Abstract Title Page

Title: The Evolution, Design and Implementation of the Minds in Motion Curriculum

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Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Description of prior research and its intellectual context.

Building on the empirical work of the previous two studies, this paper describes the development of the Minds In Motion curriculum, as well as the setting and circumstances of a randomized controlled trial conducted to evaluate this intervention. Throughout this paper we emphasize the benefits and challenges of assembling an interdisciplinary team of researchers and practitioners from disparate fields into a team focused on developing a mature intervention. The fourth paper in this symposium will describes the results of the randomized controlled trial.

Setting:

Description of the research location.

The Minds In Motion curriculum was evaluated as a component of the WINGS for Kids© after-school program located in three schools in North Charleston, SC. WINGS for Kids© is a structured after-school program that serves socio-demographically disadvantaged elementary students for 3 hours daily. The WINGS for Kids© curriculum emphasizes social and emotional learning (SEL) objectives through large and small group activity sessions that follow a regular schedule at all WINGS schools.

The schools and communities that are served by WINGS have high levels of social, economic, and academic risk. Over 90% of students in the district are Black, over 90% are eligible for free or reduced-price lunch, and large percentages of students in the study schools do not meet statewide proficiency standards (42% for reading, 52% for writing, 50% for math, 65% for science). Further, the graduation rate for the high school attended by students in the study schools was 34.3% in 2007-08, compared to 73.2% for the nation as a whole (Cataldi, Laird, & Kewal Ramani, 2009; McGinley, Rose, & Donnelly, 2010). These characteristics suggested that the children we enrolled in the study would be likely to have low fine motor skills and executive function (Grissmer & Eiseman, 2008).

Population / Participants / Subjects:

Description of the participants in the study: who, how many, key features, or characteristics.

The children who participated in the MIM study were kindergartners and first graders recruited from the WINGS program in three schools in North Charleston. Eighty-six children entered the study, including 78 African-Americans (91%), 3 Caucasians (3%), 2 Hispanics (2%), and 3 multiracial children (3%). Forty-eight (56%) of the children were male, and 82 (95%) qualified for free or reduced-price lunch (FORL). The mean age of participants at the start of the study was 6.0 years old with a range from 4.9 to 7.7 years old.

Intervention / Program / Practice:

Description of the intervention, program, or practice, including details of administration and duration.

A Process for Intervention Development. The Minds in Motion study began with a traditional definition of the main construct, fine motor skills, and the creation of its related intervention, an occupational therapy (OT) derived curriculum created to improve sensory motor skills in normal children. Using an interactive discussion process drawing from experience in the field together with knowledge gained from the literature, we learned from our conceptual and field-based mistakes. We leveraged areas of mismatch between our construct, the intervention, and our research goals to intensively re-examine and ultimately re-invent the intervention.

Five general lessons emerged. First, we learned that constructs may be defined differently across disciplines. For example, differing perspectives on fine motor skills were revealed by a deeper look at the ECLS-K variable labeled “fine motor”. The task most significantly related to achievement (design copying), appeared more complex than simply targeting and improving small muscle movements in the hand, the traditional task of fine motor skills from the field of occupational therapy. We recognized that math achievement is not bolstered by improving small muscle movements per se, but instead by the processes involved in copying a design. We thus re-evaluated whether the occupational therapy-derived activities were addressing our research focus: improving math through a motor pathway. Second, we discovered that clinical techniques may not work with normally developing children. Early in the course of the intervention, we observed a lack of relevance of clinical techniques to our non-clinical population. The rote, repetitive motor activities were neither challenging nor engaging for our students. Third, we discovered that instruction does not automatically transfer from individualized to group format. The scalability of individualized OT techniques to small groups was not workable, leading to large amounts of lost instructional time. Fourth, expertise in one’s field requires time and labor intensive training. While the program implementers participated in lengthy training sessions, they were not formally certified therapists and therefore did not know how to provide constructive feedback to students related to the tasks introduced (e.g. pencil grip, crossing midline). Finally, we learned the value of teacher-child relationships. With our instructors new to the schools and the students, each underwent a period of rapport-building and limit-testing during which behavioral issues interfered with students’ time on task.

