Using Small Groups to Support Mathematics Learning in Preschool

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Capstone Project: An Action Research

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Abstract

The purpose of this action research project was to gather data on the use of small group learning as a setting for increasing number sense skills for preschool students. The researcher met with a classroom of preschool students over the course of 6 weeks, one week for pre-assessment, four weeks for playing math games in the small group setting, and one week for post-assessment, to implement the intervention. The quantitative research gathered was analyzed to determine whether the addition of small group math time was impactful in increasing student number sense in the areas of 1:1 counting and numeral identification. The researcher does not currently work in the classroom but has experience teaching in a preschool classroom in previous years. The findings determined that the implementation of the two selected math games significantly increased student number sense in the area of numeral identification and insignificantly increased student number sense in the area of 1:1 counting. The conclusion drawn was that implementing small group time dedicated to math at least once a week had a positive impact on student number sense in the defined areas.

Keywords: preschool, small group learning, playful learning, math, early childhood
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**Introduction**

Use of small groups in preschool is not a novel idea. It is a practice that you will find in nearly every early childhood classroom that you step into. The reason for this is the evidence that shows how much students can learn and grow in all domains—literacy, language, science, social-emotional, and mathematics (Tal, 2018). The problem is that the focus of small groups leans heavily on literacy and social skill growth, even though research points to the importance of early childhood mathematics in predicting later achievement in school (ten Braak et al., 2022; Jacob & Jacob, 2018). By omitting opportunities to develop mathematics skills at a deeper level, something that small group learning allows students the chance to do (Tal, 2018) a disservice is being done to the growth in the child as a whole student. Research shows the connection between early math skills and later achievement (Purpura et al., 2019) and that small group instruction is an effective tool in not only teaching, but scaffolding and reinforcing learning (Jacob & Jacob, 2018). Combining these two areas of research, which is the path of this action research project, should lead to an easy way to transition towards adding more mathematics learning into the classroom in a way that is impactful for the students.

The purpose of this action research project is to look at weekly, intentionally planned small group mathematics learning, to see if there is indeed a positive impact being made. Once the research is complete, classroom teachers or preschool directors will be able to use it to reflect upon whether or not adding math small groups to part of the weekly classroom routine is a worthwhile change. This should be clear once the results of the action research project is complete. Data will be collected three times during the study: before intervention, to gather baseline data, after three weeks of intervention, which will operate as a checkpoint to see if the
students are ready for a more complex game, and after the full six weeks of intervention, to see how much growth was made by the students throughout the six-week period.

Research for this literature review was found through two main databases: The DeWitt Library as accessed through Northwestern College in Orange City, Iowa, and Google Scholar. All 23 scholarly articles included in this literature review are from scholarly journals and are peer reviewed. Additionally, aside from two, all articles are from within the last 10 years. The exception are two articles that are important in the field of the connection between reading and mathematics achievement and the positive impact of small group instruction at the preschool level and the author of this literature review felt they contained information and data that are still relative today. The focus of the articles that were gathered were three-fold: looking at early mathematics achievement and noting the connection to later math and reading achievement, the impact that small group instruction has in the preschool classroom, and the importance of playful learning in early childhood. These were the focuses because the author’s focus is early childhood mathematics and the need to keep early elementary learning playful. In some articles, specifically those looking at math and reading achievement, the scope went passed the preschool classroom and included middle school and high school scores, to determine whether or not there is a connection between early math and later achievement.

It is the belief of the author that adding in weekly math small group instruction will increase student number sense knowledge. Teachers within the Linn-Mar School District already incorporate one required literacy small group a week, in order to increase early literacy skills. This same principle is what the author feels can translate to early mathematics skills. This is supported by Jacob & Jacob’s (2018) research, which found that preschool students who were given supplemental mathematics small group instruction made meaningful growth in the studied
math areas. By utilizing the 15–20-minute small group time once a week to play mathematics games with students, they will have exposure to logical, number-related ways of thinking, through the act of play, which will help students lay the foundation for later mathematic learning. With the findings of this study, the author will have what is needed to advocate for and justify the importance of early mathematics small group instruction in the classroom.

The author has organized the literature review by starting with a wide lens look at education and zooming in until the focus comes to playful learning as an instructional component to early childhood mathematics. The widest focus, the beginning of the literature review, is early elementary mathematics and how it connects to the learning that students will do as they continue their schooling. Research notes that there is a direct connection with early childhood mathematics achievement and later mathematics and literacy skills (Grimm, 2008; Watts et al., 2014; ten Braak et al., 2022). Next, the focus becomes how preschoolers learn, the importance of playful learning in preschool classrooms. The role of playful learning in early childhood classrooms is discussed frequently, with researchers noting the positive impact that intentional planning for play in the classroom has on student learning (Guarrella et al., 2023; Hadley & Newman, 2023; Kangas et al., 2022). Following this is a look into small group instruction and the role it plays in early childhood classrooms. Research supports the use of small group learning in the preschool classroom, highlighting the importance of teachers being able to provide direct and differentiated instruction when introducing topics and scaffolding learning (Winstead et al., 2019; Lane & Shepley, 2019). Finally, to wrap it all together, the focus is the use of small group instruction to play games that are intended to strengthen mathematical skills of preschool students. The use of games as an instructional tool for small group learning is also well
researched, finding that students were engaged and active in multiple learning domains when participating in these types of small group situations (Strasser et al., 2023).

**Review of Literature**

**Early Mathematics and Later Achievement**

The connection between early mathematics skills and later achievement has been well researched, particularly in recent years. In a monumental study on the topic, 1,364 students were assessed periodically from age 4.5 until age 15 (Watts et al., 2014). This study found that early math skills to be “highly significant predictors of mathematics achievement through age 15 (Watts et al., 2014, p. 357.). A similarly structured study found nearly identical results, with Nguyen and their team assessing 1,375 students in preschool and fifth grade. They found that students who scored well in preschool math competencies, particularly the areas of numeracy and counting, typically also scored well in those areas when assessed in fifth grade (Nguyen, 2016).

