HOW TO IMPROVE AUTISTIC STUDENTS' HANDWRITING

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ABSTRACT

Autism is a lifelong neurological disorder that affects the weaknesses of memory and causes visual-motor coordination skills impairment. This problem constrains autistic students from mastering handwriting skills. Their handwriting is illegible. This single-subject design research aims to identify the effect of "Efficient Writing" on autistic students' handwriting in the following aspects: visual motor skills and letter formation proficiency to improve the autistic students' handwriting. In this study, the ABA design was selected. The study was carried out in an intervention centre at Seberang Perai Tengah, Penang. In this study, just one sample was used. The independent variable of this research is "Efficient Writing' which underpins the combination of the Brain Gym and The Size Matter Handwriting Programme concept that underlies the Bandura social cognitive learning theory. Over six weeks, "Efficient Writing" was implemented for 80 minutes daily by an experienced special education teacher. A pre-test was given in the first phase (baseline phase) before the intervention was implemented. During the intervention phase, the informal assessment was carried out to identify the respondent's progress. A post-test was given after the treatment ended. The data collected during the intervention phase was analyzed using visual inspection. The documentation analysis was done on the respondent's pre and post-test paper to support the data collected during the intervention phase. The outcome of the research shows that there is a significant difference in the respondent's handwriting. The independent variable in this research, "Efficient Writing" can improve autistic students' handwriting.

Keywords: handwriting, autism, intervention, visual motor, legible, brain gym

1. Introduction

Handwriting skills are the basis of literacy. Mastering handwriting allows the pertaining knowledge to become cognitive resources utilized at the mentalist writing level (Graham et al., 2000). It was commonly used to express feelings, communicate and record one's experiences and common sense. Thus, all students with disabilities must be educated (NCLB, 2001; IDEA, 2004) to master basic writing skills.

Generally, two factors are used to assess and/or define poor handwriting: (1) legibility and (2) performance time (Koziatek & Powell, 2002; Rosenblum et al., 2003). Dysgraphia implies seriously poor legibility or low writing speed, or both, interfering with the child's educational achievements and with daily activities requiring these abilities (APA, 2013). The condition represents a neurocognitive disorder associated with executive functioning and fine-motor and visual-motor deficits (Mayes et al., 2017). According to Calhoun (2007), 50%

of 724 autistic students between 6 to 16 years old have dysgraphia. Autism is a lifelong neurological disorder that affects the weaknesses of memory and causes visual-motor coordination skills impairment. This problem constrains autistic students from mastering handwriting skills.

Although there are studies that suggest that short term interventions focusing on fine motor skills and visual motor skills are effective in improving handwriting skills among all categories of primary school students (Ohl et al., 2013), research on handwriting interventions for autistic students is currently limited (Asaro-Saddler, 2015; Finnergan & Accardo, 2018; Kuskhki, Chau & Anagnostou, 2011; Pennington & Delano, 2012). "Efficient Writing" is a handwriting intervention specially designed to improve autistic students' handwriting. It underpins the combination of Brain Gym and The Size Matter Handwriting Programme concepts. It was carried out based on Bandura's (1977) social cognitive learning theory.

The Size Matter Handwriting Program Intervention is a comprehensive method that combined the principles of three theories: Motor Learning Theory, Cognitive Theory, and Motivation Theory (Moskowitz, 2009). The principle of Motor Learning Theory is implemented by incorporating practice and repetition into program materials and daily life. The principle of Motivation Theory is incorporated through colourful, fun, and engaging activities. Meanwhile, the cognitive principles are incorporated into the direct instruction of explicit letter formation techniques with consistent, and meaningful terminology. Children learn the importance of letter size at different stages. The Size Matter Handwriting Program suggests teachers motivate their students by incorporating meaningful learning activities and rigorous objectives in teaching based on student needs and modifying their teaching methods according to students' achievement levels. This will assist them in mastering writing skills in terms of forming legible alphabet letters. The Size Matter Handwriting Program Intervention uses explicit teaching sessions, correction, self-assessment, and verbal feedback with visual motivation (Pfeiffer et al., 2015).

