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Using Ozobots to Learn Character Traits

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USING OZOBOTS TO LEARN CHARACTER TRAITS

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ABSTRACT

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Technology is utilized in everyday life. As such, teachers can employ educational robots and technology to assist in growing skills in collaboration, communication, computational thinking, and problem-solving. Educational robots also appear to increase engagement and motivation in students to participate in lessons. This study employed design-based research (DBR) to explore the use of Ozobots in teaching character traits in a fourth-grade classroom. Together with fourth-grade teachers, a set of lessons was created that employed Ozobots to engage students in learning character traits. Two technology integration frameworks, technological pedagogical and content knowledge (TPACK) and Substitution, Augmentation, Modification, and Redefinition (SAMR), were incorporated to ensure that the technology integration lessons were developed with structure and intent. Through the DBR study, findings showed that educators could utilize Ozobots to support teaching character traits through instructional lessons. The lessons can be modified for additional grade levels depending on student needs. Implications for future studies include more research on how Ozobots and other educational robots may be suitable to help with reading and writing skills.

Keywords: educational robots, Ozobots, character traits, design-based research (DBR)

In loving memory of my brother who always believed in me

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CHAPTER 1

Introduction

Robotics has become more prevalent in today's society with the rapid growth of technology (Qu & Fok, 2021). The use of technology and robotics has also progressed in schools and classrooms. Students are learning how robots function but also are fostering skills in computational thinking, problem-solving, collaboration, and communication (Eguchi, 2017; Tengler et al., 2022). It also appears that students are engaged and motivated when using educational robots to learn (Al Hakin et al., 2022; Tengler et al., 2021, 2022). The purpose of this study is to determine if a type of educational robot, Ozobots, can assist students in learning character traits.

Educational Robots

Educational robots are used as a technology tool to assist students in their learning (Cheng et al., 2018; Eguchi, 2017). Educational robots have multiple advantages; for example, integrating these technology tools can help elementary-aged students build problem-solving and creative thinking skills (Çakir et al., 2021; Taylor & Baek, 2018). Lessons with educational robots can also encourage teamwork and critical thinking skills. Another benefit of educational robots is the immediate feedback students can receive as they engage with educational robots (Zhang et al., 2021). The feedback can be a significant, meaningful feature of educational robots as it allows the teacher to facilitate and then continually evaluate student progress (Zhang et al., 2021). Teachers can then support students who have challenges or questions.

Problem-solving skills may also be improved by implementing lessons with educational robots (Çakir et al., 2021; Taylor & Baek, 2018; Usengul & Bahceci, 2020). By implementing lessons that integrate educational robots, educators provide opportunities for students to interface with the robot, develop codes for the robot, and then decide if the solution shown by the robot is suitable. Through this process of engaging with robots, students can be actively involved in problem-solving and constructing knowledge simultaneously.

Çakir and his colleagues (2021) conducted a quasi-experimental study with preschoolers to determine the effect of robotics and coding instruction on problem-solving and creative thinking abilities. A total of 40 preschool students were involved in this study for four weeks. The experimental group used WeDo 2.0 Educational Robotics Kit; the control group used pen and paper activities (Çakir et al., 2021). Data analysis showed that robotics and coding instruction provided statistically significant contributions to preschoolers' problem-solving skills compared to pen and paper activities.

Another positive feature of educational robots is the opportunity for students to develop computational thinking (Zhang et al., 2021). Computational thinking is discerning and interpreting complicated problems by applying computer science elements and strategies such as decomposition, pattern recognition, abstraction, and algorithms (Kale et al., 2018). Wing (2006) appears to believe computational thinking skills are necessary for individuals. Kale and colleagues (2018) also discern that computational thinking is a fundamental skill now and will be in the future. Computational thinking supports advancing students' problem-solving abilities in elementary school (Tengler et al., 2020). Therefore, presenting students with learning opportunities in computational thinking can be vital for their ensuing academics and achievements.

Ozobots

Ozobots have been applied in a variety of ways by teachers. For example, Tengler and colleagues (2021, 2022) created a long-term research study with Ozobots to investigate how to support and encourage the introduction of computer science education in primary schools. Tengler and colleagues' studies centered on examining the implementation of computational thinking utilizing Ozobts and digital storytelling with third and fourth graders. Students were divided into collaborative groups and given a problem-based task to create a fairy tale with specific characters and facts. The task consisted of illustrating the story graphically, programming the story's plot, and then depicting the story with the Ozobot and appropriate codes. Qualitative data, including interview transcripts and observations notes, were gathered during the study.

In this study, Picka and colleagues (2020) interviewed nine elementary school teachers with varying levels of teaching experience to learn more about Ozobots in the classroom. The researchers' attention focused on reasons for choosing this device, the ways of use, the problems that educators had to solve, and the benefits that the robot brought to students in the classrooms. Teachers were interviewed, and the transcripts were analyzed. The results illustrated that Ozobots appear to lead to student enthusiasm and motivation. Regardless of the age of students or the content, motivation did not appear to wane throughout the Ozobot use in lessons. Due to the short period of the study, the researchers could not determine the influence of the Ozobots on algorithms and programming in computational thinking. Teachers from Picka and colleagues' study also noted the simplicity of learning to use the robots. The same teachers also spoke of the relative ease of teaching the students how to use the Ozobots. Educators commented on the minimal pre- and post-lesson preparation to ensure the robots are primed. The study appears to show that the implementation of Ozobots in the educational environment combines effective teaching with student enthusiasm and motivation.

In Tengler and colleagues' (2021) study, results conveyed how combining educational robots and storytelling showed promising results to assist with computational thinking. Students programmed the Ozobots to showcase a fairy tale plot with Ozobots as the characters. Groups worked collaboratively to determine which Ozobot codes should be chosen to illustrate the fairy tale's plot. During the study, the students directly observed the codes from the robots and decided if the selected code fit the storyline. If the codes were not suitable, the students could make changes. Tengler and colleagues (2021, 2022) observed how the small groups provided an opportunity for each student to have a voice in their group's ideas and apply their thinking during the lesson.

In Tengler and colleagues' study (2022), the goal focused on providing elementary school teachers with little computer science teaching experience with a simple lesson to introduce computer science without using a computer. The Tell, Draw, and Code method combines storytelling activities with educational robots. This combination appears to be a promising way to engage students with computational thinking skills. Using Ozobots with storytelling can have multiple advantages, such as beginning programming, advanced computational thinking, increased motivation, and growing problem-solving skills.

There appears to be minimal research on how to teach character traits successfully. The few articles and research I did find connected character trait lessons to positive character development (Almerico, 2014; Helterbran, 2009; Kara-Soteriou & Rose, 2008; Russell et al., 2013). This study is intended to contribute to the body of work on the connection between teaching reading concepts effectively and robotics instruction.

Technological Frameworks

Technology integration frameworks can ensure structure for technology integration lessons (Kimmons & Hall, 2018). Technology frameworks also provide educators with a guide for creating effective and engaging lessons using technology (Atun & Usta, 2019) and two frameworks were used in this study. The first framework, the technologial, pedaogigical, and content knowledge (TPACK) framework merges three types of knowledge: technology, pedagogy, and content. The second framework is Substitution, Augmentation, Modification, and Redefinition (SAMR). According to Puentedura (2006), the SAMR model is intended to be an instrument to describe and categorize K-12 teachers' uses of classroom technology.

Purpose

In this study, I explored how Ozobots engaged students in learning character traits. The purpose of this study was to determine if Ozobots can assist students in learning character traits. To help students learn and be successful with character traits, Ozobots were also utilized to foster student engagement and motivation, refine their communication and collaboration skills while working with their peers, and learn computational thinking. These create a foundation for students to use in their future studies and professions (Atun & Usta, 2019; Çakir et al., 2021; Tengler et al., 2021).

In the following chapter, I examined studies that have used a variety of educational robots. I also examined the lesson through two technology frameworks to ensure that technology integration is meaningful and purposeful.

Design-Based Research (DBR) is a research method that provides researchers the opportunity to work with classroom educators to construct interventions and local instruction theories in authentic educational settings (Anderson & Shattuck, 2012; Huang et al., 2019). DBR was used in this study to address the following research question: How can Ozobots support learning character traits in elementary school? Two sub-questions were developed to guide this research further:

1. How can teachers integrate Ozobots into teaching character traits in reading?
2. How can Ozobots facilitate students' understanding of character traits in reading?

The study culminated in the local instruction theory about students' understanding of character traits through the use of Ozobots and the lesson plans as an embodiment of the local instruction theory (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009; Huang et al., 2019)

Structure of Dissertation

This dissertation is organized into five chapters. The first chapter, the introduction, prepares the reader to understand why the study is necessary. Chapter 1 also illustrates the absence of character trait lessons and the potential benefits of educational robots. In Chapter 2, I examine each component of my research further. I begin with educational robots and their numerous benefits to student learning and achievement. The next section focuses on computational thinking skills implemented within this lesson. I then delve deeper into three different types of educational robots: LEGO Robotics, Bee-Bots, and Ozobots. In this chapter, I explain why I chose Ozobots to teach character traits. After this section, I examine two technology frameworks and how my lesson is positioned within them. Then, I briefly overview pragmatism and its relevance to the lesson. Finally, I conclude with character traits. Along with Ozobots and their learning value, the scarcity of character trait lessons illustrates why this study is necessary.

In Chapter 3, I present my research design. I chose DBR as it is a research method that provides researchers the opportunity to work with classroom educators to construct interventions and local instruction theories in real educational settings (Anderson & Shattuck, 2012; Huang et al., 2019). Participants were elementary students in two classes in an inner-city school district in a mid-Atlantic state. The findings of this study are presented in chapter 4. Finally, in chapter 5, I discuss my conclusions and implications for future research.

CHAPTER 2

Literature Review

Technological growth has inundated adolescents with different technology developments; they may spend hours on social media, gaming systems, and mobile devices (Carstens et al., 2021; Xie & Hawk, 2017). Due to the proliferation of technology in the lives of school-aged children, schools and educators are striving to implement technology in their classrooms (Carstens et al., 2021; Ertmer & Ottenbreit, 2010; Tunjera & Chigona, 2020). Educational robots provide a hands-on approach to using technology with students (Negrini & Giang, 2019). Educators seem to be able to teach academic and social skills with educational robotics. Activities involving these technology tools can be used to engage students in collaborative work and communication strategies.

Teachers may also utilize educational robots to focus on computational thinking; educational robots can be used to assist students in understanding and applying computational thinking skills (Critten et al., 2021; Negrini & Giang, 2019). Wing (2006) wrote that computational thinking is essential to individuals as it is a foundation for all professions. It involves a range of skills, including solving problems, breaking down complexities, and analyzing data. Students may benefit from programming and coding exposure to build these abilities (Bodaker & Rosenberg, 2022). Educational robots can also assist students in gaining other competencies: communication, collaboration, problem-solving, and critical thinking (Çakir et al., 2021; Taylor & Baek, 2018).

The educational robot chosen for this study is an Ozobot due to its ease of learning and use (Picka et al., 2020). In using the Ozobot, two technology integration frameworks, technology, pedagogy, and content knowledge (TPACK) and Substitution, Augmentation, Modification, and Redefinition (SAMR), are referenced as a foundation to ensure the structure of the technology integration lessons (Kimmons & Hall, 2018).

In this study, I explored the following question: how can Ozobots support learning character traits in elementary school? I also developed two sub-questions to further guide this research: How can teachers integrate Ozobots into teaching character traits in reading, and how can Ozobots facilitate students' understanding of character traits in reading? In this chapter, I present a review of the literature on educational robots, including the link between computational thinking skills, Ozobots, and technological frameworks.