Research such as this isn’t new, in fact Grimm (2008) headed one of the earliest dives into the connection between reading and math achievement. This cornerstone study took place in Chicago and looked at students from 3rd, the oldest end of what is considered early learning, through 8th grade, to see how their standardized test scores in mathematics developed during those years. His research into standardized test scores showed that there was a positive correlation between early elementary math success and later reading achievement. Looking at math concepts and estimation, computation, and problem solving/data interpretation, Grimm noted that students who scored well in 3rd grade continued to score well as they progressed to and through 8th grade (2008). It is also highlighted that students who scored well in mathematics, particularly problem solving and data interpretation and mathematical computation, also
achieved high scores in the area of reading comprehension. He states that “mathematics and reading achievement have been shown to be positively related” (Grimm, 2008, p. 412). In other words, a key to success in increasing student reading achievement is to look towards the way early math skills are incorporated in the early learning classroom.

With these studies showing the positive correlation between early math and later academic achievement, the question that remains is why? What is it about early math specifically that creates a foundation for not only later math success, but success in multiple learning domains? A team in Norway asked the same question and their research pointed them towards one possible answer: the development of executive functioning (ten Braak et al., 2022). The team looked at 243 students in Norway, testing students twice during their preschool year, once at the beginning of the year and following up a year later, and looking at 5th grade student data. Their findings showed that executive functioning played a role in the growth of math skills from early to later elementary school, but a less clear connection between math and literacy skills during that period. While they note that there is a research supported connection between early math skills and later achievement, they couldn’t clearly and confidently state that executive functioning had much to do with the connection (ten Braak et al., 2022, p. 2).

Although the team from Norway wasn’t able to definitively prove that executive functioning is the reason for early math skills being an indicator of later achievement, Nguyen and their team of researchers (2016) believes that the connecting factor has to do with a multi-domain style of teaching and learning done in preschool. Their research finds that preschool students are more likely to encounter mathematics in other content areas, particularly during their play. Emphasis is placed on the importance of intentional teaching and planning for math skills and their use throughout a typical preschool day, particularly in the math skills of counting. This
skill was found, through their research (Nguyen, 2016), to be “central to subsequent achievement” (p. 558), making it an important skill to continuously work on throughout the day. It is logical to connect the idea of intentional planning and integration of content areas throughout the day to the way that a preschool day is conducted.

Despite the research showing the connection between early math skills and later literacy achievement, there is continuous discussion about whether or not the exposure to academic skills in general has a lasting impact on the child at an individual level. McCormick et al. (2022) followed a group of 462 students from their preschool year through the spring of their kindergarten year. During this time, they observed the students in their learning environment and conducted interviews with parents and teachers, to get an idea of their demographics, experience, and, in the case of the parents, why they chose the prekindergarten and kindergarten programs to send their children to. Through reflection on observations and analysis of the data collected, McCormick et al. (2022) found that there was not a significant difference between students who did attend preschool and those who didn’t, by the end of their kindergarten year. They did find that preschool students tended to have a better chance at receiving supports they needed in kindergarten if, for example, a student struggled with letter sounds in preschool, they were more likely to receive assistance in that area sooner than peers who didn’t come into kindergarten with that preexisting information. However, overall, students were found to be at a similar level despite their background education before kindergarten: “about half of the eventual convergence on cognitive outcomes occurs during kindergarten and then by about half again by the end of second grade” (Li et al., 2020, as cited in McCormick et al., 2022, p. 1299).

Considering this research, it is of the opinion of this researcher that math should have a significant role to play in the preschool classroom. Math and problem-solving skills are laying
the foundation for student learning as they continue throughout their educational careers (Nguyen et al., 2016), so it feels important to consider how to include math learning in preschool classrooms in a way that is intentional and purposeful. Using research to back up the need for more math in preschools, the next focus becomes on how preschoolers learn.

**Playful Learning is Key**

A traditional classroom, even at the early elementary level, is an academically rigorous place. Young students are asked to sit still and participate in their learning in a passive way. For example, kindergarten classrooms saw an increase of worksheet usage from 1998, where 33% of kindergarteners used worksheets, to 46% in 2010 (Bowdon, 2015, p. 54). During her review of kindergarten cohorts from 1998 and 2010, Bowdon notes that the shift in the way learning happens inside of the early elementary classroom was around the implementation of No Child Left Behind, when the focus became more academic in nature (Bowdon, 2015). The thought process behind the changes was trying to close the learning gap in our own country and to catch up with the academic scores reported around the world. The introduction of Common Core also has played a role in the changes found within the classroom. Because of the interconnected nature of Common Core, students who are struggling meeting standards at one grade level can end up missing pieces of what they need to continue making progress in that content area as they progress in their education (Bowdon, 2015). This combination of ambition to close achievement gaps and desire for a cohesive set of standards has resulted in classrooms that are instructional-based, with the focus becoming what is being taught. Although this is the shift is necessary to meet the increasingly rigorous standards (Bowdon, 2015), the discussion in recent years has shifted to whether or not this is the best way for children to learn, especially when looking at the youngest learners.
Foundations of Early Learning

Strmiska Masters et al. (2023) researched the impact that the addition of playful learning could make on the vocabulary gained in an early childhood classroom through the addition of more playful materials: games, sociodramatic play materials, music, and rhymes. Through this research, they noticed what they termed Six Pillars of How Children Learn (Strmiska Masters et al., 2023, p. 776). The first pillar emphasizes the role of activity in learning, that the more hands-on the learning is, the more encoded the information becomes (Strmiska Masters et al., 2023). The second and third pillars are interwoven, with learning needing to be engaging and meaningful (Strmiska Masters et al., 2023). Students must find what they are learning to be something that they will use and builds upon their previous knowledge while also being something they are motivated to do. A fourth pillar, learning needing to be iterative (Strmiska Masters et al., 2023), shows how similar early learners are to scientists. The learning they are doing needs to allow creativity and for students to form, test, and adjust their own preconceived ideas or hypothesis. The final two pillars also go hand in hand: learning needs to be socially interactive and joyful (Strmiska Masters et al., 2023). Students who can collaborate, cooperate, and participate in learning with their peers, specifically in learning that is fun and motivating, “provides a suspension of social reality, a state of relaxed alertness, and a reduction of stress, all which support learning outcomes” (Strmiska Masters et al., 2023, p. 778.). These six pillars come together in a way that shows a natural connection between an early learner’s need to be active and engaged in their learning and the role that a playful classroom has in that learning.

