Inclusion

Specially Designed Instruction of Early Numeracy in the Inclusive Elementary Classroom for Students with Extensive Support Needs

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Abstract:	Inclusive opportunities for students with extensive support needs are a predictor of both in school and post-school outcomes; however, successful inclusion must consider how student learning needs and evidence-based practices are incorporated. Potential exists to align evidence-based instruction for students with extensive support needs utilizing the MTSS framework for all students within the inclusive math classroom across Tier II and Tier III. Findings of this single-case, multiple probe across student research study suggest that embedded instruction is an effective and feasible instructional practice to support specially designed instruction in early numeracy within a tiered support model for students with extensive support needs in the inclusive math classroom. Based upon our findings, we sought to develop a model of practice for SDI within tiered systems of support for students with extensive support needs that educational teams, school administrators and policymakers can use to design math instruction within inclusive settings.

Abstract

Inclusive opportunities for students with extensive support needs are a predictor of both in school and post-school outcomes; however, successful inclusion must consider how student learning needs and evidence-based practices are incorporated. Potential exists to align evidence-based instruction for students with extensive support needs utilizing the MTSS framework for all students within the inclusive math classroom across tier 2 and tier 3. Findings of this single-case, multiple probe across student research study suggest that embedded instruction is an effective and feasible instructional practice to support specially designed instruction in early numeracy within a tiered support model for students with extensive support needs in the inclusive math classroom. Based upon our findings, we sought to develop a model of practice for SDI within tiered systems of support for students with extensive support needs that educational teams, school administrators and policymakers can use to design math instruction within inclusive settings.

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Specially Designed Instruction of Early Numeracy in the Inclusive Elementary Classroom for Students with Extensive Support Needs

Although many students struggle to learn mathematics, this is especially true for students with disabilities: Only 16 percent of students with disabilities in 4th grade are proficient on math assessments; at 8th grade, that number drops to 8 percent (National Center for Education Statistics [NCES], 2019). The statistics are even more dire when we consider academic and communication competence rates of students with extensive support needs (ESN; Kearns et al., 2011, Kleinart, 2020). Student's with extensive support needs (ESN) are defined as those students who need ongoing, pervasive supports across academic and daily living domains (i.e., autism, intellectual disability, and multiple disabilities); and who are eligible to take their state's alternate assessment based on alternate achievement standards (AA-AAS; Taub et al., 2017). With approximately 40,000 students participating in AA-AAS, Kleinart et al. (2015) found that 93% were served primarily in self-contained settings, and only 3% were served in general education classrooms for at least 80% of the time, and only 4% served in general education for at least 40% of the time (resource room placement).

Serving Students with Extensive Support Needs in Math Classrooms

Inclusive opportunities for students with ESN are a predictor of both in-school and post-school outcomes, and they can lead to increased learning expectations (Mazzoti et al, 2021). If the most common value articulated for the education of students with ESN is enhanced quality of life (Browder et al., 2009), and the research outcomes support this value, then there is a great need to improve inclusive educational experiences (Saunders et al., 2019).

Although much has been published to support inclusive education for students with ESN (e.g., Kurth et al., 2014; Olson et al., 2016; Ryndak et al., 2014), there is a striking dearth of experimental studies examining the impact of specially designed instruction in inclusive settings on academic learning outcomes, particularly in the area of mathematics (Hudson et al., 2013; Kleinert et al., 2015).

Specially Designed Instruction in Math Classrooms

In order for students to generalize and continue to learn more complex math and other academic concepts over time, they must develop a strong foundation in numeracy (Claessens, & Engel, 2013; Duncan et al., 2007; Morgan et al., 2009). Although many interventions have been developed to support student early math achievement (e.g., Fuchs et al. 2005; Gersten et al., 2015) crucial to closing achievement gaps, students with more extensive needs may require greater supports (Browder et al., 2012) and specially designed instruction (SDI) to gain access to grade aligned mathematics within the inclusive classroom.

SDI for students with ESN often includes explicit instruction and the evidence-based practice of systematic instruction (observable, measurable response or set of responses with explicit prompting and feedback; Collins, 2012). IDEA explains the definition of specially designed instruction as:

> *adapting, as appropriate to the needs of an eligible child under this part, the content, methodology or delivery of instruction (i) to address the unique needs of the child that result from the child's disability; and (ii) to ensure access of the child to the general curriculum, so that the child can meet the educational standards within the jurisdiction of the public agency that apply to all children. (34 C.F.R §300.39(b)(3).*

The fundamental definition of SDI in IDEA has been elaborated by many authors (e.g., Friend & Barron, 2021; Friend & Bursuck, 2019; Riccomini et al., 2017) to include how teachers use evidence-based strategies to implement SDI across settings and content areas and ways to serve students with ESN. To this end, SDI continues to gain emphasis in many states and districts. Some are beginning to align the initiative with the implementation of a

Multi-tiered System of Support (MTSS) as an organizing framework for the delivery of effective instruction and inclusive practices (Thurlow et al., 2020).

MTSS and Alignment of Specially Designed Instruction

When appropriately implemented, MTSS clearly enhances student learning and improves outcomes (Sanetti & Collier, 2015; Sanetti & Luh, 2019; Sailor, 2015) and is an approach with the purpose of efficiently identifying students who need support, using research-based interventions to accelerate learning and address concerns. In most systems, the tiers are defined as follows:

- Tier I- Differentiated core instruction that effectively reaches 80% or more of students
- Tier II- Supplemental instruction that includes scaffolding that supports the majority of the remaining 20%.
- Tier III- Intensive instruction that is specific and supports students with the most intense needs.