Educational Robots

Educational robots are becoming more prevalent in educational environments across numerous disciplines and content areas (Negrini & Giang, 2019; Toh et al., 2016; Usengül & Bahçeci, 2020). Educational robots are defined simply as robots used as learning devices in classrooms (Cheng et al., 2018; Eguchi, 2017). These technology tools can be advantageous for educators and students alike. Integrating these technology tools into learning environments can produce multiple benefits, including assisting elementary-aged students in building problem-solving tactics and creative thinking skills (Çakir et al., 2021; Taylor & Baek, 2018). Lessons with educational robots can also encourage teamwork and critical thinking skills (Çakir et al., 2021; Taylor & Baek; 2018). Becoming immersed in educational robotics can benefit learners in today's society as they learn how to think computationally and code (Çakir et al., 2021; Negrini & Giang, 2019).

A critical computational thinking skill is coding, the creation of a set of directions to communicate with computers (Tengler et al., 2022). The process of coding can be intricate and abstract. Yet, students can acquire problem-solving, mathematical thinking, critical thinking, and creative thinking abilities while they are learning to code (Atun & Usta, 2019; Çakir et al., 2021). The skills acquired while engaged in programming educational robots may potentially help students in their future professions (Atun & Usta, 2019; Çakir et al., 2021; Tengler et al., 2021). Students can often make connections beyond the classroom by experiencing authentic and meaningful lessons with coding. Coding educational robots enables students to construct their learning physically or conceptually (Cheng et al., 2018; Eguchi, 2017).

Robots are increasingly utilized in science, technology, engineering, and mathematics (STEM), particularly in courses that involve engineering and science curricula (Negrini & Giang, 2019; Zhang et al., 2021). In STEM-related activities, educational robots can develop problem-solving and teamwork skills, especially in elementary-aged students (Anwar et al., 2019; Cheng et al., 2018; Taylor & Baek, 2018). STEM is interdisciplinary and commonly used to solve everyday challenges (Karaahmetoglu & Korkmaz, 2019; Negrini & Giang, 2019; Usengul & Bahceci, 2020). Educational robots can contribute to fundamental knowledge and abilities linked with STEM. The use of these robotic tools in STEM can assist in producing student connections to the world outside of school. In addition to STEM concepts, students can also develop other skills such as creativity, collaboration, problem-solving, and computational thinking (Negrini & Giang, 2019; Taylor & Baek, 2018). These skills and STEM skills will be foundational in many future work environments.

Another benefit of educational robotics is that student learning can become adaptive and reflective. Students receive immediate feedback as they directly interface with the robots (Chevalier et al., 2020; Zhang et al., 2021). For example, Al Hakin and colleagues (2022) conducted a study during three English as a second language class for ninth graders that included two experimental groups and a control group. The measurement tools were a pre- and postassessment to examine students' learning achievement and a questionnaire to measure students' learning motivation and engagement. An interactive situated learning approach was designed to advance students' learning performances. The students and robot role-played characters and immersed themselves in digitally situated learning activities, including a real-time feedback tool to assist and analyze student learning (Hakin et al., 2022). Students who learned with the experimental approach revealed better learning achievement and significant positive effects in learning motivation and engagement. The results also showed that interaction with physical robots improved student learning achievements significantly compared with virtual interaction.

Educational robots can immediately show the programmed codes, providing feedback to the user. The user can then determine if the robot was programmed correctly or if the code needs to be amended (Tengler et al., 2022). In Tengler and colleagues' (2021) study using Ozobots to illustrate fairy tale plots, the students directly observed robots' movements from the codes students had selected. The children could then decide if the selected code fit the fairy tale storyline. If the codes were not suitable, the students could make changes.

The immediate feedback from the interaction with the educational robots may be considered a critical, worthwhile feature of educational robots as the teacher can function more as a facilitator than an evaluator (Zhang et al., 2021). It frees the teacher to impart more support to the students who may need it. Zhang and the authors (2021) found that when robotic activities merge with the STEM curriculum, more students can become proficient in reasoning, inquiry, creativity, and critical thinking with the help of immediate feedback and teacher facilitation.

Educational robots also are a meaningful and hands-on approach to improving problem-solving skills (Çakir et al., 2021; Taylor & Baek, 2018; Usengul & Bahceci, 2020). These learning tools can positively influence students' STEM learning by creating an environment for elementary students to learn and apply skills. In problem-solving, students must understand the problem and its context and try multiple solutions (Chevalier et al., 2020). When working with educational robots, students can interface with the robot, create codes for the robot, and then determine if the solution shown by the robot is feasible. Students can change the solution and try again if it does not work. The language of the student and the robot's language are typically dissimilar. The learner can determine the best way to communicate with the robot. The learner may translate their language into the robot's language. Through this process of engaging with robots, students can be actively involved in problem-solving and constructing knowledge simultaneously.

When teachers demonstrate to students how to work effectively together for a shared purpose or goal, learners can benefit from working collaboratively (Eguchi, 2017; Sullivan et al., 2013; Taylor & Baek, 2018). Collaboration is a significant skill for individuals as it brings together multiple perspectives, thoughts, and abilities. This was evident in a study conducted by Nemiro (2021), the three-year study using School Robotics Initiative (SRI) to engage fourth - sixth graders in problem-based learning to develop science and mathematics concepts and collaboration skills. The program occurred for two-hour weekly sessions on the robotics curriculum created by professors and cooperating teachers for five months. After being provided with multiple pieces of training, students were given a series of robotic challenges to be completed with teams. Data collected by Nemiro included field observations, student journals, and teacher interviews. Findings illustrated that SRI promoted the use of children's strengths in team roles, conflict-resolution strategies, knowledge-sharing among the students, and helping one another. From this study, a proposal for a model to develop student collaboration abilities through the use of robotics was designed.

When using educational robots, students typically work with their peers in small groups (Eguchi, 2017; Negrini & Giang, 2019). In collaborative groups, students are engaged in making decisions while attempting to solve a challenge. Hence, students are potentially improving their communication and collaboration skills. In a study where students used Ozobots to represent a fairy tale, the researchers noticed that, in small groups, each student had the opportunity to contribute to their group's ideas and use the robot (Tengler et al., 2021). Additionally, the student groups collaborated on which Ozobot action and code worked best to depict the fairy tale plot. Students also used communication and collaboration skills to determine each group member's responsibilities in this activity.

Computational Thinking

By using educational robots, teachers can begin to positively shape the development of computational thinking in young learners (Zhang et al., 2021). Computational thinking is discerning and interpreting complicated problems by applying computer science elements and strategies such as decomposition, pattern recognition, abstraction, and algorithms (Kale et al., 2018). Computational thinking is believed to be fundamental for all individuals, not just engineers or programmers (Wing, 2006, 2017). Students' problem-solving capabilities in elementary school may grow by using computational thinking (Tengler et al., 2020). As technology is employed more in society daily, computational thinking may become necessary (Kale et al., 2018). Some professions already require computational thinking, particularly in STEM fields. Therefore, providing students with exposure and learning opportunities in computational thinking can be critical for their future success. For this study, Ozobots were chosen to teach character traits with the knowledge that students would also be exposed to computational thinking.

In 2006, Wing authored an article on computational thinking in which they expressed the importance that all individuals, regardless of profession, would benefit from thinking like a computer scientist and using computational thinking. Wing believed that computational thinking is essential for all individuals (Lodi & Martini, 2021). For this study, I will make use of the following computational thinking elements: data collection, decomposition, abstraction, algorithm, and evaluation. These elements were chosen based on how computational thinking can be applied to character traits.

Data collection and analysis is the process of gathering relevant data, scrutinizing data, determining patterns, and drawing conclusions (International Society for Technology in Education [ISTE], 2011; Tengler et al., 2022). Students use decomposition to break down abstract concepts or problems into smaller, manageable pieces (Angelia & Makridou, 2018; ISTE, 2011; Noh & Lee, 2020; Silva et al., 2021; Tengler et al., 2022; Williams, 2021). A third component, abstraction, removes unnecessary pieces or aspects of the task. It reduces the complexity of defining the main idea. Another element of computational thinking is an algorithm in which a series of instructions in the correct order results in a solution to a problem. Evaluation is the process that ensures the solution solves the problem and then reflects on what could be improved (Noh & Lee, 2020; Tengler et al., 2022). Table 1 shows the computational thinking elements in the Character Traits in Ozobots study context.

Table 1

Computational thinking elements in the Ozobots character traits study

Elements of Computational Thinking	Description	Computational Thinking in Character Traits with Ozobots
Data collection and analysis	the process of gathering relevant data, scrutinizing data, determining patterns, and drawing conclusions	reading the text, reading the assignment, identifying character traits, determining text evidence that is essential, deciding what colors and lines are needed
Decomposition	the breaking down abstract concepts or problems into smaller, manageable pieces	determining which character and its traits are applicable
Abstraction	the removal of pieces or aspects that are unnecessary for the text; reduces the complexity to define the main idea	determining which Ozobot codes can be represented by the different character traits
Algorithm	a series of instructions in the correct order results in a solution to a problem	programming the character traits in the right order
Evaluation	the process that ensures the solution resolves the problem and then reflects on what could be improved	retelling the story with emphasis on how characters traits were utilized, ensuring Ozobot codes represent the character trait, presentation to class

Note. Adapted from "The effect of robotics-based storytelling activities on primary school students' computational thinking" by K. Tengler, O. Kastner-Hauler, B. Sabitzer, & Z. Lavicza, 2022, *Education Sciences, 12*, p. 4. (https://doi.org/10.3390/educsci12010010). Copyright 2021 by the authors.

Tengler and her colleagues (2021) studied how Ozobots could enhance children's computational thinking skills through storytelling activities. Results revealed that combining educational robots and storytelling is a promising approach for students to learn computational thinking. There appears to be a relationship between the different elements of computational thinking and the storytelling lessons' problem-solving process. For example, one computational thinking component is data collection and analysis, which is collecting relevant information, understanding the information, and drawing conclusions (Tengler et al., 2021). In the study, students learned how to identify the challenge and to determine which characters and details were pertinent to create the story.

Another study centered on how computational thinking could be enhanced by student-robot interaction was conducted by Qu and Fok (2022). They studied a robotics summer camp with primary school students and a robotics teacher. Students were given 12 lessons along with 11 problem-solving tasks. Each lesson lasted 90 minutes. Data collected were rubrics, semi-structured interviews, and classroom observations. Results showed that students' computational thinking skills increased during the summer camp. It also indicated that the change in their computational thinking skills was positively correlated to the time spent on student-robot interaction. The interaction between the student and the robot assisted the student with computational thinking. The robot is a tangible and visible entity that operates between the real and abstract computer worlds. The robot helps students equate real-world tasks to the programming process. During the interaction with the robots, students used evaluation and debugging, elements of computational thinking, to observe the robot's behaviors and decide if the given task was solved. By assessing the solution, students may also seek resolutions for any problems they may find, known as debugging.

Some scholars believe computational thinking is the new literacy of the 21st century (Wing, 2017). There appear to be benefits to learning and understanding computational thinking for educators and students. It supplies the user with the knowledge to recognize, employ, and amend a computational tool or formula in a different, new way. Computational strategies can be wielded in situations elementary students confront. The brain grows and strengthens when engaging in computational thinking during these learning encounters. The earlier students are introduced to computational thinking, the better they can recognize and solve real-world problems (Angelia & Makridou, 2018).