In line with the six pillars highlighted by Strmiska Masters et al. (2023), Nesbitt et al. (2023) stated in their research that “humans learn best when they can be active and engaged in learning that is meaningful, socially interactive, iterative, and joyful (p. 142). This idea reflects
the ideal setting for early childhood and early elementary students, active and meaningful learning that incorporates opportunities for social and joyous interactions (Pyle et al., 2017). Both teams spent time looking at the research done around guided play and playful learning environments. Their findings were quite similar, with Nesbitt and team (2023) finding that the benefits of guided play can be found in all subject areas and help create more easily transferable knowledge and Pyle et al. (2017) also highlighting the way that playful learning is found throughout content areas and is beneficial for more than just social skill development.

**The Role of the Teacher**

An important factor to playful classrooms that comes continuously is the role of the teacher. This comes into play with intentionally provided play materials (Pyle et al., 2017), continuous observations and adjustments based off of the observations (Guarrella et al., 2021) and a teaching approach that includes a teacher who is engaged and playing a part in the learning and play that is occurring (Kangas et al., 2023). When looking at what a teacher provides to their playful classroom, it is important to look at the roles that they can play and how they are integrated. Through the use of observation, teachers can make note of themes that students are interested in, which could later be used to create engagement or as a vehicle for guiding learning. Teachers are also able to use observations to see if there are common misconceptions several students have that need to be addressed in group time, if there are students who need to be met with in a small group setting for reteaching, or if there are students who are demonstrating skills in their play that they don’t demonstrate in a more traditional setting (Storksen et al., 2023).

While the above research concludes that teachers need to participate in the playful classroom as well as their students, others provide evidence that there can be too much adult involvement. In a study done in an effort to help teachers become better prepared for adding
more intentional play into their classroom, Burke-Hadley & Mackay-Newman (2022) found that “the more teachers talked overall in small-group guided play, the less children learned” (p. 472). Teachers have their own agenda behind play, which can cause them to intervene or provide scaffolding too quickly, before students have had a chance to create their own connections (Burke-Hadley & Mackay-Newman, 2022).

In her study, McInnes (2019) demonstrated how the fixed mindset of an adult can alter what is perceived as play. The study subjects, 80 students and 14 teachers in early childhood classrooms, were shown the same series of pictures, which depicted students and adults in various places around the classroom. In some of the pictures, the students were working alone, some with peers, and some with an adult nearby. Students in the pictures were shown at the table, on the floor, or in their own defined space on a mat. The teachers who were shown these pictures viewed very few of them as showing children at play for various reasons, such as an adult being too close by, students being alone, and students being at the table or on the floor (McInnes, 2019). The students who were interviewed had a much more flexible idea of what play looked like, with only the pictures where an adult was present being ones where they said the children in the pictures were not playing (McInnes, 2019). This can all be summarized to note that students can find play in any situation, but that teachers must adjust how they interact with students within the playful learning environment in order for those students to continue to have a playful learning experiences.

Play in the Classroom

Thinking about play in the classroom can lead to ideas of a free for all, a mental image where students are completely in charge of the setting, materials, and rules for their play, the opposite of a traditional learning setting, where students are sitting in desks or at tables and
completing worksheets or attending to teacher lead activities. In reality, the play that is happening in an early childhood or elementary classroom should be a combination of both free play and intentionally planned play (Storksen et al., 2023). When Storksen et al. (2023) observed 1,400 students across Norway who were participating in a playful learning curriculum, they found that the strongest results came when students were given freedom to explore ideas AND had an adult present to scaffold their knowledge. Burke-Hadley & Mackay-Newman (2022) also noted the importance of play being guided, or purposeful, in order to create growth in students. Their work, which focused on vocabulary growth, emphasized the use of center time as a way to allow students to support and interact with each other while creating new or practicing recently learned skills, specifically with the successes coming from an environment in which the teacher prepared materials to encourage practice and collaboration (Burke-Hadley & Mackay-Newman, 2022). Strmiska Masters et al. (2023) had similar results to their evaluation of play in the early childhood classroom, finding that large and small group time, making sociodramatic play available in all centers, and incorporating music and rhyme into the learning all helped students to increase their knowledge and skills.

When Guarrella et al. (2021) observed classrooms in Australia, they combined this idea of purposeful play throughout the classroom with teachers playing an active role in the classroom: “guided play enhances learning opportunities in playful contexts by allowing the child to direct play while the teacher embeds the learning objectives, thus making guidance explicit in a context meaningful to the child” (Gurrella et al., 2021, p. 612). In other words, creating an environment that encourages the teacher to cultivate a deep knowledge of the learning objectives and planning for integration of those objectives throughout the school day in a way that considers the six pillars of how children learn (Strmiska Masters et al., 2023), children
are more likely to actively engage in the play and learning that is presented to them in the classroom.

The Role of Small Groups

One potential way to meet the academic requirements for early learners with the evidence-based knowledge that children need a more playful approach to their learning is through the use of small group instruction. Small group learning allows for students to have more guided peer interactions, one of the pillars of how students learn (Strmiska Masters et al., 2023). Winstead et al. (2019) looked at the use of small group instruction as a way to provide opportunities for students with disabilities to learn alongside peers through the use of peer modeling, collaboration, and peer praise. The structure of small group time lends itself to these important peer interactions, where teachers can monitor, correct, and scaffold conversational skills, turn taking abilities, and other social skills that might not be as easily guided by an adult during free play, large group, or large motor learning. In fact, the students who were observed to all have made growth in the areas of conversational skills and peer interactions during the time that the study took place (Winstead et al., 2019).