Often the misconception exists that Tier 3 is the “special education” tier; however, it is for any student who needs intensive interventions.While actually, the tiers are additive (Thurlow et al., 2020), providing supports ‘in addition to’ those provided in Tiers I and II, not ‘in place of” tier I or II. Often students with ESN are either excluded from the system (Thurlow et al., 2020) or only receive support in Tier III that includes a self-contained setting (Kleinart, 2020), but recent literature has discussed supports that can be integrated across tiers (Agran et al., 2020; Thurlow et al., 2020). Instruction can be delivered across all levels, as shown in Figure 1. There is potential to use the framework of MTSS and high-quality, aligned SDI to meet student's individualized support needs and increase access in an inclusive setting. In fact, the current study shows that students with moderate to severe disability may be served across settings with the proper support.

Embedding Systematic Numeracy Instruction

The number of students with ESN taught within the inclusive classroom has continued to increase in recent years (Morningstar et al., 2015; Morningstar et al., 2017). As more students are included in the inclusive mathematics classroom, educators must continue to consider how they will provide students with ESN the instructional approaches that are used to support their progress. Specially designed instruction (SDI) for students with ESN incorporates research- and evidence-based practices (EBPs; i.e., systematic instruction; Saunders et al., 2020; Spooner et al., 2019) to support all students, across tiered instruction.

One such EBP is embedded instruction (EI), designed to distribute instructional trials (i.e., learning opportunities) using systematic instruction within ongoing routines and activities of the classroom environment (Jimenez & Kamei, 2015; Jameson et al., 2020). In a review of practices used to teach students with severe disabilities in inclusive settings, embedded instructional trials using constant time delay were found to be an evidence-based practice (Spooner et al., 2019) across disciplines including mathematics. The practice of EI aligns directly with both SDI and MTSS, as the educational team identifies prioritized learning goals for a specific student, then finds ways in which they can ‘embed’ opportunities to explicitly teach this new skill throughout their lessons (Jimenez, 2020). EI has been shown to be an effective and feasible way for general educators, special educators, and paraprofessionals to prioritize learning goals for students with ESN to receive academic instruction within the inclusive elementary school classroom (Jimenez & Barron, 2018).

Purpose of the Present Study

Utilizing a model of practice may provide a feasible way to support tiered interventions for students with ESN within the general education classroom (Jimenez & Barron, 2019). Therefore, the purpose of this study was to provide SDI of foundational early numeracy skill instruction within inclusive education mathematics classrooms through a system of tiered supports. Specifically, the research questions were:

1. What is the effect of explicit early numeracy skill instruction on student numeracy skill acquisition?
2. What is the effect of embedded instruction (EI) of early numeracy skills on student acquisition and generalization of skills?
3. What is the feasibility of EI across instructional teams in elementary mathematics classrooms as part of a plan for core support, supplemental support, and intensive support?

Based upon the findings of this study, we sought to develop a model of practice for including SDI within tiered systems of support for students with ESN that school administrators and policymakers can use to design math instruction within inclusive settings.

Method

Participants and Setting

This study was conducted in a suburban school system in the southeastern United States. The intervention was conducted by an educational team consisting of the general education teacher, paraprofessional, and special education teacher, within the resource pull-out and general education classroom. The study was conducted at two elementary schools with three students with ESN who received 80% or more of their instruction within the general education inclusive classroom with the same age- and grade-level peers. Participants were identified by recruiting a special education teacher at both schools and asking them to nominate one or two students who would benefit from SDI in numeracy and also met the following criteria: (a) identified as having an intellectual disability, (b) an ability to communicate verbally or with an augmentative communication system, and (c) consistent attendance (absent less than two times per month). Additionally, the special education teachers were asked to nominate the student's instructional team (i.e., general education teacher, classroom paraprofessional) to participate in the study. All student participants participated in the state's large-scale alternate assessments (if enrolled in a testing grade). The three students' grade levels ranged from kindergarten to fourth grade; all students were identified as having an intellectual disability; however, IQ scores were not gained due to school district confidentiality procedures.

Student Participants

Lilli was an 8-year old Caucasian third grade female with a mild intellectual disability and autism. She was able to speak verbally but tended to only vocalize with echolalic responses. She was very shy but did engage with her special education teacher in one-on-one activities. Lilli spent more than 80% of her instruction time within the general education classroom; however, at the beginning of the study, her math instruction was primarily provided only with one-to-one paraprofessional assistance. Math related IEP goals for Lilli included simple addition and set making. Additionally, her special education teacher pulled her out of her general education classroom into a separate resource room for early numeracy skill instruction, typically in a massed trial format (e.g., practice counting and adding sets).

Kyle was a 6-year old African-American male kindergartener with Downs Syndrome. Kyle communicated via picture/symbol images by choosing a response from an array of three to four items. Kyle did show limited attention and was easily distracted. He was receiving special education services under the category of Developmental Delay. Kyle spent more than 80% of this instructional time within the general education classroom; however, at the beginning of the study, his math instruction was primarily in one-to-one format with the paraprofessional in the classroom. It was noted by his instructional team that he needed this type of instruction due to his limited early numeracy skills. Kyle’s math related IEP goals included number identification, and concepts of more/less.

Sammy was a 9-year old Caucasian fourth grade male with a moderate intellectual disability and autism. He was able to communicate verbally. He interacted well with adults and students within the classroom and would often raise his hand to answer questions during the lesson; however, he typically did not know the answer. Sammy spent more than 80% of his instruction time within the general education classroom; yet, he was unable to participate meaningfully in the grade-aligned math lessons due to his limited numeracy skills and knowledge. Sammy's math related IEP goals included set making and simple addition. At the beginning of the study, Sammy did participate with his peers during math lessons but was not making any progress on the grade-level outcomes associated with the lesson. Sammy's special education teacher, who was the same as Kyle's, pulled both boys to the resource room for early numeracy skill instruction, typically in a massed trial format.