Educational Robot Examples

LEGO Robotics. Robotic construction kits, such as LEGO Education's LEGO WeDo 2.0 or LEGO Essentials (LEGO Group, 2022), are a simple way to introduce computational thinking to students. LEGO WeDo 2.0 kits contain 280 pieces, not limited to an intelligent brick, a motor, a motion sensor, and a training sensor (Çakir et al., 2021). The software, controlled through a tablet or computer, has a visual programming platform. It provides students the ability to code through drag-and-drop operations. The software also has multiple projects illustrating the steps of building and programming one at a time. According to the LEGO website, LEGO WeDo and LEGO WeDo 2.0 kits have been discontinued (LEGO Robotics, 2021).

In 2021, LEGO Education released SPIKE Essential, a cross-curricular science, technology, engineering, arts, and mathematics (STEAM) kit for elementary education (LEGO Robotics, 2021). It is also aimed at elementary-aged students. Unlike LEGO WeDo 2.0, it engages students in STEAM concepts while integrating literacy, math, computer science, and social-emotional skills. LEGO uses academic standards to create learning with everyday themes. LEGO also added Minifigures with different personalities to help students solve challenges through storytelling. One of the more noticeable differences between the LEGO WeDo 2.0 and SPIKE Essential kits, both kits by LEGO Education, is the level of focus on science. SPIKE

Essential is not targeted at life, physical, earth, and space science standards like LEGO WeDo 2.0. Another difference is the focus on oral communication in all the SPIKE Essential curricula; each lesson has an oral communication learning target.

Regardless of the LEGO kit, students create programs by maneuvering visual blocks on the device's screen (Angelia & Makridou, 2018). The automated robotic program then guides the students to create more complicated programming. The kits also allow students to test and discover with the robots. LEGO kits allow students to correct their programming when there are missteps.

There have been few empirical studies done about LEGO Education kits. Usengül & Bahçeci (2020) investigated the effect of LEGO WeDo 2.0 robotics education on academic achievement, attitude, and computational thinking skills of students toward science. They studied 5th-grade students at a private school using an experimental method. They compared a group with traditional direct instruction with a LEGO WeDo 2.0 Robotics group. The results illustrated that attitudes toward science, academic achievements, and computational thinking skills of the experimental group differed significantly compared to the control group.

Figure 1

Students creating with a Lego SPIKE kit

Bee-Bots. Critten et al. (2021) found a way to introduce computational thinking to younger students. They conducted a study to teach children via play activities how to program and code with pictures or symbols to manipulate Bee-Bots (Terrapin Logo, n.d.). The Bee-Bot looks like a bee with its bright yellow color and black stripes. It is about the size of an adult hand. It has up, down, left, and right arrow buttons on top of the bee. The Bee-Bot follows programmed commands by pressing the seven buttons on its top surface (forward, back, left, right, pause, clear, and go). Through the study, Critten and colleagues learned that guided play would teach students basic computational thinking (CT) skills and guide them to acquire programming and coding skills. Students were able to develop the beginning of CT through skills such as communication and collaboration, planning, and problem-solving involving the play activities utilizing Bee-Bots. A limitation of using Bee-Bots and other educational robots is the lack of training educators have in pedagogical approaches to teaching computational thinking.

Bee-Bots have also been utilized to display how students can develop and apply computational thinking skills even in a brief period of time (Angeli & Valanides, 2019). The computational thinking posttest results in Angeli and Valanides's (2019) study showed significant improvements in overall performance and the four computational thinking skills (sequencing, correspondence between actions and instructions, debugging, and flow of control). In this study, Angeli and Valanides employed two strategies to teach computational thinking and scaffolded the students' learning. One strategy was for students to manipulate Bee-Bot command cards to determine the sequence of commands for each task. The order of cards was used as an external memory system for the students to program the Bee-Bot and test the algorithm. The other technique was for the student to collaboratively work with the researcher to think about the sequence of the commands. The child participant told the researcher the order of commands; the researcher wrote the sequence in a matrix. The child then used the matrix to program the Bee-Bot and test the algorithm. Both scaffolding techniques were found to be statistically significant when the children employed them with the Bee-Bots.

Figure 2

Bee-Bot

Figure 3

Bee-Bot on a Mat

Ozobots. An Ozobot is a 2.5-centimeter-wide robot that moves on two wheels and uses color sensors to follow lines and recognize color codes (Picka et al., 2020; Tengler et al., 2021, 2022). Its appearance and simple operation may make it suitable for beginning coding. The children draw lines and color codes with red, green, and blue to maneuver the tiny robot. Ozobots are versatile as they can be used for simple programmings, such as line coding, or more intricate programming (Tengler et al., 2021, 2022). The more complex programming is executed through Ozoblockly, block programming, by connecting through Bluetooth to a device (Picka et al., 2020). The predefined codes follow commands such as directional changes, speed changes, and other moves, such as tornado and back walk (Tengler et al., 2020). Even though the robots are accessible to all levels, it is important that teachers learn how to use them in suitable pedagogical ways to help students succeed with computational thinking.

In a study by Tengler and colleagues (2021, 2022), Ozobots were utilized in storytelling. The authors noted that students can often see types of educational robots as living actors of stories when working with technology. Therefore, Tengler and colleagues chose Ozobots to promote creativity. Additionally, Ozobots can be a starting point for computational thinking. Therefore, the study integrated Ozobots into storytelling. The assignment was to create a fairy tale with characters and non-negotiables that the characters had to perform; students had to program the Ozobots to illustrate the plot. It appears that using the Ozobots with storytelling strengthened students' computational thinking. The educational robot also assisted with increasing student motivation. Collaboration and communication also appeared to grow as students worked in small groups and problem-solved how to best use the Ozobot and its codes to depict the fairy tale. Using Ozobots with storytelling appears to have multiple advantages, such as beginning programming, increased motivation, and enhanced problem-solving skills.

Ozobots were used in various grades and content areas with nine different elementary teachers (Picka et al., 2020). In the lessons, the introduction of Ozobots appeared to lead to student enthusiasm and motivation. Regardless of age or content area, students appeared to be motivated throughout the entirety of the Ozobot lesson. The enthusiasm and engagement did not wane even when students had engaged with the Ozobot previously. Due to the short period of the study, the researchers could not determine the influence of the Ozobots on algorithms and programming in computational thinking.

The teachers from Picka and colleagues' (2020) study shared that one challenge with educational robots was the lack of time to learn a new technology tool and then ascertain how to integrate it into the curriculum. Despite this challenge, it was also noted that the Ozobot had several strengths. One was the simplicity of its uses. The same teachers also spoke of the relative ease of teaching the students how to use the Ozobots. With Ozobot lessons, minimal pre- and post-lesson work may be necessary to ensure the robots are ready to use. There is no need for a computer when line coding with the Ozobots. However, Ozobots are not free from technology glitches. The robot can sometimes ignore the color code or incorrectly read the color code. Sometimes it could be a user error.

In comparing the educational robots, Ozobots were determined to be the best choice to teach character traits to the students due to a variety of reasons. First, students also would be exposed to a variety of computational thinking skills with the use of Ozobots. Employing Ozobots in school environments can provide myriad learning opportunities for students. Second, problem-solving, critical thinking, creative thinking, and collaboration can be fostered through the utilization of Ozobots. Third, by working hands-on with Ozobots within authentic learning and problem-solving contexts, students are enabled to construct their own knowledge. Fourth, Ozobots also help students build their communication and collaboration skills, which are vital skills necessary for life outside of school.

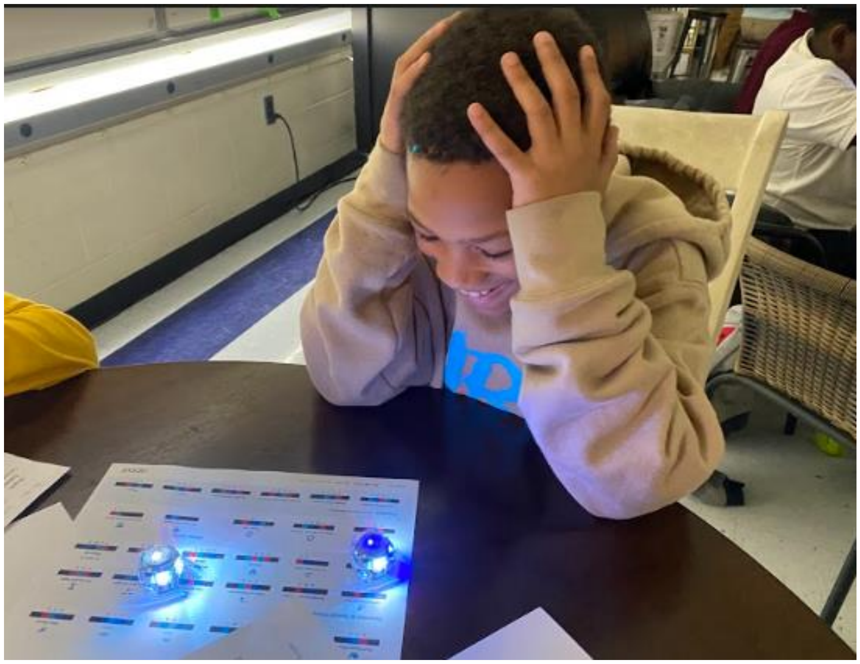
Picka and colleagues (2020) chose the Ozobots because of the ease of learning the robots and teaching the students. Also, students were motivated and engaged with the Ozobots during the lesson's entirety in the aforementioned studies (Picka et al., 2020; Tengler et al., 2020, 2021, 2022). Additionally, Ozobots were chosen for this study because there is limited research on using them to support reading skills. The only study that used Ozobots implicitly for a reading skill was Tengler and colleagues' study (2020, 2021, 2022). They wrote multiple articles from their study, which involved programming Ozobots portraying a fairy tale's plot.

Figure 4

Ozobot

Figure 5

Student observing Ozobots reading the line codes



Technology Frameworks

Educators can utilize technology integration frameworks to provide structure to technology integration lessons (Kimmons & Hall, 2018). Technology frameworks provide educators with a guide for creating lessons that are effective and engaging while using technology (Atun & Usta, 2019). Frameworks can help benefit students' and teachers' learning. Atun and Usta conducted a study that illustrated how technology, pedagogy, and content work as a framework (TPACK). Combining these three types of knowledge may allow students to get an optimal technology integration lesson. Computing, programming, and informational technology courses can be recommended to support students' academic achievement, problem-solving, and computational thinking skills.

TPACK Technology Framework

Koehler and Mishra (2005) realized that mere technology usage was insufficient to change student learning and achievement. However, technology can transform education when it is merged with pedagogy and content. Learning about various educational technology platforms and tools, including educational robots, and how their features can best support educational objectives and goals may lead to better student learning outcomes.

TPACK is a technology integration framework for educators that can assist teachers in learning and understanding technology, including educational robots (Mishra & Koehler, 2006; Koehler & Mishra, 2008, 2009). TPACK merges three types of knowledge: technology, pedagogy, and content. The TPACK framework augments Shulman's (1986) descriptions of pedagogy and comprehension (Bower, 2017; Koehler & Mishra, 2009; Mishra & Koehler, 2006).

Instructional technology and pedagogy content knowledge (PCK), are integrated to create effective TPACK lessons (Mishra & Koehler, 2006; Koehler & Mishra, 2008, 2009). Successful technology integration is achieved when the three components operate cooperatively in a lesson. In a TPACK lesson, all three components perform together without overshadowing one another; not one piece of TPACK is more vital than another. Content, pedagogical, and technological knowledges meld as one, producing a learning experience for the students. The standard perspective of the TPACK relationship is that the content directs the pedagogy and technology options. Although, as technology becomes even more ubiquitous, content may not be the primary driver.