Small group learning isn’t limited to being beneficial for social skills. Winstead et al. (2019) also found that “children acquired targeted academic and social behaviors during the study” (p. 203), again noting that the subjects of their study made academic growth, in this case the number of known sight words, that went along with their social skill gains. Other researchers noted the importance of utilizing small group instruction when introducing academic skills as well. Jacob & Jacob (2018) conducted a study that looked at the use of a supplemental small group curriculum, High 5s, to supplement and enrich the mathematic learning of preschool students. Students in this supplemental small group participated 3 times a week in playful, hands-
on, small group math instruction. They found that there was an improvement in the math scores of students who participated in this study. Similarly, Ledford & Wolery (2015) looked at preschool classrooms and the use of small group instruction within them. They created mixed-ability small groups that focused on vocabulary and target word knowledge. The findings showed that students with disabilities made growth in their participation within the small group time, but didn’t show transfer of that knowledge outside of small groups, and that typically developing peers were able to transfer what they worked on in small group time to other areas (Ledford & Wolery, 2015). Finally, in a reflection by Clodie Tal (2018), the benefits of small group instruction were shown to be increased achievement and retention in math, science, literacy, and language as well as building relationship skills among the students.

Teachers have an important role in small group instruction, like the role they have when leading a guided play learning environment: intentionality (Winstead et al., 2019). Teachers must have purpose behind how small group time is structured, how the groups are selected, and the activity and materials provided. Tal (2018) notes the role of the teacher to be facilitating, modeling, and creating relationships both amongst students and between teacher and student. Small group learning allows time for teachers to gather data on where students are in their learning, which skills are fully grasped and which ones need more practice, and allows teachers to see how students interact with peers who they might not regularly interact with.

Even with these positives to small group instruction, there are areas where improvements need to be made, in order for this type of instruction to be most beneficial. One such area is the frequency and fidelity in which small group learning is conducted. Often, if small group learning is implemented, it is a way to do a craft or to more easily manage independent activities. As noted, small group learning is most impactful when it is cooperative and collaborative (Ledford
& Wolery, 2015). By using small group time for this type of activity, students are missing out on the chance to create connections with peers, with teachers, and with the skills they’re gaining. Another area that needs addressed is ensuring that there is an identified purpose behind small group time. It is common to see little to no preparation for small group learning happening in the early childhood classroom, which is another disservice to the students. Both of these areas can be addressed through, again, intentionality on the part of the teacher and a knowledge of the content and learning objectives required in an early childhood and early elementary classroom. By knowing what it is that students need to be learning, keeping in mind that collaboration is a key to relationship and knowledge building, and using some preplanning to create lessons or pull materials before small group time takes place, teachers can have small group lessons that will be beneficial to students.

Although small group learning is shown to be impactful, not all teachers have positive feelings towards implementing this instruction. Tal (2018) conducted qualitative and quantitative research to determine what teacher’s perception of and what the difficulties were when implementing small group time in their classrooms. She found that there was a correlation between teachers who had a positive attitude towards small group instruction and how that time was used in their classroom. Teachers who didn’t feel positively towards small group learning felt that it was burdensome to what little planning time teachers have, the need to either teach independence to the students who weren’t at the small group that was led by the teacher or having another adult or two present to lead those groups, and that the things students would work on in these sessions could be done at other times of the day that were already familiar with the teacher. The noted that small group instruction didn’t feel feasible because teachers would need to “redistribute power between the teacher and the children, and organize group work to ensure
the children’s participation” (Tal, 2018, p. 133). Small group learning requires planning for every student to participate as opposed to large group learning, where a select few (often the same few) students actively participate and the rest are observed using the skills at a late time. Small group learning pushes at this, requiring that all students play some role in the collective learning process, which puts pressure on the teacher to plan for these situations.

This hesitancy that Tal (2018) found in the teachers she interviewed is understandable. There is a lack of teacher support and it can feel like this is another task on already full plates, especially when it is being brought to the teaching staff by the administrator, as was the case with the teachers Tal (2018) followed. However, the benefits are proven and present. Small group learning can plan an impactful role in student learning, both socially and academically (Ledford & Wolery, 2015). Students engaged in small group instruction are more likely to be motivated and hands on with their learning and part of the collaborative learning process, all of which creates a result of long-lasting skill development.

**Math Games in Preschool**

The knowledge that early math skills can predict later math and literacy achievement, recognizing the need for learning to be intentionally playful, and utilizing small group time as a method of instruction all meet at using one type of material: math games. Math games here are going to refer to the use of board or card games, although there are other forms of games that could be used by other teacher researchers, such as virtual or toy-based games. These games could be manufactured, such as using Chutes and Ladders to play with numerals 1-100 and counting, they could be using open-ended materials for several different games, such as using a deck of cards to play War, Go Fish, or matching games, or could be created by the teacher, such
as creating a blank ten-frame to create a game that works on composing and decomposing numbers 0-10.

In an attempt to make math interactive, engaging, and exciting, Fish et al. (2023) set out to research the use of math games in the classroom. Students were asked to play board games in various scenarios: playing with no adult prompts or scaffolding, as a competition against the peers in their small group, and collaboratively with the peers in their small group. During these games, it was found that students learned the targeted math skills regardless of the type of game they were playing and that students reported enjoyment out of this type of math work, as opposed to traditional math learning, such as worksheets, or large group instruction (Fish et al., 2023). Similar research was conducted in a kindergarten classroom in Germany, where students were asked to participate in several small group sessions. During these sessions, students played conventional, manufactured board games: a dice game and a simplified version of Parcheesi (Gasteiger & Moeller, 2018). They assessed students before implementing the games and after 4 weeks and found that children’s numerical competencies and skills grew. Findings from both of these studies are important because we know that “early counting skills are considered to be a relevant and meaningful predictor for future mathematical development” (Gasteiger & Moeller, 2018), so having a tool to develop those skills in a way that is fun for students is beneficial to their future mathematic achievement.

Using board games with preschoolers is an easy addition to the routine. Ramani and their team (2012) studied the use of math games as a small group activity by studying 62 preschool students over the course of 4 weeks. Groups were divided into students who were introduced to and played a game that was colors-based and didn’t involve numbers at all and students who were introduced to and played a game that included both colors and numerals. They found that
by simply adding the numerals to the game and giving students repeated opportunities to play the game, students made growth in the areas of counting, numerical comparison, number line estimation, and numeral identification (Ramani et al., 2012). They also noted that “the small group format may have been effective because children learned from each other while playing the game” (Ramani et al., 2012, p. 669). In a small group setting, teachers are able to better meet the needs of specific students, allow for students to interact and support each other while providing support as needed, and let an authentic interest in math develop as students play games (Ramani et al., 2012).