Besides, The Size Matter Handwriting Program Intervention also supports the development of handwriting skills in a linear sequence. It begins with precise alphabet formation, placement of alphabet writing on lines, and able to justify the spaces between alphabets. This is in line with Bandura's cognitive social learning theory where the theory prioritizes the use of visual cues and frequent verbal descriptions (Moskowitz, 2009). Several past studies have shown that SMHP is a curriculum for improving effective handwriting skills and can be absorbed in classroom teaching (Pfeiffer et al., 2015; Zylstra & Pfeiffer, 2016). Other than explicit teaching and handwriting practice, "Efficient Writing" also focuses on Brain Gym to enable the integration between both sides of the brain hemisphere via simple visual-motor activities, which consist of gross motor activity, fine motor activity, bilateral coordination activity, vision training activity and hand-eye coordination activity with visual cues and verbal feedback. According to Ocampo et al. (2017), Brain Gym is an effective intervention in improving writing skills. The study involved four first-year students who had difficulties in handwriting. The students were instructed to undergo Brain Gym exercises including SBCH, drinking water, Brain Buttons, Cross Crawls, Hook-ups, and six movements such as Lazy 8, The Energy Yawn, The Owl, The Thinking Cap, The Positive Points, and The Gravity Glider. After the exercises, the students were able to write correctly and neatly following the blue-red-blue lines and correct spacing between letters and words.

Given that the combination of Brain Gym and The Size Matter Handwriting Program has never been studied among autistic students in Malaysia, this study can be used to strengthen both interventions and contribute to new knowledge in the field of Special Education research.

1.1 Problem statement

Dysgraphia is closely related to executive functions such as working memory (Rosenblum, 2016). Both motor and cognitive development are interrelated (Diamond, 2000). Automatic deficits at the cognitive level, caused by the deterioration of procedural learning networks involving the cerebellum at the neural circuit level that occur in dysgraphia, cause a decline in the motor-cerebellar circuit (Nicolson & Fawcett, 2011). Damage to the cerebellum will affect an individual's motor function (Konczak & Tim-mann, 2007). Thus, a person with dysgraphia has difficulty remembering and mastering the sequence of automatic motor movements required to write letters or numbers (Bright Solutions for Dyslexia, 2014). They need explicit instructions and feedback on letter formation and guidance to achieve automated handwriting performance before using letters to write words, phrases, and sentences (Bright Solutions for Dyslexia, 2014).

According to Datuk Dr Yasmin Binti Hussain, Deputy Director, Special Education Division, during a special interview with the media at the Ministry of Education on 25th December 2018, the Ministry of Education will strengthen the Zero Reject Policy to ensure Special Needs Students receive education in line with their disabilities. However, 60% of autistic children have dysgraphia (Mayes & Calhoun, 2006). The study found that of the 40% of occupational therapist cases consisting of autistic students, as many as 86% of those who sought ongoing treatment sought help to overcome writing skills or fine motor skills (Cartmill, Rodger, and Ziviani, 2009). This is because 87% of autistic students suffer from motor impairment (Bhat, 2020). This caused them to have difficulty in the formation of the alphabet.

Studies show that visual motor skill is an important factor in determining the handwriting quality of autistic students (Hellinckx et al., 2013). Although there are studies that suggest that short term interventions focusing on fine motor skills and visual motor skills are effective in improving handwriting skills among all categories of primary school students (Ohl et al., 2013), the handwriting interventions studied among autistic students is still lacking (Asaro-Saddler, 2015; Finnergan & Accardo, 2018; Kuskhki, Chau & Anagnostou, 2011; Pennington & Delano, 2012). Furthermore, studies show that the visual motor skills achievement of autistic students is lower when compared to their peers (Hellinckx et al., 2013). The condition worsens if they do not receive proper treatment (Cheatum & Hammond, 2000; Jackman & Stagnitti, 2007; Mu et al., 2002). Handwriting skills of autistic children or students are normally not emphasized due to lack of specialized teachers (Graham et al., 2008). The phenomenon lingered when incompetency in handwriting skills is viewed as trivial or ignored by researchers and schools (Mayes & Calhoun, 2007). Thus, they need guidance from environmental agents to help them improve their visual motor skills.

Brain Gym is a simple movement that can be used to train the cognitive, motor skills, and agility of the small muscles on the fingers and connect the brain with the shoulders, arms, and eyes (Ningrum et al., 2018). It was effective in improving students' handwriting skills on blue-red-blue lined paper (Ocampo et al., 2017). The SMHP intervention effectively improves handwriting skills on three-lined paper among students with learning difficulties (Pfeiffer et al., 2015). According to Bandura's social cognitive learning theory, the principle of learning is to increase attention through observation, reinforcement, and motivation as three key teaching guidelines. In that way, the movement task information presented can remain in the working memory. Since the number of previous studies that can support the effectiveness of both types of interventions is still lacking, a study needs to be conducted to improve autistic students' handwriting.

