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Using Project MIND - *Math Is Not Difficult* Strategies to Help Children with Autism Improve Mathematics Skills

Hui Fang Huang Su, Leanne Lai, Pei-Fen Li, Mei-Hwei Ho, Yu-Wen Chiu

***Abstract*—**This study aimed to provide a practical, systematic, and comprehensive intervention for children with Autism Spectrum Disorder (ASD). A pilot study of quasi-experimental pre-post intervention with control group design was conducted to evaluate if the mathematical intervention (*Project MIND - Math Is Not Difficult*) increases the math comprehension of children with ASD Children with ASD in the primary grades (K-1, 2) participated in math interventions to enhance their math comprehension and cognitive ability. The Bracken basic concept scale was used to evaluate subjects' language skills, cognitive development, and school readiness. The study found that our systemic interventions of Project MIND significantly improved the mathematical and cognitive abilities in children with autism. The results of this study may lead to a major change in effective and adequate health care services for children with ASD and their families. All statistical analyses were performed with the IBM SPSS Statistics Version 25 for Windows. The significant level was set at 0.05 P-value.

***Keywords*—**Young Children, Autism, Mathematics, Curriculum, teaching and learning, children with special needs, Project MIND.

I. Introduction

CHILDREN with ASD face challenges with attention and comprehension, that have an effect on their learning and development. The majority of research studies have focused on the behavioral and social skills of students with ASD, with little research conducted on the academic skills of students from the same population [7], [8] According to the National Academy of Sciences [8], some studies were in the area of reading, but research on strategies for teaching mathematics to students with ASD is limited. Researchers identified mathematical skills as one of the difficulties that children with ASD have. Educators must use the most effective methods for teaching mathematical skills to students with ASD [1]. Su created a program in 1988 to motivate and engage students through games, songs, arts, puzzles and brainteasers, poems, and mental calculation. The program's foundation was to capture students at their creative moments and engage them in problem-solving in real-world situations. The program started in the elementary school for general education and later expanded into all K-12 schools including, gifted, special needs, homeless, home-schooled, and high poverty [2]. Further, the report suggested that Project MIND could become a model program for mathematics instructions for all students. In the Project MIND training model, all stakeholders, teachers, parents, administrators, secretaries, nurses, cafeteria workers, and teacher's aides all attended 30-hours of mathematics training. The data gathered by the University of Miami, an independent evaluation team, concluded that Project MIND should be the effective mathematical strategy used for all students.

Hui Fang Su is with the Nova Southeastern University, United States (e-mail: shuifang@nova.edu).

II. Background and Significance

The severity and increasing prevalence rate of ASD make Autism a priority among researchers focusing on the development of effective interventions [10].

Su [11] discussed the development of a unique program that focused on content integration utilizing innovative strategies and instructional models designed to engage students and teachers in mathematics through games, stories, poems, songs, arts, puzzles, and mental math activities. Students who participated in the MIND strategies, especially at the elementary level, obtained significant results as reported by independent evaluators from the University of Miami [2]. According to the Annenberg Challenge Report, the results of the Project MIND (Math is Not Difficult) pilot study could become a model for math instruction throughout the country. The report prepared by an independent evaluator supported the effective use of the strategies for all learners. The study indicated that students with A.S.D. increased their mathematical knowledge, skills, and attitudes. To investigate the effectiveness of Project MIND, Su [11], [12] implemented a teaching methodology, using a quasi-experimental design, with a South Florida preschool serving children with ASD. The purpose of the previous studies was to identify the practical uses of instructional strategies that impacted students' learning across content areas [11], [12].

A. Using Project MIND with Children with Autism

In 2005, Su et al. investigated the effectiveness of Project MIND with the population of children with ASD. Su et al. used an exploratory approach with quasi-experimental pre-/post and a comparison group design [4], [5], [9] at a South Florida preschool serving children with Autism. Project MIND instruction focused on using materials and learning objects that are familiar to the students and could be found or identified in his/her surroundings, such as food, friends, cartoon characters, and etc. [10]. In one prior study, 25 students with Autism and ten typically developing students participated in the study. The arrangement for the study was one class with children diagnosed with ASD and one

