Global Journal of Health Science; Vol. 8, No. 12; 2016
ISSN 1916-9736 E-ISSN 1916-9744
Published by Canadian Center of Science and Education

Fine Motor Activities Program to Promote Fine Motor Skills in a Case Study of Down's Syndrome

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Received: January 4, 2016 Accepted: February 25, 2016 Online Published: April 29, 2016

doi:10.5539/gjhs.v8n12p60 URL: http://dx.doi.org/10.5539/gjhs.v8n12p60

Abstract

Children with Down's syndrome have developmental delays, particularly regarding cognitive and motor development. Fine motor skill problems are related to motor development. They have impact on occupational performances in school-age children with Down's syndrome because they relate to participation in school activities, such as grasping, writing, and carrying out self-care duties. This study aimed to develop a fine motor activities program and to examine the efficiency of the program that promoted fine motor skills in a case study of Down's syndrome. The case study subject was an 8 -year-old male called Kai, who had Down's syndrome. He was a first grader in a regular school that provided classrooms for students with special needs. This study used the fine motor activities program with assessment tools, which included 3 subtests of the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT-2) that applied to Upper-limb coordination, Fine motor precision and Manual dexterity; as well as the In-hand Manipulation Checklist, and Jamar Hand Dynamometer Grip Test. The fine motor activities program was implemented separately and consisted of 3 sessions of 45 activities per week for 5 weeks, with each session taking 45 minutes. The results showed obvious improvement of fine motor skills, including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength. This positive result was an example of a fine motor intervention program designed and developed for therapists and related service providers in choosing activities that enhance fine motor skills in children with Down's syndrome.

Keywords: fine motor skill, activities program, Down's syndrome

1. Introduction

1.1 Introduction to the Problem

Down's syndrome is the most common genetic disorder that causes developmental delay worldwide. Most children with Down's syndrome have an IQ score of below average level and moderate to severe mental retardation. Children with Down's syndrome have a smaller oral cavity, large tongue, and limited lip and tongue movements that can affect their verbal communication. Furthermore, musculoskeletal, visual, hearing, perception and cognition problems are often found in these children and influence them when they perform their daily life activities such as self-hygiene, education, recreation, and social participation (Pueschel, 2001). This information relates to Conolly & Michael (1986) who studied the comparison of gross motor and fine motor abilities between children with intellectual disability and Down's syndrome, and those who did not have Down's syndrome. The Bruininks Oseretsky Test of Motor Proficiency, second edition, was the assessment tool used in their study. Results showed that children with intellectual disability and Down's syndrome had significantly lower scores of gross motor and fine motor abilities than those with intellectual disability, but no Down's syndrome. Additionally, a research on "motor, linguistic, personal and social aspects of children with Down's syndrome" found that a statistically significant difference was verified between groups for language and fine-motor adaptive areas. That is to say, children with Down's syndrome show lower performance in language and fine motor skills when compared to typical developing children, but there was no statistically significant difference in gross motor or personal-social areas (Ferreira-Vasques & Lamonica, 2015). The results of these

researches pointed to the problems of fine motor skills in children with Down's syndrome. A particular study about "clumsiness in fine motor tasks: evidence from the quantitative drawing evaluation of children with Down's syndrome" indicated that participants with Down's syndrome tended to draw faster, but with less accuracy than controls (Vimercati et al., 2015). Indeed, this study pointed to the necessary awareness of fine motor accuracy as an important problem in the fine motor developmental area in children with Down's syndrome.

Occupational therapists realize the importance of fine motor skills that include patterns of reaching, grasping, carrying, voluntary release, in-hand manipulation, and bilateral hand use. A variety of child factors influence the development of fine motor skills such as movement skills, visual skills, sensory integration, visual perception, cognition, and social and culture factors. When children mature with normal development, they have effective visual-hand coordination skills, and later develop eye-hand coordination with visual perception skills (Ayres, 1958; cited in Exner, 2005). For these reasons, children have delayed fine motor development when barriers reach academic achievement goals. Children with Down's syndrome are at risk of delayed fine motor development.