Learning to think strategically to utilize TPACK is often essential for effective teaching (Niess, 2011). Koehler and Mishra (2005, 2006) noted that teachers learn by design how TPACK functions. In learning by design with TPACK, educators may benefit from authentic, challenging, and messy situations that can mirror their classrooms. Willingly engaging in inquiry, research, and design with other educators can help those other educators construct TPACK lessons. Also, the educators can experience the lesson themselves and have an opportunity to learn the intricacies of the technology. In addition to learning by designing the lesson, teachers can also learn by participating in the lesson as students. As a student, teachers may be able to determine where the lesson works or does not quite work. Teachers are not just learning technology but also how to integrate the technology and how TPACK's three knowledges merge for student learning and achievement.

For the current study, Ozobots were selected as the robots are an easier way to begin to learn code and programming (Picka et al., 2020; Tengler et al., 2021, 2022). Also, Ozobots are simple to learn for teachers and students (Picka et al., 2020). Lessons with Ozobots appear to engage the students during the entire lesson. Ozobots and their line codes can be a practical lesson for learning uncomplicated coding. In previous discussions with the reading specialist at the research site, she mentioned that character traits are more difficult for the students to understand than other reading concepts. She also commented that students need the skill of finding text evidence. Therefore, I created a lesson using Ozobots to teach character traits. To ensure student learning, the teacher scaffolded the lesson. The students worked together in partners to select a picture book, read the book, and then determine the character traits of two characters with text evidence. After determining the character traits, students used critical thinking skills to select a code that correlates with the character trait and provide reasoning for why that particular code was chosen. With educational robots, students can develop critical thinking skills (Atun & Usta, 2019; Çakir et al., 2021; Taylor & Baek; 2018; Zhang et al., 2021).

The students had a visual representation of the Ozobot codes. I intentionally designed the lesson so that students will work in pairs to foster their communication and collaboration capabilities. All three components of the TPACK framework were in this lesson.

SAMR Technology Framework

Although the TPACK model emphasizes integrating technology, content, and pedagogical knowledge, it does not target student outcomes (Tunjera & Chigona, 2020). The Substitution, Augmentation, Modification, and Redefinition (SAMR) model of technology integration focuses more on student products and outcomes (Puentendura, 2006; Tundra & Chigona, 2020). SAMR considers the student and the strength of the technology integration at four different stages. It is a four-level, taxonomy-based approach for choosing, utilizing, and evaluating technology in K-12 settings, introduced by Dr. Ruben Puentendura in 2006. SAMR is a model, often depicted as a ladder, intended to assist educators in describing and categorizing the use of technology in classrooms (Puentendura, 2013). SAMR supports educators to advance from lower to higher levels of technology integration, guiding them to more advanced levels of teaching and learning. Puentendura (2013) also developed a ladder of questions to help creators identify the level of technology integration that their lesson is at. In this model, technology integration is categorized into four levels: substitution, augmentation, modification, and redefinition.

The lower two levels are substitution and augmentation (Crompton, 2013; Hamilton et al., 2016; Puentendura, 2013). The lowest stratum is substitution, where technology directly substitutes for the original task, with no significant alteration of the original learning outcome or improvement to the lesson. With or without the technology, the same outcome is achieved in substitution. For example, a teacher switching a paper worksheet to a digitized worksheet is a substitution. The other lower level is augmentation, when technology still functions as a direct substitute but slightly increases the rigor of student learning. Technology helps accomplish a minor adaptation to the outcome. An example of augmentation is when students can use personal devices to read and listen to different books instead of a teacher-led, whole-class read-aloud lesson. The personal devices augment the reading task enabling students to choose what they read and listen to.

SAMR's upper two levels are modification and redefinition (Crompton, 2013; Hamilton et al., 2016; Puentendura, 2013). Modification is where technology integration allows for substantial task redesign. For example, in science, an instructor uses an interactive computer simulation with variables that can be altered to understand how light travels instead of a paper diagram or illustration. Data that would take time and effort to collect and manipulate can be instantly processed using the simulation. Students have the control to change the variables. The top level of the SAMR model is redefinition, where technology allows for new, previously unavailable tasks that would not be possible without technology. An example of redefinition is when students create and edit a video demonstrating their argument instead of writing a persuasive essay. Students learn valuable skills for their future using creativity and editing in their presentations.

The current study, Teaching Character Traits with Ozobots, is at the modification level of SAMR. Without technology integration, the final result of learning how to program and code Ozobots would not be feasible. The utilization of the Ozobots will likely help develop computational thinking skills, including collaboration and communication, although the aforementioned skills could have been developed in other ways without technology. Therefore, the study is not at the redefinition level.

Pragmatism

Design-based research (DBR) has roots in pragmatism. This paradigm searches for the best solution to the current problem (Cherryholmes, 1992; Biesta, 2014). Utilizing experience, ideas, and knowledge, DBR and pragmatism's goal is to create results that assist the teacher in the classroom, with the understanding that the findings are not concrete. As situations or experiences change, results will shift with the new learning. Realizing this aspect, pragmatists continuously seek best practices for educators and students. This is evident in DBR as there are multiple macro cycles to help develop a local instruction theory that is relevant and authentic in the educational world. During the macro cycle, a retrospective analysis encourages reflection on the experience to ensure that learning is valuable for the parties involved.

Dewey (1910) expounded that individuals learn from reflecting on the experience, not the experience. Reflection from experience leads to relevant and accessible educational research allowing educators to benefit from it (Cherryholmes, 1992). With experience, answers are possible for researchers. Then, educators would not have them either, as DBR bridges the researcher and educator settings. The goal is to construct results utilizing experience, ideas, and knowledge that assist the teacher in the classroom with the understanding that the results may vary from classroom to classroom. As situations or experiences change, results will shift with the new learning.

Character Traits

There is minimal empirical research on how to best teach character traits. Through my review of the literature, I discovered that character trait lessons were often linked to positive character development. Two studies were conducted using children's literature on the development of positive character traits among elementary students (Almerico, 2014; Russell et al., 2013). Russell and colleagues (2013) wrote that picture books were essential in teaching positive character traits and development. Characters from the story can have an influence on children's behavior and provide ways to handle moral dilemmas. Helterbran (2009) also wrote an article on how teachers can use picture books to teach good citizenship. Picture books provide an approach to allowing students to see simulated authentic human interactions and the development of relationships and character. Therefore, the author suggested using children's picture books to integrate character education into global understanding.

Almerico (2014) designed a character education curriculum for use in grades K - 6 using children's literature. Specific character traits were highlighted with the intention of helping students learn how to develop the ability to understand moral values and then choose to do the right thing. A panel of educators with expertise in character education recommended certain character traits, such as compassion, empathy, courage, perseverance, and honesty, to be included in the curriculum. Another set of educators, Kara-Soteriou and Rose (2008), developed a thematic unit on positive character traits utilizing Janell Cannon's picture books. They also noted that children's books help students deal with their emotions and encourage the growth of positive character traits. It appears that most character trait literature and research focus on children's literature, particularly picture books, to develop positive character traits and development.

Serravoallo's *The Reading Strategies Book* (2015) was employed to review character traits lessons. Her book is set up with goals, and these goals are the most common in grades K-8. Each goal has multiple strategies for the reader. The strategy is how to teach that particular skill; then that skill can be used in a student conference, whole group lesson, or mini-lesson. The book's goal Supporting Comprehension in Fiction, *Thinking About Characters* has 24 strategies.

One strategy, 6.8 Look for a Pattern, asks students to look for traits by observing behaviors that a character repeats. The pattern can be used to name the character's trait. The teaching tip for this strategy is how to help students distinguish between character feelings and character traits. Another strategy, 6.6 Back-Up Ideas About Characters with Evidence, emphasizes the importance of using what the character says or does to back up the student's idea. Then the student should explain how the text evidence supports that idea.

Characters can be viewed as the impetus for stories (Roser et al., 2007). Knowing the importance of characters, I chose character traits as a focus in these lessons, believing that not enough attention is given to characters and their traits. There are few lessons that directly teach character traits. Therefore, I developed a character traits lesson using educational robots. To help ensure understanding, students provided text evidence from picture books for each character trait they identified.

Summary

In this study, I explored how educational robots can engage students in learning character traits. As characters can be essential to children's literature, understanding character traits appear to be important to understanding the story. To help students learn and be successful with character traits, educational robots, specifically Ozobots, were utilized to help student engagement and motivation. Students also assimilated critical thinking and problem-solving skills and learn to refine their communication and collaboration skills while working with their peers. They were exposed to different elements of computational thinking. It provided a foundation for students to use in their future studies and professions.

In this literature review, I examined studies that used a variety of educational robots. From those studies, I concluded that Ozobots would be my choice for their simplicity in learning and integration for educators and students. By applying the TPACK framework, I tried to ensure that the Ozobot lesson was representative of technology, pedagogy, and content knowledges. In the SAMR framework, the lesson operated at the modification stage, as mastering programming and coding would not have been achievable without the use of technology. In the following chapter, the methods for this study will be explained.

In this study, I used Design-Based Research (DBR) , a research method that allows researchers to collaborate with classroom educators to construct interventions and local instruction theories in real educational environments (Anderson & Shattuck, 2012; Huang et al., 2019). DBR with qualitative methods is used in this study to address the following research question: How can Ozobots support learning character traits in elementary school? Two sub-questions were developed to guide this research further:

1. How can teachers integrate Ozobots into teaching character traits in reading?
2. How can Ozobots facilitate students' understanding of character traits in reading?

CHAPTER III

DESIGN-BASED RESEARCH

Design-Based Research (DBR) is a method that provides researchers the opportunity to work with classroom educators to construct interventions and local instruction theories in real educational settings (Anderson & Shattuck, 2012; Huang et al., 2019). DBR with qualitative methods was used in this study to address the following research question: How can Ozobots support learning character traits in elementary school? Two sub-questions were developed to guide this research further:

1. How can teachers integrate Ozobots into teaching character traits in reading?
2. How can Ozobots facilitate students' understanding of character traits in reading?