The benefits of using math games seem to be plentiful, however, similar to how some teachers feel that small group instruction is more of a hindrance than a help (Tal, 2018), teachers aren’t always convinced that the time needed to implement games in the classroom is worth these benefits. Research conducted in Chile looked at this point of view, using quantitative collection of student data to determine the efficacy of using math games and qualitative collection of teacher perceptions on the feasibility and ease of including these games into their routine (Strasser et al., 2023). Before beginning the study, teachers were interviewed and it was determined that there was some hesitation about adding games into their classrooms. Teachers found the possibility of games as small groups to be an obstacle more than a tool (Strasser et al. 2023). This is a reasonable worry, especially when considering the groundwork that needs to be laid to incorporate the games. To start, all students will need to learn the rules of the game and how it is to be played in the classroom. The first session or two can often be repeating the rules and managing the gameplay before the math skills that are intended to be grown can be deeply considered. And, while the role of the teacher is to sit back and allow the game to be played, often there is some aspect of hand holding that needs to be done, especially thinking about how a
child’s previous knowledge, either with the game or the math skill, will impact how they interact with the game. Finally, when considering the differing cultures of each classroom, it can be difficult to implement games in a classroom where many students need frequent adult guidance, taking the teacher away from the intended activity (Strasser et al., 2023).

What Stasser et al. (2023) found at the end of the six-month period, however, is that not only did students gain knowledge in three of the four targeted areas, but teacher perceptions of games in the classroom changed as well. By the end of the study, only one of the twelve teachers said that they didn’t see themselves using a fishing game in their classroom because of lack of interest, but they said the other games would have a place in their room. And academically, students grew in three of the four targeted areas, with the fourth target area seeing growth in half of the twelve classrooms, but not in the other half. Their findings highlight the way that “games are easily linked to curriculum goals by promoting conversations or actions that support specific skills or knowledge” (Strasser et al., 2023, p. 398).

A benefit to using games in the classroom is the ease at which they can be added. Playing board games is something that most students in a typical early childhood classroom are able to do, and if they haven’t been introduced to these types of games, they are simple enough to pick up (Gasteiger & Moeller, 2018). It is also beneficial because of the multitude of developmental domains that are worked during board game play. Preschool teachers are familiar with the task of needing to collect data for the variety of developmental domains that are being tracked. Through the use of board games, not only are students working on the math objectives that are being targeted, but they are also developing social skills, emotional skills, and communication skills. There is also a positive when thinking about how the same game can be played multiple times and have different opportunity for practice (Strasser, 2023). It is atypical for games to become
repetitive to students because there are a multitude of variables that impact the game and, therefore, the outcome, all while practicing the skills repeatedly (Strasser, 2023). Games can also be easily repeated at home (Gasteiger & Moeller, 2018), either by creating a library of games for families to check out from the classroom, listing out rules for a card game that is being played in the classroom, or providing parents with at home copies of the materials created by the teacher when using a homemade board game. This ability to transfer the game between home and school also opens the doors for students to be able to transfer the knowledge worked on within the game setting to other settings as well.

After looking at the research in the areas of the importance of early math learning, the use of guided play at the preschool level, the importance of collaborative small group learning, and how math games can play a role in achieving learning objectives for preschoolers, the need for research in one area comes to mind: intentionality of planning. Each portion of the reviewed literature mentions the need for intentionality behind the activities that are selected, the way they are integrated into the school day, and the ways that teachers use their adult voice to impact student learning. This all leads to the need for further research into what happens when math small groups, something not required of preschool teachers at the time of the research, are intentionally planned and executed in the classroom. When math small group learning becomes a routine part of a preschooler’s week, what changes happen in student number knowledge? Does the use of math games keep students engaged in the learning while also strengthening their skills?

**Methods**

**Setting**
The setting for this study is the half-day morning session of a preschool classroom. The classroom is part of the Statewide Voluntary Preschool Program, which works within public school districts across the state of Iowa. This particular district is in a suburban community, where the families served include 22% low-income and 95% of the staff has three or more years’ worth of teaching experience (Great Schools, 2023). The district’s preschool program is housed within 4 of the 9 elementary schools. Each of those four schools has two preschool teachers and those teachers each have two sessions, one morning and one afternoon session.

The school is in a suburban area which has a population of 41,864 (Census, 2022). The city has a poverty rate of 7.1%, while the average household income is $81,519 (Census, 2022). Finally, 78.3% of the households are owner-occupied, while 21.7% are rental properties (Census, 2022).

**Participants**

Fourteen preschool students are going to be participating in this action research. Of these fifteen students, three are in their 3-year-old preschool year and attend the program because of a preexisting Individualized Family Service Plan (IFSP) and eleven are in their 4-year-old preschool year. The class is evenly split with 7 male students and 7 female students. Two of the students are African American and the remaining twelve are Caucasian. Finally, along with the three students who qualified for preschool a year early with their IFSP, one additional student is on an IFSP for speech support. One student qualifies for services that include a one-on-one para and, because of the special education services provided in the classroom, an additional staff member is in the classroom to support the other students receiving services.

**Variables (Independent and Dependent)**
The small group sessions are aiming to answer the question of whether or not the use of dedicated math small group time each week impacts growth in the targeted area, in this case 1:1 counting and connecting numerals with their quantities. In this situation, the independent variable is the addition of the math small group intervention. The dependent variable is whether or not there is an impact made on student number knowledge in the areas of 1:1 counting and connecting numerals with their quantities.

**Interventions**

Students will participate in two supplemental math small group sessions per week over the course of four weeks. Each session will be 10 minutes long. Groups will be mixed ability, with the only consideration in the selection of group members being the ability of the group of students to stay on task. The small group sessions will take place in the library at the elementary school that the preschool program resides inside. Students will be pulled out of their classroom to the library during centers time to meet for 10 minutes of dedicated math time. During the first two weeks of the four-week research, students will play a version of Go Fish using cards with dots in various arrangements (in a circle, of various sizes, and arranged like the face of dice), ten frames, and numerals. This game will be played as a whole group, so that all students in the small group are playing together. For the final two weeks of the research, students will play a game called Fill Your Cup (Dees, 2014), where students will draw a dot card and place the number of pompoms into their cup that corresponds with the number represented on their card.