Minds in Motion Redefined. Based on these lessons, we reinvented the curriculum and ultimately implemented it successfully with a population of children at high risk for academic failure. Minds in Motion was newly grounded in strong empirical findings that link design copying tasks to achievement, especially in math (Cameron, Brock, et al., 2012; Grissmer, et al., 2010; Murrah, 2010), with the majority of the MIM curriculum consisting of similar constructional tasks requiring children to visually perceive a pre-determined design or model, and then recreate it in 2 or 3 dimensions. Curriculum activities now targeted visuospatial, EF, and sensorimotor skills, having been developed under the collective expertise of professionals with knowledge of these cognitive skills, including psychologists, teachers trained in the Waldorf and Montessori traditions, math educators, and occupational therapists.

The revised MIM curriculum consisted of structured lessons that drew heavily from play-based materials, arts-and-crafts activities, and games. Activities were chosen to exercise children’s design copying skills to increase mathematics directly as well as indirectly through improving visuospatial, EF, and sensorimotor skills. Several “templates” were developed for each design copy activity, which varied in difficulty to allow for differing initial skill levels among the children, and provide a challenge them as their skills improved (see Figure 1).

In structured lessons the instructor first demonstrated how to create the design, and children then copied these designs using colorful arts and crafts materials such as waxed yarn, heat-fused beads, clay, pattern blocks, and other commercially available building toys. The children were also encouraged to engage in structured free-play with materials. Each session had a main activity centered on a design copying task that typically consumed over half of the time.

A small number of tracing and motor precision activities were also included in the lessons. Anecdotal data from children in our sample suggests that they had little prior exposure to the materials used in the intervention. This supports Ramani and Siegler's (2011) finding that middle-income children have much greater access than Head Start children to commonly available commercial games.

The intervention was administered after school in a 45-min period, 4 days a week, for a maximum of 28 weeks. The average number of sessions attended by children was 73. Seven experienced instructors from the WINGS staff administered the intervention. Eleven hours of training for instructors in the MIM curriculum was provided across three sessions during the intervention period. Lesson plans were written for each 45-min period in a prescriptive, yet flexible manner that allowed for adults who were not trained teachers to successfully implement the intervention. Each instructor worked with four to seven children in a mixed-gender group.

During the direct training (divided equally across three sessions), we explained the research constructs, questions and logic model; the structure of the program was presented on a monthly and daily level; and the lessons were modeled individually with opportunities for hands-on, guided practice. We provided each instructor with a training binder that included a "Month-at-a-Glance" calendar of activities for the entire curriculum (see Table 2), attendance and student feedback forms, lesson plans, and handouts. In addition, instructors received all materials needed for individual lessons during the 8-week period of the training. Ongoing field training was also provided in the form of observations with feedback sessions, behavior management support, and scaffolding of specific lessons as needed.

All 36 lesson plans in the 27-week MIM curriculum are fully developed. Lessons are written in a prescriptive, yet flexible manner that allow for heterogeneity in children's skill levels, and for fairly inexperienced adults receiving minimal training to be successful implementers of the intervention. Materials and lessons are highly interesting to children, relatively low in cost, and easily manageable in a small group setting of approximately five to seven mixed gender children.

Research Design:

Description of the research design.

See Paper 4 in the Symposium

Data Collection :

We selected the measures described below because they align with the constructs identified in the theory of change, demonstrate scientific properties of reliability and validity, are appropriate for young children, and can be administered in a school context. Outcomes included both direct assessments and teacher surveys (see Table 3).

Visuospatial skills, executive function, and sensorimotor skills. Pre- and post-intervention assessments were completed of children's skills across three domains (visuospatial, executive function, and sensorimotor skills) using relevant subtests from the *NEPSY* (*A Developmental Neuropsychological Assessment*; Korkman et al., 1998). The NEPSY is a comprehensive neuropsychological assessment battery for children aged 3-12 years that is considered useful in identifying the cognitive mechanisms that underlie achievement. We used seven subtests from the three domains of interest: Arrows and Design Copying (from visuospatial domain); Tower, Auditory Attention , and Visual Attention (from executive function domain); and Visuomotor Precision and Imitating Hand Positions (from sensorimotor domain). One indirect measure, the *Motor Skills Rating Scale*, was administered to assess teacher perceptions of children's fine motor skills in the classroom (Cameron, Chen, et al., in press); this measure predicts teacher ratings of children's mathematics skills, as well as their mathematics achievement, using a standardized measure.