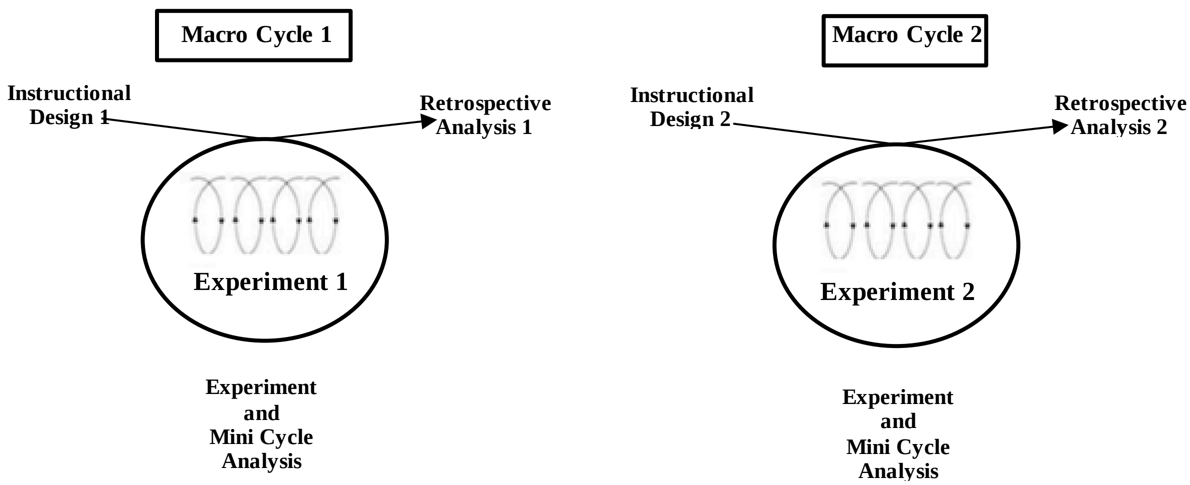
Design-Based Research Design

DBR was used in this study to develop an intervention that applies and is usable in an actual school setting with realistic and reasonable support (Brown, 1992). DBR melds research and practice together by emphasizing the need for theory development and the creation of design principles that lead, saturate, and ameliorate both research and practice (Anderson & Shattuck, 2012; Huang et al., 2019). This method was chosen as it assists educators by influencing their practice using research (Anderson & Shattuck, 2012; Huang et al., 2019). The DBR process includes creating and testing an intervention that influences student learning. The intervention can be an educational product, process, program, or policy (Huang et al., 2019). DBR can utilize qualitative research methods with data collected to assist in constructing the intervention and local instruction theory (Anderson & Shattuck, 2012; Huang et al., 2019). Following the DBR method, this study has two iterations to ensure the development of a strong intervention and local instruction theory. In this study, the research team consists of the researcher and the classroom teacher who help bridge the gap between PK-12 and higher education (Bungam & Sanne, 2021).

This DBR study consisted of two macro cycles, as shown in Figure 6. The macro cycles included instructional design, experiment, and retrospective analysis. The second macro cycle incorporated the adjustments from the first macro cycle based on the conjectured local instruction theory modifications.

Figure 6

Two Macro Cycles of Design-Based Research



Note. Adapted from "Developing instructional technology standards for educators: A design-based research study" by H. Crompton and C. Sykora, 2021, *Computers and Education Open*, *2*, p. 4. (https://doi.org/10.1016/j.caeo.2021.100044). Copyright 2021 by Elsevier.

Design-Based Research Phases

The Instructional Design

DBR research begins with a broad theoretical background, such as constructivism or pragmatism, to guide the creation of the local instruction theory and intervention (Anderson & Shattuck, 2012; Huang et al., 2019). The goal of this method is to create an original local instruction theory that can be expanded and tweaked during the actual design experiment. The instructional goals were written during the preliminary work to guide the development of the local instruction theory. This study's instructional goal is for students to learn character traits through Ozobots. Therefore, one of the first pre-work activities was thinking and reflecting on desired instructional goals. The teacher and researcher examined current reading curriculums and disciplinary research to determine the goals.

During this period, instructional starting points were also reviewed to help formulate the local instruction theory. The conjectured local instruction theory is composed of the instructional goals and starting points (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009). This involved how educational robots, specifically Ozobots, would be utilized in five lessons. The instructional design literature of character traits, educational robots, reading standards, and technology frameworks was examined and used with Ozobots to create the conjectured local instruction theory. In this particular study, I conjectured that teachers who utilize Ozobots in character trait lessons assist students in understanding and learning character traits. Macro cycle one was done with one class of students testing the conjectured local theory. After macro cycle one was completed and revisions were made, macro cycle two was completed with a new class of students.

School Demographics. The school is located in the mid-Atlantic region of the United States. It is an inner-city school where 91% of the school is considered socioeconomically disadvantaged. There are approximately 450 students who attend this school with a majority of African American students (86%). Fourteen percent of the population are students with disabilities.

Participants. The protocol for this design-based research study involved two macro cycles with two teaching experiments. The two teaching experiments were implemented, one each with a fourth-grade class.There are four teachers in total for the grade level at the school site. Two of the teachers had multiple years of experience in education and were selected for the study. One teacher not selected for the study is new to fourth grade, Virginia education, and its standards. The fourth teacher not selected for the study is recovering from a medical condition. The two teacher participants were sent an email with the study's information. Once the two teacher participants agreed to do the study, their fourth grade classes were recruited for the study. Participants were elementary students in two classes in an inner-city school district in a mid-Atlantic state. One class consisted of 20 students, and the other class consisted of 21 students. Due to some parents not consenting to the research study, a total of 29 students were included. All students in this school are eligible for free and reduced meals.

The Classroom-Based Teaching Experiment

After the preparatory work, including constructing the goals, delineating the starting points, and forming the conjectured local instruction theory, the second phase commenced. The teaching experiment's phase two objective was to test and refine the local instruction theory. There were multiple lesson cycles during the teaching experiment phase called mini-cycles (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009). Each day, an iterative process of micro design cycle was completed including instruction, observation, analysis, evaluation, and reflection. Based on these cycles, the instructional activity was revised or started anew. It was essential to monitor the students' cognition as the research team tried to understand how and why the learning occurred to improve the local instruction theory. The micro cycles of design and analysis supported molding the local instruction theory. During the experiment, I was present in the classroom when the design experiment occurred observing and taking notes. The instructor and researcher debriefed immediately after the lesson to share and analyze their observations and reflections (Gravemeijjer & Cobb, 2013). I took notes on the discourse and reflections the research team shared after the lessons. I also collected data and artifacts throughout the teaching experiment phase. Data collection included teacher interviews, student post-lesson reflections, student work, and observation notes.

A sequence of five lessons was developed as an embodiment of the local instruction theory. The lessons were approximately 60 minutes daily. An overview of the instructional sequence is provided in Table 2 including the learning goals and instructional activities. (See Appendix A for a list of picture books utilized in the lesson plans.) The instructional plans were created utilizing two technology integration frameworks: technological, pedagogical, and content knowledge framework (TPACK), and Substitution Augmentation Modification Redefinition Model (SAMR). The teacher and researcher collaborated in teaching the lessons. Throughout the lessons, the teacher and I co-taught the reading instruction, and I took the lead on the Ozobot instruction with support from the teacher. The teacher and I acted as co-facilitators on the fourth and fifth days of instruction monitoring student progress.

Table 2

Macro Cycle One Lesson Plans

Lesson	Learning Goal	Instructional Activity
1	- Using a picture book of student choice, students will be able to determine multiple characters' character traits with text evidence to support the student's thinking. - Using Ozobots, students will be able to learn how to code using line coding.	- Teacher will teach using direct instruction on character traits. - Students will pair with another student. They will each select a character trait from the character trait map. They will then decide what actions portrayed those traits. - The teacher will read a picture book to the class.
2	- Using a picture book of student choice, students will be able to	- Teacher will reread the picture book from Day 1 to class. The class will determine

	determine a character's character traits with text evidence to support the student's thinking. - Using Ozobots, students will be able to learn how to code using line coding.	character traits and textual evidence from the picture book. Teacher will share character trait map with students for use as a resource as needed. - The teacher and class will fill out the first two lines of the graphic organizer. - With a partner, students will fill out the remainder of the graphic organizer. - I will lead "play" on Ozobots. - I will lead a lesson on coding.
3	- Using a picture book of student choice, students will be able to determine at least two characters and their character traits with text evidence to support the student's thinking. - Using Ozobots, students will be able to learn how to code using line coding.	- I will share the different Ozobot codes. - Using the graphic organizer from yesterday, I will choose an Ozobot code that correlates to the character trait. After picking the code, I will share why I picked that code. Next, the class will select an Ozobot code for a character trait and provide reasoning. - Students will pair to do the activity. - Students will select a picture book and read it together.
4	- Using a picture book of student choice, students will be able to determine at least two characters and their character traits with text evidence to support their thinking. - Using Ozobots, students will be able to learn how to code using line coding.	- The teacher and I will review lesson goals and expectations with the class. - Students will reread their chosen picture book. - Students will pick character traits with text evidence and fill out the graphic organizer.
5	- Using a picture book of student choice, students will be able to determine at least two characters and their character traits with text evidence to support the student's thinking. - Using Ozobots, students will be able to learn how to code using line coding.	- The teacher and I will review lesson goals and expectations with the class. - The pairs of students will determine Ozobot codes and provide reasoning. They will finish filling in the graphic organizer. - Students will draw the codes that show the character trait and then have the Ozobots follow the codes.

During each daily mini cycle during the teaching experiment, the teacher and I conferred on any modifications needed for the next day's instruction when necessary. During each macro cycle, I collected the following data: teacher interviews, researcher, researcher journal, student artifacts, and student feedback forms. Data were grounded theory coded. Grounded theory is a qualitative research method that allows the researcher to develop new theories formed from the iterative process and data analysis (Delve & Limpaecher, 2021). Iterative data collection and analysis occur until theoretical saturation is attained when additional data adds no further insight into your new theory. In DBR, the grounded theory coding refines the conjectured local theory and its embodiment. The data were used to make any changes to instruction. The second teaching experiment was started immediately after the conclusion of the first teaching experiment. There were two retrospective analyses conducted, one at the conclusion of each macro cycle. The local instruction theory came from the final retrospective analysis.

Teacher Interviews. I took notes during the semi-structured interviews with the fourth-grade teachers on the first through fifth days the lessons were implemented. As the interviews were semi-structured; I had a set of guiding questions. However, I was able to ask to follow-up questions if needed. Interview protocols (Appendix B) were created for days one and five. Interviews were not audio or video recorded.

Observations. I also conducted observations during the study. I used the chart (Appendix C) to note student reactions and work. Observations were written daily for the nine days the lessons too place.

Journal. I kept a daily journal during each macro cycle. Reflective journaling aims to make the thinking and decisions as transparent as possible to the audience (Ortlipp, 2008). Non-researchers may not be cognizant of the messiness that may happen in empirical research, as published studies often show the research as a linear and neat process. Using a journal allows the audience to see the researcher's thoughts on the study's success or failure. Journaling also allows the researcher to describe a recent experience and then unpack salient conditions and elements that influenced learning (Lutz & Paretti, 2019). The reflective journal data were used to help support any needed change to the lessons and allow other educators to replicate the lessons.

Artifacts. Hard copies of students' work, including graphic organizers and Ozobot practice, were collected. Students' names or any other identifiers were removed from their work.

Student Questionnaire. Students responded to a student questionnaire (Appendix D) at the conclusion of each macro cycle. The questionnaire assisted the teacher and me in lesson changes. Students also responded to questions indicating whether or not they believed that Ozobots helped them learn character traits.

The Retrospective Analysis

The retrospective analysis included all collected data and artifacts to refine the local instruction theory. The research team analyzed the data systematically. All components of the interpretation were documented to ensure the credibility of the work. Then, final claims and assertions were shown through the numerous levels of analytic work (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009).

The instructional activities and their data were critiqued during the retrospective analysis to determine what led to student learning (Gravemeijjer & Cobb, 2013). All instructional lesson components were examined, including activities and learning that were failures. The analysis and reflection on the unsuccessful lesson pieces are considered vital to the success of the advancement of the research (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009; Huang et al., 2019).

I analyzed data collected from both macro cycles. Data and analysis from macro cycle one led to modifications used in macro cycle two. Macro cycle two data and analysis culminated in the local instruction theory about students' understanding of character traits through the use of educational robots and the lesson plans as an embodiment of the local instruction theory (Gravemeijjer & Cobb, 2013; Gravemeijjer & van Eerde, 2009; Huang et al., 2019).