Teacher Participants

A total of five educational team members participated across the three student teams. Each student had a team of three people collaborating to plan for SDI through tiered instruction. Lilli attended school A, and both Kyle and Sammy attended school B. School B only had one special education teacher who supported both students. The three general education teachers had a range of experience from two years to 16 years. All three paraprofessionals had more than five years of experience, and the special educators both had eight years of experience. All educators and paraprofessionals were caucasian females.

Setting

All early numeracy skill instructional lessons were taught by the special education teacher in the resource classroom (Lilli and Sammy) or by the paraprofessional in the Kindergarten classroom (Kyle). EI trials were conducted in-vivo, in the general education classroom during ongoing math lessons. During the typical math lessons in the general education classroom, the entire class participated; however, data was only recorded on the target student (e.g., Kyle). Class sizes varied from 19-25 students. Thirty percent of early numeracy lessons, assessment probes, and general math lessons were video recorded. The initial educational team training occurred in a large training room in the district central office.

Materials

The *Early Numeracy* curriculum (Jimenez et al., 2013) was used to teach early numeracy lessons (i.e., new math skills). This math program was specifically developed for students with ESN. Prior research using this curriculum has only included participants in separate settings (e.g., Browder et al., 2012; Jimenez & Kemmery, 2013; Root et al., 2020). There are four units of instruction in the curriculum; however, only Unit 1 was used in this study. Each lesson within each unit addresses seven early numeracy domains: (a) counting, (b) sets, (c) symbol use, (d) patterns, (e) measurement, (f) calendar, and (g) numeral identification. The units are thematic (i.e., math is everywhere, math at celebrations, math in nature, math + me = fun). The five lessons within each unit use math stories, graphic organizers, and theme-based manipulatives (e.g., seashells) related to the theme to address skills within each of the seven early numeracy domains. Each unit also includes an assessment of the included early numeracy skills. Students are asked a question and respond verbally, via manipulatives, or via an array of three options (e.g., Make a set of 3). For additional information on materials included in the curriculum, see Jimenez and Kemmery (2013).

Within the curriculum Teacher's Guide, an EI template is introduced to support educators in planning where within a lesson and how (i.e., instructional strategies) the early numeracy skill taught via the *Early Numeracy* curriculum can be embedded to allow student practice of their newly forming early numeracy skills within an inclusive math lesson (see Figure 2 for an example). Teacher teams used this template to plan for, and record data on student achievement of early numeracy skills within inclusive math lessons as a Tier II support for repeated practice and generalization of Tier III instruction.

Experimental Design and Analysis

Research Design

A single case research design was used to demonstrate a functional relationship between the mathematics intervention and the dependent variables (i.e., acquisition and generalization of early numeracy skills). Specifically, the research design was a multiple probe across three students (Horner & Baer, 1978; Ledford & Gast, 2018). During the baseline phase, the early numeracy responses were probed for each student at a minimum of five sessions and until data was consistent for three sessions. Following baseline, instruction began with the first student, Lilli. Each student received *Early Numeracy* math lessons one time per week, with the same early numeracy skill instruction (i.e., learning trials of the same seven skills) embedded into the general inclusive math lessons within the student's classroom three times per week. Prior to the next student beginning the intervention, a change in level and/or trend was noted with Lilli's data. Once the next student was ready to begin the intervention, both students Kyle and Sammy completed an assessment probe to assure that their early numeracy skills data had remained stable. Once Kyle received the early numeracy intervention and began to show a change in level and/or trend, one additional data probe was conducted with Sammy to assure stable baseline data. Finally, Sammy was then introduced to the intervention, and data were collected until a change in level and/or trend was established.

Dependent Variable & Data Collection

Dependent Variables. The primary dependent variable was the number of independent correct early numeracy skill responses made by the student during the early numeracy assessment probe. Additionally, the secondary dependent variable was the number of correct early numeracy responses (generalization) made by the student during the inclusive math lesson. Early numeracy response data was collected via the *Early Numeracy* assessment of skills. Student responses to EI trials within the general inclusive math lesson (e.g., 'adding a pre-made set' within multiplication activity in a 3rd-grade classroom) were recorded using the EI Planning Template (see Figure 2). Finally, we recorded the fidelity of embedded instructional trials (i.e., number of embedded trials and use of systematic instruction procedures) by the educational team (i.e., general education teacher, paraprofessional) within the inclusive lesson.

Data Analysis. Only independent correct student responses during the math assessment probes were graphed and used for visual analysis of the data. Procedures followed guidelines to “meets evidence standards” for single-case research procedures set forth by the What Works Clearinghouse (WWC; Kratochwill et al., 2010); however, only one data probe was conducted immediately prior to entrance into the intervention phase for the final two students. For feasibility and due to very consistent low performance in baseline, students were not asked to repeat baseline three times to “meet (WWC standards) without reservation” (asking them to do something they consistently couldn’t perform, which may impact motivation and frustration). Data analysis consisted of visual analysis and calculating level, trend, and effect size for the dependent variables (i.e., early numeracy skill acquisition and generalization; Gast & Spriggs, 2014). To calculate the level, the researcher determined the stability of the intervention conditions. The data were considered stable if 80% of the data fell within 25% of the median (Gast & Spriggs, 2014). The researcher used the split middle method to calculate trends. The researcher divided the intervention data in half for each condition, drew a line between calculated mid-rate and mid-date, and determined whether each trend was accelerating, decelerating, or zero-celerating (White & Haring, 1980).

