to encourage students to share their ideas as a basis for discussion while ensuring the students engaged in mathematically productive discussions. After feeling unsuccessful in developing a community with the components of the Fostering a Community of Teachers as Learners project, the middle school teacher believed that “encouraging students to talk about their mathematical ideas was the critical element in developing” (Sherin, 2002, p. 210) a discourse community in a mathematics classroom. The middle school teacher's plan for the upcoming year was to develop a mathematical community in the classroom where students could share their ideas and comment on and critique each other's ideas.

Sherin (2002) obtained data from one of the teacher's eighth-grade classrooms. The researcher observed and recorded three of the four weekly classes from September to December and two of the four weekly classes from January through June, for a total of 78 classes over the school year. Multiple microphones and an audio mixer were the devices used to capture the discussions. Sherin also collected field notes to track the mathematical ideas discussed in the class and record who represented these ideas and how. The teacher also kept a reflection journal to reflect on teaching practices three times a week from September to December and twice a month from January to June. Furthermore, the teacher participated in four interviews throughout the school year, which the researcher audiotaped and transcribed the interviews. The goal of the qualitative study was to understand teaching by looking at classroom interactions focused on class discussions over one school year. The author analyzed and coded the class discussions, finding that the teacher shifted his pedagogical style of teaching and used a student-centered approach to meaningful discourse in the classroom.

Using a survey approach, Huang et al. (2017) examined how teachers improved core instructional practices in teaching mathematics for problem-solving through lesson study using the NCTM's eight effective teaching practices. The teachers in the three lesson study groups developed lessons on problem-solving in algebra, including collaborative planning, repeated teachings, and debriefings. The data collected included lesson plans, videotaped research lessons, videotaped debriefing meetings, and an end-of-project survey. With the case study, Huang et al. used survey data to describe how the teachers improved the research lessons and what they learned from lesson study. An analysis of the data showed that the participants improved their strategies for teaching mathematical problem-solving, learned how to implement core mathematical instructional practices, and changed their views about students' learning. The study showed how the teachers improved their teaching and teaching expertise and the importance of the dynamic between repeated teaching and immediate feedback. Improving teaching practice is a crucial part of student learning, facilitated by the NCTM's (2014a) proven and scholarly data with the eight recommended practices for K–12 teachers.

Conclusion

In this literature review, a synthesis of action research occurred via systematic inquiry that is "collective, collaborative, self-reflective, and is a critical undertaking by participants in phenomenological inquiry to establish meaning" (McCutcheon & Jung, 1990, p. 148). In education, action research is an inquiry in which teachers systematically examine the process of teaching and learning in their classrooms (Mills, 2018). The literature suggests that action research is a beneficial and practical approach for engaging in action research.

Reflection is a critical and essential component of action research and novice teachers' development. Teachers having the "opportunities to reflect on and refine teaching practices is crucial in the vision of school mathematics outlined in *Principles and Standards for School Mathematics* document" (NCTM, 2000a). Although the literature has suggested the benefits and practicality of action research, little research has focused on the experiences of novice mathematics teachers in an action research course and how those experiences enable them to improve their teaching practices (Fasching-Varner et al., 2014).

3 METHODOLOGY

Introduction

The goal of this qualitative study was to investigate the influence of an action research course in a teacher preparation program on the teaching practices of novice mathematics teachers. This study was a semester-long investigation of what occurred in an action research course at a local university and in the participants' classrooms during their clinical experience. The purpose of the action research course was to help novice teachers solve educational issues in their classrooms by engaging in inquiry, reflection, and experiences. In this chapter, there are discussions of the research design; the context of the study, including the research context; and the participants. Chapter 3 also presents the data collection method and the steps to ensure the study's credibility.

Qualitative Research

Qualitative research is a "form of social inquiry that focuses on the way people interpret and make sense of their experiences and the world in which they live" (Everett, 2013). The goal of qualitative research is to perceive the social realities of individuals, cultures, and groups (Aspers & Corte, 2019). Qualitative research has its basis in the interpretive paradigm, the central objective of which is to understand the subjective world of human experiences (Guba & Lincoln, 1989).

The case study design is a qualitative approach to investigating a phenomenon in depth and within a context through various data resources (Baxter & Jack, 2008; Yin et al., 2016). A phenomenon and context may not always have apparent or easily distinguishable boundaries in real-world situations. The boundaries between a phenomena and context may become apparent using numerous data sources, such as observations, interviews, and journal reflections (Yin, 2018).

Case Study Design

The qualitative case study design was the approach used to examine the teaching practices of novice mathematics teachers as they engaged in the experiences of the implementation cycle of action research. Merriam (1998) asserted that a qualitative case study is an intensive, holistic description and analysis of a single phenomenon that provides insight into the phenomenon under study. In this study, the phenomenon under study was teaching practices. According to Yin (2018), case study researchers use "how" questions to study events within real-life settings. The central "how" research questions in this study were:

1. How do the experiences in an action research course influence the teaching practices of mathematics teachers?
    a. In what ways did the teachers engage in experiences in the action research course?
    b. How did the action research become evident in their teaching practices?
2. How do the action research experiences align with Kolb's experiential learning theory?

The goal of this study was to gain a better understanding of novice teachers' teaching practices after their experiences in an action research course. Therefore, a qualitative case study was the most appropriate approach.

Research Context

The study occurred during the Fall 2020 semester at a local university in a large Southern U.S. city. The student population of approximately 55,000 was 42% Black, 13% Asian, 11%

Hispanic, 23% White, and 11% other. The 4-year university provides bachelor's, master's, and doctoral degrees, including degrees in initial teacher preparation programs in mathematics and science. Many new teachers attend this institution because of the many available scholarships and awards.

Description of the Robert Noyce Teacher Scholarship Program

The National Science Foundation Robert Noyce Teacher Scholarship (Noyce) program provides funds to higher education institutions via scholarships, stipends, and programming support for STEM majors and professionals interested in becoming K–12 teachers. This study's context was a project funded by the Noyce program to address STEM teacher shortages and retention in secondary mathematics and science in two urban high-needs school districts; accordingly, the problem of practice was how to attract, prepare, and retain highly qualified STEM teachers in high-need schools. This project involved teaching scholars, known as teaching fellows (TFs), each holding a bachelor's degree in mathematics, biology, chemistry, physics, computer science, or engineering. The TFs received support throughout the program and beyond.

Recruitment of Candidates

The program's leaders used a variety of recruitment strategies to attract top professionals in STEM, including partnerships with local universities, institutions, and organizations; social media channels; career fairs; a dynamic website; advertisements; and brochures. Minor adaptions to the Cohort 2 recruitment process were necessary due to COVID-19. Cohort 2 TF recruitment and selection in September 2019, with advertisements and interviews in November 2019. After March 2020, all interviews occurred via video conferencing, and the project team could not organize mock teaching sessions for candidates.

Coronavirus Disease 2019

The novel coronavirus disease (COVID-19) emerged in 2019 with the symptoms of fever, chills, sore throat, muscle aches, cough, runny nose, shortness of breath, respiratory symptoms, exhaustion, nausea, vomiting, and the loss of smell and taste (Zviedrite et al., 2021). COVID-19, which is caused by the SARS-CoV-2 virus, was first discovered in Wuhan, China, in late December of 2019 (Zviedrite et al., 2021). The highly contagious nature of the virus resulted in its rapid spread and classification as a worldwide health crisis, with the World Health Organization identifying COVID-19 outbreak as a pandemic in early 2020 (Zviedrite et al., 2021). In March 2020, measures used to stop the virus's spread, including university closures, lockdowns, and mandatory quarantine periods, had an abrupt and significant impact on people's lives. Many colleges and universities switched teaching to online platforms.

Selection Process and Job Placement

Each STEM professional had to meet all the requirements for admission to the Master of Arts in Teaching (MAT) program and have a bachelor's degree or higher in mathematics, engineering, science, or a related field from an accredited institution or university to gain admittance into the program. All candidates also needed a minimum grade point average of 2.5, an appropriate Georgia Assessments for the Certification of Educators exam result, three letters of recommendation, a synopsis of professional ambitions, and a positive interview with the Noyce project leadership team. Furthermore, each candidate had to have prior coursework of at least 24 upper-division semester hours in mathematics or science. The selected TFs gained employment at the two participating school systems as provisional teachers and were placed in classrooms. The TFs were contractually obligated to teach for 5 years, for which they received a stipend each year.

The Master of Arts in Teaching Program in Mathematics and Science

The purpose of the local university's MAT program in secondary mathematics and science teaching is to help novice mathematics and science teachers execute standards-based instructional techniques more effectively. The MAT program prepares teachers for action research in their classrooms to inform instruction and share what they have learned with other teachers in a professional community. The purpose of the curriculum is to increase novice teachers' mathematical and science content understanding and ability to teach mathematics and science via advanced mathematics, science, mathematics education, and science education coursework. Framing the program study were the NCTM, the Next Generation Science Standards, the Association of Mathematics Teacher Educators Standards for Preparing Teachers of Mathematics, the State Standards of Excellence in Mathematics and Science, and the International Standards for Technology Education.

A goal of the degree program is integrated instruction across STEM disciplines and STEM education classes via reflective interviewing, reflective teaching, and microteaching. Moreover, this degree program provides numerous possibilities to create pedagogical content knowledge by teaching, observing, and reflecting on one's own and others' practices. The program includes early ongoing and authentic clinical (field) experiences with real-world teaching, as well as follow-up reflections with feedback from carefully chosen mentor teachers. Close collaboration with the College of Arts and Sciences occurs to ensure that the university's content knowledge mirrors the needs of STEM teachers for public school curricula.

Design of the Master of Arts in Teaching Programs in Mathematics and Science

STEM professionals, referred to as TFs, will finish the program of study in three semesters, taking 12 credit hours per semester. The TFs begin the program each year in the summer and complete the curriculum and the graduation and initial certification requirements in the spring semester of the following year. Table 2 provides an overview of the study program for the MAT in mathematics/science education.

Table 2

Overview of Program of Study for Master of Arts in Teaching in Mathematics/Science Education

Professional Studies (9 hours)	Teaching Field/Major (9 hours)	Teaching Field/Major (9 hours)	Internship (9 hours)
Multicultural Education	Introduction to Secondary Teaching	3 Content Courses in a Discipline	Practicum I
Action Research	Principles of Mathematics (Science) Instruction		Practicum II
The Psychology of Learning and Learners	Theory and Pedagogy of Mathematics (Science) Instruction		

COVID-19 had several effects on the MAT program in March of 2020. The university switched all course delivery to an online format, with all courses taught fully online in Summer 2020. With the shift to online courses and fewer opportunities for face-to-face interactions, the Noyce project team decided to supplement MAT courses with additional experiences to ensure the TFs received the pedagogical support they needed to provide high-quality instruction to students.

Required Methods Coursework in the Master of Arts in Teaching Program

Twenty-three TFs from the second cohort entered the MAT program in Summer 2020. Eight of the TFs were mathematics teachers, and 15 were science teachers; this study focused on the former. The following section presents the TFs' required courses.

The mathematics TFs began the program with an 8-week summer session that included two introductory mathematics teaching methods courses: Introduction to Secondary Teaching and Principles of Mathematics Instruction. The goal of these courses was to help new mathematics teachers with training and development in the field of education. The Introduction to Secondary Teaching required teachers-to-be to examine secondary students and schools, instructional materials, teaching strategies, technology, and effective teaching and gain experience in reflective teaching and microteaching. The NCTM, the Interstate New Teacher Assessment and Support Consortium standards, Georgia Standards of Excellence, and the standards of mathematical practices were the lenses used to examine instructional practices, teaching strategies, technology, and evaluation procedures for middle and secondary school mathematics. In this course, the students used the reflective teaching model to develop and improve their dispositions and pedagogies to facilitate content knowledge and widen and deepen their understanding of teaching and learning mathematics in multicultural classrooms (Junor Clarke, 2020).

The TFs participated in a virtual microteaching experience, using the knowledge and skills they gained in the course to plan and teach lessons at Lakeside STEM Camp, a 4-week summer camp for K–12 children. The children's range of ages gave the TFs a unique opportunity to interact with the grade bands they would teach in the fall. The TFs also participated in collaborative teaching inside and across disciplines. Most TFs' first opportunity to engage in virtual teaching was the Lakeside STEM camp, which provided a unique opportunity for training before the formal academic year.

The cohort had several course options the following semester. One mandatory course focused on the theory and pedagogy of mathematics instruction, and another pertained to action research. Both courses coincided with an 18-week practicum teaching experience in two partnering school districts. The objective of the action research course was to encourage students to study reflective practices and action research to evaluate effective mathematics teaching practices.

The Action Research Course in Master of Arts in Teaching Programs

A core component of the MAT program is preparing teachers to conduct action research in their classrooms to inform instruction and share their findings with a professional community. The introduction to action research course is a requirement in the MAT program for all TFs in mathematics and science. The purpose of the course is developing teachers as researchers to use systematic inquiry to address educational problems. This systematic approach enabled the teachers to make well-informed decisions at the classroom and school levels. The participants targeted personal concerns and explored possible solutions and interventions to improve practice via intentional research. According to the curriculum, the TFs conduct a literature review, gather and analyze data, and generate the first cycle of an action plan. The course also includes assigned readings from chapters and supplemental documents, online synchronous discussions, and regularly updated reflective journals. The course instructor guides the participants through step-by-step planning and implementing, analyzing, and evaluating strategies and techniques. This process includes creating artifacts to gather qualitative and quantitative data, such as surveys, interviews, and field notes of an identified issue, concern, or situation relevant to the content.

Selection of Study Participants

A purposeful sample strategy occurred to select four participants for this study. Merriam (1998) noted, "Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned" (p. 61). Researchers use purposeful sampling to increase the utility of the information obtained from small samples (McMillan & Schumacher, 2001). In this study, participant criteria were male or female TFs teaching middle and high school mathematics who were career-changers going from undergraduate to graduate studies and were new to teaching. Following these criteria enabled participant diversity to address the study's guiding research questions. The four teachers in the study comprised an appropriate sample size and a representative sample (see Table 3). All participants received pseudonyms to protect their identities.