In this chapter, the tenets of DBR were explained. A conjectured local instruction theory was proposed with a description of instructional activities illustrating the application of the local instruction theory. The chapter also included the DBR protocol and data collection and analysis methods. In summary, Ozobots can be used to help students learn character traits. In the next chapter, I will present the findings from the retrospective analysis.

CHAPTER 4

FINDINGS

Design-Based Research (DBR) was the selected research method for this study, as it allows practitioners and researchers to collaborate and construct significant change in the context of practice (The Design-Based Research Collective, 2002). DBR also allows the researcher to answer the research questions and allows the practitioner to participate in the research. DBR was chosen for this study as it provides the opportunity for me, as the researcher, to work with an educator to create lessons using educational technology. I am also able to observe and modify lessons immediately if necessary. The partnership develops an intervention and a local instruction theory in an authentic educational setting (Anderson & Shattuck, 2012; Huang et al., 2019). Chapter III detailed how a conjectured local instruction theory was created using Ozobots in character trait lessons to assist students in understanding and learning character traits. Additionally, an instructional sequence of lesson plans was designed and summarized.

These lesson plans included a series of lessons designed for use in fourth-grade classrooms. The lessons were implemented in two macro cycles (see Figure 1). The DBR protocol is detailed in the previous chapter, and the methods utilized in the data collection and analysis were explained. During the two macro cycles, data from teacher interviews, observations, journals, student artifacts, and student questionnaires were collected and analyzed to help answer the following question: How can Ozobots support learning character traits in elementary school? Two sub-questions were developed to guide this research further:

1. How can teachers integrate Ozobots into teaching character traits in reading?
2. How can Ozobot facilitate students' understanding of character traits in reading?

In this chapter, the results of the analysis are presented. The chapter will focus on the research goal: how can educational robots support learning character traits?

Retrospective Analysis: Macro Cycle One

Day One

Before beginning the lessons, I conducted a 30 minute semi-structured interview with Mrs. Kooke[1], the fourth-grade teacher. We discussed Ozobots and her familiarity with them. She had used Ozobots in previous years in science lessons with the support of the instructional technology coach. She had not used Ozobots with a reading lesson.

On day one, Mrs. Kooke introduced character traits to the students. She passed out the district character trait mats (Appendix E). Students read over the various character traits. There were corresponding pictures beside the listed character traits on the character traits mat. The pictures appeared not to help students determine what the words meant as they raised their hands to ask what several words meant. In my notes, I wrote that it appeared students did not know several of the character traits, including but not limited to generous, diligent, determined, enthusiastic, and lazy. Mrs. Kooke and I acted out some of the character trait words hoping that the actions would help the students learn the words. For example, I acted out lazy by slumping in a chair, miming eating potato chips, and watching television.

After setting a purpose for the read-aloud to pay close attention to the character traits, Mrs. Kooke read *3 Hens and a Peacock* to the class (Laminack & Cole, 2014). The class appeared engaged as they laughed at key points during the read-aloud. Before inquiring about the peacock and hens' character traits, Mrs. Kooke reminded the students that character traits "come from the heart" in that character traits are innate to who we are. She also prompted them to refer

[1] In this chapter, all names, including this one, are pseudonyms.

to their character traits mat. As students shared the character traits of the hens or the peacock, students also provided text evidence from the story of why they selected that particular character trait.

Each day after the lesson, Mrs. Kooke and I reflected on the lesson. Each reflection lasted from 15 to 30 minutes. I used the semi-structured questions (see Appendix B) as a guide. After day one, Mrs. Kooke was concerned about the students' lack of vocabulary. She wondered if students should act out some of the character traits tomorrow. She also noted that the students appeared to enjoy the book. She also believed they did a good job identifying character traits and supporting them with text evidence. She thought *3 Hens and a Peacock* was a helpful text for character traits (Laminack & Cole, 2014).

Day 2

Mrs. Kooke started the class by asking students what character traits were. She then asked if they would like to act out some character traits from the character trait map. Several students volunteered. One boy acted bossy by pretending to yell at his friend, telling him to do his work, sit up straight, and stop talking. A girl demonstrated cruelty by pretending to push a student down and then laughing at that student. Students appeared to be engaged during this activity as multiple students raised their hands to guess the character trait and by laughing as students acted out the words. Next, I led a lesson on Ozobots and coding. I went over the features of an Ozobot and how to code them. I also went over the different codes using the Ozobot color codes sheet (Appendix F). Students were then given Ozobots and code sheets to explore and play with the Ozobots for approximately 20 minutes.

In our discussion, Mrs. Kooke noted that she loved the student excitement when they learned something new. She wondered if the coding lesson could be more intentional and specific before students interacted with the Ozobots because, as we walked around the classroom, we both noticed that some students were more into drawing with markers than creating the Ozobot codes. Additionally, several students asked for additional help in drawing the codes. For example, in the following macro cycle, students needed more direct instruction on how to draw the codes correctly. I needed to be more purposeful in showing how to draw the codes and how not to. Another concern was that students were playing with the Ozobots without understanding the purpose behind the Ozobot. She also wondered if we had passed out the Ozobots too soon as students appeared to be focused more on the Ozobots than listening to directions. The next lesson in macro cycle two, we decided I would pass the Ozobots out after explicitly teaching the codes, including common mistakes made when drawing the codes.

Day 3

Mrs. Kooke went over the graphic organizer (see Appendix G) and used *3 Hens and a Peacock* to illustrate how to complete the graphic organizer (Laminack & Cole, 2014). As a class, students filled in character traits and character trait evidence on the graphic organizer for this book. I then talked about determining an Ozobot code to depict a character trait. I used the Tasmanian Devil YouTube clip (Brothers, 2020). This clip shows Taz trying to eat the rabbit, Bugs Bunny. He realizes this and tricks Taz. It showcases Taz trying to capture Bugs and morphing into a tornado and greedily destroying items in his way. I shared my thinking that Taz was greedy as he took everything in his path. Therefore, I believed the code illustrating greed would be the Ozobot code, tornado. Students nodded and agreed that the tornado was the correct code for greedy. As a class, we determined which Ozobot codes would fit the character traits of the peacock. Students decided that the peacock was hard-working as he had to strut back and forth each day, all day long to attract customers. Therefore, students chose the code back walk to demonstrate hard-working. Students thought that the code best represented what the peacock must have looked like on the side of the road.

In our discourse after day three's lesson, Mrs. Kooke wondered if we had given the students too much at once. She went on to share that students appeared overwhelmed with the graphic organizer. She noticed several students just sitting; their facial expressions seemed to convey confusion. While walking around, I also noticed that I had several questions from the students on what exactly they were supposed to be doing. Mrs. Kooke expressed concern that the students may need clarification on the graphic organizer with filling out the character traits, text evidence, the Ozobot codes, and reasonings for selecting that Ozobot code. She and I discussed chunking the lesson into separate parts, such as character traits, then Ozobots codes, in the next macro cycle.

Day 4

Mrs. Kooke began the class with a reminder of how to fill out the graphic organizer. She shared that students would be placed with a partner, then the partners would select a picture book (Appendix A). After going over directions and expectations again, students were released to work with their partners (pre-selected by Mrs. Kooke) and read their books together. After finishing the book, students worked on the graphic organizer. From walking around the room, observing students, and answering questions, I observed that students struggled to fill out the graphic organizer. They also were not on task. I observed students having side conversations with other students. I also observed the students asking Mrs. Kooke repeatedly when they could play with the Ozobots again. Due to the lack of student focus and actual work, Mrs. Kooke ended the lesson for the day. In day four's reflection, Mrs. Kooke was highly concerned about the lesson. She believed her students were "off" and did not meet their normal expectations and understand the lesson. She asked for a restart the next day. I agreed. She also questioned whether students should choose one character to focus on. Due to this concern, I decided that the following macro cycle would have students focused on one character from the beginning of the lesson.

Mrs. Kooke and I also discussed chunking the graphic organizer the next day to see if that would assist the students with their learning. For the next macro cycle, I also decided I would chunk the graphic organizer to ensure student understanding. First, the class would work on character traits and text evidence. After this session, students would work on Ozobot codes and their reasoning. Mrs. Kooke also expressed concern that the students, in previous years, had not worked with character traits and found evidence from the book to validate them. That may have led to them guessing character traits without corroborating text evidence.

Day 5

Mrs. Kooke and I went over class procedures and lesson expectations. After we passed out the materials, including the picture book and graphic organizer, students moved to sit with their partners. Mrs. Kooke then guided them through selecting a character trait and text evidence for one character from each of their books. Students were not allowed to work ahead to the Ozobot codes and justification. After students had filled in the graphic organizer with three traits and evidence, they had to present it to Mrs. Kooke or me.

After the class finished with the first part, I reviewed Ozobot codes and how the codes related to the character trait. I utilized the Ozobot color code sheet Appendix F. Mrs. Kooke and I both talked about the importance of the justification of the Ozobot code and asked students, why did you select this code? Students then worked on that section of the graphic organizer. After students completed the graphic organizer, they conveyed the codes and justifications to

Mrs. Kooke or me. In our daily reflection, Mrs. Kooke expressed her satisfaction with the day's work. She believed it all came together. Having the partners focus on one character allowed for more sharing of thoughts and developed into effective collaboration. The students were responsible for the same character, allowing them to collaborate. I also agreed with her. I noticed that the discourse amongst partners was focused on the books and characters today.

She also thought the guided practice of separating the graphic organizer into two parts, character traits and Ozobot codes, was highly effective. Chunking the work was more constructive for student learning. I agreed as I had noticed that once she told students we were going just to complete the character and character evidence part, students went to work immediately. Only one set of partners had a question as compared to the day before when it appeared every duo had questions. She questioned whether this was specific to the students in her class or applicable to all fourth-graders. She noted that having five days to implement the lesson helped provide adequate time to integrate the technology into the lesson. Engaging with the Ozobots helped the students learn character traits. Mrs. Kooke also believed the students used critical thinking to justify the Ozobot code choice. Mrs. Kooke shared that she had another idea for the lesson for macro cycle two. She wondered about using gifs to help students understand character traits. She suggested having a presentation with selected character traits and gifs. Then the next day, the lesson would allow students to pick gifs to represent character traits.

Modifications

I reviewed the data collected, including teacher interviews, researcher observations, researcher journal, student artifacts, and student feedback forms. The retrospective analysis for macro cycle one revealed that the students were engaged and appeared to have fun with the Ozobots. In the student feedback forms, students noted that they liked working with a partner as it helped them learn. In these forms, students needed to verbalize how Ozobots helped with learning character traits.

After reviewing the data, the second macro cycle would include the teacher introducing character traits with gifs. Students would also have the opportunity to select gifs to describe character traits. Additionally, character traits and text evidence would be taught before introducing Ozobots and coding. Students would read their book with a partner, select one character and its traits, and text evidence. Next, students would be instructed on how to and how not to draw the Ozobot codes. After learning to draw the codes correctly, students would select codes that best fit the character traits and then justify their choices. Table 3 shows modifications to the lessons.

Retrospective Analysis: Macro Cycle Two

Day One

Before day one's lesson of macro cycle two, I conducted a 35-minute semi-structured interview with Mrs. Morris, the fourth-grade teacher, about Ozobots and her familiarity with them. She had used Ozobots and other educational robots in past lessons. Specifically, she utilized Ozobots with skip counting. She shared that she struggles with implementing robots within lessons that match the district standards. She believed her current class would be engaged with the educational robots while learning character traits. Mrs. Morris started the lesson with a simple presentation of character traits and related gifs. For example, she showed impatient with a gif (Webhead, 2020). The gif shows a young boy tapping his fingers on a table, appearing impatient. (Figure 7)

Figure 7

Young Boy Tapping his Fingers

Note. (Webhead, 2020). (https://tenor.com/view/spanky-waiting-hurry-up-come-on-tapping-gif-17714497)

She also showed bossy as a gif with Bart Simpson telling Milhouse to do *less barking, more marking.* (Figure 8).