In addition to the traditional visual inspection of participant's performance data to determine the presence of a functional relationship, percentage of nonoverlapping data (PND) analysis was also conducted as an effect size (ES) measure. PND is one of the most widely used ES measure in single case research, and allows for ES to be measured with small data sets (Lenz, 2013). PND was calculated by (a) drawing a horizontal line across the greatest datum point in the baseline condition for each unit, (b) counting the total number of data points in the intervention condition, and (c) dividing the number of data points above the horizontal line in the intervention condition by the total number of data points in the intervention condition (Wolery et al., 2010).

Intervention Procedures

Baseline. Prior to baseline, all three students completed the *Early Numeracy* assessment to identify their current level of early numeracy skills. It was identified that Unit 1 of the curriculum was an appropriate starting point in the curriculum to meet all three participant's numeracy needs (< 80% skill mastery).

During the baseline phase, early numeracy responses were probed for each student at a minimum of three sessions until the data was stable. Prior to intervention, a minimum of five data probes was conducted in alignment with the WWC guidelines. During the baseline phase, students received their typical math instruction. Typical instruction in the general education classroom included whole group lessons, and one-on-one math instruction by the paraprofessional on other math-related topics (e.g., number identification, time to the hour, money identification). Typical resource level supports in mathematics consisted of 'pull out supports' with massed instruction (repeated trials in quick succession) of early numeracy skills (e.g., number identification, set making, counting, simple addition) aligned to the student's IEP goals, in one-to-one or small groups. During baseline sessions, instructional teams (general educator, special educator, paraprofessional) were told to continue lessons "as usual" and data was collected on the number of early numeracy skills students were able to perform independently correct based on the *Early Numeracy* assessment. Additionally, during baseline, the number of EI trials embedded within the inclusive lesson by any member of the inclusive team was recorded three times per week.

Training. All three instruction teams participated in a one-day 5-hour training and team planning session on using the *Early Numeracy* curriculum held in a central location in the school district. The training specifically addressed a rationale for early numeracy skill instruction, use of the curriculum, implementation of EI, description, and examples of least intrusive prompting and time-delay strategies (Collins, 2012), videos of the curriculum in practice, videos of EI (embedded science vocabulary instruction) in inclusive classrooms and a planning session to identify how to embed early numeracy skills within inclusive math lessons (e.g., number identification while measuring side of the triangle).

Specific emphasis was placed on instructional teams planning for embedded opportunities during lessons, beginning with role-play opportunities for all members of the team to teach sample lessons from the curriculum, and then opportunities for those skills to be embedded in the inclusive lessons for repeated practice with feedback and error correction. Although all three teams participated in the training prior to intervention, we staggered implementation of and access to the actual *Early Numeracy* curriculum one student (and team) at a time in order to establish experimental control. Student IEPs, the state extended content curriculum standards, and general curriculum current units of instruction of that particular grade-level were used to guide discussions and examples throughout the professional development. Teams were provided with the EI planning template to identify when and how students may be provided with opportunities to practice their early numeracy skills via EI, as well as an opportunity for teachers to practice collecting student data on independence or level of error correction needed (see Figure 2 for an example).

Early Numeracy Skill Instruction. The *Early Numeracy* curriculum is a research-based instructional program developed to build early numeracy skills in students via story-based lessons, systematic instruction, graphic organizers, theme-based manipulatives, and repeated practice. This curriculum was implemented by the ‘resource level’ special educator in a pull-out session one time per week, either in a 1:1 format or small group instruction (with other students not in the study who were also working on similar math IEP goals). The resource teacher taught the lessons in 15-20 minute sessions, using Unit 1 (based upon the pre-assessment of the three student’s current early numeracy level) of the curriculum. During the *Early Numeracy* lessons, the teacher would read the story, provide the student’s the graphic organizers and manipulatives. Students would then be asked to complete the math skills in the order they were introduced in the lesson. For example, after reading a story about “Fishing with Grandpop”, in which the young boy catches two fish and his grandfather catches one fish, the student would be asked to make a set of two using the graphic organizer and manipulatives, then repeat the skill to make a set of one. Finally, the student would be asked to count how many ‘fish’ they caught all together. If the student was not able to complete any of these skills independently, the teacher would then provide support using systematic instruction (i.e., error correction with least-intrusive prompts; verbal, model, physical).

Early Numeracy Data Probes. Each unit of the *Early Numeracy* curriculum consists of 12 early numeracy skills; data was only collected on 11 of these skills. Rote counting was not included in data collection because not all students were verbal; therefore, this skill could not be collected across all three students. Rote counting was still included in lessons. Data probes were collected on student independent completion of the math skills during the math lessons taught once per week. Student data was recorded by the special education teacher and coded as correct (+) or incorrect (-) to indicate no response or that the student needed prompts/error correction. All sessions were observed by the first author in person or via video recordings. IOA was taken on a random selection of at least 40% of sessions.

Embedded Instruction. Educational teams were asked to embed at least four early numeracy skills per lesson (making sure to embed at least one trial per week of each of the 11 skills) and not spend more than 20-30 minutes per week planning for EI. Planning sessions were intended to allow teams to develop ideas for EI but also allowing for unplanned teaching opportunities to be utilized, increasing the sustainability and feasibility of EI across multiple math units and the school year. Teams used the planning template (see Figure 2) to plan for when (potential opportunities during the upcoming math lesson/unit) and how (prompting method) they may embed early numeracy skill opportunities for the student using constant time delay (e.g., number identification, symbol recognition) or least intrusive prompts (e.g., measurement, set making). The prompting method used during EI was the same instructional strategies used in the *Early Numeracy* curriculum lessons.