**Data Collecting**

*Measurement Instrument*

Quantitative data will be collected the week before the added small group period and the week after the small group period. Students will be individually pulled to see where their
baseline data lies when it comes to the targeted objectives. For the students in their three-year-old preschool year: Objective 20.a: Verbally counts to 10; counts up to five objects accurately, using one number name for each object and Objective 20.c: Recognizes and names a few numerals (Troy University, 2010). For those in their four-year-old preschool year: Objective 20.a: Counts 10-20 objects accurately and Objective 20.c: Identifies numerals to 5 by name and connects each to counted objects (Troy University, 2010).

Data Collection: Process and Timeline

Pre- and post-assessments will be conducted in the same way. Students will be pulled individually to identify numerals that they are shown on a card and 1:1 count a series of manipulatives, to get a grasp on where they started, before the addition of the intervention, and after 4 weeks of including the intervention into their routine. The data collected will be compared to the benchmarks set by Teaching Strategies GOLD. GOLD is the assessment tool used by the state, in alignment with the Iowa Early Learning Standards, to track and monitor student progress throughout their early childhood education (Teaching Strategies, LLC, 2024). This assessment tool has objectives for ages birth-7 years and offers a benchmark for each age range. For this classroom, objectives from the 3-year-old preschool year and 4-year-old preschool year are used, as appropriate for the individual student and their current age.

Security of Data

The data will be recorded in an Excel spreadsheet, which is kept on the computer belonging to the researcher, which is securely password protected. After 4 weeks of intervention, students will be individually assessed once again, with their data being recorded in the Excel spreadsheet again. The researcher will share the data with the classroom teacher in a one on one, in person meeting, so that the teacher has access to the data for their records. At this time, the
classroom teacher will copy the data into their Teaching Strategies GOLD digital portfolio, a password protected data collection tool used by early childhood educators in the area.

**Data Analysis**

The collected quantitative data will be analyzed using a Dependent Samples T-Test. This was the selected method for data analysis because students will be participating in a pre-test and post-test and those scores will be compared to determine the impact that the intervention has on student learning. The nature of the Dependent Samples T-Test aligns closely with the intended plan for the collected data for the research project, which is why it was selected as the method for data analysis. T-Tests allow two numbers to be compared and Dependent Samples T-Tests focus specifically on two numbers collected using repeated measures (Statistics Solutions, 2024). For this data analysis, the two compared numbers using repeated measures will be the pre-assessment data and post-assessment data. Through the use of the Dependent Samples T-Test, the researcher will be able to easily compare the numbers to determine the impact (Statistics Solutions, 2024) that adding intervention into students’ week of learning has.

**IRB Process**

For this action research, an IRB Exemption was granted. The research is not going to adversely impact student learning or teacher assessment and the research will be conducted in an established educational setting, involving normal educational practices. Because the research is not experimental in nature, an IRB Exemption was granted on February 5, 2024 by the IRB Committee at Northwestern College in Orange City, Iowa. The permission request for participation will be sent out to parents before the research is conducted. The request will inform
parents on the background of the study, ensure anonymity, and allow for parents to opt their child out of participation.

**Findings**

**Data Collection**

Data was collected in a one-on-one setting in the library of the elementary school. Students met with the teacher for data collection at two points: one 3-minute session the week before the intervention was in place and one 3-minute session the week after the intervention was in place. The assessment took place in the school library, which is directly across the hall from their classroom. Here, student and researcher were able to use a room to sit in, in order to complete the assessment with minimal distractions. For the pre-assessment, students were shown a card with a numeral on it and asked to name the numeral. Because the 3-year-old benchmark is looking for students to identify a few numerals and the 4-year-old benchmark focuses on numerals to 5 (Troy University, 2010), the cards used each had one numeral from 0-10. The cards were shown to students in a random order. As students verbalized the numeral, the researcher placed the cards in two separate piles: one pile for numerals that were answered correctly and numeral on the card for numbers 0-5.

Once the student had gone through the cards, the researcher recorded their answer in an Excel document and made note of whether the child met the benchmark appropriate for their age. To collect data for Objective 20.a, the researcher had a set of 20 pom poms laid out for students to count. The number 20 was chosen because that is the high end of the benchmark for the assessed learning objective (Troy University, 2010). As students counted, the researcher made note of where they stopped using 1:1 counting and recorded this number in the Excel document, again making note of whether the child met the benchmark appropriate for their age.
Post-assessment data was collected in the same way as the pre-assessment data. This allowed for a more even comparison between where a student was before and after participating in the intervention activity. The only addition was to the Excel document. Recorded in the document along with the collected data and whether they met the benchmark after the addition of the intervention was a column for improvement made. This helped determine the growth that was made by students, even if they came into the study already meeting the benchmark or if they were still working towards the benchmark at the end of the intervention.

**Data Analysis**

To determine the impact that small group math intervention had on student math knowledge, quantitative data was collected. Two tables were used to record the data: one for recording the numerals that each student knew and one where the number which a student could 1:1 count to was recorded. The researcher collected data on number knowledge before the addition of the intervention, the pre-assessment, and after four weeks of intervention had taken place, the post-assessment. The table also had a column for recording whether the student was at the benchmark for their age for each targeted number skill. This data was recorded with a ‘yes’ or a ‘no’. Figure 1 below shows the number of students who did or did not meet the benchmark using pre- and post-assessment data for Objective 20.a and Figure 2 below shows the number of students who did or did not meet the benchmark using pre- and post-assessment data for Objective 20.c.

**Figure 1**

*Comparison of Whole Class Pre- and Post-Assessment Data for Objective 20.a*
Dependent Samples T-Tests were completed to more easily compare the pre- and post-assessment data. This comparison helped to determine the differences in student number knowledge before and after the implementation of the intervention. For Objective 20.a, the pre-assessment data compared with the post-assessment data showed that the class as a whole made growth in each objective, with more students meeting the objective by the end of the intervention.
cycle. However, upon reflection, it was realized that these graphs didn’t answer the initial research questions. The target for the present study wasn’t meant to see if students met the learning objective, but to see if growth was made after implementation of the intervention. In order to more accurately answer the research questions, the data was organized in a different way.