This study aims at answering the following research questions:

i. To what extent is the "Efficient Writing" intervention affect the visual motor skills of autistic students with dysgraphia?
ii. How effective is the "Efficient Writing" intervention on the letter formation proficiency of autistic students with dysgraphia?

2. Literature Review

According to the American Psychiatric Association (2013), dysgraphia is not a disease but is a neurological developmental disorder such as ADHD (hyperactive), developmental coordination disorders, dyslexia, and autism spectrum disorders. It stems from neurological damage (Rapcsak et al., 2009; Rapp, Purcell, Hillis, ECapasso & Miceli, 2016). Dysgraphia also occurs among students with cognitive-developmental problems such as autism, cerebral palsy, and ADHD (Reisman & Severino, 2020). Educators often overlook the symptoms of dysgraphia, and students with the condition are viewed as unmotivated or uncaring (Berninger & Wolf, 2009). Other than poor handwriting, students with dysgraphia might display some of the symptoms as listed below (Berninger & Wolf, 2009). Not all of the symptoms listed will be present in all students. It's because it's still unclear how many students are observed on a regular basis.

- Poor legibility
- Excessive erasures
- Inefficient speed of copying
- Misuse of lines and margins
- Frequent need of verbal cues
- Poor spatial planning on paper
- Relies heavily on vision to write
- Inattentiveness over details when writing
- Mixed upper-case and lower-case letters
- Cramping of fingers while writing short entries
- Difficulty in visualizing letter formation beforehand
- Inconsistent form and size of letters or unfinished letters
- Difficulty in understanding homophones and what spelling to use
- May feel pain while writing (cramps in fingers, wrist and palms)
- Difficulty in writing and thinking at the same time (creative writing, taking notes)
- Having a hard time translating ideas to writing, sometimes using the wrong words altogether
- Handwriting abilities that may interfere with spelling and written composition
- Odd wrist, arm, body or paper orientations such as bending an arm into an L shape

Handwriting execution involves not only motor sensors influencing muscle energy to perform fine movements to grip a pencil, release pressure on a pencil to write, and perform the autographic coordination needed to form a legible alphabet, but also a memory to form the alphabet in the correct sequence in composing and performing movements when writing. (Amundson, 2005). A key component of cognitive function is working memory. Working memory plays an important role in the execution function because it is a short-term memory system that controls current information processing (Gathercole & Baddeley, 2014). It is an important factor in the development of writing (Hayes & Berninger, 2014) and the academic achievement of autistic students (Bauminger-Zviely, 2013, 2014). Many studies have found that dysgraphia commonly occurs among autism category students in primary and secondary schools (Fuentes, Mostofsky & Bastian, 2010; Ghaziuddin & Mountain-Kimchi,

2004; Hellinckx, Roeyers & Van Waelvelde, 2013; Kushki, Chau & Anagnostou, 2011; Mayes & Couhoun, 2008; Mayes et al., 2012; Myles et al., 2003). A large number of meta-analytic studies have found that people with autism have impaired executive function (Demetriou, Lampit, & Quintana, 2018; Habib, Harris, Pollick, & Melville, 2019; Lai, Lau, Lui, Lok, & Tam, 2017; Wang, Zhang, Liu, & Cui, 2017). They experience working memory deficits in the phonological and visual (visual-spatial) memory domains (Habib et al., 2019).

Weaknesses in motor skills among autists occur from the early stages of development until adulthood (Fournier, Hass, Nait, Lodha & Cauraugh, 2010; Ming, Brimacombe & Wagner, 2007; Minshew, Sung, Jone & Fuman, 2004). Gross and fine motor skills, as well as dexterity (Greffou et al., 2012), balance and body posture position (Memari et al., 2013), daily living skills (Jasmin et al., 2009), and the use of domain hands (handedness) and laterality, are all examples of motor skill deficiencies (spatial awareness that aids memory) (Preslar, Kushner, Marino & Pearce, 2014). Thus, they are unable to perform rapid movements involving motor integration and sensory fusion, including tasks involving both sides of the brain hemisphere (lateralization task) (Halayem et al., 2010, 2017) and have motor coordination and motor movements that have complex sequences (Mayoral et al., 2010). In addition, they may also have problems with visual movement coordination that makes it difficult to mimic body movements because there is a deficit of visual focus retention in one place (visual fixation) (Connolly, Rinehart, Johnson, Papadopoolors & Fielding, 2016; Johnson et al., 2012; Schmitt, Cook, Sweeney & Mosconi, 2014). Thus, they are unable to gain a complete visual picture while acquiring handwriting skills due to such deficiencies.