EI data collection. Although instructional teams were asked to embed a minimum of four skills, they were not instructed on the total possible number of EI trials per lesson, nor were they instructed on who should embed the trials (e.g., paraprofessional). Teams were directed to collect data on the level of prompting needed for the student to correctly demonstrate the early numeracy skill during the inclusive math lessons (e.g., error correction needed, independent – no prompts). The instructor (e.g., general education teacher) allowed the student to first answer independently, only providing prompting as needed. Data was collected three times per week using the EI planning template, and all lessons were observed in person or via video recording for IOA data collection purposes.

Reliability. To ensure fidelity and reliability, the first and second author served as a second coder. Both in vivo and permanent product (video) observations were used.

Implementation Fidelity**.** To ensure fidelity of each component of the intervention, a procedural fidelity checklist was developed. For the teacher training, a 15-step procedural fidelity was used to assure the first authors' adherence to the planned outline of the training session, including practice and feedback to participants on the implementation of the curriculum and systematic instruction procedures (i.e., time delay, least intrusive prompts). The percentage of agreement was calculated at 100%.

For the implementation of the *Early Numeracy* curriculum by the two special educators, a 10 step 20-point procedural fidelity checklist was used to assure the special educator's adherence to the lesson plan, scripted systematic instruction procedure, and the correct level of student performance contingent praise/feedback. Teacher fidelity was collected on a minimum of 40% of lessons for each teacher. Procedural fidelity agreement was calculated at a mean of 98% across participants with a range of 92-100%.

Interobserver Agreement. Interobserver agreement (IOA) measured the reliability of the dependent measures, the number of early numeracy skills performed correctly during *Early Numeracy* lessons and EI trials. IOA was computed as agreements divided by agreements plus disagreements. IOA was taken on 40% of baseline sessions with 100% agreement and 44% of all intervention sessions with 98% agreement (range 92-100%) for Lilli. IOA was taken on 50% of baseline sessions with 100% agreement and 50% of all intervention sessions with 100% agreement for Kyle. IOA was taken on 67% of baseline sessions with 100% agreement and 50% of all intervention sessions with 100% agreement for Sammy.

Maintenance. Two weeks for Lilli and Kyle and one week for Sammy after the completion of the intervention, a maintenance probe was conducted to measure how well the students retained the skills learned during the study. Individually, each student participated in an assessment probe identical to those during the intervention.

Results

Visual inspections of the graph show a functional relationship between the introduction of the intervention and a change in level and trend across all three participants (see Figure 3). In addition, according to guidelines provided by Scruggs and Mastropieri (1998), the results of the effect size measure, PND demonstrated a highly effective intervention (0.90 –1.0) for two of the three students (Kyle 100%, Sammy 100%).

Lilli

During baseline probe sessions, Lilli correctly responded to a mean of 7.6 out of 11 assessment items (range of 7-8). During the intervention, Lilli correctly demonstrated a mean of 8.4 skills (range of 6-10). Although there was not an immediate change in level and trend, she began to increase her number of correct responses on the second assessment probe. Lilli met the mastery criteria of an addition of two new numeracy skills correct for two consecutive sessions after the eighth probe session. Lilli maintained the same number of correct responses two weeks after intervention.

Kyle

During baseline probe sessions, Kyle correctly responded to a mean of 2 out of 11 assessment items (range of 1-3). During the intervention, Kyle correctly demonstrated a mean of 5 skills. There was an immediate change in level once the intervention was introduced. Kyle met the mastery criteria of an addition of two new numeracy skills correct for two consecutive sessions after the second probe sessions. Kyle maintained the same number of correct responses two weeks after intervention.

Sammy

During baseline probe sessions, Sammy correctly responded to a mean of .7 out of 11 assessment items (range of 0-1). During the intervention, Sammy correctly demonstrated a mean of 6.3 skills (range of 5-7). There was an immediate change in level and trend once the intervention was introduced. Sammy met the mastery criteria of an addition of two new numeracy skills correct for two consecutive sessions after the second probe sessions. He also maintained the same number of correct responses during the maintenance probe.

Embedded Instruction of EN skills

Student acquisition and generalization of early numeracy skills within the general education inclusive math lessons were demonstrated across the intervention phase. All embedded instruction opportunities were recorded, and student independent correct responses were recorded. Lilli correctly demonstrated an average of 32% (range 0-63%) of the early numeracy skills embedded per lesson. Kyle correctly demonstrated an average of 25% (range 0-64%) of the early numeracy skills embedded per lesson. Sammy correctly demonstrated 88% of the early numeracy skills embedded per lesson. The range of correct answers corresponded (Lilli, Sammy) or exceeded (Kyle) with each student's *Early Numeracy* skill assessment performance, demonstrating student generalization across settings, teachers, and contexts (i.e., multiplication lessons, math stories about addition/subtraction, linear equations, geometric lines and angles, and polygons). Specifically, Kyle was able to correctly perform 5 out of 11 (45%) early numeracy skills during *Early Numeracy* lessons; however, during embedded trials his performance ranged from zero correct during the first week of instruction to 64% correct (7 out of 11 correct) during the final week of instruction.

Feasibility of EI across instructional teams

Due to the nature of the EI portion of the intervention's flexibility for the educational team members to determine the number of skills, which early numeracy skills (at least 4 out of 11) best fit the learning intentions of the lesson/unit, and when they wanted to embed the trials, data was collected on the number of trials embedded per lesson. Educational teams embedded an average of 6.6 trials per lesson with a range of 4-11 trials. There was a range of trials provided across each of the teams and lessons.