In order to view the data in a way that more closely aligns to the research question, it was necessary to shift from looking at the data from the class as a whole to looking at the students on an individual level and to transition to using the numbers collected, rather than the ‘yes’ or ‘no’ answers from the checklist asking whether students met the learning objective or not. The data used to create these graphs is the data that was collected during the pre- and post-assessments. Figure 3 below shows the number each student was able to 1:1 count to, with the blue part of the graph showing pre-assessment and intervention counting while the orange part shows how far beyond the pre-assessment students were able to count when assessed after completing a cycle of intervention.

Figure 3

*Comparison of Individual Pre- and Post-Assessment Data for Objective 20.a*
Figure 4 below shows the pre- and post-assessment results for student’s ability to identify and name numerals. For the purpose of this study, student names were changed to alphabet letter representations, to uphold their privacy. In each graph, the alphabet letter that represents a student in one graph represents the same student in the other graph.

**Figure 4**

*Comparison of Individual Pre- and Post-Assessment Data for Objective 20.c*
These graphs were more useful in illustrating the data collected and connecting that data to the research questions. Dependent Samples T-Tests were conducted to determine whether the individual student made growth in their number sense knowledge, specifically the areas of 1:1 counting and numeral identification. In the comparison of pre-assessment of 1:1 counting skills (M=9.21, SD= 6.72) and post-assessment of 1:1 counting skills (M=5, SD=4.99), the results of the T-Test showed an insignificant difference between pre- and post-assessments. This was found within the results of the t-test equation: \( t(13)=-1.5043, p <0.1564 \). When comparing the pre-assessment of numeral identification (M=7.93, SD=4.01) and the post-assessment of numeral identification (M=1.21, SD=1.67), the difference was found to be largely significant. These results came from the t-test equation: \( t(13)=4.7, p<.001 \).

These results tell us two things. First, the intervention of 1:1 counting didn’t not yield statistically significant growth. This could mean that the intervention needed more time between pre- and post-assessment to show more significant growth, needed to occur more frequently in the week, or that this type of intervention was not effective in significantly strengthening the skill of 1:1 counting. When looking at the t-test results for numeral identification, the results were found to be largely significant. Students were found to have made significant growth in their knowledge of numerals when they were given the chance to play with, discuss, and are exposed to those numerals in a small group setting.

**Discussion**

**Summary of Major Findings**

In comparing student number sense growth, specifically in the areas of 1:1 counting and numeral identification, when adding small group math games into their week, it was found that there was significant growth made in numeral identification and insignificant growth made in the area of 1:1 counting.
counting, according to the Dependent Samples T-Tests that were run. It is important to note that, when looking at Figure 3 and Figure 4, nearly all students made some sort of growth, even if it was insignificant when analyzed as a whole class. The fact that students made growth, however significant it is, makes sense, especially when considering the structure: small group learning and learning through play.

When looking at the growth gained by students following implementation of the intervention, one thing that stands out as a difference maker is the use of games to expose students to number sense concepts. The cards used for each game included numbers represented on a ten-frame, in various dot formations, and as a numeral. By allowing students to experience these visual representations of numbers through play, the researcher was able to use the concept that Strasser and her team (2023) found to be important: having students play a rules-based game where the adult present acted as a guide. The role of the researcher, and in the future the teacher, wasn’t meant to be one where direct instruction was taking place. Instead, the present adult played the game alongside the students, to model expectations and gameplay (Winstead et al., 2019). Because the students and teacher were playing the game together, this type of intervention felt less like a planned lesson and more like an opportunity to play in a small group setting. Kangas and team highlighted that the teacher’s role in playful learning is to be engaged in the learning alongside the child (2017), which aligns with the present action research.

The setting being a small group session also reflected previous research. Utilizing the small group setting allowed the researcher to adjust the gameplay for the group at hand and provided the opportunity for scaffolding to be done based on the student’s needs at the time of play, rather than predicting what a student might need support with based off of prior knowledge of the student. Because the groups were mixed-ability, students naturally fell into a pattern of helping those who might need help and found ways to extend their learning through collaboration with similarly-skilled peers present in the group, something that reflects the research of Winstead and her team (2019). Finally, with the small groups consisting of 3-4 students each, the students were more likely to be engaged in the game for the entirety of the small group period, which lead to growth in content knowledge for the students. This was something that was
noted by Ledford & Wolerly (2015), who discussed the positive impact of utilizing small group learning as the opportunity for learning to happen in a deeper way.

Something of interest that came from this study comes from thinking about the exposure to the concept of 1:1 counting and numeral identification that the students were receiving before the intervention. Student were exposed to numbers intentionally during large group calendar time and a handful of worksheets that were completed during various small group activities done during the school year, alongside any times they noticed and brought up numbers authentically. Through the use of this intervention time, students were purposefully exposed to numerals and the quantities they represent at least once a week over the course of four weeks. This intentionally planned, math-based small group allowed students the chance to see numbers in a different way and engaged them in play to learn more about the concepts (Ramani et al., 2012). The concept of 1:1 counting was planned for more throughout the school year, before the intervention, which could explain why there was growth made in the area, although it ultimately wasn’t significant growth. Overall, there was a positive impact on having students participate in a math-based small group on a weekly basis.

The impact that this research could have on future teaching is encouraging to use of more games during small group time. Small group learning can often be seen as a tedious addition to the classroom, especially if the teacher has a less than positive view of small groups or if they tend to plan small group instruction last minute or without purpose (Tal, 2018). However, the results of the study illuminate a few things: 1) that using a game can be beneficial to the child’s academic gain, 2) allowing students to explore concepts during small groups can deepen or extend the knowledge that they have and 3) planning for small group doesn’t have to be time consuming to have intentionally planned outcomes. Students were able to increase their number sense knowledge, especially in the area of numeral identification, by simply playing games with their peers and the researcher (Ramani et al, 2012).