Autistic students often have weaknesses and difficulties in alphabet formation from an individual point of view as distinct factors that contribute to handwriting clarity (Cartmill et al., 2009; Fuentes et al., 2009, 2010; Myles et al., 2003). Among the shortcomings in alphabet formation that is often detected are the use of sharp straight-line angles at curved corners in some parts of the alphabet and the use of font sizes larger than the proper size (Fuentes et al., 2009). The situation is exacerbated when there is a shortage of specialized teachers in the field of teaching handwriting skills (Chiu, Heidebrecht, Wehrmann, Sinclair & Reid, 2008; Mu, Royeen, Paschal & Zardetto-Smith, 2002). As a result, they are hesitant to teach such skills (Graham et al., 2008). Given that autistic students suffer from motor skills problems and executive function impairments that make it difficult to learn handwriting skills among autistic students (Broun, 2009), the "Efficient Writing" intervention designed in this study aims to improve the autistic students' handwriting through visual-motor skills training and writing training to facilitate the learning process of handwriting skills based on the needs of autistic students.

2.1 “Efficient Writing” Intervention

"Efficient Writing" intervention is an intervention specifically designed to improve the handwriting skills of autistic students with dysgraphia. It underpins the combination of Brain Gym and The Size Matter Handwriting Programme concepts that underlies Bandura's social cognitive learning theory.

Brain Gym is based on the Theory of Educational Kinesiology. It was defined as learning through movement. Body movement is closely related to brain function (Kirpichnikova, 2006, p.2). The founder of Brain Gym, founder Paul Dennison (1969), believed that good physical development could optimize the learning experience. He also revealed that when the brain can function laterally (e.g. from left to right), bilateral integration and the ability to perform bilateral skill activities can activate both sides of the hemisphere, which allows the brain to function. The movement of crossing the midline can improve neural communication, which helps the blood flow to both sides of the brain hemisphere (Blaydes,

2001) and, in turn, balance the activation rate on both sides of the brain hemisphere. Consequently, cognitive functions such as concentration and working memory can be improved. Therefore, Brain Gym is widely used to integrate both sides of the brain's hemisphere and reduce stress in enabling individuals to concentrate on optimizing study experiences (Dennison & Dennison, 2007; Spaulding, Mostert & Beam, 2010). It is also capable of improving the coordination skills of an individual's movement through activities involving bilateral coordination skills and crossing the midline (Dennison & Dennison, 2007) that is required during writing. As such, it is suitable for an autistic student with dysgraphia, who experiences uneven activation rates on both sides of the brain hemisphere during information processing.

Based on the Brain Gym concept, different movements can stimulate brain function in several parts of the brain. The Brain Gym movements selected for use in this intervention include Cross Crawl, Lazy 8, and Alphabet 8s. While among the selected SMHP concepts include line names, alphabetical lines, contact points, stars and dice games, second and third alphabet sizes and noodles and balls. The Size Matter Handwriting Program Intervention uses explicit teaching sessions, correction, self-assessment, and verbal feedback with visual motivation (Pfeiffer et al., 2015). It suggests teachers motivate their students by incorporating meaningful learning activities and rigorous objectives in teaching based on student needs and modifying their teaching methods according to students' achievement levels. This will assist them in mastering writing skills in terms of forming legible alphabet letters. According to Ghani and Ahmad (2011), the explicit teaching process consists of setting (content introduction), description (teaching and learning content), modelling (demonstration), and guidance. Through this method, teachers can make lesson plans more carefully by using various activities and effective teaching aids. Meanwhile, teachers can also assess the level of student achievement at each teaching session. In addition to focusing on writing exercises, "Efficient Writing" also focuses on training to improve visual motor skills that can stimulate the parts of the brain connected to the body's motor nerves so that the cognitive function of autistic students can be developed. In addition, teaching aids used for the purpose of training and teaching writing are also built based on the needs of autistic students. For example, 4 lines of red-blue-blue and red paper with Alphabet 8s printed on it is constructed based on the needs of the autistic students.

"Efficient Writing" underlies Bandura's cognitive social learning theory. The theory uses the principles of learning consisting of learning through observation, reinforcement, and motivation as teaching guidelines to increase the attention needed so that the movement task information presented can remain in the working memory. According to Bandura (1977), the learning of motor movement skills through imitation depends on 4 processes in sequence, namely the process of concentration, retention, repetition, and motivation. This theory acts as a key teaching step in the "Efficient Writing" intervention. Autistic students are taught to practice visual motor skills and handwriting skills to improve their handwriting.