Figure 8

Bart Simpson Telling Milhouse Less Barking, More Marking

Note. Simpsons World, 2016 (https://giphy.com/gifs/season-12-the-simpsons-12x11-3orieSuZfVCUe2UVmE)

She then had students search for gifs for the character trait curious. Students then shared their chosen gif with the class. Students appeared fully engaged as they looked for gifs and then yelled out that they had found the perfect one. After the lesson, Mrs. Morris and I completed the post-lesson reflection. Each daily reflection lasted between 12 to 26 minutes. She thought the lesson had gone well. She noted that even her reluctant learners had participated in the activity. Compared to the first macro cycle, it appeared that students understood the character traits more with the example gifs.

Day Two

Mrs. Morris started the lesson by selecting a character trait from the district's character trait map and having students search for gifs. Again, students appeared to be excited to define character traits with gifs. Mrs. Morris selected several character traits from the district character trait map for students to practice defining. During this macro cycle, the focus was on instructing about character traits and text evidence before introducing Ozobots and coding. Students also had to complete the graphic organizer selection on character traits and text evidence. Doing this appeared to help students center on understanding character traits. During our daily reflection, the teacher noted that she was impressed with the learning when students worked with their partners. Students diligently read their picture books and then worked to determine the character traits.

Day 3

After the class completed the graphic organizer's character traits and text evidence sections, I began the lesson on Ozobots and coding. After demonstrating how the Ozobots worked, Mrs. Morris and I explicitly instructed on how to draw the codes correctly. In the previous macro cycle, students just played with the Ozobots to determine what they could learn independently. They also could attempt to draw the codes before I gave instructions. Learning from the previous macro cycle, I suggested being more direct with Ozobot instruction. Mrs.

Morris agreed, as the Ozobots and line coding were new concepts to the students. She wondered if showing students precisely what to do and what not to do would be helpful in the students' learning. Therefore, that is what we did during macro cycle two. After this lesson, students had to practice working with the Ozobots. After drawing the codes correctly, they were allowed to finish their graphic organizer. Mrs. Morris commented that students should have to correctly draw three codes before moving on to the graphic organizer. She thought that would ensure students' ability to understand and utilize the codes correctly.

Figure 9

Student Practice from Ms. Kooke's Room

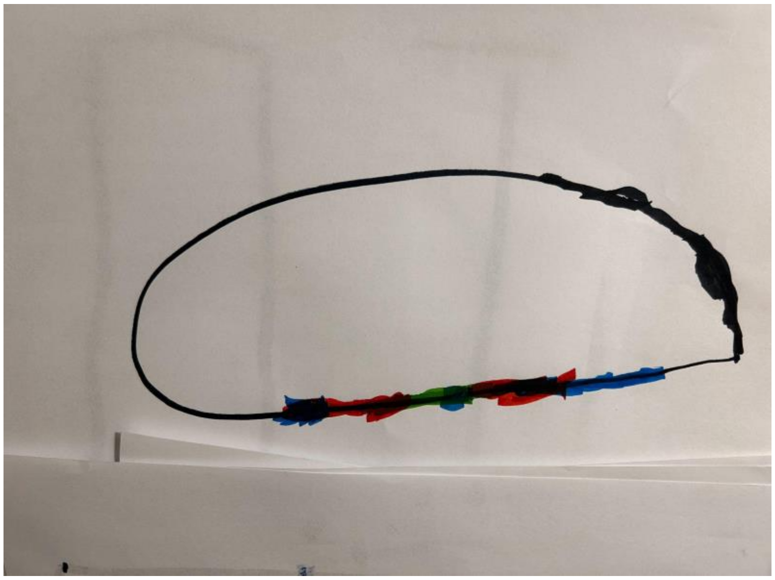
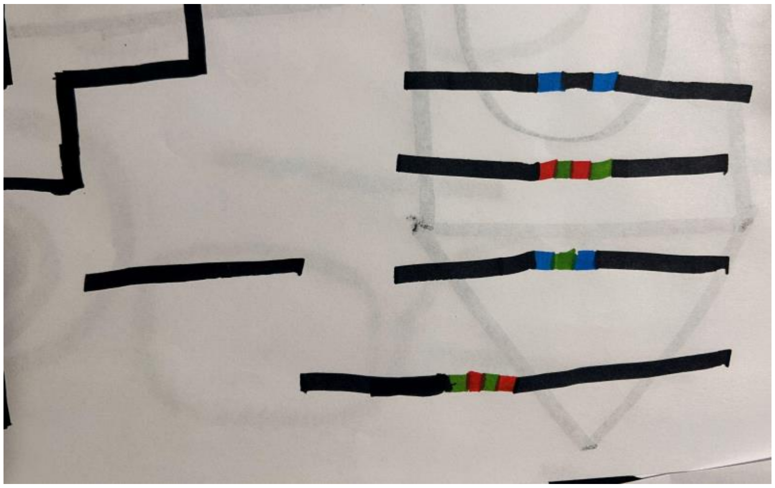


Figure 10

Student Practice from Mrs. Morris's Room



Day 4:

The lessons went more smoothly due to the chunking of the lesson into character traits and then Ozobots. Therefore, the lessons were condensed into four days instead of five.

Table 3

Macro Cycle Two Lesson Plans

Lesson	Learning Goal	Instructional Activity
1	- Students determined a character's character traits using a picture book of student choice with text evidence to support their thinking. - Using Ozobots, students learned how to code using line coding.	- The teacher taught using direct instruction on character traits. - The teacher shared a presentation with character traits and related gifs. The teacher led a discussion on how the gif demonstrated the character trait. - The teacher read a picture book to the class. - The teacher and class filled out the graphic organizer together.

2	- Students determined a character's character traits using a picture book of student choice with text evidence to support their thinking. - Using Ozobots, students learned how to code using line coding.	- The teacher shared yesterday’s presentation with character traits and related gifs reminding students of character traits. - Students selected gifs for specific character traits. -The teacher went over yesterday’s book and graphic organizer. -The teacher assigned students their partners. Students selected a picture book and read it with their partners. - The students began filling in the graphic organizer.
3	- Students determined a character's character traits using a picture book of student choice with text evidence to support their thinking. - Using Ozobots, students learned how to code using line coding.	-The teacher went over the graphic organizer again. - Students completed the graphic organizer. - I led “play” on Ozobots. - I led a lesson on coding with the Ozobot. - I shared the different Ozobot codes.
4	- Students determined a character's character traits using a picture book of student choice with text evidence to support their thinking. - Using Ozobots, students learned how to code using line coding.	- The teacher and I completed the graphic organizer with the Ozobots codes and justification for the previously read book on day one. - The pairs of students determined Ozobot codes and provided reasoning. They finished filling in the graphic organizer. - Students drew the codes that showed the character trait and then had the Ozobots follow the codes.

Instructional Material Changes

Several changes were made to the instructional lesson plans in macro cycle one based on the data, including the teacher interviews and the researcher observations. To assist students in learning the character traits and understanding them, the teacher used gifs to teach them. Students also were able to find gifs to help understand character traits. Additionally, the lesson was separated into two parts: character traits and Ozobots and coding. Furthermore, data indicated that students needed more explicit and focused direct instruction on accurately drawing Ozobot codes. Allowing student pairs to choose only one character to focus on also appeared to help in learning the character traits. Students from the first macro cycle did not get these changes. The students in the second macro cycle did receive these modifications. After macro cycle two’s coding lesson, the teacher suggested that students correctly draw three Ozobot codes before moving on to the next step. It also appears that the lesson can be completed in four days instead of five. The findings from macro cycle 2 are the final set of plans.

In conclusion, the findings have focused on how Ozobots can support learning character traits in elementary school. With the two macro cycles and modifications, an intervention and local instruction theory have been developed. In Chapter 5, I will discuss conclusions and implications.

CHAPTER 5

CONCLUSION

This study began with the design of an intervention and a conjectured local instruction theory about using Ozobots to teach character traits. Design-Based Research (DBR) was used in this study to develop an intervention that applies to and is usable in an actual school setting with realistic and reasonable support (Brown, 1992). The conjectured local instruction theory includes a learning process and a means for sustaining that process (Gravemeijer & Cobb, 2006). The means for supporting the learning process involved the creation of a set of instructional activities illustrating the application of the local instruction theory.

This study aimed to develop a conjectured local instruction theory to determine if a type of educational robot, Ozobots, can assist students in learning character traits. In this study, I intended to address the following question: how can Ozobots support learning character traits in elementary school? Two sub-questions were developed to guide this research:

1. How can teachers integrate Ozobots into teaching character traits in reading?
2. How can Ozobots facilitate students' understanding of character traits in reading?

Conjectured Local Instruction Theory

Through the process of DBR, a conjectured local instruction theory is adjusted and strengthened. The analysis from the macro cycles continues throughout the research and indicates what is working and not working for the student learning process. (Gravemeijjer & Cobb, 2006; Gravemeijjer & van Eerde, 2009). The conjectured local instruction theory for this study was based on the literature review of character traits, educational robots, reading standards, and technology frameworks. In this study, I conjectured that teachers who utilize Ozobots in character trait lessons aid students in understanding and learning character traits.

A set of sequential instructional lessons was designed for use in fourth-grade classrooms. These lessons were developed as an embodiment of the local instruction theory. The lessons were approximately 60 minutes daily. A cyclical iterative process was conducted, including instructional design, experiment, and retrospective analysis. The second macro cycle incorporated the adjustments from the first macro cycle based on the conjectured local instruction theory modifications. The previous chapter presented the findings from the two macro cycles. Study findings showed that teachers could utilize Ozobots to support teaching character traits through instructional lessons. The final set of lessons is presented in Table 3, Chapter 4.

The analyzed data from macro cycle one led to modifications that appeared to promote increased student engagement and learning. Enhancements were made to the use of the Character Traits Mat (Appendix E), as the pictures on the mat appeared not to help students determine accurate definitions of the character trait words. Observations and the teacher interview illustrated students' lack understanding of the character traits vocabulary. Therefore, pairing selected character traits with gifs was a modification designed to address the students' lack of prior knowledge in vocabulary and support their engagement through relevance. In addition, observations, teacher interview, and student artifacts indicated that students needed more explicit and focused direct instruction in correctly drawing Ozobot codes. Researcher observations, teacher interviews, and student artifacts show that modifying the lesson by chunking it into separate parts, character traits instruction and Ozobots code instruction, appears to have minimized distractions and increased focus on learning outcomes. Data, including student artifacts ad researcher observations, showed that allowing student pairs to choose only one character to focus on was theorized to support more effective collaboration.

Limitations and Future Research

There are limitations to this study. One limitation includes the study's population. For this study, the researcher chose to utilize two fourth-grade classes with a total of 29 students. The population size may not be generalizable to the population at large. Data is also limited as no formative or summative assessments of the students were included in the instructional materials. Therefore, the researcher cannot generalize past these two classrooms.

Another limitation is the lack of empirical research on utilizing educational robots in reading. Even though these instruction lessons were only used with fourth-grade students, it appears that the instructional activities could be used with other grade levels. Furthermore, it appears that Ozobots could also be used to teach character feelings. A future study should focus on students learning character feelings with Ozobots. The researcher also suggests a longitudinal study to determine the long-term effects of using the Ozobots to teach character traits, as this study was limited to two week-long macro cycles.