Limitations of the Study

The size of the class for this study was 14. It is possible that the results of the study are limited to this particular class and their size and are not transferable to other classrooms or larger groups of preschool students. The research was also limited in various ways because the researcher is not the classroom teacher and does not currently work in the school setting. Due to illness, conferences, and other
scheduling concerns, the intervention was not always implemented twice a week for every student. In the future, using this intervention in a more consistent way may create different results than what was found for the study. Also, due to these scheduling conflicts and time constrains, the researcher chose to conduct the study within the confines of the learning objectives appropriate for the age of the students who were assessed. Because of this, students who came into the study already meeting the objective didn’t have the chance to show what they knew beyond the objective. Finally, because the researcher was a new face to the students, their level of comfort may not have been as high at the beginning of the study as it was at the end of the study. Because of this, some students may have been more hesitant to answer questions for the pre-assessment but felt comfortable enough by the post-assessment to showcase their full knowledge. This lack of familiarity could have yielded different results than the researcher would have received had they been a familiar face before the study.

**Further Study**

The findings from the study of adding in math small group intervention during the week have several areas for potential future studies. One possible adjustment that could be made for future research is conducting this same study in a larger classroom, in both the morning and afternoon preschool sessions, and/or implementing this intervention throughout a district of preschool classrooms. This would allow the researchers to determine how transferrable the findings are and make not of how effective the intervention is under various teaching styles. Martinez-Mesa, et al. (2014) note the importance of using a sample size appropriate to the study, stating “an insufficient or small sample size may not be able to demonstrate the desired difference, or estimate the frequency of the event of interest with acceptable precision” (p. 615). If the desire of future research is to see how transferrable the use of math small group is within a preschool classroom, a larger pool of subjects would be needed.

Another potential area that could be expanded on in the future is the type of card used to play the math games. The researcher for this study used the same type of dot cards for both Go Fish and Fill Your Cup. Future researchers could play with one set of cards for a week then switch to
a traditional deck of cards for the second week or use other representations of numbers (dot or numeral dice, digital randomizers, etc.). This would allow researchers the chance to see if students are able to use the same knowledge with a slight change and have the same results. In a similar way, future researchers might consider playing these math games during centers or sending home instructions on how to play to families, so that students have the opportunity to use the knowledge they’ve gained during the intervention in new settings. Palmer and Bjorklund (2022) highlighted the importance of using math concepts in various settings and through the use of various materials, stating “it is essential that teachers point out necessary aspects of numbers through [various] modes of representation and carefully selected patterns of variation in a context” (Palmer & Bjorklund, 2022, p. 979). By varying the materials, the representation of the numbers on cards, and allowing the games to be played in different settings, students are able to better deepen their knowledge of the numbers and can use the knowledge gained in the present study in different contexts.

Extending the duration in which the games were played is another area future researchers could explore. Students in the present study had two weeks to play with each game. The results from the t-test found that this was long enough to make a significant difference when it comes to numeral identification, but not in the area of 1:1 counting. Studies that are able to play dedicated 1:1 counting games for a longer period of time may see different results. A similar study was conducted by Ramani, Siegler, and Hitti (2012), where students were able to play math games as an intervention with a 3–4-week period for each game. Their findings were able to show more concrete growth, assumed by the researcher to be because the students had time to learn the rules and fully understand the methodology of the game, which allowed them to make growth in the targeted content areas. If the games used in the present study were able to be played for a longer
period of time or if they are revisited in the future, the results could differ from those in this action research.

Finally, future researchers may consider having materials and time available to allow students the chance to show what they know beyond the learning objective. As noted, because of time constraints, the materials present were meant to assess students for their knowledge up until the learning objective that was appropriate for their age. Future researchers could keep in mind that some students would have or will gain knowledge beyond the learning objective and could include in their research the ability to note if growth was made for students who may have already met the learning objective. Magnusson and Backman (2021) observed classrooms in Sweden, some of which were mixed-ability and some of which were not. Two of their findings of importance aligned with the suggested future research for the present study: having materials for all ability levels and allowing students to learn from each other (Magnusson & Backman, 2021). In the present study, students who were already beyond the targeted objectives were already setting an example for their peers through their precise counting and numeral naming, but by not having the time or materials prepared for those students to show or strengthen their knowledge beyond the benchmark, the researcher limited their ability to build upon their what they already know or show the full extend of their knowledge. Conducting future research with the time and materials prepared for such extension may show growth out of students who appeared to have made no growth within the duration of this action research.

**Conclusion**

The problem that preschool classrooms face is the desire for more and more academic achievement with fewer resources, less developmentally appropriate expectations from policymakers, and less time to produce these results (Bowdon, 2015). There is also a great push
for early literacy skills which, while important, doesn’t reflect the research that early math skills are just as much of an indicator, if not a greater indicator, to future literacy success than early literacy does (Grimm, 2008). In an effort to make learning more playful (Burke-Hadley & Mackay, 2022) while still fitting in the requirements of a state-run preschool classroom, the action research project looked at using games in small group to fuse the two.

This action research project was intended to see if planned small group math time impacted student number knowledge in the areas of 1:1 counting and numeral identification. Students were assessed before and after the implementation of a 4-week intervention and quantitative data was collected and analyzed. The intervention included playing two different card games: Go Fish and Fill Your Cup. Students were placed in mixed-ability groups and played the games alongside the researcher. Data was collected from the pre- and post-assessments, to be analyzed for growth.

Data analysis showed insignificant growth in the area of 1:1 counting. Growth was shown for 11 of the 14 students, but when it was analyzed using Dependent Samples T-Test, the growth was deemed insignificant. Students were shown to have made significant growth in the area of numeral identification from the pre-assessment to the post-assessment. The researcher notes that the differences in results may have come from previous exposure. The classroom teacher had planned more activities around the concept of counting than numerals, which could be why growth was made, but not significantly. It could also be due to the fact that the concept of 1:1 counting needed more time before significant growth could have been made.

The results from this study can be of use in the preschool classroom. One way is by increasing the frequency in which math takes place, particularly through small groups. The results of the study showed growth in the raw data, which can be reasonably connected to the
addition of math into the weekly routine. Another way the study could impact a classroom is using games as a learning opportunity. Intentionality behind the use of the games is important (Kangas et al., 2023), but finding a game that connects to the learning objectives can help students to increase their knowledge in a way that is fun and engaging, as shown through the results of this study. Finally, the conclusion of the study provides data that could be used to advocate to shareholders the importance of increased mathematics in early childhood classrooms, particularly if the goal is to increase student literacy skills later on (Grimm, 2008).
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