Each intervention session begins with a Brain Gym exercise (simple visual-motor coordination movement or activity) that acts as a stimulus to draw the students' attention to observe the demonstration, followed by a repetition exercise of the movements demonstrated by the model. Guidance supported by visual cues teaching aids such as Alphabet 8s is provided to increase their attention to strengthen their memory on how to form lower-case letters in the correct sequence. Next, reinforcement activities such as reading words based on pictures aim to strengthen students' memory of the lower-case letter shapes learnt. Finally, feedback and motivation such as praise and stars given before, during, and after writing exercises serve to correct mistakes made and maintain encouraged movement so that the information to be conveyed can remain in the students' memory (Bandura, 1977). Bandura's theory is a good fit for "Efficient Writing" because the learning principles used can help students improve concentration and strengthen the memory of information conveyed

through guidance, motivation, and reinforcement provided by environmental agents, allowing them to write lower-case letters legibly.

3. METHOD

3.1 Research Design

This is a quantitative study using a single-subject design. The researcher chose the most basic pattern for studying one subject, which is a withdrawal design, known as ABA design. The independent variable of this study is the "Efficient Writing" intervention designed by the researcher. The "Efficient Writing" intervention serves as the primary teaching method to improve autistic students' handwriting. The dependent variable of this study is lower-case writing achievement which was assessed based on changes in the respondents' motor visual skills achievement and changes in the respondents' letter formation proficiency. There are three phases in this study. The first phase is the baseline phase, the second phase is the "Efficient Writing" treatment phase, and the third phase is the baseline phase. A pre-test was given in the first phase to identify existing skills before treatment was given. In the second phase, a total of 30 sessions of "Efficient Writing" treatment were provided for 6 weeks. During the treatment period, quantitative data was collected from informal assessments on the respondents' visual-motor skills and handwriting skills. In the third phase, no treatment was given. In this phase, post-test was given until the respondents' results are stable. It aims to help the researcher identify the respondents' handwriting progress after using the "Efficient Writing" teaching method.

3.2 Sample

The purposive sampling method was used to ensure the most suitable sample for this study was selected. The sample was taken from an intervention centre in Seberang Perai Tengah, Penang, based on the students' individualized educational plan and development progress report. Few criteria were used to filter out the most suitable sample from the population. First, the sample selected must understand the teacher's instructions and answer when his or her name is called. Next, the sample should be autistic students who have poor handwriting even though they have exceeded the age of 12 years old. Finally, the sample should be able to use both sides of his or her finger and wrist. Only one sample was chosen based on these criteria, and the chosen sample was given the nickname Chong in this study.

3.3 Instrumentation

In this study, two performance tests were employed. The first one is the visual-motor skill assessment instrument. The second one is the letter formation skill assessment instrument. A formal test paper was modified as a pre-test and post-test to determine the students' handwriting ability before and after treatment. The formal test paper consists of two parts. The questions in the first part aim to assess one of the lower-case letter formations from each letter family, while the second part aims to assess the lower-case letter formation on four-lined paper. Questions in the first part were adapted from the first constructs of the LINUS test, while the questions in the second section were extracted from the Year 2 3M Malay basic activity book (learning disabilities) based on the standard curriculum of primary school.

The visual-motor skill evaluation test assessed five different aspects. These aspects include visual skills, bilateral coordination skills, gross motor skills, fine motor skills, and visual-motor skills. Each of these aspects consists of at least one item that needs to be

evaluated. Scores are given based on scales 0, 1, and 2 according to the criteria stated in the scale on the instrument. Total marks are calculated by dividing the total marks obtained by the maximum marks then multiplied by 100. 5 items assessed for the visual skills aspect consisted of activities tracking the movement of a laser light moving from left to right, from left to right, then to bottom left and to the right, clockwise rotation, counter clockwise rotation direction and Lazy 8 drawing direction. One item assessed for aspects of bilateral coordination skills was Cross Crawl by standing for 20 times. The 3 items assessed for gross motor skills consisted of the ball shooting 10 times, bouncing the ball while walking forward in a distance of 2 meters, and bouncing the ball while walking to the right in a distance of 2 meters.

The 2 items assessed for the fine motor skill aspect consisted of grasping 5 marbles in hand and inserting them one by one into a mineral bottle and grasping 10 buttons, and inserting them one by one into the 4 In A Row game rack. There were 3 items assessed for aspects of visual motor skills. Part A assessed the student's ability to copy various types of lines. Section B assessed the student's 'ability to copy geometric shapes, and Section C assessed the student's ability to copy combinations of geometric shapes. Scores were given based on the criteria stated in the scale on the visual motor skills assessment instrument.