integrated class randomly assigned as the study group with the remaining two classes identified as the control group. The study arrangement for both groups was the same (pre and post assessments). The mathematics assessments were selected subtests from the Hawaii Early Learning Profile (HELP). The instrument assesses a student's mathematical reasoning and problem-solving skills. The Bracken Basic Concept Scale-Revised (BBCS-R) [4], [5], was used to evaluate participants' knowledge of mathematical concepts. We also evaluated (before the intervention) the students' cognitive and visual-spatial abilities. Cognitive abilities were assessed using the Mullen Scales of Early Learning (MSEL), a comprehensive individually administered measure of cognitive functioning. We also evaluated the visual-spatial skills of the students using the Beery Developmental Test of Visual-Motor Integration (VMI). The instruments helped identify the effects on the knowledge of mathematical concepts. The data showed that the students in the study group (high functioning), increased their understanding of mathematical concepts when exposed to Project MIND strategies. Also, the study revealed significant differences between the study and control groups in the results of the MSEL and V.M.I. [12], [13].

Project MIND uses familiar concepts to build bridges to unfamiliar and abstract concepts. For example, an introduction to the base-10 concept can begin by demonstrating these concepts with items that students understand (e.g., people, fruits, and vegetables, candies, classroom items, toys, and animals). For example, [11] created mathematical 'best friends' to teach higher-level concepts for solving mathematical problems. One MIND-based strategy shows children that combinations of numbers such as 1 and 9, 2 and 8, 3 and 7, and 4 and 6 are 'best friends' because the sum of each combination is 10. The best friends' concept has proven to help students perform activities such as the addition of multi-digit numbers, subtraction, multiplication, division, fractions, and other numeric operations. The concept of best friends was extended to other digital systems quickly [11].

B. Using Project MIND with Children with Autism in Taiwan

The original intervention design for the students in Taiwan is to follow the same plan, as noted in the previous studies [12], [13]. However, due to the small sample size, the researchers decided to recruit K – 1st and 2nd-grade participants for the study in and near the Southern regions of Taiwan. Working with university faculty members and teachers who specialize in special education, the research team recruited about 20 students. The students were new students to the teachers who participated in the study. There was a total of about 13 teachers who were trained by the co-investigator. The teachers participated in a three-day training workshop and translated the content of the learning manuals and activities to mandarin. The teachers then implemented the strategies learned in training on five consecutive weekends, and each weekend intervention lasted for 5 hours. A training model was put in place to accommodate the teachers' location and needs. The students were transported to the site by their parents weekly. The supervising university faculty member, used a Project MIND Fidelity Checklist, developed by one of the Co-Investigators, during classroom visits and observations. Another exciting "First" for Project MIND in the training and implementation design, is that the trained teachers had to teach students they have never met and in an unfamiliar setting.

III. Study Results

The collected data were tabulated and analyzed with two types of statistical methods, including descriptive and inferential statistics. We used nonparametric statistics to analyze the data due to the non-normal distribution of data from a relatively small sample size in this pilot study [5], [9]. We used IBM SPSS-Statistics Version 25 for Windows to perform all statistical analyses. We set a significant level at 0.05 P-value [6].

A. Mathematic Intervention

During the study period, a total of 13 children with high functioning autism completed the mathematic intervention with a mean age of 7.50 years (76.92% female). We placed these 13 children in the study group. We also identified 17 other children with a mean age of 7.33 years and 88.20% female and with similar autistic functioning skills and put them in the control group. The results in Table I show no significant differences in age (P = 0.44) and gender (P = 0.41) for two groups. We used nonparametric Friedman tests to compare the pre- to post-intervention change between the study and control subjects [9]. The results indicated significant differences between the study and control group in both mathematic problem-solving ability (P = 0.04) (Table II) and Bracken receptive total composite score (P = 0.002) (Table III). Further, we compared the relevant Bracken subset assessments for the two groups. Although the study group demonstrated improvement in all the Bracken subsets after the intervention, there were only two Bracken subsets: self/social awareness (P = 0.000) and time/sequence (P = 0.015) showed significant differences between study and control groups (Table IV).