Table 3

Description of Research Participants

Participant	Age	Ethnicity	Gender	Class taught	Previous career	Undergraduate degree
Christie	50	African American	Female	Geometry	Professional tutor	Electrical engineering
Jerome	49	Caucasian	Male	Eighth-grade math	Corporate data analyst	Mathematics
Nancy	21	African American	Female	Sixth-grade math	Mathematics student	Mathematics
Samuel	22	Caucasian	Male	Geometry	Mathematics and physics student	Mathematics and physics

Understanding the impact of the action research experience first required examining the factors leading the participants to change careers and become teachers. The next section provides rich descriptions of the participants and the unique experiences they brought to the program. The presented data are direct statements from the participants obtained through the biographies they submitted in the action research course and the digital dossiers they compiled through their practicum experiences.

Portrait of Participants

Christie: The Lifelong Learner

Christie was a novice teacher with a diverse background in various fields. She held seven degrees: two bachelor's degrees in electrical engineering and information technology; four master's degrees in mathematics education, marketing research, business administration, and human resources development; and a doctorate in educational innovation. She was also a licensed professional engineer. As a career-changer, Christie brought experience, critical thinking, and in-depth knowledge to the MAT program that could not be taught in class.

A single parent of five children, Christie felt the educational system did not adequately provide for her oldest son and youngest daughter. She claimed her oldest son could not graduate because he had to take four mathematics courses during his senior year. Her daughter, a sixth-grader at the time, still counted with her fingers and misspelled even the most basic words. Christie's experience working with people of various ages led her to believe that the school systems had not adequately provided for many of them. As a result, she regarded formal education as a necessary evil. However, she soon realized her teachers' profound influence on her. She met teachers passionate about their subjects who used different techniques to assist their students and took time to ensure their students learned. Christie's teachers had instilled their enthusiasm in her and shaped her into who she had become.

Christie had a passion for learning, stating, "Lifelong learning is my battle armor." Although she had not worked as an academically trained educator or gained teaching experience in a school environment, she had engaged with students for over 30 years. She began tutoring students as an undergraduate. Additionally, Christie volunteered with Junior Achievement while directing a reading program at a local elementary school and working in corporate America. She also led summer camps that provided workshops for high school students through charitable organizations. Later, in 2013, she established her tutoring enterprise and began tutoring students from 8 to 80 years. She began pursuing a doctorate in education 4 years later, aspiring to become a true educator. Christie believed that acquiring this degree would enable her to influence a greater number of students. Furthermore, her vast background, experience, and education would allow her to integrate the framework she received as a student. She pursued the MAT degree to become a teacher. She believed that learning pedagogical skills would help her work with her children and students who face educational challenges.

Despite her success in assisting others with their academic aspirations, Christie admitted, "I lack a foundation in teaching." However, she believed the MAT program would enable her to acquire the practicality needed to assist a broader group of students who genuinely have the desire to learn. Christie said, "The MAT program will serve as a base on which I can build an effective practice as I work to help students learn effectively and efficiently."

Jerome: The Business Expert

Jerome was a novice teacher with over 25 years of business experience. He oversaw multinational teams of data scientists, statisticians, and analysts in the credit industry and trained and developed young experts in STEM. Jerome had two master's degrees in mathematics education and mathematics and a bachelor's degree in mathematics. Like Christie, Jerome to the MAT brought experience, critical thinking, and knowledge not teachable in a classroom setting. He had two sons and came from a family of educators, including two parents and a sister who were teachers.

Jerome desired to teach, motivate, and mentor the next generation of professionals in STEM with the skills he had gained in the industry. He said, "There is a shortage of people who have been taught to think analytically in the corporate world, and there are so many opportunities for those who study advanced mathematics." He argued that teaching math for comprehension rather than memorizing a set of rules could be a way to make mathematics accessible to anybody. Jerome wanted to

> Move students beyond computational competence and develop skills to approach any problem, whether in mathematics or life, by defining the problem, gathering the facts needed to solve the problem, critically examining the data by exploring multiple solutions, and then drawing logical conclusions.

Through the MAT program, Jerome hoped to learn how to help students think critically and analytically. For him, critical and analytical thinking was a priority. Jerome's objective was to provide children with hands-on learning opportunities to explore underlying mathematical principles and develop mathematical mindsets. He wanted his students to develop analytical abilities to succeed in today's workforce, which requires tenacity in tackling complex problems and innovative ideas. Furthermore, he wished to provide students with a research-based educational approach to cultivate their enthusiasm for mathematics and all it provides.

Samuel: The Inquisitive One

Samuel was a novice teacher who had recently graduated from a well-known technical institution with two majors: mathematics and physics. His initial ambition was to seek a Ph.D. in mathematics; however, Samuel decided that academia was not for him. However, his desire to teach did not disappear, and the more he thought about it, the more he wanted to do it.

Samuel viewed education as a chance to show students they have value in the world and can demonstrate their strength and potential. He sought to create a positive learning atmosphere to encourage the growth of the whole student, not just academic skills. Furthermore, he wished to establish an environment where students could approach and learn to apply mathematical concepts and problems with the tools supplied to achieve a holistic grasp of mathematics in society.

Nancy: The Beacon of Light

Nancy had a Bachelor of Arts in mathematics and a minor in teaching. She was a first-year teacher who viewed her profession as a chance to empower pupils to seek new perspectives and approach mathematics holistically. She believed that by combining identity consciousness with a desire to understand underlying concepts, she could produce magic. Her long-term ambition was to open a STEM school for women.

Throughout her college career, Nancy tutored students in private settings, where she developed data-driven approaches to improve students’ retention and performance in mathematics classrooms. She worked primarily with minority students and had learned to appreciate the difficulties of students from underprivileged communities. As a result, Nancy felt inspired to facilitate projects for enhancing these students’ experiences. She created a Sisterhood

Empowerment Workshop, a Queen's enrichment course, and a character and leadership workshop.

Nancy's goal was to be a lighthouse for students facing the daily struggles of adolescence. She aspired to make all of her students globally competitive in mathematics and help them develop better critical-thinking skills. In addition, she wanted her students to become teachable, culturally conscious, and impactful people who want to improve.

Role of the Researcher

The goal of this study was to examine the effective teaching practices that emerged as the novice mathematics teachers engaged in the experiences of the action research course. As the researcher, I considered my biases and limitations throughout the data collection, analysis, interpretation, and reporting stages. According to Merriam (1998), qualitative research includes the assumption that the researcher's biases and values could affect a study's outcome. However, Peshkin (1993) stated, "One's subjectivities could be seen as positive, for bias is the basis from which researchers make a distinctive contribution, one that results from the unique configuration of their personal qualities and joined to the data they have collected" (p. 18). In this study, I disclosed my subjectivities upfront and revealed personal characteristics that could have skewed study outcomes if not acknowledged. The following discussion presents my personal experience as they related to the study.

I identify as a middle-class Black woman, math professor, wife, and mother. After teaching for 19 years and obtaining four degrees, I am pursuing a Ph.D. in Teaching and Learning with a Mathematics Concentration at Georgia State University. However, I did not embark on my career path with a mathematics education degree. After changing my major three times, I earned a B.S. in Natural Science with a primary concentration in mathematics and a minor in physics. Although I was the first in my family to attend college, I credit my academic achievement to my parents.

Mathematics was my favorite subject in school, and my math teachers greatly influenced my academic success. My passion for mathematics increased, and after years of tutoring and mentoring, I decided to become a mathematics instructor. I gained admittance into the Fifth-Year Alternative Certification Mathematics program at the University of Alabama at Birmingham (UAB). I worked as a high school mathematics teacher at a large school district in Birmingham during my studies.

After 4 years of teaching in Alabama, I relocated to Georgia and began working at a new charter high school in the Atlanta area. At this high school, I developed curriculum activities and led two programs: a summer camp mathematics program for ninth graders and a Saturday school program for students needing extra help to pass the Georgia High School Graduation Exam in mathematics. I began to think more seriously about my teaching strategies while at this high school.

My interactions with students who despised or performed poorly in math motivated me to seek ways to improve my teaching methods. I advanced my professional expertise in mathematics teaching by reading and utilizing materials from the NCTM. I also researched the literature to identify what those documents presented about effective teaching practices. With the help of *Principles and Standards*, I understood NCTM’s (2000) contributions to mathematics education while completing my graduate studies and teaching.

I became involved with the Noyce project as a doctoral student at the local university. I received the opportunity to work with the second cohort of the TFs in this program in Summer 2020 as a graduate teaching assistant (TA). In this role, I assisted the Master of Arts in Teaching

Secondary Mathematics program coordinator with two introductory mathematics method courses.

Robert Noyce Teacher Scholarship Project: Summer 2020

In the two methods courses, some of my responsibilities included assisting the professor with preparing course materials; evaluating, grading, and making comments on course assignments; preparing and leading discussions on topics from the course syllabi; and supporting individual or groups of students. The goal of the methods courses was to introduce the mathematics TFs to the world of education and assist them in their training and development throughout the courses.

Microteaching in a summer camp was a required activity of the course, requiring the TFs to prepare and present lessons to the students. Creating lessons and tasks were new experiences for many TFs; thus, I helped them with their lesson plans by offering resources they could utilize online during their instruction. Because the summer camp occurred virtually, I showed the TFs how to use technological tools such as Nearpod, Quia, and Kahoot! to augment their teachings. Journaling of the microteaching experiences was another course requirement. I read and reviewed the TFs' reflection journal entries of their experiences and provided feedback. In addition, I assisted the professor in delivering the co-planning and co-teaching model approach she developed.

Robert Noyce Teacher Scholarship Project: Fall 2020

In Fall 2020, I continued to work with the aspiring math teachers in an action research course required for all Noyce participants. I worked as a TA for an adjunct professor at the local university who taught this course, where the TFs learned how to conduct action research to study and improve their practices. My responsibilities in this course were to assist the instructor with course materials, grade assignments, participate in online discussions, read and provide feedback on the TFs' required journals, and facilitate three synchronous discussion sessions. In addition, I held meeting sessions with another TA to provide support on the course content.

In addition to serving as a graduate TA in the action research course, I became a practicum (university) supervisor of middle and secondary mathematics teaching in Fall 2020. In this role, I observed, assessed, and evaluated the mathematics TFs' teaching, planning, management, and professionalism regularly. After examining the lesson plans, I provided verbal and written feedback, conducting one-on-one sessions with the TFs to discuss their observations. The Director of Field Experiences and I developed growth plans for the TFs who needed to address problematic areas.

I developed my research interest during this time and in the action research course. As a TA in the action research course and while working with the TFs, I reflected on my teacher preparation program at UAB. The action course differed significantly from my research course at UAB. In my teacher preparation program, the students explored lesson study to reflect on and improve our teaching practices. In considering my teaching career in the action research course, I realized I had conducted some action research in the past but not in an organized, systematic way. As a member of the educational community who had participated in research to improve instructional practices, I shared similar experiences with my participants. As a researcher, a vital part of this study was to avoid having my experiences affect my interpretation and analysis of the participants' teaching practices. Therefore, I attempted not to project my thoughts and feelings onto the participants.

Data Collection

This study included secondary data sources from the Noyce project, the action research course, and the Fall 2020 practicum experience. The data included documents from the action research course, such as the syllabus, participants' journals, action research proposals, synchronous discussions, interviews, and a survey (see appendix D). Practicum experience artifacts included teaching observations, lesson plans, and digital dossiers, with all documents transcribed for analysis and coding. Journals, synchronous discussions, action plans, and literature reviews were the data sources used and analyzed to describe how the participants engaged in the experiences of the action research course and how those experiences emerged in their teaching practices. I also kept a reflective journal of my thoughts and feelings about the experience throughout the \ data collection process (see Bogdan & Biklen, 2007).

Limitations

This study has several limitations. A significant limitation is that the research occurred during the COVID-19 pandemic. The closures of educational institutions worldwide and the resultant shift to online learning created additional stress for the participants. Another limitation is the small sample size, which increased the diversity of the findings via purposeful participant selection. Data analysis and interpretation are also a limitation. Although this study occurred with triangulation techniques, other readers could develop their own interpretations of the findings.

Confidentiality and Ethics

Creswell (2003) stated,

> Researchers should anticipate the possibility of harmful information being disclosed during the data collection process. …The ethical code for researchers is to protect the

> privacy of the participants and to convey this protection to all individuals involved in the study (p. 65).

Among the concerns of qualitative research is the possibility of harm to individual subjects. I obtained permission from the University International Review Board (IRB) to ensure the ethical nature of my research. IRB approval required the deidentification of all the data collected. The study included pseudonyms in place of participant names to ensure the participants' confidentiality. All data remained in a secure location, and triangulation occurred to ensure the validity of the research.

4 DATA ANALYSIS AND RESULTS

As indicated in Chapter 1, the purpose of this study was to investigate the influence of an action research course in a teacher preparation program on the teaching practices of novice mathematics teachers. This study was a means of exploring how the novice teachers engaged in the experiences of the action research course and the influence of those experiences on their teaching practices. The following research questions guided the study:

1. How do the experiences in an action research course influence the teaching practices of mathematics teachers?
    a. In what ways did the teachers engage in experiences in the action research course?
    b. How did the action research become evident in their teaching practices?
2. How do the action research experiences align with Kolb's experiential learning theory?

Chapter 4 presents the investigation of the experiences of the action research course and their influence on the participants' teaching practices. The experiences of the action course were (a) journaling, (b) participating in synchronous discussions, (c) writing the literature review, and (d) writing an action plan. The results underwent coding and analysis from the perspectives of the four participants. Observations and lesson plans were the documents used to examine the influence of the experiences on their teaching.

The following tables present the findings of the participants' action research experiences. The tables include the emergent categories from each participant's action research experiences and the common categories that emerged from a cross-case analysis of the action research experiences. This chapter presents a description of the emergent categories for each action research experience and the themes that emerged. Finally, the chapter shows how the action research experiences aligned with Kolb's ELT.

Coding and Analyzing the Action Research Experiences

The coding process began with precoding, which entailed reading all data sources and circling, highlighting, bolding, underlining, or coloring rich or significant quotes or parts that appeared important or relevant. According to Saldaña (2021), researchers can use the data as evidence to back up their ideas, concepts, or theories and as illustrative examples throughout their reports. Furthermore, Saldaña (2021) stated, "The codes or quotes may even be so provocative that they become part of the title, organizational framework, or through-line of the report" (p. 21). Table 4 is an example of the coding for the journaling experience from a participant's journal.