As mentioned above, early detection and evaluation of fine motor problems in children with Down's syndrome are needed. After evaluating a child's performances, therapists develop and design an intervention program individually by systematic activity analysis and a synthesis process for each child, in order that the program can be related to a child's skills, limitations and culture (Case-Smith, 2005). Most intervention programs for improving fine motor skills include exercises or activities by using hands. A research for adults with Down's syndrome included assisted and voluntary exercise with music that could improve fine manual dexterity (Chen, Ringenbach, & Albert, 2014). However, more consideration should be given to the developmental milestone of children with Down's syndrome (Frank & Esbensen, 2015). For these reasons, this study was interested in designing an intervention program and researching effectiveness of the fine motor activities program in order to promote fine motor skills, including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength in a case study of Down's syndrome.

1.2 Specification of Problem

This case study involved an 8-year-old Asian male called Kai, who was diagnosed congenitally with Down's syndrome. His mother had been pregnant for 39 weeks and he was born by Caesarean section with a birth weight of 3,300 grams. He had a problem with vision that was corrected by the use of spectacles and a heart disease treated with medication, which comprised Euthyrox and Folate. His developmental history showed delayed development in head lifting, sitting, standing, walking, grasping, self-eating, and communicating. After repeating Grade 3 in kindergarten, Kai's academic and functional performances saw him through his first grade in a regular private school in Chiang Mai, Thailand. He was a child with mild (educable) intellectual disability (I.Q.=50) and lived with his parents and an older brother who was studying in Grade 6. When in school, a special education teacher taught him individually and supported him in the classroom. Kai was able to perform basic daily living activities, such as brushing his teeth, showering, dressing, and eating. However, he was unable to copy assignments from the whiteboard into his notebook in sufficient time, and his special teacher needed to help him. In terms of leisurely behaviour, he was able to play and socialize actively with his male and female peers. He received related services that encouraged him in his development, such as occupational, physical, speech therapy, etc. He received academic services from the Individualized Education Program (IEP) and scheduling in a resource room for Thai language and mathematical subjects.

As a student in an inclusive classroom of a regular school, Kai was expected to have basic academic skills, particularly in writing and manipulating learning materials in the class such as a pencil, rubber, ruler, scissors and other writing utensils. These skills were related to fine motor skills including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength. However, awareness of performance components, areas, and contexts is important in developing fine motor skills. For performance components, this case study analysed the subject's sensorimotor, cognitive, and psychosocial components such as hand muscle strength, language understanding, and motivation. For performance areas and contexts, he was the only child with special needs in his family, and a student with special needs in a regular classroom. His abilities in performing activities of daily living and educational activities at home and school were analysed in the process of designing the program. The factor of disability status has a greater influence on fine motor skill development, especially for a student with Down's syndrome. These reasons included the research problems in the fine motor activities program, which promoted fine motor skills in the case study of Down's syndrome, and suited the basic skills needed to improve Kai's fine motor skills, including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength.

2. Method

The methodology of this study consisted of two phases. The first phase was a process of preparing the research instruments and developing the intervention program. The second phase was a process of evaluating the effectiveness of the intervention program in the case study by the pre-test-post-test method. The process of the research method is as follows in Figure 1.