TABLE I
Demographic Characteristics of Study Subjects (Children)

Gender	Study Group		Control Group		P-value
	n	%	n	%	
Male	10	76.92	15	88.20	0.41
Female	3	23.08	2	11.80	
Age (years)	Mean	SD	Mean	SD	0.44
	7.50	.73	7.33	.91	

II. Discussion

The findings suggested that children participants with ASD in the treatment group had significantly better outcomes in mathematic solving ability total score, Bracken receptive total composite score and two Bracken sub test scores such as self/ social awareness and time/sequence than the control group. These positive findings were in line with [12], [13] that preschool students with high-functioning autism were able to

increase knowledge of mathematical concepts, cognitive abilities and visual-spatial abilities [12], [13] when exposed to Project MIND.

TABLE II
FRIEDMAN TEST RESULTS FOR MATHEMATICS PROBLEM-SOLVING ABILITY SCORE

	Study Group			Control Group			P-value
	Mean	SD	Median	Mean	SD	Median	
Pre-Math Intervention	27.92	16.32	29.00	32.35	10.65	31.00	.04*
Post-Math Intervention	35.77	14.30	4.00	35.42	8.89	34.00	

*Significant at $P \leq 0.05$

TABLE IV
FRIEDMAN TEST RESULTS FOR BRACKEN RECEPTIVE TOTAL COMPOSITE SCORE (R.T.C.)

Bracken R.T.C.	Study Group			Control Group			P-value
	Mean	SD	Median	Mean	SD	Median	
Pre-Math Intervention	129.23	22.21	145.00	128.29	24.73	135.00	.002*
Post-Math Intervention	140.38	18.08	146.00	134.59	26.95	148.00	

*Significant at $P \leq 0.05$

TABLE V
FRIEDMAN TEST RESULTS FOR BRACKEN SUBSET ASSESSMENT

	Study Group			Control Group			P-value
	Mean	SD	Median	Mean	SD	Median	
Bracken Direction/Position							
Pre-Math Intervention	14.62	4.31	16.00	15.18	5.09	18.00	.525
Post-Math Intervention	15.92	3.80	16.00	15.41	5.00	18.00	
Bracken Self/Social Awareness							
Pre-Math Intervention	4.38	1.71	5.00	4.53	1.94	5.00	.000*
Post-Math Intervention	5.38	1.12	6.00	4.76	1.75	5.00	
Bracken Texture/Material							
Pre-Math Intervention	6.77	3.19	7.00	7.18	3.50	8.00	.067
Post-Math Intervention	9.15	2.94	10.00	8.18	4.32	10.00	
Bracken Quantity							
Pre-Math Intervention	17.23	4.19	18.00	16.65	4.37	18.00	.054
Post-Math Intervention	19.31	3.47	20.00	17.41	5.30	19.00	
Bracken Time/Sequence							
Pre-Math Intervention	12.08	4.23	14.00	11.06	3.99	12.00	.015*
Post-Math Intervention	14.23	3.22	15.00	12.88	4.24	13.00	

*Significant at $P \leq 0.05$

Project MIND uses familiar concepts to build bridges to unfamiliar and abstract concepts. For example, an introduction to the base-10 concept can begin with by demonstrating these concepts with items that students understand (e.g., people, fruits, and vegetables, candies, classroom items, toys, and animals). Su [11] created mathematical 'best friends' to teach higher-level concepts for solving mathematical problems. One MIND-based strategy shows children that combinations of numbers such as 1 and 9, 2 and 8, 3 and 7, and 4 and 6 are 'best friends' because the sum of each combination is 10. The best friend's concept has been shown to help students perform activities such as the addition of multi-digit numbers, subtraction, multiplication, division, fractions, and other numeric operations. Project MIND uses diverse classroom activities such as games, stories, poems, songs, art, puzzles, mental math activities, and competitions for all children [11].

To find the "best friend" to sum up their assigned numbers to 10, the children participants in the current study needed to be attentive to observe the other participants' assigned numbers, make eye contact with others, initiate interaction with another participant whose numbers matched with their own and engage body movement to sit next to the other. This series of cognitive processing, body movements and social engagement activities facilitated the children participants' experiential learning in which they not only gained the sense of numbers but also developed appropriate social skills in connecting with others. Based on the researchers' observation notes on the intervention site, children participants actively participated in classroom social activities with math interventionists' guidance and encouragement, developed friendships, built a sense of belonging and continued playing together during the break. Even though some of them were not verbally expressive due to ASD characteristics, most of them enjoyed running and playing hide and seek together during the break.