Table 4

Example of an Excerpt of Precoding from Samuel's Journal

Excerpt	Samuel
One ***struggle*** I have encountered recently is <u>student engagement</u>. The ***virtual setting*** and unwillingness of students to turn on their cameras makes checking for <u>engagement and work difficult</u>. I have tried ***calling*** on students individually to gauge their interest and understanding informally but ensuring that I call on each student has been difficult.	struggling with student engagement reflecting on the virtual setting calling on students to measure their interest and understanding
I am ***thinking*** about the <u>popsicle stick method</u>, where each student has a corresponding popsicle stick in a cup/bowl, and I draw one each time I need to call on a student.	thinking about the popsicle stick method to promote engagement and participation

Another technique used in this study, open coding entailed reading and labeling each line, sentence, or paragraph with the word or phrase the most representative of the meanings and actions of the action research experiences of the participants (Charmaz, 2003; Strauss & Corbin, 1990). NVivo qualitative software was the best fit for the study because of its user-friendly nature and the large number of documents to analyze. Coding in NVivo consisted of assembling relevant information into a container known as a node (Saldaña, 2021). Opening the node provides the opportunity to see all the references coded to that node in the project. While open coding, I remained open to whatever possibilities I could discern in the data (Saldaña, 2021). The nodes included concepts, ideas, and thoughts. Many of the nodes were socially negotiated, generated because of my interactions with the data sources.

The emerging concepts underwent evaluation for similarities and differences to organize similar code phrases into designated categories. “This process of grouping open codes is sometimes called axial coding (Saldaña, 2021) or analytical coding. Analytical coding goes beyond descriptive coding; it is coding that comes from interpretation and reflection on meaning” (Richards, 2015, p. 135). Repeating the grouping process is a means to ensure that categories and their properties emerge from participants’ meaning of an incident or scenario (Charmaz, 2014).

Jamboard was the tool used to organize the categories to create meaning. Analytical coding occurred by deleting, combining, or integrating categories. The next step was conceptualization and interpretation, which resulted in the construction of the themes that emerged from the action research experiences. The following section presents the journaling experience, with the emergent categories for each participant and the common categories across all four participants and a description of each common category.

Action Research Experiences

Journaling

Journaling is a narrative technique for recording meaningful experiences, thoughts, and feelings (Mills, 2018). Journaling has various benefits:

> Journals capture the immediacy of teaching: teachers' evolving perceptions of what is happening with the students in their classrooms and what this means for their continued practice. Furthermore, because journals stand as a written record of practice, they provide teachers with a way to revisit, analyze, and evaluate their experiences over time and in relation to broader frames of reference. And they provide access to the ways that teachers' interpretive perspectives are constructed and reconstructed using data from their classrooms. (Mills, 2018, p. 127)

"Journals are an ongoing attempt by teachers to systematically reflect on their practice by constructing a narrative that honors the unique and powerful voice of the teachers' language" (Mills, 2018, p. 127). A requirement of the action research course was to keep a research journal. First, the participants used journals to reflect on their experiences and observations of the school day and write down questions or concerns. Later, the participants used their journals to reflect on educational problems, construct research questions, reflect on class readings and class sessions, and consider the benefits and drawbacks of the action research process.

Categories That Emerged From the Journaling Experience of Each Participant

Various categories emerged from the narrative content of each participant's journal (see Tables 5–8). Following each table is a summary of the influence of journaling on each participant. For example, Nancy's experience with journaling caused her to reflect on her students' learning. Table 5 shows the categories that emerged from Nancy's journal.

Table 5

Categories That Emerged from Nancy's Journal

Participant	Categories
Nancy	Journaling allowed Nancy to reflect: on her students' performance on various as-signments on the technology she used to engage her stu-dents on the difficulties her students had with the mathematics she was teaching on strategies she used to help her struggling students, and on identifying a problem that she wanted to investigate further.

Through journaling, Nancy became more aware of how her students acquired and retained knowledge in her classroom. Nancy solicited students' feedback via technology to discern what her students had comprehended due to her instruction. In addition, she utilized technology to identify which mathematical content the students struggled to understand. Journaling enabled Nancy to become intentional about stating and revisiting class objectives throughout the lesson to make her students more aware of what they were learning. After stating the class objectives at the beginning of the lessons and repeating them during the lessons, she assessed her students' gaps or misconceptions about the mathematical concepts. Nancy said, "In my journal, I was able to document my teaching's evolution as it pertained to watching my growth in the varied ways that I presented information to my students." Additionally, she stated, "Through my second set of journal entries, I began implementing some of the methods highlighted in the research and observing its effects on my students."

Samuel's journal produced several categories about lesson planning and classroom discourse (see Table 6).

Table 6

Categories that Emerged from Samuel's Journal

Participant	Categories
Samuel	Journaling allowed Samuel to reflect:
	on his lesson plans and what he needed to do differently to engage his students in learning mathematics
	on how much he talked (discourse) in the mathematics classroom
	on the technology he used to engage his students
	on the type of problems/tasks he was using in his classroom to engage students

In his early journal entries, Samuel wrote about his challenges with creating effective lessons and acquiring rich mathematical tasks. He mentioned struggling to manage his own time. He wrote in his journal that his lessons lacked clarity and goals and focused on direct instruction and teacher-centered activities. Samuel realized he needed to create more engaging lessons to delve deeper into a broader range of topics and restructure his lessons from a teacher-centered to a student-centered approach.

Samuel noted in his journal how much he talked in class without interruption. When he began teaching, he struggled to balance talking to the students and the students talking back to him in mathematical dialogues. The action research course presented an NCTM article by Parrish et al. (2019) on classroom dialogue in one of the required synchronous discussions. Samuel gathered early data for his action research project using the strategies of the NCTM article to monitor student talks in his classroom. He wrote in his journal that he talked for 25 minutes in one of his classes without interruption. As a result, Samuel made a conscious effort to improve classroom discourse. He used the popsicle stick approach and other technology, such as Padlet and Nearpod, to boost student participation and engagement.

Samuel took advantage of the fall break to reflect on his successful actions, the areas where he needed to grow, and the changes he needed to make. Toward the end of the semester, he had discovered methods to engage his students in successful mathematical dialogue and had become more deliberate in his lesson preparation and classroom discourse. For example, he wrote in his journal that he had read an NCTM article on chunking a lesson into parts and measuring the number, order, and frequency of talks in the class and found the material helpful.

Jerome’s journaling experience caused him to reflect on engaging students in the mathematics classroom and on effective teaching practices. Several categories emerged as a result of this reflection. Table 7 shows the categories that emerged.

Table 7

Categories that Emerged from Jerome's Journal.

Participant	Categories
Jerome	Journaling allowed Jerome to reflect: on the difficulties he was having getting students to participate in class discussions (discourse) and engage in the course activities on the strategies/technologies he used to engage his online students in learning mathematics and encourage participation on the teaching practice of asking meaningful mathematical questions to elicit deep thinking and more thoughtful student responses on the technology he used in the classroom

Jerome journaled about the strategies he had discovered to increase student engagement and improve student participation. Jerome saw a slight improvement in student engagement after providing feedback on his students' assignments. At the beginning of the course, Jerome wrote in his journal about the difficulty of getting students to participate (especially his online students) in class discussions and course activities. He tried using different technology, such as Kahoot!, Nearpod, and Padlet, to engage students in learning mathematics. Still, he felt that learning about technology would require much of his time; therefore, he wanted to make sure it would be worth the investment to get the results he wanted. In the journal, he wrote about borrowing strategies from his coworkers to promote student engagement and participation in his class. One of his coworkers recommended giving bonus points to students if they completed a do-now or exit ticket. However, this strategy did not correlate with increased participation for Jerome. He found that he did not receive responses from students until he posted grades early in the semester.

Student participation increased when he posted the grades. Many students previously absent began coming to class, and he received an influx of emails, texts, and telephone calls from students concerned about their grades.

Christie's experience with journaling caused her to reflect on student achievement and her practices. Several categories emerged from her reflections, as presented in Table 8.

Table 8

Categories That Emerged from Christie's Journal

Participant	Categories
Christie	Journaling allowed Christie to reflect: on student achievement on her lack of content knowledge on the use of technology on learning styles

Christie used journaling to reflect on her students' achievements, which included students missing, not coming to class, not understanding mathematical content, having performing poorly on exams, and not taking advantage of opportunities to replace their poor grades. Christie reflected on the underlying causes of these issues and on her practices to discern if she delivered content that addressed her students' needs. She also reflected on what she could do to help her students use their prior knowledge to master the content.

Christie taught geometry. Although not initially assigned to teach all geometry courses, she realized that it was a course in which she was not content-rich. Through journaling, Christie reflected deeply on her content knowledge of geometry and the potential effects on her students if she did not take the initiative to increase her knowledge. Christie increased her content knowledge by engaging with the geometry professional learning community. Moreover, she discovered that she did not unpack the standards correctly. Correctly unpacking the standards in the Georgia curriculum consists of using the big ideas to establish goals for a lesson, communicating what the students will learn, writing essential questions to produce inquiry and argument, and developing lessons and assessments in alignment with the grade-level standard (Georgia Standards of Excellence [GSE], 2020). Christie learned how to unpack the standards correctly after her professional learning community meeting.

Christie wrote in her journal about using Nearpod to encourage engagement and live proctoring to observe students take tests so she could get rapid feedback. Christie expressed her disappointment when she learned that just three of her students had passed the exam. As a result, she decided to have her students complete a learning styles inventory. She reasoned that the students could apply the strategies she shared to improve their class engagement and study skills if they knew which learning styles were strengths for them.

Common Categories That Emerged From Journaling

The previous sections presented the data from the four participants' journaling experiences. Cross-case categories emerged from data analysis and synthesis, indicating four major common areas: (a) utilization of student data, (b) acquisition of learning, (c) the use of technology, and (d) purposeful lesson plans. Table 9 provides a description of each category.

Table 9

Common Categories That Emerged as a Result of Journaling

Common Categories	Description of Common Categories
Utilization of student data	Student data is used to solicit students' input into their learning, enhance student performance (some students do, some can't do, and some won't do), and identify students' understandings and misconceptions of concepts.
Acquisition of learning	Acquisition of learning is learned knowledge through teacher discourse that facilitates student learning.
The use of technology	The use of technology in the classroom entails participants using it to engage their students and soliciting students' input to identify what difficulties students were experiencing with mathematical content.
Purposeful lesson planning	The term "purposeful lesson planning" is a plan developed based on standards, well-defined objectives that meet the needs of all students, and activities that engage students in mathematics learning. An essential component of purposeful lesson planning is employing effective classroom discourse.

Utilization of Student Data. Analyzing student data elicited the students' input on their learning, whether through whole-class conversations, prior understanding of the topic, post lesson comprehension via technology, or feedback on assignments. In addition, student data were useful to improve student performance and highlight the areas where students showed confusion. The participants journaled about how they used student data. One reported utilizing student data, and the others provided examples of such utilization. The student data enabled the participants to identify their students' mathematical understanding and misconceptions and adapt their instruction to better meet their students' learning needs.

Acquisition of Learning. The acquisition of learning is learning knowledge through teacher discourse. The acquisition of learning occurs based on students' ability to grasp the topics discussed and absorb and retain new knowledge. The participants used their journals to reflect on how their students acquired and retained knowledge in the classroom. Some participants expressed anxiety about their students' difficulties grasping the mathematics content. The participants wrote about their teaching methods in the classroom, and several made immediate changes to their practices.

Analyzing the student data enabled the participants to infer which concepts and topics their students had mastered or struggled with due to their teaching efforts. Additionally, the participants used strategies such as think-pair-share and technology such as Nearpod and Kahoot! to help their students make sense of and integrate the new information with their prior knowledge. In this way, the participants could discern what their students had grasped as a result of their instruction.

The Use of Technology. Many of the participants found it difficult to teach during the COVID-19 pandemic. They frequently experienced challenges with student engagement and participation. The participants' journal entries included reflections on how they used technology to engage their students and drive their instructional practices. The participants also used technology to detect gaps in their students' mathematical understanding and seek students' feedback to discover their challenges with the mathematical content.

Purposeful Lesson Plans. Purposeful lesson planning consists of developing a plan based on standards and well-defined objectives that address the needs of all the students, and engaging activities for mathematics learning. Effective classroom discourse is an essential component of purposeful lesson planning. "Discussing and referring to the mathematical purpose and goal of a lesson during instruction to ensure that students understand how the current work contributes to their learning" (NCTM, 2014a).

Through journaling, the participants learned the importance of preparing mathematics lessons carefully, developing engaging activities to aid learning, fostering productive classroom discourse, and having clearly stated objectives. One participant reported that purposeful lesson planning resulted in improved student engagement and crosstalk (classroom discourse) in his mathematics classroom. Other participants provided examples of how they planned activities and integrated technology into their lessons. One of the eight effective teaching practices of NCTM (2014) is that "teachers should establish clear goals that articulate the mathematics that students are learning as a result of instruction in a lesson, over a series of lessons, or throughout a unit" (p. 16).

As a result of the journaling experience, the participants increased their ability to focus on their teaching, learners, classroom environment, and lessons and think more deeply about their teaching. Journaling also allowed them to reflect on how they could improve the next day. Furthermore, journaling as an experience and part of the action research course enabled the participants to improve their teaching skills, grasp what was going on in their classrooms, and identify improvements to enhance teaching and learning. The following section presents the experience of synchronous discussions. The data analysis in this section led to the emergent categories for each participant and the common categories across all four participants.

Synchronous Discussions

Synchronous discussions are real-time, online discussions in which all the participants actively engage and participate at the same time via web-based technology (Fontenot et al., 2002). Synchronous discussions are “designed to stimulate conversations among students and the teacher and mimic conversations they could have in face-to-face classrooms” (Fontenot et al., 2002). Effective synchronous discussions can occur in a variety of ways due to the wide range of formats available.

As a course requirement, each participant took part in three synchronous discussions sessions led by the course instructor or the teaching assistants. The synchronous discussions included the participants and three experienced mathematics teachers with 2 to 5 years of teaching experience. The synchronous discussions focused on course topics and were sources of support throughout the course.