There are two types of scoring rubrics in this study: scoring rubrics for visual-motor skills assessment and scoring rubrics for letter formation skills assessment. The scoring rubric for motor visual skills assessment was obtained using a scale set. The scoring for visual-motor skills is based on the criteria of each skill assessed on the motor visual skills assessment instrument. The skills assessed on the motor visual skills assessment instrument consist of gross motor skill, fine motor skill, bilateral coordination, vision training, and hand-eye coordination. The purpose was to identify the effect of "Efficient Writing" on autistic students' visual-motor skills. It was adapted from past year's research conducted by Afiqah (2019). According to Afiqah (2019), visual-motor skill is an important prewriting skill that should be mastered in the early stage of handwriting skill.

The scoring rubric for the assessment of handwriting skills in terms of legibility is the same for formal assessment (pre and post-test) and informal assessment (during the treatment period). According to Keifer (2015), the direction or sequence of writing, the point of overlap (closure of circle shape and accuracy of straight lines), and the type of line (alphabetical component) should be prioritized. Due to the validity of the assessment rubric that has never been studied in Malaysia, the researcher adapted the scoring rubric for the handwriting skills instrument designed by Keifer (2015). Besides, Cori (2015) also emphasized that all letters must touch the lines of the paper at the correct point. It is similar to the concept of The Size Matter Handwriting Programme. The rubric aims to identify the autistic students' handwriting progress after using the "Efficient Writing" teaching method.

In the first part of the lower-case letter writing assessment paper, Chong was instructed to write down the lower-case letters based on the card shown while the teacher mentioned the name of the letter. One of the alphabets for each letter family will be evaluated. Chong was asked to write a selected letter in the space of each of the five square boxes provided. Then, the same letter was then instructed to be written five times in the four-lined space. The teacher will choose the most appropriate letter to give marks. All the lower-case letters learnt were assessed through an informal assessment. The full mark for each letter is four. The total assessment mark obtained by the students will then be divided by the maximum total mark and then multiplied by 100%. The scores are recorded in percentage in a table in the visual motor skill assessment instrument and the letter formation skill assessment instrument and interpreted in line graphs.

The pre-test was given in phase one, and the post-test was given in phase three. Informal assessments were carried out throughout the treatment period in phase two during the handwriting practice. A laminated four lined paper with alphabet 8s printed on it, and a four-lined exercise book used to practice handwriting were treated as informal assessment instrument.

3.4 The Procedure of the Intervention

"Efficient Writing" was conducted by an experienced special education teacher in an intervention centre. A total of 30 sessions of treatment were provided in six weeks, with each session consisting of four slots taking a total of 80-minutes. The first slot started with simple visual-motor activities of the Brain Gym for brain activation. In the second slot, Chong learned lower-case letter formation using a laminated blank A4 paper with Alphabet 8s printed on it (see Figure 1). Visual cues and verbal guidance such as bright colors teaching aids, and verbal instructions describing the line characteristics of each component for each alphabet were given. In the third slot, Chong learned and practiced the same lower-case letter on four-lined laminated A4 paper with alphabet 8s printed on it (see Figure 2). Chong was guided to read the syllabus in the fourth slot, where the first letter started with the letter learned. Chong was required to write the letters taught under parental observation at home. Chong's handwriting on the teaching material (laminated A4 paper printed with Alphabet 8s), and the four-lined exercise book were being assessed informally during treatment. The effectiveness of interventions was assessed based on changes in the achievement of visual motor skills and the lower-case letter formation.

Figure 1: Laminated blank A4 paper with Alphabet 8s printed on it

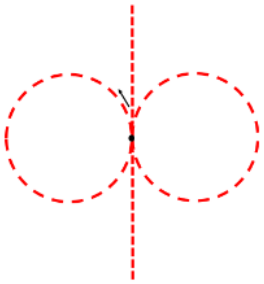
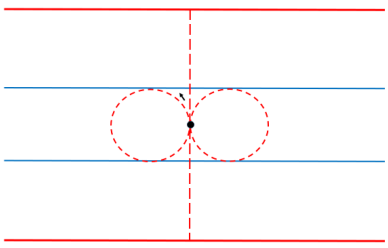


Figure 2:_ Four lined laminated A4 paper with Alphabet 8s printed on it



3.5 Data Analysis

In phase one, Chong was given a pre-test, and in phase two, Chong was given a post-test. In phase three, repeated measurements on letter formation were carried out until the data collected was consistent. Quantitative data collected from an informal assessment based on Chong's visual-motor skills and letter formation achievement during the treatment period was rated in percentage and then interpreted into a line graph for visual analysis. The documentation analysis was then used to support the results by comparing the respondents' handwriting on their pre-test and post-test papers.