Mathematics/academic skills. Mathematical skills were directly assessed using Numeration, Geometry, and Measurement subtests from the *KeyMath3 Diagnostic Assessment (KeyMath3*; Connolly, 2007), the *Test of Early Mathematics Ability – Third Edition (TEMA-3*; Ginsberg & Baroody; 2003), and the Applied Problems subtest from the *Woodcock-Johnson III, Tests of Achievement* (*WJ-III-A*; Woodcock; McGrew, & Mather, 2001). The Academic Knowledge subtest from the WJ-III-A was also given as a measure of children's general knowledge of science, social studies, and humanities. Children's mathematical skills were indirectly assessed through teachers' reports using the Mathematical Thinking subscale of the *Academic Rating Scale* (*ARS*; NCES, n.d.).

Socio-behavioral skills. Socio-behavioral ratings were also collected from kindergarten and 1st grade teachers using the *Social Skills Improvement System* (*SSIS*; Gresham & Elliott, 2008), and the *Child Behavior Rating Scale* (*CBRS*; Bronson et al., 1990). Both are widely-used and validated teacher-reported measures of an individual child's relationships, social behaviors, and self-regulation in the classroom.

We assessed intervention fidelity to test explanations of the strength of the intervention compared to the counterfactual, accounting for differential effects in the treatment group, and identifying the relative importance of core intervention components (Hulleman & Cordray, 2009). To this end we collected multiple occasions of video data for each instructor. We collected six 45-minute video cycles per 7 instructors (42 videos, 31.5 hours total). Videos were coded using the Classroom Assessment Scoring System (CLASS) measure of adult-child interactions (Pianta, La Paro, & Hamre, 2008). We plan to develop specific measures of fidelity that are tailored to the MIM curriculum. As we follow children into late elementary school, a measure of fidelity may enable us to explain variability in long-term impacts.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

See Paper 4 in the Symposium

Appendices

Not included in page count.

Appendix A. References

References are to be in APA version 6 format.

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Appendix B. Tables and Figures

Table 1. Minds in Motion: Glossary of Activities/ Materials for 27 Week Curriculum

1. Callirobics
2. Clay Work
3. Colorforms
4. Colorforms Categories
5. Finger Crocheting
6. Fuse Beads
7. Game Time!
    a. Card Games- War, Go Fish, Old Maid.
    b. Dominoes
    c. Kanoodle
    d. Kerplunk*
    e. Lite Brite
    f. Memory
    g. Perfection
8. God's Eyes
9. Large Group Activities Using Hand Motions, Songs, Rhythm and Gestures
    a. Ah-So-Gi
    b. Button Song
    c. The Chicken Game
    d. Concentration
    e. Father Abraham
    f. Fruit Reactions
    g. Head-Shoulders-Knees-Toes
    h. Hot Potato
    i. If You're Happy and You Know It
    j. Itsy-Bitsy Spider
    k. Miming and Mirroring
    l. Miss Mary Mac
    m. One Fat Hen, A Couple of Ducks
    n. Pom Pom Relay
    o. Princess Pat
    p. Red Light Green Light
    q. Rhythm with Instruments
    r. Wheels on the Bus
    s. Where is Thumbkin?

10. Legos
11. Legos Group Scene
12. Legos Teamwork
13. Multimodal Drawing Using Crayon, Chalk, Markers and Colored Pencils
14. Paper Pencil Activities
15. Pattern Blocks
16. Pattern Blocks Categories
17. Pattern Blocks Teamwork
18. Pin Punching
19. Play Doh
20. Rain Stick Making
21. Scissor Work- Include paper chains, placemats and snowflakes
22. Stamper Creations
23. Stained Glass
24. Stencil Drawing
25. Tambourine Making
26. Wiki Stix
27. Wiki Stix Copy Cat
28. Wiki Stix Mystery Design
29. Zoob