The synchronous discussions produced several categories. This section provides a table with the emergent categories from each participant’s involvement in the synchronous discussions. Table 10 presents the categories that emerged from each participant’s experience.

Table 10

Categories that Emerged from Each Participant's Synchronous Discussions Participation

Participants	Categories
Nancy	By participating in the synchronous discussion, Nancy:
	received immediate feedback from her colleagues on the strategies she was using in her mathematics classroom to increase engagement and participation
	acquired tech tools that would allow her to see how her students work on math problems
	saw her colleagues as learning resources
	shared her level of concerns with her colleagues
	became aware of the things that she had control of
	developed her interest in the research she wanted to conduct in the action research course

Participants	Categories
Samuel	By participating in the synchronous discussion, Samuel: received immediate feedback on the things he was struggling with realized the things he could control in his mathematics classroom, for example, the way he planned his lessons, classroom discourse, and technologies he used discovered that he could create a classroom climate in which students take control of their learning and see the teacher as a resource rather than a transmitter of information developed his interest in the research he wanted to conduct in the action research course
Jerome	By participating in the synchronous discussion, Jerome: discovered ways to plan his lessons better realized the things he had control over such as how he set up his classroom, how he asked mathematical questions to engage his students in effective mathematical discourse, and how parental involvement increase student learning in mathematics

Participants	Categories
Christie	By participating in the synchronous discussion, Christie: was able to share her frustration on the lack of pedagogical skills she needed to be effective saw her colleagues as learning resources was able to share and obtain feedback on how she could use her students' learning styles to implement best mathematics teaching practices

Common Categories That Emerged From Synchronous Discussions

This section presents the data from the synchronous discussion experiences of the four participants. The data underwent analysis and synthesis, and cross-case categories emerged. The cross-case investigation showed three common major areas: (a) developing a sense of community as mathematics educators, (b) receiving immediate feedback, and (c) remaining self-aware of the internal locus of control. Table 11 provides a description of each category.

Table 11

Categories That Emerged as a Result of the Synchronous Discussions

Common Categories	Description of Common Categories
Developing a sense of community as mathematics educators	Teachers collaborating on mathematical strategies, sharing resources to support each other, sharing mathematical content knowledge, and having mutual respect and trust for each other's math expertise or lack of math expertise are examples of developing a sense of community as mathematics educators.

Common Categories	Description of Common Categories
Receiving Immediate feedback from peers	The term "receiving immediate feedback from peers" refers to being open to fresh ideas and others' points of view.
Being self-aware of their internal locus of control	Being self-aware of their internal locus of control refers to the participants' ability to control what's going on in their mathematics classroom.

Developing a Sense of Community as Mathematics Educators. The synchronous discussions provided a forum for the participants to think aloud, work through difficulties with mathematical content, collaborate and share ideas on mathematics strategies and resources, gain instantaneous feedback, and alleviate course navigation anxiety. The synchronous discussions had a question/answer format; however, the participants had a free platform to express themselves. Furthermore, many participants benefited from mentoring by the group's more experienced teachers, whom they saw as learning resources. A sense of community emerged from exploring mathematical ideas in other people's thinking, sharing mathematical strategies and resources, and listening to other people's points of view to make sense of them.

Receiving Immediate Feedback From Peers. Participants benefited from immediate feedback on the mathematics issues discussed in the synchronous meetings and clarity on the action research course topics presented in the course. The participants felt comfortable discussing their difficulties with engaging students with mathematical content or developing successful lesson plans that students would find more interesting. Additionally, the participants identified areas of difficulty in their teaching and opened up about their lack of content knowledge or pedagogical skills. The experienced mathematics teachers and the instructor and

TA shared resources and methods with the participants so they could reflect on how to enhance their teaching practices.

Being Self-Aware of Their Internal Locus of Control. Self-awareness of the internal locus of control was the participants' ability to control occurrences in their mathematics classrooms. Through these discussions, each participant became self-aware of the internal locus of control. As a result, the participants realized they had more control over the things in the classroom than they initially thought. For example, one participant stated, "I can control how I set up the mathematics classroom, pose mathematical questions, respond to those questions, and follow up with parents. I can control all of that." The realization that they had control enabled the participants to adjust their teaching.

The synchronous discussions provided the participants with the opportunity to hear the perspectives of their colleagues, discuss their thoughts in a smaller context, and share strategies for engaging learners. The discussions also helped participants gain confidence in the areas of their mathematics classrooms that they could control. In addition, the participants took the time to collaborate on mathematical content and discuss the best mathematics teaching practices. One participant stated, "I'm really glad that we are having this conversation. I can implement all of these things." The following section presents the experience of writing a literature review. The data analysis led to emergent categories for each participant and common categories across the four participants, as described.

Writing a Literature Review

A literature review is a document used to gather important sources on a subject and discuss them in dialogue with one another (Mills, 2018). The literature review is a thorough review of current knowledge that enables a researcher to identify key concepts, approaches, and gaps in the literature. Examining the literature is an integral part of the action research process. In addition, reading the literature provides the opportunity to reflect on problems through someone else's eyes. Finding and critically examining relevant publications, such as books and peer-reviewed journal articles, and summarizing the findings are part of writing a literature review.

All the participants had to write a literature review as part of the action research course, providing a summary and analysis of five or more professional literature sources relevant to their research topics. The participants were novice teachers; therefore, preliminary interviews occurred to discern their familiarity with the process of conducting a literature review. Three of the four participants stated they had never conducted a literature review. A survey administered after the course showed that most participants did not find the task of completing the literature review difficult. However, they found it challenging to achieve saturation when communicating themes from the literature because there were only a few sources required. Table 12 presents the categories that emerged from the literature review experience of each participant.

Table 12

Categories That Emerged From Writing a Literature Review for Each Participant

Participant	Categories
Nancy	Writing the literature review allowed Nancy to: identify new ways of teaching mathematical content through homogeneous and heterogeneous grouping identify ways to differentiate mathematics content by processes that supported her learners identify ways to represent mathematical concepts
Samuel	Writing the literature review allowed Samuel to: identify new ways of creating effective mathematics lesson plans identify new ways of teaching mathematical content identify new ways to facilitate classroom discourse identify new ways to model mathematical questions and answers

Participant	Categories
Jerome	Writing the literature review allowed Jerome to:
	identify ways to increase students' teacher support
	identify ways to create and design effective assignments that move from procedural fluency to those that increase mathematical reasoning skills
	identify ways to increase mathematical discourse
Christie	Writing the literature review allowed Christie to:
	identify ways to create a student-centered learning approach to deliver mathematical content
	identify ways to personalize students' learning based on learning styles

Common Categories That Emerged From Writing the Literature Review

This section presents the data from the literature review experience across the four participants. The data underwent analysis and synthesis, and cross-case categories emerged. The cross-case investigation produced two major common areas: (a) evidence-based mathematics teaching practices and (b) mathematical pedagogy. Table 13 provides a description of each category.

Table 13

Common Categories that Emerged as a Result of Writing the Literature Review

Common Categories	Description of Common Categories
Evidence-based mathematics teaching practices	Evidence-based mathematics teaching practices refers to practices that are used in the classroom to ensure that all students are learning mathematics at high levels.
Mathematical pedagogy	Mathematical pedagogy refers to methods through which teachers assist their students in developing an understanding of, and ability to perform and apply mathematics.

Evidence-Based Mathematics Teaching Practices. The literature reviews were essential to determine evidence-based mathematics teaching practices. The participants identified the following evidence-based teaching practices: (a) grouping students together for mathematical tasks to draw on students' prior knowledge and experiences; (b) adopting a student-centered learning approach in which students learn math by discovery, drawing on and making connections with their own ideas, knowledge, and understanding; and (c) facilitating effective discourse to enhance mathematics learning across the whole class.

Mathematical Pedagogy. Mathematical pedagogy consists of the methods through which teachers assist their students with understanding, performing, and applying mathematics.

Knowing how students learn math is an essential part of developing new pedagogical skills for teaching mathematical content. The participants' literature reviews had an essential role in identifying the pedagogical skills needed to focus students' mathematical learning. The pedagogical skills reported by the participants included differentiating learning, facilitating effective mathematical discourse by providing the students with opportunities to present their work, and using learner-centered instructional strategies to provide students with voice and choice in learning math.

A review of the literature presented in a professional publication provided the participants with a complete understanding of previous research, its limitations, and substantive ideas about mathematics teaching. The literature review enabled them to identify useful strategies and acquire material on effective mathematics teaching practices and pedagogical skills. As a result, the participants adapted their teaching practices.

The following section presents the experience of writing an action plan. The data analysis found the emergent categories for each participant and the common categories that appeared across the four participants. There is a description of each common category.

Writing the Action Plan

An action plan is a guide to planning for change. An action plan provides a clear image of where one currently is, where one wants to go, where one wants to be, how one intends to get there, and who and what will be involved (Mills, 2018). In this study, the action plan enabled the participants to reflect on what they learned from their research and the associated professional literature and decide on the necessary actions. Table 14 shows the categories that emerged from each participant's action plans.

Table 14

Categories That Emerged From Each Participant's Action Plan Experience

Participants	Categories
Nancy	The action plan allowed Nancy to: examine how she grouped students for learning examine the impact that grouping students for learning had on their mathematical performance in the classroom
Samuel	The action plan allowed Samuel to: focus on student learning examine his impact on student learning as a result of his actions
Jerome	The action plan allowed Jerome to: examine his locus of control with respect to students' success examine his influence on student learning
Christie	The action plan allowed Christie to: get to know her students as learners become knowledgeable of her students' learning styles

Common Categories That Emerged Across the Action Plans

The study presented data from the literature review experience across the four participants. The data underwent analysis and synthesis, and cross-case categories emerged. The cross-case investigation produced two major common areas: (a) teacher impact on student learning and (b) an understanding of how students learn mathematics. Table 15 provides a description of each category.

Table 15

Common Categories That Emerged Across All Participants' Action Plan

Common Categories	Description of Categories
Teacher impact on student learning	The term "teacher impact on student learning" refers to the participants' examination of mathematics classroom practices from the perspective of teacher moves. It involves their ideas, decisions, and actions.
Understanding how students learn mathematics	The term "understanding how students learn mathematics" refers to developing knowledge on how students learn mathematics, becoming knowledgeable of students' different learning styles, and creating an atmosphere where students can learn mathematics with the help and acceptance they need.

Teacher Impact on Student Learning. The participants in this study examined themselves and their influence on their students' learning. A requirement of the action plan was to look at the different ways they could facilitate students' learning. For example, in their action plans, the participants selected mathematical tasks that enabled the students to construct new meanings, created more positive learning atmospheres where the students could engage in extensive mathematical discourse, and empowered students to take an active role in facilitating their mathematical learning.

Understanding How Students Learn Mathematics. Knowing how students learn mathematics requires teachers to research and develop knowledge about their students' learning (NCTM, 1991), examine their students' preferred learning styles, and create environments where students can learn mathematics with the assistance and acceptance of their peers and teachers. In this study, the action plan provided the participants with the opportunity to examine and determine how their students learned mathematics. For example, the participants grouped students for learning by placing them in heterogeneous or homogeneous groups to determine what students knew about mathematical concepts and their struggles with understanding the content.

One of the participants examined the benefits of knowing students' learning styles. The participant wanted to become knowledgeable about how her students learned mathematics best. She gave her students a learning styles inventory and conducted a student self-assessment and student reflective analysis of the findings. The participant believed her students could improve their mathematics learning if they knew their learning styles.

The action plans provided the participants with the opportunity to consider the advantages of establishing a mathematics learning community within the classroom and encouraging students to take risks so they could better understand the mathematics taught. In addition, one participant said, "Having deeply-supported norms and expectations and more effective methods of learning would provide a more positive learning community in which students can learn." The action plan required the participants to investigate how they could facilitate students' learning and how students learn mathematics. Using the action plan, participants could examine and implement new instructional approaches and methods into their teaching practices. The action plans also gave them a sense of direction for their future studies. Finally, the action plans showed the participants' commitment to maintaining intentional efforts to improve students' mathematics learning and academic growth.

Themes That Emerged From the Common Categories of Each Action Research Experience

The data was analyzed and synthesized again to determine the relationship between the 11 common categories and three themes emerged:

1. Engagement in action research cultivated novice mathematics teachers' sense of community and collaboration for sharing effective strategies that became evident in their classroom instruction.
2. Exploring and unpacking scholarly literature through action research strengthened the pedagogical content knowledge of novice mathematics teachers and promoted their use of evidence-based practices.
3. Reflective journaling in action research resulted in novice mathematics teachers having the capacity to assess the effects of their teaching on student learning.

Engagement in Action Research Cultivated Novice Mathematics Teachers' Sense of Community and Collaboration for Sharing Effective Strategies That Became Evident in Their Classroom Instruction. Engaging in the action research experiences cultivated a sense of community and collaboration. By collaborating with more experienced colleagues, the novice mathematics teachers were able to develop the skills and resources needed to succeed in their classrooms. Concerns about student engagement and participation were expressed by all four novice mathematics teachers in a synchronous discussion meeting. To increase student engagement and participation in her classroom, one of the experienced teachers, shared a strategy she uses every year. She shared a method employing popsicle sticks to increase student engagement. Her strategy helped participants envisage possibilities to increase student participation and engagement. Other experienced teachers also shared ideas, strategies, and resources within this community, and as a result, the participants immediately altered their teaching practices.

Cultivating a sense of community helped novice mathematics teachers gain confidence in expressing their concerns and struggles with content and pedagogy. Furthermore, they discovered their internal locus of control in their classrooms. During Jerome's interview, he stated "I enjoy our discussions. Hearing what others are doing helps me figure out what I need to change or do better." "It is extremely helpful to have a place where you can gather ideas from individuals who teach similar content or in similar areas," Nancy noted. The feedback provided by Jerome and Nancy provided a clear insight into the significant impact these experiences had on the novice mathematics teachers in the classroom.

Exploring and Unpacking Scholarly Literature Through Action Research Strengthened the Pedagogical Content Knowledge of Novice Mathematics Teachers and Promoted Their Use of Evidence-Based Practices. Knowing how their students learned math was essential in developing and strengthening novice mathematics pedagogical content knowledge. The participants uncovered evidence-based instructional strategies while pursuing the literature. The literature presented in professional publications provided participants with an awareness of prior research, its limits, and important ideas about mathematics teaching. The participants identified and obtained content on effective mathematics teaching practices and pedagogical skills.