Additionally, at the conclusion of the study, the special education teacher, general education and paraprofessionals were asked to complete a 4 question social validity survey based on a 5-point Likert scale (5 strongly agree - 1 strongly disagree) regarding their: (a) feelings towards the intervention of *Early Numeracy* instruction one time per week and EI within the inclusive classroom to support SDI, (b) their child's educational numeracy outcomes, (c) feasibility of EI during grade-aligned inclusive math lessons, and (d) recommendations for continued use. Both special educators, two of the three of the general educators, and two of the three paraprofessionals participated in the survey and indicated that they "strongly agreed" that math intervention was appropriate and made a positive impact on student learning. All educators indicated that they would like to see continued use of the *Early Numeracy* skill instruction as an individualized Tier III support for students, along with ongoing, embedded instruction in the inclusive math lessons. Additionally, the special and general educators noted that a focus on IEP skill instruction both as explicit individualized instruction, then embedded within the ongoing math lessons, provided their educational teams a focus for planning and shared teaching goals. Finally, all participants either "agreed" or "strongly agreed" that embedded systematic instruction was easy to use, and two participants (one general educator and one paraprofessional) noted that EI became easier with practice. One general educator stated that EI started to be "almost natural".

Discussion

The objective of this study was to extend previous mathematics research for students with ESN (e.g., Browder et al., 2012; Jimenez & Kemmery, 2013) by providing foundational early numeracy skill instruction within a tiered system of support within inclusive education. Through this research, we sought to provide a research-based model of practice that schools can use to develop SDI through tiered systems of support for all students, including those with ESN. Specifically, we investigated the effect: (a) of explicit early numeracy skill instruction on student numeracy skill acquisition, (b) of embedded instruction (EI) of early numeracy skills on student acquisition and generalization of skills, and (c) the feasibility of EI across instructional teams in elementary mathematics classrooms.

Visual analysis and the PND effect size measure indicate a functional relationship was established between the use of the early numeracy intervention (i.e., Tier III- resource level individualized instruction support paired with Tier II – priority learning embedded early numeracy skills within-grade aligned instruction) and student skill acquisition. These findings suggest that EI was a feasible and successful practice to support student SDI within a tiered support model. It should be noted that it is possible to conceptualize the *Early Numeracy* lessons and/or the embedded numeracy skills as Tier II or Tier III supports, clear guidelines regarding which tier each intervention lays do not exist. However, rather than hard line rules regarding where each intervention belongs, the emphasis of SDI within a tiered framework should remain on providing increasing intensity of supports 'in addition to' the previous tier to promote student success.

This study adds to the research that supports the use of EI as part of a robust implementation of SDI in inclusive settings. Historically, placement decisions for students with ESN have typically been based upon the assumptions and beliefs about student learning rather than student need (Agran et al., 2020). Regardless of the plethora of positive outcomes inclusive education has demonstrated for this population of students, students with ESN are still not being placed in general education classrooms (Kurth et al., 2015). Consequently, when reviewing the research that has been conducted in inclusive settings with students with ESN, fewer have taken place in general education mathematics settings compared to the reading and science classroom (Hudson et al., 2013).

Legally, educational administrators know there is a clear definition of MTSS and SDI but how educators go about implementing these for students with ESN requires models of instruction in action. Within a MTSS, the goal should always be to serve the student in the most appropriate environment; not to remove students out of the tiered system or to exclude students from the process. Given the data-driven team-based problem-solving approach of MTSS, system-wide implementation has the potential to include students with ESN from the commencement, rather than more restrictive settings (Agran et al., 2020; Sailor et al., 2018). The current study provides a research-based model of how to do just that. Administrators and policymakers can use these findings to serve as a model of how to align key initiatives many districts are implementing currently while also maximizing the educational environment to serve those who need it most.

Future Directions

Although this study provides positive findings and a model to support SDI within the inclusive math classroom, more research should be completed to understand the complexities of aligning SDI and MTSS. There were a few limitations of the research that should be considered in the interpretation of the results that should guide future research. Intervention data was collected during story-based early numeracy lessons. While the baseline data was not collected in a contextualized application, all data collected during the math lessons corresponded one-to-one with the *Early Numeracy* assessment probes in baseline; with the teacher asking the student to perform each skill with the same manipulatives. Another limitation to the finding of this study was that the second dependent variable was not able to be rigorously tested. Student accuracy data of EI early numeracy skills began as soon as students entered the intervention phase, students did not always perform those skills independently correctly, as would be expected during the acquisition stage. The EI was part of the intervention, an opportunity for students to receive prompting and feedback. Due to the lack of EI prior to the study intervention, it was not possible to take baseline data on student or teacher performance during this time. Additionally, teachers were provided flexibility (to increase feasibility and sustainability of the intervention) to embed numeracy skills that aligned with the math lessons being taught. Upon analysis of the embedded trials across students, all students were consistently provided a minimum of two embedded opportunities of each of the 11 skills per week; however, some skills (e.g., number identification, making sets) were embedded at a higher rate. Higher rates of systematic practice with feedback may have increased the performance of those specific skills. Analysis of student performance data also indicates that those skills practiced more often were the same skills mastered by the students (i.e., Figure 3). Skills such as, calendar use and patterning were not embedded as often, and were not the skills mastered by the students. More research is needed to determine if those skills are more complex; therefore harder for students to acquire in short periods of time, and/or the relationship to repeated practice (embedded trials).