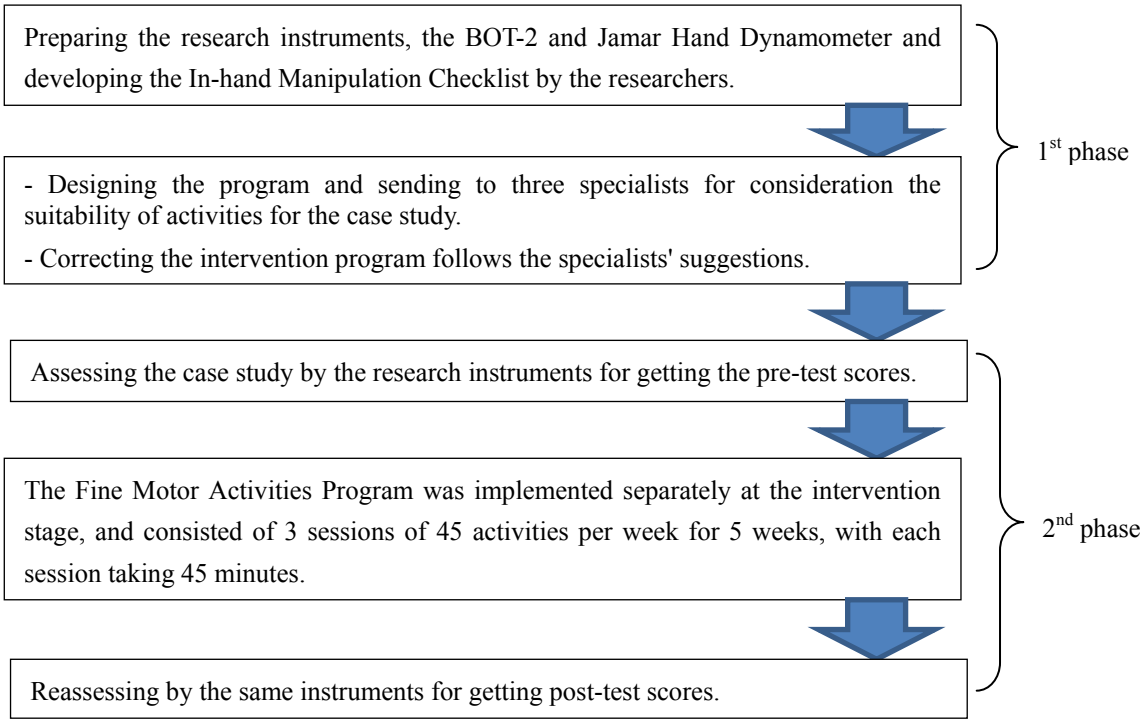

Figure 1. The process of the research method

In the first step of the first phase, three assessments were prepared, i.e. the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT-2) (R. H. Bruininks & B. D. Bruininks, 2005) with subtests of Fine motor precision, Manual dexterity and Upper-limb coordination; as well as the Jamar Hand Dynamometer and In-hand Manipulation Checklist. The BOT-2 and Jamar Hand Dynamometer are standardized instruments, but the In-hand Manipulation Checklist was developed by the researchers and the appropriateness of assessment activities in each subtest of in-hand manipulation skills was considered by three related specialists.

The fine motor precision subtest of BOT-2 is a test of hand prehension patterns that includes 7 activities such as filling in circle-shapes, filling in star-shapes, drawing lines through crooked-paths, drawing lines through curved-paths, connecting dots, folding paper, and cutting out a circle. The manual dexterity subtest of BOT-2 is a test of hand dexterity that includes 5 activities such as marking dots in circles, transferring pennies, placing pegs into a pegboard, sorting cards, and using a stringing block. The upper-limb coordination subtest of BOT-2 is a test of bilateral hand coordination that includes 7 activities such as dropping and catching a ball-both hands, catching a tossed ball-both hands, dropping and catching a ball-one hand, catching a tossed ball-one hand, dribbling a ball-one hand, dribbling a ball-alternating hands, and throwing a ball at a target.

The Jamar Hand Dynamometer is the standard tool for assessing hand muscle strength in pound (lb.) units. During this assessment, the case subject sat on a chair with his feet on the floor, and his upper limb was tested three times with elbow flexed at 90° and pressing down fully on the dynamometer. Then, the examiner calculated the average hand strength.

The In-hand Manipulation Checklist comprises five sub-skills, including Finger-to-palm translation, Palm-to-finger translation, Shifting, Simple rotation, and Complex rotation. These skills were evaluated by observing the activities designed by the researchers, which included picking up coins with one hand for evaluated Finger-to-palm translation and Palm-to-finger translation skills, a writing task using a pencil with fixed eraser for evaluating Shifting and Simple rotation skills, and opening a bottle for evaluating Complex rotation

skill. It was a dichotomous score (Yes=1 (means that the child can do) and No=0 (means that the child cannot do)) and the total score was 5, which came from the five sub-skills.

Next, the intervention program was designed for fine motor activities by the researchers and based on the Neurodevelopmental, Biomechanical, Motor Skill Acquisition and Psychosocial Approach (Dutton, 1993; Simon, 1993; Amundson, 1998). The Neurodevelopmental (NDT) sensorimotor approach was applied to remediate developmental dysfunctions. Sensorimotor intervention techniques were designed to enhance the quality of motor performance and this approach is used to focus on active participation in goal-directed activities (Schoen & Anderson, 1999). The Biomechanical approach is applied when a child has the problem of postural control. The goals of this approach are to enhance the development of postural reactions and improve distal function and skilled activity (Colangelo, 1999). Motor Skill Acquisition is related to motor learning, motor control, motor development, and learning. It focuses on encouraging movement that enables a child to have motor learning experience, which leads to improved motor behaviour and developed movement skills. The intervention program also was based on the Psychosocial Approach because this case study subject was placed in an inclusive classroom in a regular school setting. His social environment consisted of general peers, general teachers, and general educational media. He frequently experienced compromising situations in his relationships with peers and teachers, and in his ability to participate fully in educational activities. In fact, the Psychosocial Approach was applied to help him develop interest in play, skills, and interpersonal relationships that were supportive of his mental health (Olson, 1999).