Table 2. Minds in Motion Fine Motor Skills Curriculum Sample, Weeks 21-28

(Wk21) March 28- Mon	**March 29- Tues**	**March 30- Weds**	**March 31- Thurs**
Arts and Crafts- **Stamp Pad and Stamper Creations**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Lite Brite, Kerplunk, Memory)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Pattern Blocks- Teamwork**	**VARIETY DAY** Stamp pad, Pattern Blocks, Cards,
(Wk22) April 4- Mon	**April 5- Tues**	**April 6- Weds**	**April 7- Thurs**
Arts and Crafts- **Fun with Clay**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Lite Brite, Memory, Perfection)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Legos- Teamwork**	**VARIETY DAY** Stamp pad, Legos, Clay
(Wk23) April 11- Mon	**April 12- Tues**	**April 13- Weds**	**April 14- Thurs**
Arts and Crafts- **ZOOB!**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Dominoes, Perfection,Kanoodle)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Wiki Stix- Mystery Design**	**VARIETY DAY** Wiki Stix, Zoob, Legos
(Wk24) April 18	**April 19- Tues**	**April 20- Weds**	**April 21- Thurs**
SPRING BREAK NO WINGS	SPRING BREAK NO WINGS	SPRING BREAK NO WINGS	SPRING BREAK NO WINGS
(Wk25) April 25- Mon	**April 26- Tues**	**April 27- Weds**	**April 28- Thurs**
Arts and Crafts- **Drawing with Stencils**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Cards, Kanoodle, Memory)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Colorforms- Categories**	**VARIETY DAY** Stencils, Colorforms, Clay

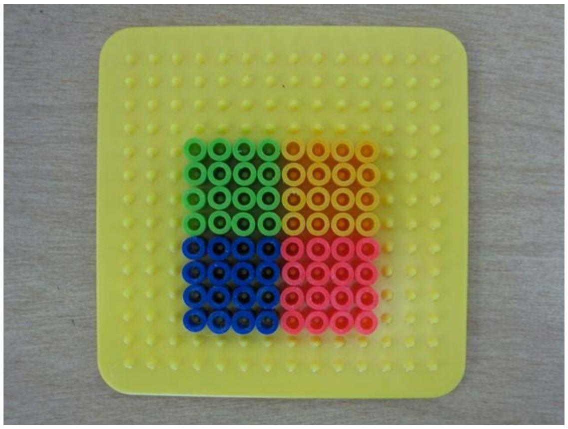
(Wk26) May 2- Mon	May 3- Tues	May 4- Weds	May 5- Thurs
Arts and Crafts- **More Stamp Pad Creations**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Kerplunk, Perfection, Cards)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Legos- Group Scene**	**VARIETY DAY** Fuse Beads, Pattern Blocks, Stamp Pads
(Wk27) May 9- Mon	**May 10- Tues**	**May 11- Weds**	**May 12- Thurs**
Arts and Crafts- **Wiki Stix- Copy Cat**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Kanoodle, Lite Brite, Perfection)	Paper and Pencil Activities (10 min.) Arts and Crafts- **More ZOOB!**	**VARIETY DAY** Wiki Stix, chalk, cards
(Wk 28) May 16- Mon	**May 17- Tues**	**May 18- Weds**	**May 19- Thurs**
Arts and Crafts- **More Fun with Clay**	Paper and Pencil Activities (10 min.) **GAME TIME!** (Cards, Dominoes, Kerplunk)	Paper and Pencil Activities (10 min.) Arts and Crafts- **Pattern Blocks- Categories**	**VARIETY DAY** Finger Crocheting, Paper chains, Zoob

Table 3. Assessment Battery for Minds in Motion

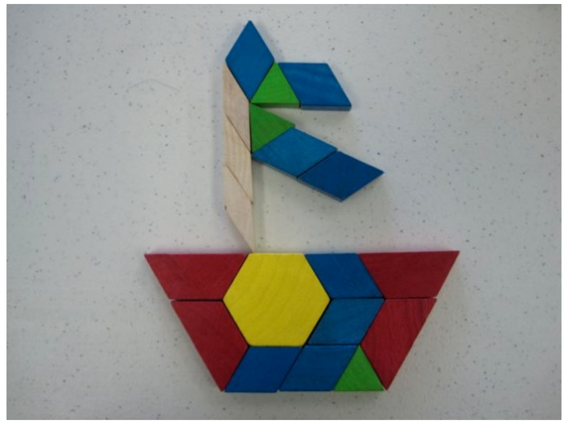
Visuospatial Processing			
Measure Name and Author	*Measure Description*	*Sub-Scales*	*Psychometric Properties*
NEPSY: A Developmental Neuropsychological Assessment (Korkman, Kirk, & Kemp, 1998)	The NEPSY was developed to assess neuropsychological development in pre-school and school-age children. The authors provide standardized information on performance relative to age-based expectations. Theoretical underpinnings are well-established.	On **Arrows**, the child has to identify which of several arrows are directed at a central target; on **Design Copying**, the child has to copy increasingly complex figures using a pencil.	Subtest reliability ranges are predominantly high (and, if not, are acceptable). Inter-rater reliability (Design Copying) is high.
Sensorimotor Functioning			
Measure Name and Author	*Measure Description*	*Sub-Scales*	*Psychometric Properties*
NEPSY (see above)	See above.	On **Imitating Hand Positions**, the child has to copy a series of finger/hand positions, as modeled by the examiner. On **Visuomotor Precision**, the child has to trace a pencil line on a narrow path under time pressures.	Subtest reliability ranges from acceptable to high. Inter-rater reliability (Visuomotor Precision) is high.
Executive Functioning			
Measure Name and Author	*Measure Description*	*Sub-Scales*	*Psychometric Properties*
NEPSY (see above)	The Executive Functioning scales of the NEPSY measure auditory and visual attention, together with planning and inhibition.	On **Visual Attention** the child has to locate and mark instances of a specified target(s) in a confusing visual field under time pressures; on **Auditory Attention and Response Set**, he or she listens to an audiotape and must give a specified response or inhibit responses to color and non-color words; on **Tower**, he or she must move colored balls in a planful sequence to arrive at a specified finish point.	Subtest reliability ranges from acceptable to high.