Nancy's literary search prompted her to investigate literature on homogenous grouping. The mathematics content was proving difficult for many of Nancy's students. She discovered effective strategies from the literature about grouping her students according to their abilities. Resulting in, Nancy making immediate adjustments to her current teaching practices.

Subsequently, the other participants altered their current teaching practices based on what they learned from the literature. Unpacking scholarly literature provided insight about effective approaches used to address students' learning.

Reflective Journaling in Action Research Resulted in Novice Mathematics Teachers Having the Capacity to Assess the Effects of Their Teaching on Student Learning. Participants utilized their journals to reflect on how their students acquired and retained knowledge in their classrooms. They also used it to keep track of their students' progress, and the impact they had on their students' learning. By utilizing student data, novice mathematics teachers were able to identify their students' current mathematical understandings and misconceptions. In addition, the use of technology helped participants infer which concepts and topics their students mastered or struggled with due to their teaching efforts. Documenting their students' learning through reflective journaling served as a resource for identifying knowledge gaps, identifying students' strengths, and developing a road map for effective instructional practices.

Alignment of the Action Research Experiences to Kolb's Experiential Learning Theory

Kolb (1984) defined learning as "the process whereby knowledge is created through the transformation of experience" (p. 38). Kolb believed that learning results from resolving the creative tension between the four phases of learning: concrete experience, reflective observation, abstract conceptualization, and active experimentation (see Figure 2). According to Kolb (as cited in Smith, 2001), this process is a learning cycle or spiral in which the learner touches all the bases. The learning cycle is a cycle of experiencing, reflecting, thinking, and acting on what one has learned. Concrete experiences are the basis for observations and reflection, with individuals building on those experiences (Kolb & Kolb, 2005). Assimilation and distillation of these reflections result in abstract concepts from which individuals can generate new ideas or modify extant ideas (Sato & Laughlin, 2018). The learners can put the new knowledge into practice and observe what happens due to their actions. If learning has occurred, the process spirals. The action occurs under new conditions, and the learner gains the ability to anticipate the action's possible consequences (Smith, 2001).

The participants in this study engaged in the concrete experiences of journaling, participating in synchronous discussions, writing a literature review, and writing an action plan. Each experience underwent analysis through the lens of Kolb's ELT. Each experience resulted in a unique set of learning outcomes for the participants. Synthesis of the outcomes occurred to construct meaning. Table 16 shows how the action research experiences connect to Kolb's ELT. The following section presents the experience of journaling to show how it aligned with the stages in Kolb's ELT.

Table 16

Alignment of the Action Research Experiences to Kolb's Experiential Learning Theory

Action Research Experiences	Kolb's Experiential Learning Theory			
	Concrete Experience (Experiencing)	Reflective Observation (Reflecting)	Forming Abstract Concepts (Thinking)	Testing in new situations (Doing)
The Journaling Experience Example	Participants recorded feelings, perceptions, and thoughts of what was going on in their classrooms regarding students' mathematics learning.	Teachers are reflecting on student learning and looking at it from different perspectives.	Teachers explore the effects of how student data and classroom discourse can help students learn mathematics.	Teachers adapt their instruction to better meet the learning needs of their students by using activities and technology such as think-pair-share, Kahoot, and Nearpod to engage students in mathematics learning and identify students' understandings and misconceptions of mathematical concepts.

Action Research Experiences	Kolb's Experiential Learning Theory			
	Concrete Experience (Experiencing)	Reflective Observation (Reflecting)	Forming Abstract Concepts (Thinking)	Testing in new situations (Doing)
The Synchronous Discussions Experience Example	Participating in synchronous discussions	Teachers reflecting on the conversations with other experienced teachers in the synchronous sessions	Teachers thought about the mathematical strategies and resources shared, for example, using the popsicle stick method to promote engagement and classroom discourse in the mathematics classroom.	Teachers learned strategies for engaging their students, became self-aware of their internal locus of control, and received positive feedback on the type of strategies they were using in their classrooms.
The Experience of Writing the Literature Review Example	Writing the literature review	Teachers reflected on the solutions, strategies, and effective teaching practices they read about in the literature.	Teachers explored ways of grouping students for mathematical tasks and adopting a student-centered learning approach in their mathematics classrooms.	By writing the literature review, teachers were able to identify evidence-based mathematics teaching practices and new pedagogical skills needed to teach mathematics effectively.

Action Research Experiences	Kolb's Experiential Learning Theory			
	Concrete Experience (Experiencing)	Reflective Observation (Reflecting)	Forming Abstract Concepts (Thinking)	Testing in new situations (Doing)
The Experience of Writing the Action Plan Example	Writing the action plan	Teachers reflected on student learning and how they could get to know their students as learners. They also reflected on their locus of control concerning students' success.	Teachers explored ways to group students for learning.	Teachers learned different ways to facilitate student learning by selecting rich mathematical tasks that allowed students to connect new meanings.

Journaling was a concrete experience in which the participants expressed their emotions, views, and ideas about what was occurring in their classrooms regarding their students' mathematical learning. The observation and reflection phase required the teachers to reflect on and examine student learning from various perspectives. In the next phase, the development of abstract concepts, the participants considered student data and effective classroom discourse to discern how they could help their students learn mathematics. In the last step, the teachers evaluated their ideas and strategies in new environments: their classrooms. Table 16 presents summaries of the remaining experiences and how they correlated with Kolb's ELT.

Summary

Precoding, open coding, and axial coding occurred to code the journals, synchronous discussions, literature reviews, and action plans and construct themes. The goal of the study was to investigate the experiences of an action research course that the participants took. The action research experiences included (a) journaling, (b) participating in synchronous discussions, (c) writing a literature review, and (d) writing up an action plan. Kolb's ELT was the lens used to analyze the concrete experiences of the four participants.

Four common categories emerged from the journaling experience: student data, acquisition of learning, technology, and purposeful lesson planning. Journaling enabled the participants to understand the importance of carefully planning their mathematics lessons, creating engaging activities to facilitate learning, encouraging good classroom conversations, and having clearly stated goals. Three common categories emerged from the synchronous discussions: developing a sense of community as mathematics educators, receiving immediate feedback, and remaining self-aware of the internal locus of control. The synchronous discussions provided an opportunity for the participants to think aloud, express their challenges, exchange ideas, get quick feedback, and alleviate the tension associated with course navigation. From these discussions, the participants gained a greater awareness of their internal locus of control, which enabled them to alter their teaching.

Writing the literature review resulted in two main common categories: evidence-based mathematics teaching approaches and mathematical pedagogy. Reading the literature allowed the participants to gain a thorough understanding of the previous research and its limitations. Participants used the literature to find answers to their research inquiries and other classroom concerns. The literature review provided an opportunity to identify successful techniques and acquire information about effective mathematics teaching practices and pedagogical skills. The participants altered their teaching practices due to this experience.

Writing the action plan resulted in two common categories: teacher impact on student learning and an understanding of how students learn mathematics. Developing an action plan enabled the participants to gain a fresh perspective on teaching as a learning process. The participants shifted their attention from teaching to determining what their students understood and assisting them with learning. The participants experimented with different methods of instruction while examining their own methods.

The 11 common categories of the action research experiences across the four participants were analyzed and synthesized, yielding three themes. These themes summarized the influence the action research experiences had on the participants' teaching practices. Kolb's ELT was the lens used to investigate the influence of the action research experiences on the participants' teaching practices. By engaging in action research, the participants gained knowledge of their classrooms, became more reflective about their teaching, and gained an openness to learning something new. In addition, the participants became more aware of what was happening in their classrooms and identified the necessary changes to improve the teaching and learning of mathematics in their classrooms.

5 DISCUSSION

This chapter includes a brief summary of the study, the common categories that emerged from the data, and the themes. Chapter 5 also includes a discussion of the findings. Additionally, the chapter presents the implications, limitations, and recommendations for future research and a closing statement about the study.

Summary of the Study

Action research has an essential role in the preparation and professional development of teachers and preservice teachers (Holter & Frabutt, 2011). The purpose of action research is to assist teachers in gaining new skills and expanding their pedagogical repertoire in their classrooms (Henson, 1996). The literature has shown that teachers who engage in action research learn more about the "teaching and learning process, and mathematics, in ways that empower them" (Crawford & Adler, 1996, p. 1596).

Hagevik et al. (2012) found that middle-grade interns who reflected critically on their action research experiences during the year-long practicum became more reflective about teaching mathematics differently, learned how to work together, and learned from what other interns had done. Their study showed the importance of engaging in and developing daily reflections into more transformative practices in action research. Junor Clarke and Fournillier (2012) researched four preservice secondary school mathematics teachers in an action research project who reflected on specific teaching strategies and their comfort and needs for better practices within their urban classrooms. Both studies had similar findings to those of this study.

Chapter 1 presented the gap in the literature on whether action research courses in teacher preparation programs could have an influence on the teaching practices of novice mathematics teachers during their coursework and clinical experience. This study was a means of investigating the influence of action research experiences on the teaching practices of novice mathematics teachers. This study filled the gap in the literature by focusing on how novice mathematics teachers can alter their teaching practices by participating in action research experiences during their coursework and clinical experience.

A qualitative case study framed with Kolb's ELT was the approach used to explore the influence of the action research experiences on the teaching practices of four novice secondary mathematics teacher educators in an action research course. The participants engaged in the following action research experiences: (a) journaling, (b) synchronous discussions, (c) a literature review, and (d) an action plan. This study included the collection, coding, and analysis of multiple data sources. 11 common categories emerged from the action research experiences, resulting in three themes.

Discussion of the Findings

This study had two research questions:

1. How do the experiences in an action research course influence the teaching practices of mathematics teachers?
    a. In what ways did the teachers engage in experiences in the action research course?
    b. How did the action research become evident in their teaching practices?
2. How do the action research experiences align with Kolb's ELT?

First, this chapter presents how the teachers engaged in the experiences in the action research course. Second, the chapter addresses the 11 common categories that emerged from the data and how those common categories aligned with NCTM's eight effective teaching practices. The three themes that emerged are also addressed. Third, there is a discussion of how the participants made action research evident in their teaching practices. Last, the chapter presents how the action research experiences aligned with Kolb's ELT.

Ways the Mathematics Teachers Engaged in the Action Research

The participants engaged in the action research course via (a) journaling, (b) synchronous discussions, (c) literature reviews, and (d) action plans. For journaling, the teachers used journals to record their thoughts, feelings, and experiences in their classrooms. Four common categories emerged from the data: (a) student data, (b) the acquisition of learning, (c) technology, and (d) purposeful lesson planning. (Chapter 4 presents these common categories in detail.) Through journaling, the participants learned the importance of carefully preparing their mathematics lessons, developing engaging activities to aid learning, fostering productive classroom discourse, and having clearly stated objectives.

The participants also engaged in synchronous discussions focused on course topics and served as sources of support throughout the course. Three common categories emerged from the data: (a) developing a sense of community as mathematics educators, (b) receiving immediate feedback, and (c) being self-aware of the internal locus of control. (Chapter 4 provided a description of these common categories.) Through the synchronous discussions, the participants heard the perspectives of their colleagues, practiced sharing thinking in a smaller context, shared strategies for engaging their learners, and communicated their thoughts in an intimate context.

The participants also wrote literature reviews. Because the participants were novice teachers, a preliminary interview occurred to determine their familiarity with conducting literature reviews. All but one participant reported having never done one. The administration of a survey occurred at the end of the course. The participants reported that they did not find the literature review complicated; however, they found achieving saturation a challenge due to the few sources required. Two common categories emerged from the experience of writing the literature reviews: (a) evidence-based mathematics teaching and (b) mathematical pedagogy. (Chapter 4 presented these common categories.) A literature review provided the participants with a complete understanding of previous research and its limitations and substantive ideas about mathematics teaching. The teachers identified valuable strategies and acquired material on effective mathematics teaching practices and pedagogical skills to adapt their teaching.

Finally, the teachers engaged in writing action plans. The action plans served as blueprints for implementing what the teachers had learned through their research and readings, helping them decide what to do next. Two common categories emerged from the findings: (a) teacher impact on student learning and (b) an understanding of how students learn mathematics. (Chapter 4 provided a brief overview of each common category.) The action plans gave participants the opportunity to identify new instructional strategies for examining how their students learned mathematics and the impact of their actions on student learning.

Three themes developed from the 11 common categories included: (a) engagement in action research cultivated novice mathematics teachers' sense of community and collaboration for sharing effective strategies that became evident in their classroom teaching, (b) exploring and unpacking scholarly literature through action research strengthened the pedagogical content knowledge of novice mathematics teachers and promoted their use of evidence-based practices, and (c) reflective journaling in action research resulted in novice mathematics teachers having the capacity to assess the effects of their teaching on student learning. These themes summarized the influence the action research experiences had on the teaching practices of the participants. Reflecting and collaborating with peers stimulated participants' thinking and made them more intentional about improving their practice. Furthermore, unpacking scholarly literature served as a resource for them in finding solutions to problems encountered in their classrooms.

The following section briefly presents the eight effective mathematics teaching practices. A table shows how the common categories from the data analysis aligned with the eight effective mathematics teaching practices. Finally, the section provides an example of how student data aligned with one of the effective mathematics teaching practices.

Connecting the 11 Common Categories to the National Council of Teachers of Mathematics' Eight Effective Teaching Practices

The NCTM produced a document in 2014 that addressed the essential elements of teaching and learning and how teachers could become proficient in developing mathematics learning for all students. This document presented eight research-based teaching practices for supporting all students' mathematical development, as follows:

> (a) establish mathematics goals to focus on learning, (b) implement tasks that promote reasoning and problem-solving, (c) use and connect mathematical representation, (d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking. (NCTM, 2014a, p. 12)

The eight effective teaching practices are the foundation of improving the teaching and learning of mathematics in the classroom. 11 common categories emerged from the action research experiences. Table 17 shows the common categories aligned with the NCTM's eight effective teaching practices as well as a description of each category.