After designing the program, it was sent to three specialists for considering the suitability of activities for this case study. The specialists comprised an occupational therapy instructor, a school occupational therapist, and a special educator. Their suggestions were as follows.

1) In terms of activity design;

a) The design should have graded activities in each activity set.

b) Although some activities are integrated fine motor skills, the researchers should consider a major fine motor skill and group each activity in each activity set.

2) In terms of materials or tools;

Materials or tools are appropriate for finding clinical or community settings.

3) In terms of activity duration;

Activity duration is appropriate for the attention span of a child at the age of the one in this study. However, the researchers should be flexible and observe the child's attention, motivation and distraction in order to adjust the activity duration to be suitable for him/her.

Finally, the fine motor activities for the case study subject included five activity sets for enhancing bilateral hand coordination (8 activities), hand prehension (8 activities), manual dexterity (11 activities), in-hand manipulation (9 activities), and hand muscle strength (9 activities), as presented in Table 1.

Table 1. The fine motor activity sets

Bilateral hand coordination activity set	Hand prehension activity set	Manual dexterity activity set	In-hand manipulation activity set	Hand muscle strength activity set
1. Paper scissoring 2. Paper folding 3. Beading with shoe tie 4. Beading with yarn 5. Beading with monofilament 6. Paper Mace' 7. Fan making 8. PomPom making	1. Picking ball into a basket 2. Pouring water from a bottle 3. Picking fruits into a basket 4. Pulling thread from a putty 5. Pulling beads from a putty 6. Finger painting 7. Picture matching	1. fastening the big size buttons 2. fastening the medium size buttons 3. fastening the small size buttons 4. Fastening the rope buttons 5. Making bracelet 6. Threading coins with shoelace 7. Reeving plastic band	1. Picking beads into a bottle 2. Putting large pegboard 3. Putting medium pegboard 4. Putting small pegboard 5. Writing with two-side colour pen 6. Counting coins and putting in a piggy bank 7. XO coin board game	1. Pulling and pushing doughnut toy 2. Picking pegs from putty 3. Stamping on paper 4. Making alphabets by play dough 5. Pressing shaped blocks on play dough 6. Matching pictures and using large clothes pegs 7. Making new words and using small clothes pegs

	8. Key unlocking	8. Threading with practice card 9. Lacing Shoes 10. Rope braiding 11. Clothes pegging	8. Dominos game 9. Closing bottles	8. Using forceps pick red beans in cup 9. Making flowerpot by play dough

After evaluating and developing the intervention program; the demographic data, developmental history, academic performance, and general and classroom behaviour of the case study subject were collected. After that, he was assessed for pre-test scores from the BOT-2 in the subtests of Fine motor precision, Manual dexterity and Upper-limb coordination, as well as the Jamar Hand Dynamometer, and In-hand Manipulation Checklist. The Fine Motor Activities Program was implemented separately at the intervention stage, and consisted of 3 sessions of 45 activities per week for 5 weeks, with each session taking 45 minutes. Finally, the case study subject was reassessed by the same instruments as those used for the post-test scores. Data were analysed by descriptive statistics.

3. Results

Results from processing the design and development of the intervention program were in terms of analysing related theories and clinical approaches. The fine motor activities program in this study was based on multiple approaches, including Neurodevelopmental, Biomechanical, and Motor Skill Acquisition and Psychosocial ones. As fine motor skills include complicated hand movements, visual skills, sensory integration, visual perception, cognition, personal factor and environmental factor. For this reason, the activities analysis and synthesis process need to consider related approaches as a guideline for designing and developing a suitable program for individuals with special needs, as shown in Figure 2.