Conclusion

In this study, the researcher used DBR to develop a local instruction theory of how fourth-grade teachers can use technology in a reading lesson to teach character traits. The researcher examined multiple studies that focused on using educational robots in classrooms. Research indicated that students appear to be more engaged when using technology in academic environments (Al Hakin et al., 2022; Tengler et al., 2021, 2022). Therefore, it is essential for educational technology to be used effectively and intentionally. Ozobots were selected to use in this study to determine if they would assist students in learning character traits. Data indicated that using Ozobots aided in students learning character traits. Based on teacher interviews, researcher observations, and student artifacts Ozobots appear to strengthen student engagement and motivation, improve their collaboration skills while working with their peers, and use computational thinking. These skills can develop a base for students to use in the future (Atun & Usta, 2019; Çakir et al., 2021; Tengler et al., 2021).

Through two macro cycles, a sequence of instructional lessons was developed with modifications to support students' learning process with character traits. Through these lessons, teachers can use Ozobots as a pedagogical tool to engage students with character traits. I used technology integration frameworks, technological pedagogical and content knowledge (TPACK) and Substitution, Augmentation, Modification, and Redefinition (SAMR), to ensure that the technology integration lessons were developed with structure and intent. Technology frameworks equipped me to create constructive and engaging lessons using technology. In designing this lesson, I intentionally used Ozobots to help students learn character traits, work on communication and collaboration skills with a partner, and think critically. Integrating technology purposefully into lessons can lead to student achievement.

This study indicates that using technology, specifically Ozobots, can support students in learning character traits. The lessons can be modified for additional grade levels depending on student needs. In the future, Ozobots and other educational robots may be suitable to help with other reading and writing skills.

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APPENDIX A - PICTURE BOOKS USED IN LESSONS

Picturebooks	
Title	**Author**
Nobody Hugs a Cactus	Carter Goodrich
Gracie for President	Kelly DiPucchio
Creepy Carrots	Aaron Reynolds and Peter Brown
Salt in His Shoes	Deloris Jordan
Recess Queen	Alexis O'neill and Laura Huliska-Beith
Good Egg	Jory John and Pete Oswald
Bad Seed	Jory John and Pete Oswald
Enemy Pie	Derek Munson
Those Shoes	Maribeth Boelts and Noah Z. Jones
The Invisible Boy	Trudy Ludwig and Patrice Barton
The Boy Who Cried Bigfoot	Scott Magoon

APPENDIX B - TEACHER INTERVIEW QUESTIONS

Pre-lesson interview

1. How familiar are you with educational robots?
2. How familiar are you with Ozobots?
3. How have you integrated Ozobots into your teaching in previous years?
4. How do you think the students will respond to Ozobots?
5. How have you taught character traits in the past?

Post-lesson interview

1. How do you think the lesson went in terms of students learning character traits?
2. How do you think the lesson went in terms of students using Ozobots to learn character traits?
3. What went well?
4. What was challenging?
5. Did anything surprise you with the lesson? If so, what was it?
6. If this lesson was a success, do you think you would use the lesson again next year?

Follow-up prompts:

- Why?
- Tell me more about that.
- Can you give me an example?

APPENDIX C - OBSERVATION NOTES

What is Happening?	**What Am I Thinking?**
Date and Time:	

APPENDIX D - STUDENT FEEDBACK FORM

1. What did you think of this lesson? Why?

2. How do you feel about using educational robots such as Ozobots?

3. What did you like about using Ozobots?

4. What did you dislike about using Ozobots?

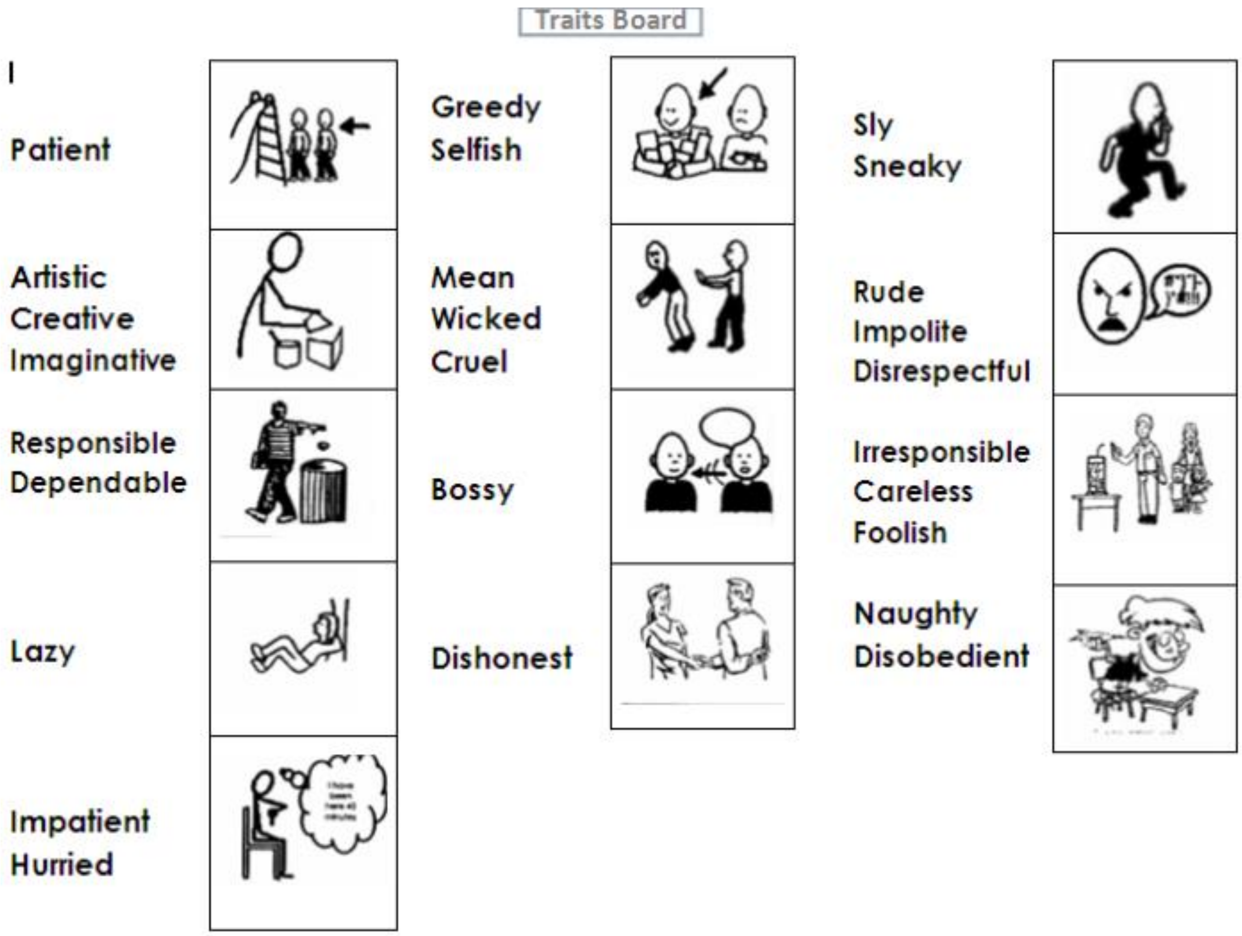
5. Tell me what you learned about character traits.

6. How did the Ozobots impact your learning of the character traits?

7. Would you like to use educational robots to learn in other classes? Why?

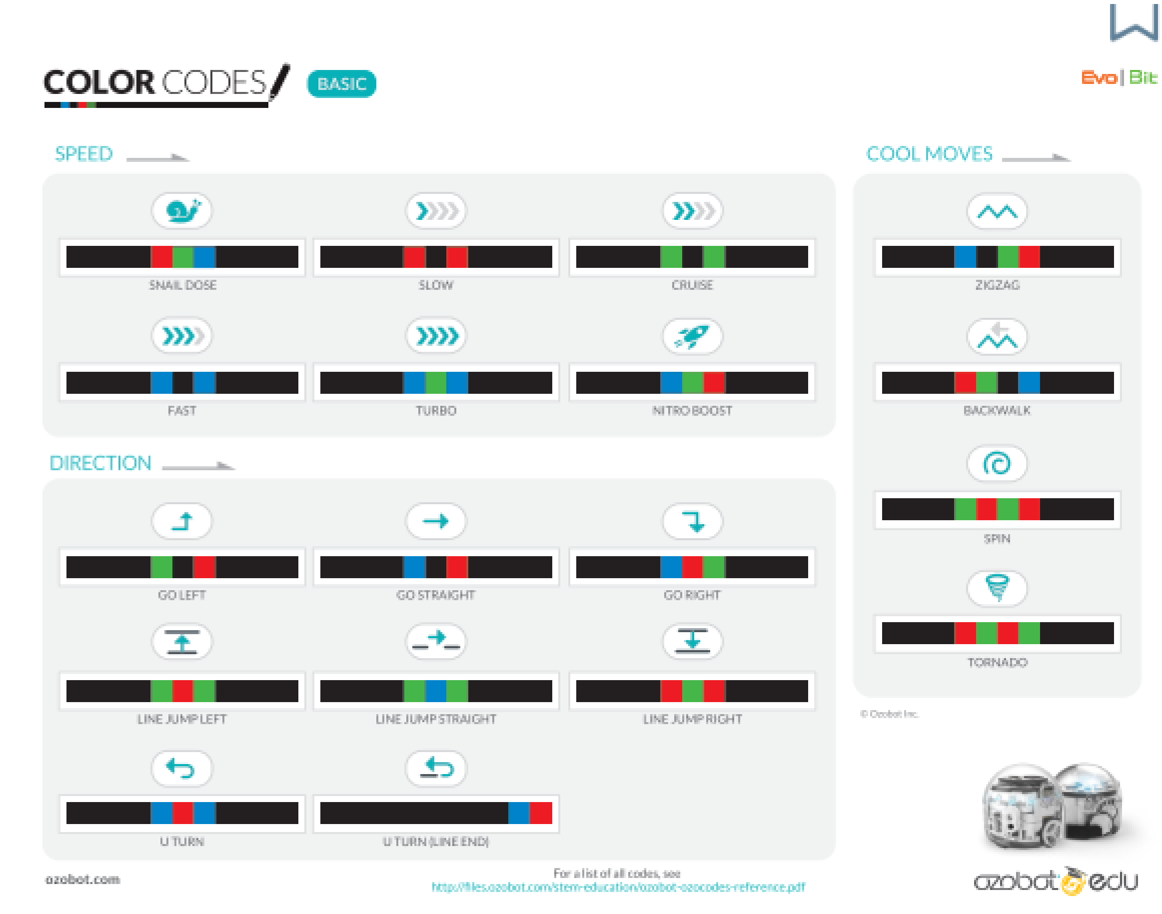
8. How do you think it would impact your learning in other classes?

APPENDIX E - CHARACTER TRAIT MAT



4th & 5th Grades

APPENDIX F - OZOBOT COLOR CODES



APPENDIX G - STUDENT GRAPHIC ORGANIZER

Book Title:
Partner Names:

Character Feeling:

Text Evidence:

Ozobot Action:

Why did you and your partner choose this action?

Character Feeling:

Text Evidence:

Ozobot Action:

Why did you and your partner choose this action?

Character Feeling:

Text Evidence:

Ozobot Action:

Why did you and your partner choose this action?

Character Feeling:

Text Evidence:

Ozobot Action:

Why did you and your partner choose this action?