Table 17

Alignment of the Common Categories With the National Council of Teachers of Mathematics' Effective Teaching Practices

Common Categories from the action research experiences	Description of Common Categories	NCTM eight effective teaching practices
Utilizing Student Data to Elicit Student' Input	Student data is used to elicit students' input into their learning, enhance student performance (some students do, some can't do, and some won't do), and identify students' understandings and misconceptions of concepts.	Elicit and use evidence of student thinking
Acquisition of Learning	Acquisition of learning is learned knowledge through teacher discourse that facilitates student learning.	Facilitate meaningful mathematical discourse
Technology	The use of technology in the classroom entails participants using it to engage their students and soliciting students' input to identify what difficulties students were experiencing with mathematical content.	Use and connect mathematical representations
Purposeful lesson planning	The term "purposeful lesson planning" is a plan developed based on standards, well-defined objectives that meet the needs of all students, and activities that engage students in mathematics learning. An essential component of purposeful lesson planning is employing effective classroom discourse.	Establish mathematics goals to focus learning Facilitate meaningful classroom discourse

Common Categories from the action research experiences	Description of Common Categories	NCTM eight effective teaching practices
Developing a sense of community as mathematics educators	Teachers collaborating on mathematical strategies, sharing resources to support each other, sharing mathematical content knowledge, and having mutual respect and trust for each other's math expertise or lack of math expertise are examples of developing a sense of community as mathematics educators.	Facilitate meaningful mathematical discourse – better instruction for better student learning
Receiving immediate feedback	The term "immediate feedback" refers to being open to fresh ideas and other points of view.	Establish mathematics goals to focus learning – builds collegial relationships and structures that encourage ongoing learning
Self-aware of their internal locus of control	Being self-aware of their internal locus of control refers to the participants' ability to control what's going on in their mathematics classroom.	Elicit and use evidence of student thinking – builds teachers' capacity to notice, analyze, and respond to students' thinking
Evidence-based mathematics teaching practices	Evidence-based mathematics teaching practices refers to practices that are used in the classroom to ensure that all students are learning mathematics at high levels.	Implement tasks that promote reasoning and problem solving Facilitate meaningful mathematical discourse Use and connect mathematical representations

Common Categories from the action research experiences	Description of Common Categories	NCTM eight effective teaching practices
Mathematical pedagogy	Mathematical pedagogy refers to methods through which teachers assist their students in developing an understanding of, and ability to perform and apply mathematics.	Implement tasks that promote reasoning and problem solving Use and connect mathematical representations Establish mathematics goals to focus learning Pose purposeful questions Facilitate meaningful mathematical discourse
Teacher impact on student learning	The phrase "teacher impact on student learning" refers to the participants' examination of mathematics classroom practices from the perspective of teacher moves. It involves their ideas, decisions, and actions.	Implement Tasks that Promote Reasoning and Problem Solving Facilitate meaningful mathematical discourse
Understanding how students learn mathematics	The phrase "understanding how students learn mathematics" refers to developing knowledge on how students learn mathematics, becoming knowledgeable of students' different learning styles, and creating an atmosphere where students can learn mathematics with the help and acceptance they need.	Establish mathematics goals to focus learning

Student data indicated and elicited students' input into their learning. The student data included whole-class conversations, students' prior understanding of topics, post lesson comprehension via technology, or the feedback given to students on assignments. In addition, student data were used to improve student performance and highlight areas of confusion for students. The participants used student data to identify their students' mathematical understanding and misconceptions and adapt their instruction to better meet the learning needs of their students. The practice of using student data to identify students' mathematical understanding and misconceptions aligned with the NCTM's teaching practice of eliciting and using evidence of student thinking. According to the NCTM (2014a), effective mathematics teaching produces evidence of students' mathematical understanding that teachers can use as the basis for making instructional decisions.

The following section presents how the results of the action research emerged in the participants' classrooms during the clinical experience. Three teaching observations occurred during this time. The participants also submitted three lesson plans over the course of their practicum.

Other Ways in Which the Action Research Became Evident in Their Teaching Practices

Observations

I was the participants' university supervisor. Therefore, I conducted teaching observations to find evidence of the action research experiences in the participants' teaching and the lesson plans submitted in their practicum. The teaching observations showed the teachers' use of student data to activate students' prior knowledge and identify their students' mathematical understanding and misconceptions. Kahoot!, Go Formative, and Nearpod were among the technologies participants used in their classrooms to engage their learners in mathematical concepts and drive their instructional practices.

Lesson Plans

At first, the lesson plans showed the participants' inexperience with writing lessons; however, they later indicated the participants had become more adaptable. The participants submitted three lesson plans during their practicum. Comparing the first to the final lesson plan, I saw that the participants had significantly improved writing the learning objectives for the mathematics lesson plans. The participants clearly stated the learning goals and the mathematical concepts, ideas, or methods their students would understand. In my observations, I witnessed the teachers communicating to the students what they would learn throughout the class period.

The participants also improved various components of the lesson plans. Initially, the participants wrote the majority of their lesson plans as summaries; however, as time went on, they described the components more thoroughly. As a result, they learned the importance of carefully planning their mathematics lessons and stating clear objectives.

The following section provides an overview of the overall impact of action research on the participants' teaching practices. A survey (see Appendix D) administered to examine the overall impact of action research had a 10-item Likert scale with five subscales (*no difficulty, a low level of difficulty, a moderate level of difficulty, a high level of difficulty,* and *an extreme level of difficulty*) and five qualitative free responses. Some of the results of the survey are shared in the following section.

The Overall Impact of Action Research on the Participants' Teaching Practices

On the qualitative survey conducted at the end of the course, all the participants reported that engaging in the action research course experiences enabled them to become more knowledgeable about what to do in their classrooms. Christie stated, "While I try to consider learning styles in my engagement with students, this effort has allowed me to be more intentional in my practice. My efforts are not haphazard but are purposeful and strategic." In another comment, Samuel stated,

> It helped me gain some background knowledge and understand the issues I am facing. I am not alone. It helped me identify problem areas and challenges in the virtual mode of education, and so I have been able to adapt my practices according to the literature I have reviewed and the conversations I have had. I was able to see how many tools I had available, even if I could not use all of them yet, to achieve my goals as a teacher.

Jerome responded, "So far, it has stimulated my thinking [about] how to improve engagement in the classroom. When I want to try new things in my classroom, I have a way to accurately measure the results rather than relying on gutfeel."

Nancy said,

> It has made me a stronger and more confident teacher because I was able to tailor my instruction after receiving the data. I feel that I can always improve my teaching by researching so I do not have to feel as frustrated if I see my students not doing well. It has also made me more confident in my practices as I have gained validation on the things I am doing correctly. I can also see with more clarity where I need to grow. It has also made me implement differentiated instruction in a more conscious way. I am also more aware of how I group the students in my classroom.

Overall, the action research experiences provided the participants with the resources they needed to further their professional development. Henson (1996) explained that when teachers engage in research, they experience a variety of positive changes in themselves and toward others and increase their commitment to developing effective teaching strategies. Teachers who engage in research can also experience an openness toward learning something new and reflect on their practices (Johnson, 2012).

Alignment of the Action Research Experiences With Kolb's Experiential Learning Theory

Kolb's ELT was the lens used to analyze the action research experiences in this study. With the theory, I investigated the influence of the action research experiences on the participants' teaching practices and what they had gained from the action research experiences. I demonstrated how the action research experiences aligned with Kolb's model, providing an example in Table 16 in Chapter 4. This section addresses the participants' experiences with synchronous discussions to show how the experience aligned with the stages in Kolb's model. Kolb (1984) defined concrete experience as an experience in which a learner engages; the key to learning is involvement. In this study, the synchronous discussions were experiences that included the participants. The concrete experiences provided the basis for observations and reflection, phases that required teachers to reflect on the conversations with other experienced teachers in the synchronous discussions. The next step is the conceptualization stage, in which the individual creates abstract conceptions. In this phase, the participants thought about the mathematical strategies and the resources shared in the group. For example, one teacher in the group shared the popsicle stick method for fostering engagement and discourse in the mathematics classroom, which the participant found highly effective. Finally, the last step required teachers to evaluate their ideas and strategies in a new environment, namely their classrooms. At this stage, the participants applied what they had learned to practice and saw what occurred due to their actions. As a result, the teachers discovered strategies for engaging their students, became self-aware of the internal locus of control, and utilized the feedback they received from their peers to improve both the teaching and learning of mathematics.

Implications

Kolb's ELT was the lens utilized in this study to investigate if action research experiences enabled four novice secondary mathematics teachers to improve their teaching practices. Kolb proposed that knowledge results from grasping and transforming an experience. The participants engaged in the concrete experiences of journaling, synchronous discussions, engagement with the literature, and the development of action plans. Concrete experiences are the first stage of Kolb's model. Reflecting on these experiences caused the participants to become aware of the various forms of knowledge and leverage those reflections for change. The reflection stage was a critical part of their development into effective mathematics teachers. Overall, the emergent categories showed that learning had begun to occur for all participants. Abstract conceptualization enabled them to think about and explore new knowledge and skills and apply the lessons learned to their current and future practices, and this study showed their ability to do so. The three themes showed that participation in the action research experiences allowed the participants to become more knowledgeable about their classroom practices, teaching, and learners, which, in turn, caused them to change their practices. "The essence of action research and experiential learning theory is students' learning from their experiences and through doing" (Rubens et al., 2020, p. 121). A theoretical implication of this study is that Kolb's ELT is an appropriate theory for exploring and comprehending how the knowledge gained via experiences results in effective teaching practices.

Each participant benefited from their participation in the action research experiences. The participants also discovered the value of recording their experiences. This study found that journaling enabled the participants to record their experiences and think more deeply about their teaching. Through journaling, the participants examined and investigated their practices and successful teaching strategies. The findings of this study showed that journaling was an essential component of the participants' development, as the participants made minor adjustments to their practices after journaling. These findings indicate the need to include reflective journals in teacher preparation, graduate, and professional development programs at the school and district levels and at public and private institutions.

Implications for Practice

The study's findings have immediate value to the department faculty who teach and design teacher preparation programs for aspiring mathematics educators. These findings could enable novice mathematics teachers to explore their own understanding of practices to improve their teaching, discover deeper meanings in their reflections, and become better decision-makers. These findings suggest that novice teachers can explore effective mathematics teaching practices and foster communities where they can share effective strategies, discuss how to improve mathematics pedagogy, present different perspectives through discourse, and receive feedback. Therefore, this study could have important implications for novice mathematics teachers who will teach in underserved communities. Developing these teachers requires a space where they can journal about their day, reflect on their teaching methods, and review evidence-based teaching practices. In addition, the space could provide them with the resources needed to become effective teachers in urban settings.

Suggestions for Further Research

This study addressed the impact of an action research course on the teaching practices of novice mathematics teachers. The study focused on four concrete experiences (journaling, synchronous discussions, literature reviews, and action plans) that had an influence on the participants' teaching practices. However, the study did not address the participants' level of agency, making it an area of inquiry for future scholars.

Researchers could investigate whether the participants in this study went on to conduct their own action research projects and changed their teaching as a result. Additional researchers could also examine the benefits of action research for the students who participated in this study. Students could benefit from any improvements in instruction due to action research.

Johnson (2012) suggested replacing traditional teacher in-service training with action research workshops for teachers' professional development. Presenting action research as a school-wide professional development opportunity for mathematics teachers could "provide active learning activities that allow teachers to collaborate and manipulate ideas, improve their assimilation of the information, and align the concepts presented with the current curriculum, goals, or teaching concerns" (Johnson, 2012, p. 22). Research on school-wide action research in mathematics could be another avenue of inquiry.

Concluding Remarks

The purpose of this study was to investigate the influence of an action research course in a teacher preparation program on the teaching practices of novice mathematics teachers. This study found that action research was a useful and effective way to investigate problems or test new ideas in the classroom. The findings suggest that engaging in action research experiences, such as journaling, synchronous discussions, literature reviews, and action plans, could enable novice teachers to grow personally and professionally during their clinical experience. In this study, action research experiences enabled the participants to discover deeper meanings in their reflections, discussions, and readings about teaching and learning mathematics.

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APPENDICES

Appendix A

Lesson Plan Template

DAY 1: LESSON AND ASSESSMENT PLAN
Curriculum Standards [redacted] / National Curriculum Standards [redacted]
1. **Write the identification number and description** of the aligned state adopted learning content standards you address in the learning objective (2-3 maximum).
ISTE Technology Standard
1. **Write the number and description** of the aligned ISTE Technology learning content standards addressed in this learning objective (1 maximum).
Mode of Instruction Face to Face / Online Synchronous / Online Asynchronous / Hybrid
Learning Objective/Goal(s)
Learning objective/goal(s) define the academic goals of the daily lesson. The goals align with curriculum standards and specifies the assessment plan, both formative and summative. Learning goal(s) address students' cultures and identities to include issues of equity and power as well as personal, academic, and developmental needs. The learning objective also describes a formative or summative assessment - how will students demonstrate/how will you know, that the goal(s) has/have been met? Five components of a Learning Goal are centered on the Historically Responsive Framework (Muhammad, 2020, p. 159): ● Identities: How will your teaching help students to learn something about themselves and/or others? ● Skills: What skills and content learning standards are you teaching? ● Intellect: What will your students become smarter about? ● Criticality: How will you engage your thinking about power, equity, and anti-oppression in the text, in society and in the world? ● and, ● Assessment – the daily assessment can be formative or summative as appropriate 1. **Write a bulleted list** (1-3 objectives/goals, maximum) of clear and measurable learning objective/goals(s) using active verb(s); describe the assessment – either formative or summative.
Formative & Summative Assessment
Assessment is part of the lesson plan/learning objective and thus is written in advance. Assessment provides evidence and/or data that demonstrate students' accomplishment of the learning objective and to what degree or level. Each day of teaching must include assessment, either formative or summative. The assessment plan should include the specific kind of evidence or demonstration students will complete, such as audio/video responses, written paper or digital project, or a performance. The evidence must align with the learning objective and provide information on how well the student accomplished the objective (strengths, areas of growth) and provide support in determining next steps for teaching. In addition to the evaluation criteria, feedback must be provided to students, perhaps in handwritten form, an audio clip or verbally; describe how the students will use the feedback to improve their learning (will they revise? use in the next assignment?). 1. **Describe the demonstration** or evidence of student learning for each learning objective 2. **Provide** the evaluation criteria (rubric or scoring guide) 3. Describe the **use of feedback** in this assessment plan and how students will use it to improve learning

Differentiation, Modification(s), & Accommodation(s)

Differentiation, modification(s), and accommodation(s) are key to providing for learner access to content and to meet all students' needs. Some are required for special education students (i.e. an Individual Education Plan, 504 plan, or students with exceptionalities) and others support the variety of learning needs your students will have (ESOL, struggling readers/writers, visual/auditory/kinesthetic, etc. learners).