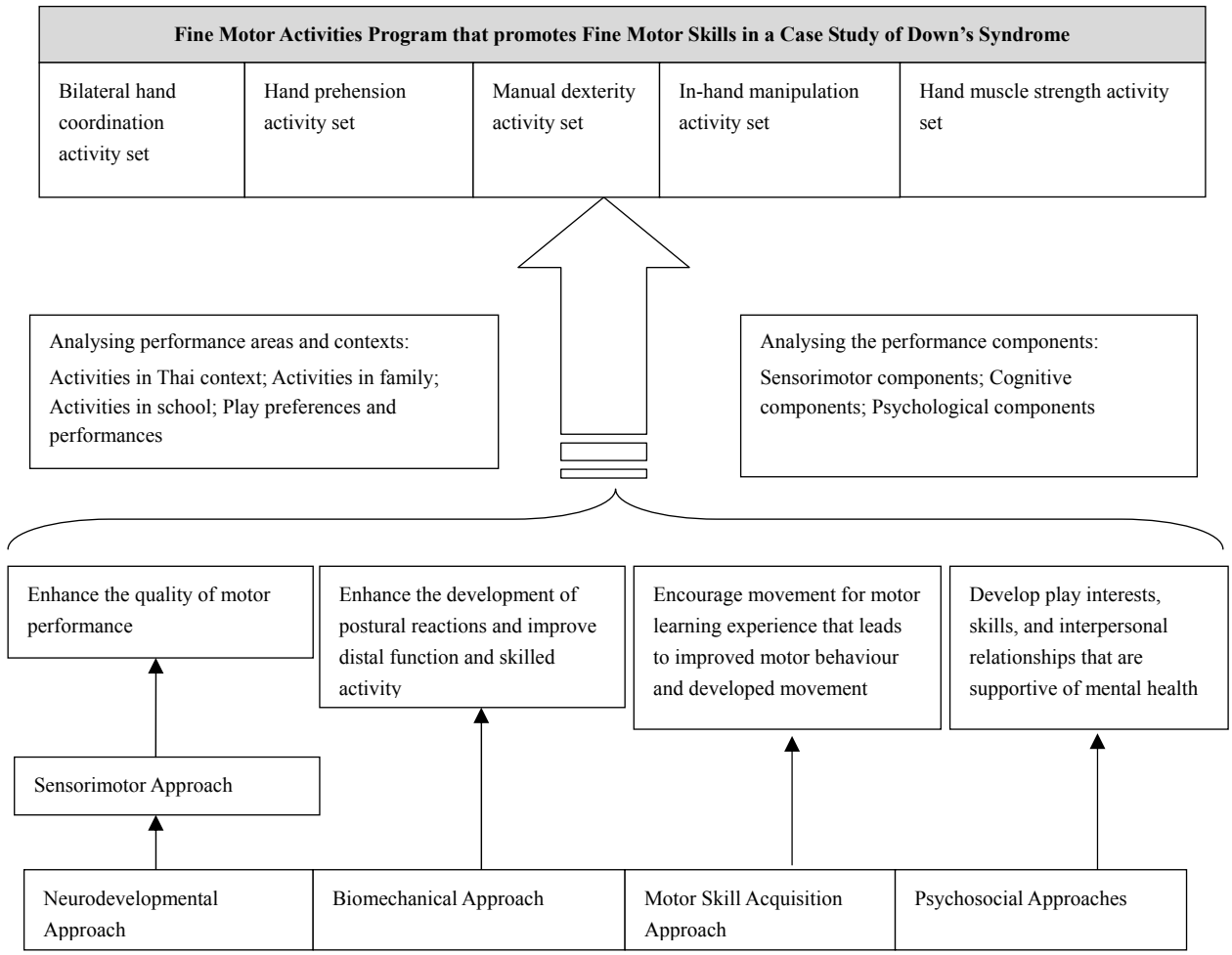

Figure 2. Activity analysis and synthesis based on related theories and clinical approaches

In addition, results from the process of studying the effectiveness of the intervention program indicated that the case study subject demonstrated obvious improvement in fine motor skills; including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength. Moreover, When considering the change of scores in bilateral hand coordination, hand prehension, manual dexterity, and in-hand manipulation skills, the in-hand manipulation score had the greatest change (80%), while the hand prehension score (8%) had the least change. Regarding hand muscle strength, the score in both the right and left hand increased by 0.5 pounds, and these changes showed a trend of skill improvement. These fine motor scores are presented in Table 2.