3.6 Results

Figure 3: Analysis of Chong's visual motor skill

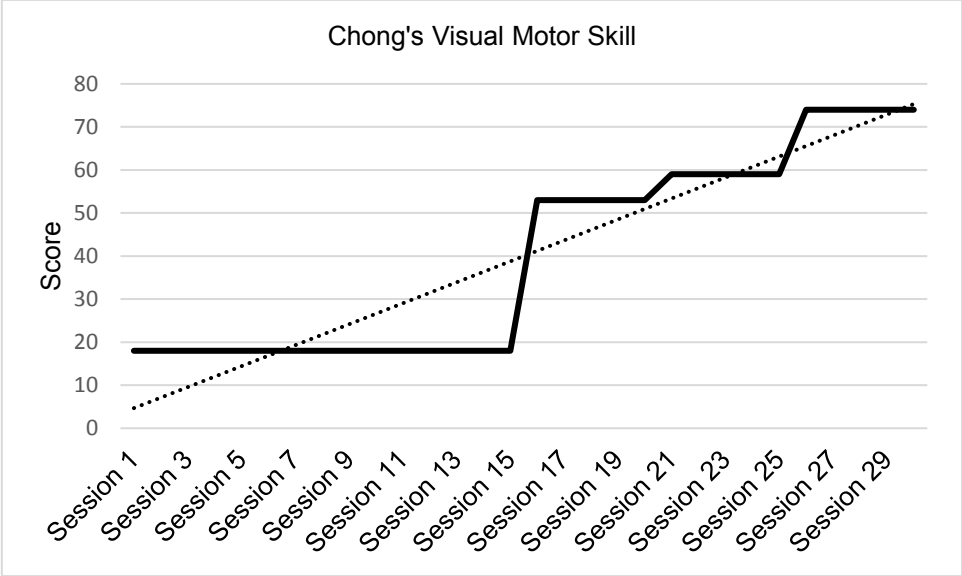


Figure 3 shows the data analysis of Chong's visual-motor skills. There was a significant increment of Chong's visual-motor skills throughout the treatment period. Chong's visual-motor skills improved from 18% to 53% after 15 sessions of treatment. After 20 sessions of treatment, Chong's visual-motor skills increased to 59%. After 25 sessions, Chong's visual-motor skill performance was maintained at 74%.

Figure 4: Analysis of Chong's letter formation proficiency

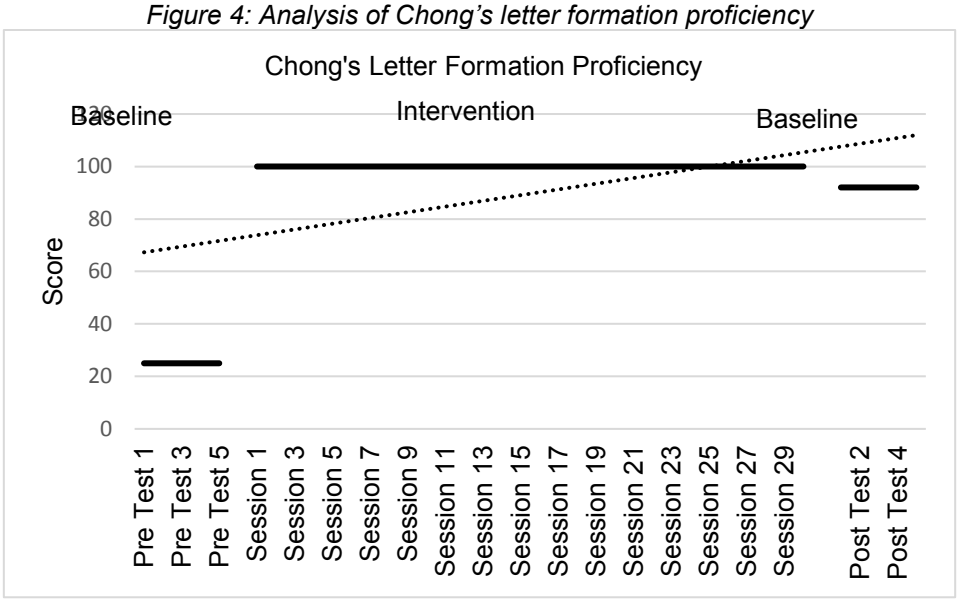
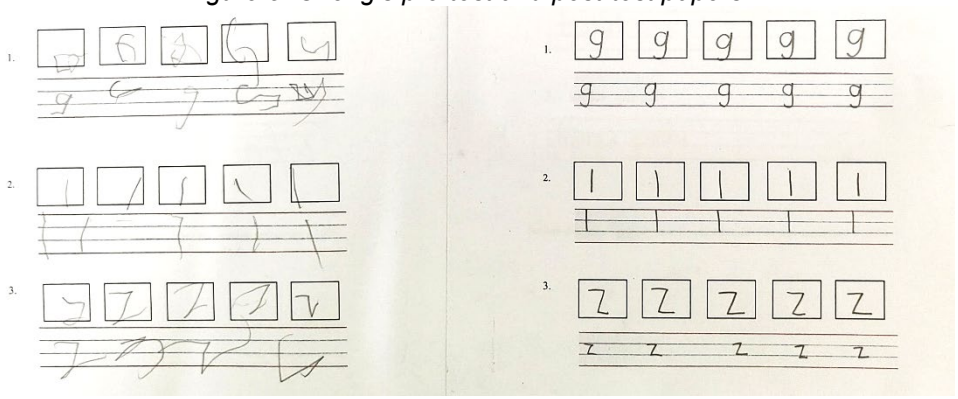