1. **Describe in detail** the student-specific **instructional support** provided for special education students;
2. describe in detail the student-specific **differentiation support** for the variety of students in the class;
3. and, describe in detail **individual modifications and accommodations** of this lesson plan required for each student's success.

Instructional Strategies & Learning Tasks to Support Diverse Learners' Needs

Introduction or Student Spark (____Number of minutes)

The introduction connects the lesson's objectives and standards and promotes intellectual development. Consider using multimodal forms of texts (short and powerful excerpts of print, image, video, and sound). Every lesson, every day, should have some kind of academic introduction. It may be introducing a new learning objective, or it could be connecting a continuing learning objective to the previous day's lesson.

1. **Describe** the plan to capture student interest and excitement for learning.
2. How will you and your students **determine and leverage** students' prior knowledge?
3. **What is the "hook"** or engaging activity to activate student thinking?

Body (____Number of minutes)

The body of the lesson is the primary part of the class session. Describe in detail each step of the instructional plan and include what you will model, explain, or demonstrate and varied/differentiated instructional approaches. Describe instructional supports that will provide strong scaffolds for student understanding such as the language of the discipline (i.e. vocabulary, sentence structure, graphic organizers, etc.). Be sure you pay attention to the variation of interaction patterns in the class (teacher-student, student-student, etc.). How often do you use whole class vs. individual instruction vs. cooperative learning?

1. Describe in detail the **consecutive steps of the lesson** that will enact the learning objective. What will students be doing and what will the teacher be doing?
2. Describe in detail the **transition plan(s)** between class activities.

Closure (____Number of minutes)

Every lesson, every day, should have some kind of academic closure that wraps up the learning for the day and connects/prepares for the next lesson – whether it is a continuation of the learning objective or for a new learning objective/content. It also must include a formative or summative assessment.

1. **Explain** how students will **demonstrate knowledge/understanding** of the learning objectives for this lesson.
2. What are **next steps** for the students and the teacher to prepare for the next class session/learning objective?

Facilitation & Safety

Classroom facilitation identifies specific structures of classroom community, physical structure, and organization that you will employ to facilitate the lesson – to make the class run smoothly and maximize instructional and learning time.

1. Describe in detail the following components of the **classroom facilitation and operation**:
   - How will you ensure students know where to find and understand class activity instructions?
   - In what ways will you respond to interruptions or disruptions?
   - How will you provide other additional support that may be needed (for students who are disengaged or who do not understand)?
   - What are your plans for transitions from one activity of the lesson to another?
   - How will you use/reinforce classroom norms?
   - How will you handle supplies needed for the lesson?
   - What are the physical components of the classroom, such as desk arrangement, stations, cooperative learning groups, etc. that support your learning objectives?

• *For SCIENCE, specifically, what lab safety measures will you use to comply with required standards of lessons involving lab experiments or demonstrations?*
Layered Texts and Other Materials
1. **Write a detailed (bulleted) list**, including authors, of all the materials/resources/links/technology needs for this lesson. 2. **Attach** all instructional support handouts, presentations, citation/copy of texts, etc. and assessment items.
References
1. **Use and cite course readings and research** knowledge to justify your pedagogical and curricular choices. Use APA formatting (https://owl.english.purdue.edu/owl/section/2/10/) and place references at the end of the lesson plan, after materials.

Appendix B

Observation Protocol – The Charlotte Danielson Framework for Teaching

(Danielson, 2013)

Communicating with Students			
Expectations for Learning			
1 Teacher's purpose in a lesson or unit is unclear to students.	2 Teacher attempts to explain the instructional purpose, with limited success.	3 Teacher's purpose for the lesson or unit is clear, including where it is situated within broader learning.	4 Teacher makes the purpose of the lesson or unit clear, including where it is situated within broader learning, linking that purpose to student interests.
Directions and Procedures			
1 Teacher's directions and procedures are confusing to students.	2 Teacher's directions and procedures are clarified after initial student confusion.	3 Teacher's directions and procedures are clear to students.	4 Teacher's directions and procedures are clear to students and anticipate possible student misunderstanding.
Explanations of Content			
1 Teacher's explanation of the content is unclear or confusing or uses inappropriate language.	2 Teacher's explanation of the content is uneven; some is done skillfully, but other portions are difficult to follow.	3 Teacher's explanation of content is appropriate and connects with students' knowledge and experience.	4 Teacher's explanation of content is imaginative and connects with students' knowledge and experience. Students contribute to explaining concepts to their peers.

Use of Oral and Written Language			
1 Teacher's spoken language is audible, or written language is illegible. Spoken or written language contains errors of grammar or syntax. Vocabulary may be inappropriate, vague, or used incorrectly, leaving students confused.	2 Teacher's spoken language is audible, and written language is legible. Both are used correctly and conform to standard English. Vocabulary is correct but limited or is not appropriate to the students' ages or backgrounds.	3 Teacher's spoken and written language is clear and correct and conforms to standard English. Vocabular is appropriate to the students' ages and interests.	4 Teachers' spoken and written language is correct and conforms to standard English. It is also expressive, with well-chosen vocabulary that enriches the lesson. Teacher finds opportunities to extend students' vocabularies.
Using Questioning and Discussion Techniques			
Quality of Questions			
1 Teacher's questions are virtually all of poor quality, with low cognitive challenge and single correct responses, and they are asked in rapid succession.	2 Teacher's questions are a combination of low and high quality, posed in rapid succession. Only some invite a thoughtful response.	3 Most of the teacher's questions are of high quality. Adequate time is provided for students to respond.	4 Teacher's questions are of uniformly high quality, with adequate time for students to respond. Students formulate many questions.
Discussion Techniques			
1 Interaction between teacher and students is predominantly recitation style, with the teacher mediating all questions and answers	2 Teacher makes some attempt to engage students in genuine discussion rather than recitation, with uneven results.	3 Teacher creates a genuine discussion among students, stepping aside when appropriate.	4 Students assume considerable responsibility for the success of the discussion, initiating topics and making unsolicited contributions.

Student Participation			
1 A few students dominate the discussion.	2 Teacher attempts to engage all students in the discussion, but with only limited success.	3 Teacher successfully engages all students in the discussion.	4 Students themselves ensure that all voices are heard in the discussion.
Engaging Students in Learning			
Activities and Assignments			
1 Activities and assignments are inappropriate for students' age or background. Students are not mentally engaged in them.	2 Activities and assignments are appropriate to some students and engage them mentally, but others are not engaged.	3 Most activities and assignments are appropriate to students, and almost all students are cognitively engaged in exploring content.	4 All students are cognitively engaged in the activities and assignments in their exploration of content. Students initiate or adapt activities and projects to enhance their understanding.
Grouping of Students			
1 Instructional groups are inappropriate to the students or to the instructional outcomes.	2 Instructional groups are only partially appropriate to the students or only moderately successful in advancing the instructional outcomes of the lesson.	3 Instructional groups are productive and fully appropriate to the students or to the instructional purposes of the lesson.	4 Instructional groups are productive and fully appropriate to the students or to the instructional purposes of the lesson. Students take the initiative to influence the formation or adjustment of instructional groups.
Instructional Materials and Resources			
1 Instructional materials and	2 Instructional materials and	3 Instructional materials and	4 Instructional materials and

resources are unsuitable to the instructional purposes or do not engage students mentally.	resources are only partially suitable to the instructional purposes, or students are only partially mentally engaged with them.	resources are suitable to the instructional purposes and engage students mentally.	resources are suitable to the instructional purposes and engage students mentally. Students initiate the choice, adaptation, or creation of materials to enhance their learning.
Structure and Pacing			
1 The lesson has no clearly defined structure, or the pace of the lesson is too slow or rushed, or both.	2 The lesson has a recognizable structure, although it is not uniformly maintained throughout the lesson. Pacing of the lesson is inconsistent.	3 The lesson has a clearly defined structure around which the activities are organized. Pacing of the lesson is generally appropriate.	4 The lesson's structure is highly coherent, allowing for reflection and closure. Pacing of the lesson is appropriate for all students.
Using Assessment in Instruction			
Assessment Criteria			
1 Students are not aware of the criteria and performance standards by which their work will be evaluated.	2 Students know some of the criteria and performance standards by which their work will be evaluated.	3 Students are fully aware of the criteria and performance standards by which their work will be evaluated.	4 Students are fully aware of the criteria and performance standards by which their work will be evaluated and have contributed to the development of the criteria.
Monitoring of Student Learning			
1 Teacher does not monitor student learning in the curriculum.	2 Teacher monitors the progress of the class as a whole but elicits no diagnostic information.	3 Teacher monitors the progress of groups of students in the curriculum, making limited use of	4 Teacher actively and systematically elicits diagnostic information from individual students regarding their

		diagnostic prompts to elicit information.	understanding and monitors the progress of individual students.
Feedback to students			
1 Instructional materials and resources are unsuitable to the instructional purposes or do not engage students mentally.	2 Teacher's feedback to students is uneven, and its timeliness is inconsistent.	3 Teacher's feedback to students is timely and of consistently high quality.	4 Teacher's feedback to students is timely and of consistently high quality, and students make use of the feedback in their learning.
Student self-assessment and monitoring of progress			
1 Students do not engage in self-assessment or monitoring of progress.	2 Students occasionally assess the quality of their own work against the assessment criteria and performance standards.	3 Students frequently assess and monitor the quality of their own work against the assessment criteria and performance standards.	4 Students not only frequently assess and monitor the quality of their own work against the assessment criteria and performance standards but also make active use of that information in their learning.
Demonstrating Flexibility and Responsiveness			
Lesson Adjustment			
1 Teacher adheres rigidly to an instructional plan, even when a change is clearly needed.	2 Teacher attempts to adjust a lesson when needed, with only partially successful results.	3 Teacher makes a minor adjustment to a lesson, and the adjustment occurs smoothly.	4 Teacher successfully makes a major adjustment to a lesson when needed.
Response to students			
1	2	3	4

Teacher ignores or brushes aside students' questions or interests.	Teacher attempts to accommodate students' questions or interests, although the pacing of the lesson is disrupted.	Teacher successfully accommodates students' questions or interests.	Teacher seizes a major opportunity to enhance learning, building on student interests or a spontaneous event.
Persistence			
1 When a student has difficulty learning, the teacher either gives up or blames the student or the student's home environment.	2 Teacher accepts responsibility for the success of all students but has only a limited repertoire of instructional strategies to draw on.	3 Teacher persists in seeking approaches for students who have difficulty learning, drawing on a broad repertoire of strategies.	4 Teacher persists in seeking effective approaches for students who need help, using an extensive repertoire of strategies and soliciting additional resources from the school.

Appendix C

Interview Questions

Please provide your best response to the questions being asked.

1. Do you feel like you completely understand the syllabus and its expectations?

1. What do you want to know about your teaching practices?
2. What is your understanding of the action research piece? So, what do you think when you look at the piece about the context?
3. What is your perspective in this course?
4. From reading the syllabus, how does this course connect with the way you teach in the classroom?
5. From looking at the course goals, which one resonate with you the most?
6. In the course you will write reflections on several topics, how will those reflections support your development as a math teacher? Or improve your mathematics teaching practices?
7. From the syllabus, what beliefs do you have about your teaching practices?
8. What do you think about the course being 100% asynchronous and taking the time to study your practices in the process?
9. Have you thought about an education problem you want to analyze?
10. Have you thought about a research question you want to explore? If so, how did that question come about?
11. What do you think about the café conversations? How will those conversations benefit you?

Appendix D

Action Research Survey

(O'Connor, Greene, & Anderson, 2006)

Please read all directions carefully before completing each section of the survey. ***Highlight your answers in yellow*** *and put your response in each box.*

Please rate the difficulty you experienced with the following components of action research using the following scale:

- 1 indicates no difficulty
- 2 indicates a low level of difficulty
- 3 indicates a moderate level of difficulty
- 4 indicates a high level of difficulty
- 5 indicates an extreme level of difficulty

1. *Defining your research question*

(no difficulty) 1 2 3 4 5 (extreme difficulty)

Explain your reason(s) for choosing that level of difficulty.

2. *Writing the literature review.*

(no difficulty) 1 2 3 4 5 (extreme difficulty)

Explain your reason(s) for choosing that level of difficulty.

3. *Developing and writing up the data collection methods you proposed.*

(no difficulty) 1 2 3 4 5 (extreme difficulty)

Explain your reason(s) for choosing that level of difficulty.

4. *Developing and writing up the data analysis section.*

(no difficulty) 1 2 3 4 5 (extreme difficulty)

Explain your reason(s) for choosing that level of difficulty.

5. *Writing up the action plan.*

(no difficulty) 1 2 3 4 5 (extreme difficulty)

Explain your reason(s) for choosing that level of difficulty.

Please answer the following by circling the appropriate number indicating whether you disagree, are neutral, or agree with the statement.

- 1 indicates you disagree with the statement
- 2 Indicates you do not feel strongly either way
- 3 Indicates you agree with the statement

6. Action research is valuable to the teaching and learning process for me as a teacher.

(disagree) 1 2 3(agree)

Explain your choice.

7. Action research is valuable to the teaching and learning process for my students.

(disagree) 1 2 3(agree)

Explain your choice.

8. This action research proposal positively impacted my students' learning.

(disagree) 1 2 3(agree)

Explain your choice.

9. This action research proposal positively impacted my teaching.

(disagree) 1 2 3(agree)

Explain your choice.

10. I view myself as a teacher-researcher.

(disagree) 1 2 3(agree)

Explain your choice.

Please respond to the following questions.

11. Describe the long-lasting efforts, if any, that you believe the action research proposal will have on your professional career?
12. In what ways has the action research experience empowered you and/or your teaching?

13. How has your research informed your instructional practices?
14. What issues arose for you while engaging in action research and how did you resolve them?
15. Overall, do you feel that you have a good understanding of Action Research and how it can improve your teaching practices? Please explain.