Table 2. Scores of fine motor skills before and after using the fine motor activities program

Fine motor skills	Before	After
Bilateral hand coordination	10 (26% of total score)	15 (38% of total score)
Hand prehension	17(41% of total score)	20 (49% of total score)
Manual dexterity	3 (7% of total score)	16 (36% of total score)
In-hand manipulation	0 (0% of total score)	4 (80% of total score)
Hand muscle strength		
- Right hand	6.5 ponds	7 ponds
- Left hand	3.5 ponds	4 ponds

4. Discussion

Although this study focused on fine motor skill, it did not cover all developmental areas, and was more useful for considering multiple approaches in designing and developing the fine motor activities program. Therefore, the program was based on related clinical approaches because while fine motor skill problems are more complex, each approach is limited by the scope of its theoretical base. This related to the study by Mosey (1986; cited in Kramer & Hinojosa, 2010), which indicated that constructing a relevant plan of intervention for a child with multiple problems often requires more than one frame of reference.

After designing and developing the program, it was examined through the case study of an 8-year-old Asian male with Down's syndrome. He was implemented individually by using the fine motor activities program that consisted of 3 sessions of 45 activities per week for 5 weeks, with each session taking 45 minutes, and the post-test scores in all assessments showed improvements. This result related to the characteristics of children with Down's syndrome, which indicated that a hypotonic problem influenced gross motor and fine motor skills (Pueschel, 2001). From an occupational therapy perspective, these fine motor skills can be improved by an appropriated program that consists of analysis and synthesis activities. Furthermore, the activities have to be graded together with the children's progression, and used consistently with enough duration for treatment, by implementing the therapeutic use of self-technique (Dutton, 1993; Simon, 1993; Amundson, 1998). Therefore, the case study subject demonstrated obvious improvement of fine motor skills, especially in the in-hand manipulation score, which had the greatest change. However, the hand prehension score had the least change. This was because hand prehension skill is related to child development that gradually develops from a basic pattern to a more complicated one (Danto & Pruzansky, 2011). However, the case study of this research used the program for 5 weeks, which may not be enough time for obvious changes to appear. Additionally, a child with Down's syndrome has intellectual disability, and limitation in learning and performing cognitive functions (Pueschel, 2001). Indeed, he/she might need more time to learn, integrate, recall, and receive feedback. Thus, increasing the intervention time would be a factor for improving the skills of the case study subject. In addition, this study had the limitation of generalizing in a large population because it was designed as a case study research. Therefore, future research should involve a larger number of subjects, or other groups of children with disabilities, such as those with learning disability and intellectual disability.

5. Conclusion

The objective of this study was to develop a fine motor activities program and examine its efficiency in promoting fine motor skills in a case study of Down's syndrome. This study found that the fine motor activities program promoted fine motor skills, including bilateral hand coordination, hand prehension, manual dexterity, in-hand manipulation, and hand muscle strength activity sets, which were designed and developed by activity analysis and a synthesis process based on various related approaches, such as Neurodevelopmental,

Biomechanical, and Motor Skill Acquisition and Psychosocial ones. As fine motor skills consist of movement and visual skills, sensory integration, visual perception, and cognition as well as social and cultural factors, the use of one approach alone in designing and developing an intervention program did not encourage fine motor skills. After designing and developing the activities program, the case study was implemented by using it for five weeks. Finally, the case study subject demonstrated obvious improvement of fine motor skills, especially in the in-hand manipulation score. However, due to limited cognitive functions, he needed more time to improve and sustain his fine motor skills by using the therapists' adaptation and modification of the program. Additionally, in order to continue his development, integration of fine motor activities into his daily activities, especially those of self-care and play, might be planned by his parents with therapists because interventions using functional life skills have been shown to increase the efficacy of an intervention program and the child's motivation to participate (Dunn & Westman, 1995; cited in Pape & Ryba, 2004).

Acknowledgements

This study was approved by the Research Ethics Committee of the Faculty of Associated Medical Sciences, Chiang Mai University, Thailand, and the case study subject and his parents were contacted and informed about the research objectives. They also signed a consent and assent form for participation in this study.

Competing Interests Statement

The authors declare that there is no conflict of interests regarding the publication of this paper.

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