Finally, although Kyle did move from no early numeracy skills mastered during baseline to an immediate increase in numeracy skills, he did not master more than five skills out of the possible eleven. Similarly, Sammy hit a ceiling of seven skills correct and Lilli's data was somewhat variable (dip in trend). It is not clear what caused a dip in Lilli's data during the intervention. The current data paths may have been due to the limited time of the study (end of the school year), more analysis of which skills were difficult for which student (unmastered skills varied across students; e.g., patterning, calendar, symbol use) and why may be helpful in future research. However, with the increased new math skills across all students within only five-eight weeks time, this may be considered a high rate of progress.

Additionally, one of the essential components of this intervention was the natural planning teachers, paraprofessionals, and special educators engaged in to determine how to embed the same early numeracy skills that occurred during pull-out individualized instruction into inclusive math lessons. To allow this intervention to occur naturally, depending on the unit of instruction (e.g., morning calendar, geometric shapes, and angles, linear equations), differing number of embedded trials were provided to each student from lesson to lesson, therefore only percentages of correct responses were compared across lessons and students. While a threat to consistent treatment across participants, the researchers tried to maintain a natural context of inclusive education by not overprescribing an intervention that was disingenuous and essentially unsustainable over time.

Further research should be conducted to monitor student progress over time using group experimental and/or single-case research methods in which experimental control is specifically monitored for student correct embedded opportunities. While student performance during EI has been recorded and positive effects found (Jimenez & Kamei, 2015), prior research has required special education teams to embed a specific number of trials per lesson, which may not be the most natural way which teams plan and work. With a continued call for researchers to address the need to support research to practice within the development of interventions (Cook & Farley, 2019) this study tried to identify how the intervention could maintain enough systematic and explicit guidelines while allowing the special education team to guide the intervention (number of skills embedded within each math lesson that felt appropriate to the learning outcomes, rather than force-fitting skills into a lesson for 'trial sake').

Concluding Thoughts

This study utilized an evidence-based practice (i.e., EI) to support the early numeracy skills of three students who participated in inclusive education. Due to the specific learning needs of each student, it was important to identify the numeracy skills they needed to gain while also taking into consideration how they could receive SDI through a tiered system of support with individualized instruction embedded for focused skill gaps if alignment with the lesson (see Figure 1). Rather than only pull the students from their inclusive settings to receive intensive systematic instruction, students were able to gain repeated individualized instruction with error correction and feedback embedded within the inclusive math lessons through the use of EI and carefully crafted SDI. As administrators and educational leaders work to use MTSS to implement SDI, they may consider these results. By using this model of practice, they can provide instruction and intervention, a feasible and sustainable way that helps all students make academic progress and gain access to mathematical content.

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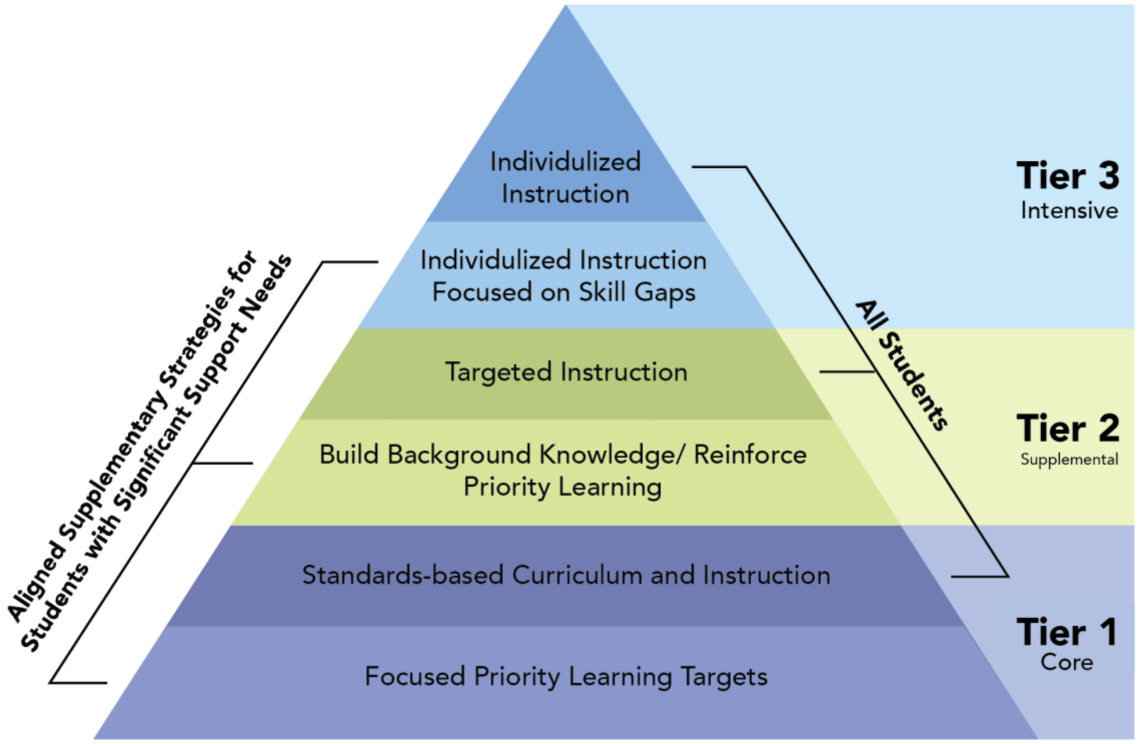
Figure 1