Appendix E

Action Research Syllabus

Course Description:
This course is an introduction to action research. The goal of action research is for teacher-researchers to solve education problems by engaging in a systematic process of inquiry. This process enables teacher-researchers to make informed decisions at both the classroom and school levels. In the course, you will propose an action research project related to your classroom or educational practice, thereby helping you bridge theory and practice. The proposal will enable you to examine an education problem as well as encourage you to be a reflective practitioner. Through lecture, discussion threads, hands-on problem solving, students will be guided by the instructor to a greater understanding of action research.

Course Goals

1. Choose an appropriate research question to explore.
2. Select and/or design data collection procedures.
3. Review and critique relevant professional literature.
4. Conduct an action research study.
5. Make changes to teaching practice through systematic reflection and experiences.

Required Text:

Action Research: A Guide for the Teacher Researcher (with MyEducationLab), 6/E, Geoff E. Mills, Pearson Higher Education (ISBN: 9780134523033) (With Online Resources)

Course Assignments:

1. **Required Synchronous Discussion Groups (15 points with Discussion Board Responses)**

You will be required to schedule and participate in three discussion groups during the semester. These small group discussion sessions will occur in a synchronous live format and will be led by the Instructor or the Teaching Assistant. You will be notified by the lead and of which classmates are included in your small group and you are asked to aid in the scheduling. These two-hour sessions have been scheduled strategically to allow for discussion of course topics and to provide support throughout the course.

2. **Discussion Board Responses.** *(15 points with Required Synchronous Discussion Groups)*

Each week, I will post discussion material related to the chapters of the text or other relevant course material. You are responsible for responding to one of the questions. Your thoughtful responses should be a minimum of 1-2 paragraphs. In addition to responding to the discussion questions I post, you should also respond to 2 of your peers' responses. These responses should be respectful. The intent of these responses should be to further discourse about the topic. You can agree or disagree but your responses should be framed within the course content and methodological perspectives.

3. **Research Journal:** *(15 points total, 7.5 and 7.5)*

Content:

The research journal will be an integral part of your action research proposal. They are a place where you record your thoughts and feelings about action research. Researchers normally keep a journal weekly throughout the course of their research projects. In the journal, you will address a variety of different stages of the project.

Weeks 9/14 & 9/21 (3 entries per week):

At the beginning of the course, your journal should focus on observations and experiences from your school day that stand out.

- You should especially record any questions you may have or things you wonder about.
- These entries will help you choose an educational problem to be addressed by your proposal.

Some questions you could address for these entries are:

- What do you believe about teaching and learning?
- As you think about your teaching, how do you know when something really went well?
- How do you know when something does not go very well?
- What approach do you take when you know something has to be changed to better your students' learning?
- What intrigues you about teaching, learning, and students?
- What dilemmas and problems are you facing in your work? ➢ How might you approach working on solving these?

Weeks 9/28 & 10/5 (3 entries per week):

Once you have chosen the problem, your entries will have focus on observations/questions/reflections on the education problem.

- This is a period of time where you focus closely on the education problem you would like to research.
- The goal of this period is to collect some informal preliminary data which will help you structure a plan to do formal data collection.

Some questions you could address for these entries are: ➢

- What is the situation you wish to change or improve?
- What evidence do you have that your area of focus is a problem?

- What critical factors affect your area of focus? ➢ How do these factors affect your area of focus? ➢ What will your first implementation be?

Weeks 10/12 -end of semester (2 entries per week):

As you begin to collect data, your entries should focus on struggles you may encounter.
- Once the data has been collected, your entries will address analysis of the data and brain-storming of possible solutions.
- When you implement the solution(s), be sure to record your observations.

Some questions you could address for these entries are:
- What data collection techniques will you use to answer each of your research questions?
- What data collection instruments do you need to locate or develop?
- How will you triangulate data?
- What are you struggling with in terms of data collection?
- What are you noticing thus far about the data you have collected?
- What stands out about the data?
- What is surprising?
- What confirms what you already know?

***Throughout the course, at least one journal entry per week should reflect on class read-ings, class sessions, and your joys or frustrations with the process of action research. ***

Some questions you could address for these entries are:
- What was beneficial to you about this evening's class?
- What do you need to know more about?
- In what ways did your research group assist you?
- What did you think of this week's readings?
- What are you most frustrated about in regards to your action research project?
- How has your thinking about action research and/or your action research project changed?

<u>**Format of Journals:**</u>
- Journals should be typed in **12-point font** and **double spaced**. Each entry should be dated and should be **about ½ page to 1 page**.

4. <u>**Action Research Proposal:**</u> *(30 points total)*

You will choose an appropriate research question/education problem related to your teaching practice to explore. Over the course of the semester, you will construct an action research pro-posal which would suggest ways to examine or address the education problem you are facing. You will not need to actually collect or analyze data.

Content:

The action research proposal will have multiple sections.

a. In your ***introduction***, you should identify an educational issue within your control that warrants examination. Describe the purpose of your study and include definitions of what the characteristics of your study mean to you. Your proposed research questions should be clearly expressed.
b. The ***context*** section will address the proposed site of your research. Describe who you would be working with and where (location, demographics, and any other pertinent information about your school). You should also address how an action researcher would obtain permission to conduct the study.
c. The ***literature review*** will be a summary and analysis of at least 5 sources of professional literature (books or journal articles) related to your proposed research topic.
d. In the ***data collection*** section, you should detail what data collection methods you propose to utilize to examine the issue, as well as discuss how you would triangulate the data.
e. In the ***data analysis*** section, you should discuss themes that might emerge from your data. List the questions that will guide you and include detailed descriptions of how you would test the questions you are examining.
f. In the ***action plan*** section, you will briefly address the significance of both the educational issue and the action research proposal. What could an action researcher learn during the process? How could the proposed study make things better for the stakeholders?

g. Works Cited Page.

Your action research proposal should be double spaced and in 12-point font. Page length will range from 7-10 pages. Your proposal should also include an appendix. (The appendix does not count toward page length). Include in the appendix examples related to data collection (surveys, observation notes, list of possible participants to interview, etc.).

5. Online Exam: This will be multiple choice and short answer (25 *points total)*

6. Action Research Presentation: *(15 points total)*

Your research proposal will be presented and posted to iCollege in the format of a PowerPoint or multi-media presentation. You should include small summaries or bullet points from each section of your proposal. What is the significance of the issue and how could an action researcher go about studying it?

Please submit assignments as Word Documents in the following format:

Journal_Last Name;

Action Research_Last Name;

Presentation_Last Name

Assignments	Course Points
1. Discussion Board Responses & 2. Synchronous Discussion Groups	15 points
3. Research Journal	15 points (7.5 and 7.5)
4. Action Research Proposal	30 points
5. Online Exam	25 points
6. Action Research Presentation	15 points
Total	**100 points**

Grading:

94-100 A
90-93 A87-89
B+
84-86 B
80-83 B77-79
C+
74-76 C
70-73 C67-69
D+
64-66 D
60-63 D-
<60 F

Policy on Academic Honesty:
As members of the academic community, students are expected to recognize and uphold standards of intellectual and academic integrity. The University assumes as a basic and minimum standard of conduct in academic matters that students be honest and that they submit for credit only the products of their own efforts. Both the ideals of scholarship and the need for fairness require that all dishonest work be rejected as a basis for academic credit. They also require that students refrain from any and all forms of dishonorable or unethical conduct related to their academic work (University Senate, 1994).

General Timeline for Completion of Action Research Proposal

Week of:	Journal Entries:	TASK
August 24 & August 31	-	Consider Topics **Week of 8/31- 1st Required Synchronous Discussion Group**
Labor Day	No Class- Enjoy	No Class- Enjoy

September 14 & September 21	3 journal entries each week ***6 journal entries due September 27th**	Choose a topic; write research question(s) Conduct reconnaissance; begin to search for literature
September 28 & October 5	3 journal entries each week	Continue search for literature; start to determine data collection instruments; consider data collection methods.
October 12	2 journal entries each week	Finish design of data collection procedures; begin reading and reviewing literature
October 19	2 journal entries each week ***10 journal entries due October 25th ***	Begin to write literature review and context sections of proposal **Week of 9/19- 2nd Required Synchronous Discussion Group**
October 26	2 journal entries each week	Begin design of data analysis, finish writing literature review and context sections of proposal ***Draft of Action Research Proposal Due by Nov 1st***
November 2	2 journal entries each week	***Exam Due by Nov 8th***
November 9	2 journal entries each week	Begin writing introduction and data collection, and data analysis sections of proposal
November 16	2 journal entries each week	Finish writing introduction, data collection, data analysis section, write action plan sections of proposal; prepare presentation **Week of 11/16- 3rd Required Synchronous Discussion Group**

November 23rd	Thanksgiving Holiday	No Class- Enjoy
November 30	2 journal entries each week	***Action Research Proposal & Presentation Due MONDAY, November 30th**
Dec 7th		*Response to Peer Presentations due by Sunday, December 6th.

Course Schedule

DATE	TOPIC	ASSIGNMENTS
August 24th	Introduction and Overview of Course	• Post #1: Review and Respond to Syllabus with 1 question • Post #2: "Educational Truth" • Introduce yourself with a short bio, and a photo or a video. **These 3 are all due by Sunday, August 30th midnight**
August 31st	Understanding action research & Ethics	• **Mills** Chapters 1 & 2 • Review PowerPoint: Understanding Action Research • Review PowerPoint: Ethics in Action Research **Week of 8/31- 1st Required Synchronous Discussion Group**
September 7th	**Labor Day Holiday**	**No Class**

September 14th	Action Research Plan and Choosing an Area of focus	• Mills Chapter 3 & 4 • Review PowerPoint: Action Research Plan and Choosing an Area of focus • Review PowerPoint: Review of Related Literature • Discussion Board Response #3 • Discussion Board #4 Due on or before Sunday, September 20th by midnight
September 21st	Data Collection (Part 1)	• Mills Chapter 5 • **Research Journals Due (6 entries)** Due Sunday, September 27th by Midnight • Review PowerPoint: Data Collection (Part 1) • Discussion Board Response #5: Due on or before Sunday, September 27th by midnight
September 28th	**Workday**	**Workday**
October 5th	Data Collection (Part 2)	● Mills Chapter 6 ● Review PowerPoint: Data Collection (Part 2) ● Discussion Board Response #6: Due on or before Sunday, October 11th by midnight
October 12th	Data Analysis and Interpretation	● Mills Chapter 7 ● Review PowerPoint: Data Analysis and Interpretation ● Discussion Board Response # 7: Due on or before Sunday, October 18th by midnight
October 19th	Action Planning for Educational Change	● Mills Chapter 8 ● Review PowerPoint: Action ● Planning for Educational Change **Week of 10/19- 2nd Required Synchronous Discussion Group**

October 26th		• **Draft of Action Research Proposal Due by Sunday, November 1st by Midnight**
November 2nd	**EXAM**	• **Online Exam (multiple choice and short answer) due by Sunday, November 8th by Midnight**
November 9th	Writing Action Research	• Mills Chapter 9 • Review PowerPoint: Writing Action Research • Discussion Board Response #8: Due on or before Sunday, November 15th by midnight
November 16th	Evaluating Action Research	• Mills Chapter 10 • Review PowerPoint: Evaluating Action Research • **Week of 11/16- 3rd Required Synchronous Discussion Group**
November 23rd	**Thanksgiving Holiday**	**No Class**
November 30th	Presentations	• **Action Research Proposal & Presentation Due Monday, November 30th by Midnight**
December 7th	Peer Response	• Respond to Peer Presentations by midnight, Monday, December 7th

The course syllabus provides a general plan for the course; deviations may be necessary.

Late policy: Work turned in after posted due dates may not be accepted, and points may be deducted.

Action Research Proposal for Non-Practitioners

The skills that you learn while completing an action research project can be utilized in your everyday life practices, or current employment to help you become an effective problem solver. Also, if you are interested in affecting educational change at any level, this course will equip you with the tools necessary to make that possible. Therefore, even if you are not currently a teacher, the course can still be valuable for you. While this course is geared toward teachers, if you are not currently in the classroom you have a few options to pursue for your action research proposal:

1. *If you do not have contact with students you may reflect on your own practice or and current employment. What areas are problematic or could benefit from systematic examination and new processes? This can be your area of focus for your action research project. Ex: How to handle work/life balance, or managing interactions with peers or supervisors.
2. You can volunteer virtually in an after-school program or a weekend enrichment program. Your proposed project could involve one or all of the students.
3. You can tutor a student or your own child. Your project would then involve improving instruction relating to this student/child.
4. An education-based service-learning project that you are a part of with proposed data collection and analysis added on to it.

*** If you choose #1, please run the topic that you are considering by me in an email. Please plan to write a paragraph detailing what kinds of data you would collect, the type of reconnaissance you would conduct, etc.**

If you choose #2, 3, or 4 the important issue is that you need continual access to the student or students who will be involved in your project. You should work with the student(s) **at least** once a week. The minimum number of hours you should plan on working with the student(s) is 2. This is because you need to have a good idea of what the student needs in order for you to be able to improve on an educational problem relating to this student. Obviously, the more time you spend with the student(s), the more detailed information you will have.

Research Journal

While some of you may be focusing on your own daily life or employment, and some of you will find projects to begin with children, the content of your research journal will be similar to teacher-researchers.

***You will still be reflecting on your practices, daily life, employment or time with students.**

At the beginning of the course, you will reflect on anything that stands out from your examination of your own practice or time with the student(s). You may also write about questions you have or problems that you are encountering each day as well as with the student(s). These entries should be focused on helping you choose a topic related to your daily practices or an educational topic related to your student(s) that you can pursue for a project. (Please see syllabus for list of questions on which to reflect)**.**

1. Once you have chosen a problem to explore, your entries will focus on your observations, questions, or reflections on the problem. (Please see syllabus for list of questions on which to reflect).
2. As you begin to collect data, your entries should focus on struggles you may encounter. (Please see syllabus for list of questions on which to reflect).

3. Once the data has been collected, your entries will address analysis of the data and brain-storming of possible solutions. When you implement the solution(s), be sure to record your observations. (Please see syllabus for list of questions on which to reflect).
4. At least one entry per week should reflect on class readings, class sessions, and your joys or frustrations with the process of action research. (Please see syllabus for list of questions on which you will reflect)