Figure 4 shows the data analysis of Chong's lower-case letter formation proficiency. There was a significant increment of Chong's letter formation proficiency throughout the study phase. Chong's letter formation proficiency improved from 25% to 100%. Even though the treatment had been removed in phase 3, his accomplishment was maintained at 92%.

Figure 5: Chong's pre-test and post-test papers



As shown in Figure 5, after treatment, Chong can write lower case letters more legibly. Furthermore, he could also maintain his handwriting proficiency even after the treatment was stopped.

4. Discussion

This study has proven that "Efficient Writing" can improve the handwriting skills of autistic students with dysgraphia. This outcome is aligned with the study conducted by Ohl et al. (2013). Interventions focusing on fine motor skills and visual-motor skills effectively improve handwriting skills among all categories of primary school students. Visual-motor skills training adopted in "Efficient Writing" such as Cross Crawl and Lazy 8 managed to activate the brain's visual parts, which connects the motor part of the brain. The documentation analysis data obtained has supported the quantitative data which was collected during the treatment period.

The lower-case letters on the post-test paper were more legible compared to the handwriting on the pre-test paper. Based on Chong's post-test paper, Chong could remember the correct writing sequence for each letter tested. He could copy all the lower-case letters correctly. Each part of the lower-case letter was written legibly. Furthermore, the size of each letter written by Chong is consistent and no longer too large until it exceeded the space provided. The result obtained is supported by a previous study conducted by Ocampo et al. (2017), which concluded that Brain Gym is effective in improving students' handwriting skills on blue-red-blue lined paper. Pfeiffer et al. (2015), who indicated that the SMHP intervention is an effective intervention in improving handwriting skills among students with learning difficulties, is in line and consistent with the findings of this study. Since the relevant studies are still limited, it is important to develop an intervention that can be used to guide all parties, especially teachers and parents, to improve autistic students' handwriting. Curriculum legislators can propose "Efficient Writing" as an annual school program to familiarize such teaching methods among teachers. This is because inadequate training among teachers is a major issue in preventing teachers from experiencing such provision (Graham et al., 2008).

Through "Efficient Writing", teachers can be more confident while teaching and dealing with autistic students with dysgraphia. The teaching method allows the teacher to set teaching objectives based on the special needs of each student specifically. Parents who participated in "Efficient Writing" should provide their full support by collaborating with the teachers and following the rules in Bandura's learning theory for the autistic students' handwriting to develop properly. The theory prioritizes verbal cue guidance and feedback, reinforcement, and motivation through processes (concentration process, retention process, movement repetition process, and motivation process). When engaging with new ideas, students who have mastered handwriting abilities retain their learning more effectively. Thus, they can effectively transform knowledge.

5. Conclusion

This study has proven that "Efficient Writing" can improve autistic students' handwriting skills through explicit teaching methods that focus on visual-motor skills training and guided handwriting training. This means that autistic students with dysgraphia should be guided using "Efficient Writing" continuously until they had fully mastered handwriting skills. They are encouraged to participate in "Efficient Writing" intervention that includes appropriate writing exercises led by teachers and supported by parents.

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