The interactive and activity based learning strategies in Project MIND explained why the children participants in the current study demonstrated a significant improvement in self/ social awareness as other researchers found that integrating children with Autism in social levels of play, which involved

other peers, improved their ability to appropriately play [10]. Akers et al. [3] also revealed that specific forms of social play, such as hide-in-seek, helped children with Autism develop independent behaviors, meaning behaviors that they engaged in without the instruction of adults, teachers, or caretakers.

III. Conclusion

Project MIND strategies proved to be effective with all populations, including the special needs population. It even created positive impacts on children with high functioning Autism within a short period of intervention time. We have encountered unforeseeable circumstances during training. It appears that the factors considered to be necessary, such as the location of the implementation, the number of hours the teachers received for the training, the selections of participants (current students or new students), or the length of an application made a difference in the final results of students improved in mathematical skills. Furthermore, the trained teachers continued to use the strategies with students with specials needs, including students with Autism in their assigned schools. The unique Project MIND strategies remain the key to student achievement success. Project MIND contains all attributes of an environment conducive to teaching and learning, a situation that promotes none threatening, hands-on, challenging, project-based, and student engagement.

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Dr. Hui Fang Huang "Angie" Su is a Professor of Mathematics Education at Nova Southeastern University's Fischler College of Education and School of Criminal Justice. She holds an Ed.D in Early and Middle Childhood from Nova University in 1991.

She is the creator of *Project MIND - Math Is Not Difficult*®, a K-12 mathematics enhancement project currently being implemented in hundreds of classrooms throughout the country. Project MIND has received numerous awards, including the Presidential Award for Excellence in Mathematics and Science Teaching from the National Science Foundation for its innovation and ability to help students, especially preschoolers, become excited about math and improve their math skills. Angie is one of the authors of the Next Generation Sunshine State Standards for mathematics for the State of Florida.

Dr. Leanne Lai, professor of biostatistics and research design, joined Nova Southeastern University College of Pharmacy over 20 years ago. Dr. Lai came to the U.S. as an international student from Taiwan and received her Ph.D. degree from the University of Maryland in Baltimore. Since arriving at N.S.U. in 1996, Lai has collaborated with and provided research design and statistical support for a wide variety of projects and grants in clinical, basic science, and social-behavioral research. She has over two-hundred publications and presentations in health and pharmacy professional journals and at conferences. Her research experience has been recognized by the National Institute of Health (N.I.H.) where she received a prestigious appointment at the Center for scientific review special emphasis panel as the research grant proposal reviewer since 2002.

Dr. Pei-Fen Li is an assistant professor of the Department of Family Therapy at Nova Southeastern University. She is a licensed therapist and approved supervisor by the American Association for Marriage and Family Therapy. Her research interests include reentry experiences of international students in Taiwan, acculturation of immigrant families, dyadic analysis of couple dynamics and relationship characteristics associated with relationship quality, Solution Focused Brief Therapy intervention with parents of children with Autism and application of family therapy models in Eastern cultures.

Dr. Mei-Hwei Ho is an associate professor of Department of Special Education at National University of Tainan. She teaches both in undergraduate and graduate programs on subjects relevant to autism spectrum disorders, emotional/behavioral disorders and severe disabilities, and on several topics such as curriculum and instruction, inclusion, social skills training and positive behavioral support. She conducts research, focusing on children and adolescents with Autism or EBD. Meanwhile, she is involved in the special education field through providing professional development training and consultations to teachers and parents for their students/children with special needs, including those with autism spectrum disorders.

Mrs. Yu-Wen Chiu obtained her Master of Science degree in 2003 at National Cheng Kung University in Psychology. She serves as the clinical psychologist and teaching assistant at the Department of Psychiatry, National Cheng Kung University Hospital, Taiwan specializing in children and adolescent mental illness consultation. During over 14 years on this position, she has provided clinical intervention and education to over ten-thousand patients and received a distinguished teaching award. Besides her clinical work, Mrs. Chiu has involved in numerous researches in ADHD, Autism, Depression, etc. as the clinical research coordinator.