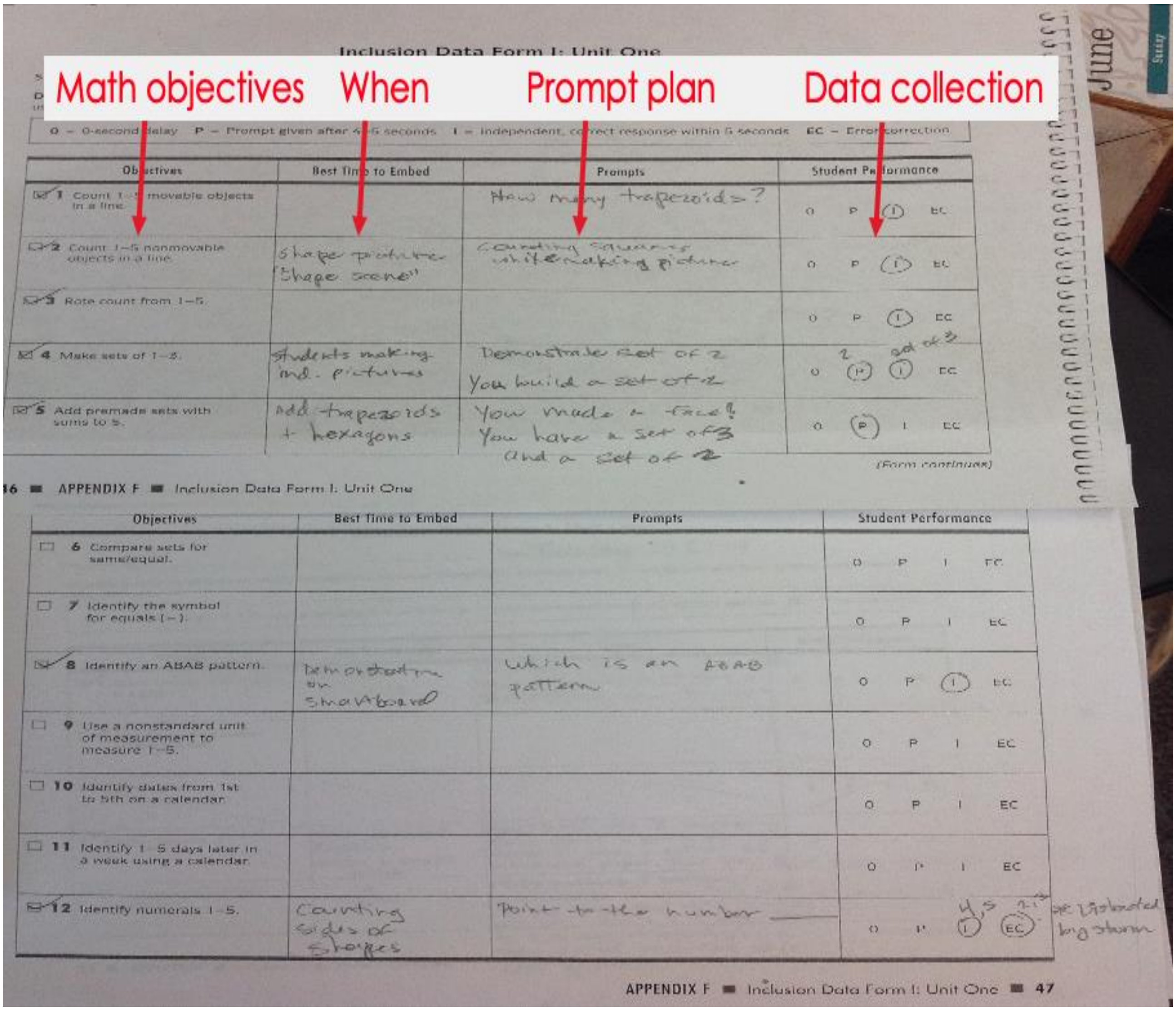
Instruction for Students with Extensive Support Needs within MTSS



Design Copyright Barron 2020; Adapted from Thurlow, M. L., Ghere, G., Lazarus, S. S., & Liu, K. K. (2020). MTSS for all: Including students with the most significant cognitive disabilities. Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. TIES Center

Figure 2

Sample Embedded Instruction Planning Template



Inclusion Data Form I: Unit One

O – 0-second delay P – Prompt given after 4–5 seconds I = Independent, correct response within 5 seconds EC – Error correction

Objectives	Best Time to Embed	Prompts	Student Performance
☑ 1 Count 1–5 movable objects in a line.		How many trapezoids?	O P I EC
☑ 2 Count 1–5 nonmovable objects in a line.	Shape picture "Shape scene"	Counting squares while making picture	O P I EC
☑ 3 Rote count from 1–5.			O P I EC
☑ 4 Make sets of 1–5.	Students making ind. pictures	Demonstrate set of 2 You build a set of 2	O 2 P+ set of 3 I EC
☑ 5 Add premade sets with sums to 5.	Add trapezoids + hexagons	You made a face! You have a set of 3 and a set of 2	O P I EC

(Form continues)

46 ■ APPENDIX F ■ Inclusion Data Form I: Unit One

Objectives	Best Time to Embed	Prompts	Student Performance
☐ 6 Compare sets for same/equal.			O P I EC
☐ 7 Identify the symbol for equals (=).			O P I EC
☑ 8 Identify an ABAB pattern.	Demonstrating on Smartboard	Which is an ABAB pattern	O P I EC
☐ 9 Use a nonstandard unit of measurement to measure 1–5.			O P I EC
☐ 10 Identify dates from 1st to 5th on a calendar.			O P I EC
☐ 11 Identify 1–5 days later in a week using a calendar.			O P I EC
☑ 12 Identify numerals 1–5.	Counting sides of shapes	Point to the number ___	O P 4, 5 I 2, 1 EC Distracted by storm

APPENDIX F ■ Inclusion Data Form I: Unit One ■ 47

Figure 3

Student Early Numeracy Skills Independently Correct