ACADEMIC ACHIEVEMENT: Math Skills; General Knowledge			
Measure Name and Author	*Measure Description*	*Sub-Scales*	*Psychometric Properties*
Test of Early Mathematics Ability – Third Edition (TEMA-3; Ginsburg & Baroody, 2003).	The TEMA-3 was developed to provide information about mathematical skills and understanding of young children, including knowledge acquired through experience and that obtained through schooling.	The TEMA-3 is a single-scale test that assesses such concepts as numeracy, comparisons, one-to-one correspondence, and early operations.	The subtests demonstrate high reliability and good validity.
Key-Math-Third Edition (Key-Math 3; Connolly, 2007).	The Key-Math 3 is a comprehensive, norm-referenced measure of essential mathematical concepts in skills for school-age (including college) individuals.	The **Numeration** subscale measures number awareness, place value, and magnitude. The **Geometry** subscale measures early geometric awareness and shapes. The **Measurement** subscale assesses early awareness of measurement, time, and money.	The subtests demonstrate high reliability and good validity, with a few exceptions for the youngest children (which relates to the study decision to augment math pre-testing).
The Woodcock-Johnson-III Tests of Achievement (WJ-III; Woodcock; McGrew, & Mather, 2001).	The WJ-III Tests of Achievement are designed to measure academic achievement in individuals from age two through adulthood, providing standardized information on performance relative to age-(and grade-) based expectations.	**Applied Problems** involves simple computation and word problems, some with picture cues.	Subtests demonstrate high internal reliability and acceptable validity.

Figure 1. Design Copy Templates

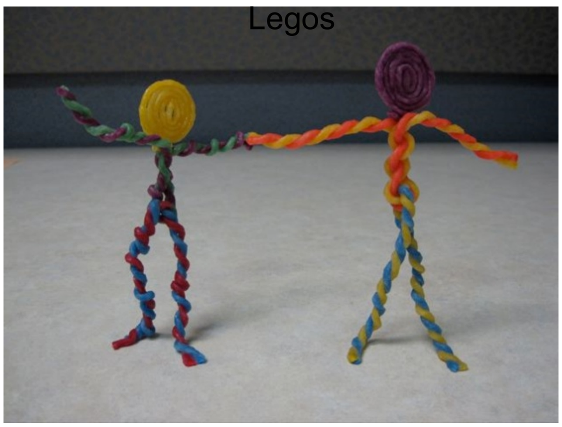


Fuse Beads

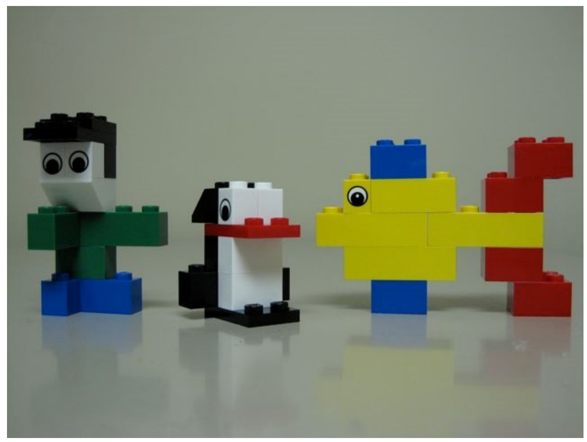


Pattern Blocks

Legos



Wikki Stix



Legos

Colorforms