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Q-LED: Handwriting Approach in Autism Spectrum Disorder

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Abstract

Handwriting is linked to a variety of systems in the human brain and has been likewise demonstrated to be affected by a variety of neurological and developmental disorders. This study was conducted to examine the effectiveness of the use of writing aids (Qalamiy) and Light-emitting diode (LED) boards in improving the handwriting skills of autistic students to hold a pencil thus subsequently write correctly and to identify the effectiveness of the Q-LED intervention in improving the good practices of teachers. A case study was conducted to collect qualitative data using checklists, parent interviews and analysis of student's work. The respondents of the study are two students with moderate functional autism at SMK Jalan Paya Besar who faced difficulties in holding a pencil and writing correctly. A preliminary survey found that autistic students have difficulty holding a pencil properly and this affects the quality of writing in terms of the spacing and size between letters and words. Q-LED approach is an innovative intervention that is used to train handwriting skills among students with autism to hold a pencil and then write correctly. The results of the study found that the Q-LED approach successfully helped improve the ability to hold a pencil correctly and the quality of handwriting of autistic students in terms of the distance and size between letters and words. Overall, Q-LED approach was successful in helping autistic students to hold a pencil and write letters according to the correct method. Q-LED approach is one of the interventions that can be used by all teachers to improve the ability of autistic students to hold a pencil and write correctly in the teaching and learning process.

Keywords: Approach, Handwriting, Autism

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder which encompasses a broad range of complex developmental and neurobiological disabilities (Zuvekas et al., 2021). The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) specifies impaired communication and social interaction, restricted interests, repetitive patterns in behavior, deficits in developing and maintaining relationships as well as impaired sensory information

processing interaction due to abnormalities in the development of the brain's nerves (Hirota & King, 2023). This condition causes individuals with autism to face difficulties in communicating, socializing, and learning (Zeidan et. al 2020). This developmental disorder is usually identified in childhood and is lifelong.

Handwriting is known to be challenging for many individuals with ASD due to difficulties with fine motor skills (Liu et al. 2021). According to Van den Bos & Rosenblum (2023), this difficulty is the main reason why many of ASD children are referred to therapy services to improve their handwriting and fine motor skills. Commonly, handwriting is typically assessed through its handwritten product and handwriting process (Yakut et al., 2024). The criteria for the handwritten product are typically: form of the letter, sizing, spacing, line-straightness and consistency and are increasingly becoming standard as a consensus is being reached among the researchers who develop these analytical writing scales (Alston & Taylor, 2024).

Study Focus

The "Q-LED" intervention is a teaching and learning approach that focuses on two writing support tools that are combined to help students with autism to master writing skills easily. The rationale behind the selection of the "Q-LED" intervention is based on the wrong pencil grip and the biased focus of autistic students when writing. Reinforcement based on the fine motor disability of autistic students and interest in new gadgets is used as an ideology to cultivate good writing skills in autistic students.

Research Objective

i. Identifying the effectiveness of the Q-LED intervention in improving the skill of writing letters correctly among autistic students.
ii. Identifying the effectiveness of the Q-LED intervention in in improving the good practices of teachers.

Literature Review

Autism Spectrum Disorder (ASD) is a disorder of behavior and social interaction due to abnormalities in the development of the brain's nerves. In general, children with autism often show intellectual, adaptive and language disabilities that are not clear due to unbalanced brain development (Handle et al. 2022). This situation not only affects social interaction but also becomes one of the reasons why these children are unable to master teaching and learning in the classroom (Rosenblum et. al 2019).

In the context of language acquisition, writing is a complex skill that requires the mastery of various motor, linguistic, cognitive, and social skills simultaneously (Hermi Zaswita & Rodiyal Ihsan, 2020). The study of Zajic et al. (2020) found that autistic children who have difficulties in more than one domain may struggle with writing problems because focusing on learning is a difficult one for them. As a result, students show a decline in academic achievement, work and daily life when they grow up (McDougal et al. 2020).

Handwriting is a complex skill involving motor planning, visual-motor integration, and cognitive engagement. Studies have consistently shown that children with ASD perform poorer on measures of handwriting quality and speed compared to typically developing children (Verma & Lahiri, 2022; Handle et al., 2022; Van den Bos et al., 2024) Factors such as

manual dexterity, graphomotor skills, and general motor skills play a significant role in these difficulties. Additionally, visual input, visual perception, and visual-motor integration are important predictors for handwriting quality and speed in individuals with ASD.

Children with ASD often demonstrate poor fine motor coordination, reduced handwriting speed and legibility and sensory processing issues impacting pencil grip and pressure. Zajic & Wilson's study (2020) found that children with ASD showed difficulties in writing skills heterogeneously compared to reading or counting skills. This is because the focus on writing requires the coordination of cognition between fine motor and gross motor abilities of ASD children in parallel. Thus, it is no wonder why these ASD children need focused guidance to achieve the objective of writing skills (Finnegan & Accardo, 2018).

Although children with autism have a higher IQ than others, activities involving handwriting become difficult tasks and take a long time for them to do. A study by Verma & Lahiri (2023) found that the poor mastery of writing skills in ASD children is caused by fine motor problems and differences in perception experienced since birth. This condition not only affects verbal and non-verbal communication but also interferes with their daily affairs (Talkar et al., 2020). As a result of this disability, the self-esteem of these ASD children also declines because they are shy to socialize and speak with others.

In addition, deficits in Theory of Mind (a person's ability to consider other people's thoughts) were also found to affect the ability of these ASD children to write persuasively and narratively (Accardo et al., 2020). A study by Hilvert et al. (2020) proved that ASD children's difficulty in writing affects their ability to verbally interpret their writing well because it is closely related to Theory of Mind. This condition ultimately limits the functional speech ability and narrative writing skills of ASD children as a whole. Therefore, it is not surprising if most ASD children are referred to therapy services, either speech therapy or occupational therapy, from an early stage to improve fine motor skills for writing and verbalization skills for speaking (Masne Kadar et. al, 2020).

Children with Autism Spectrum Disorder (ASD) often experience significant difficulties with handwriting, which can affect their academic performance and self-esteem (Rosenblum et al., 2019). These challenges stem from a combination of fine motor deficits, sensory processing difficulties, and executive functioning issues (Mohd Nordin et al., 2021; Patil et al., 2023; Liu et al., 2024).

Rozana's study (2020) found that the modification of writing techniques according to students' ability levels should be emphasized when writing interventions are applied in the classroom. This is because learning strategies that are appropriate for students' disabilities can help them to master language skills better and more consistently (Nor Azimah Akharuddin & Mohd Hanafi Mohd Yasin, 2022). Combining various supports, such as visual, motivational, choice, technology, behavioral, peer, auditory, and tactile, has shown promise in improving writing skills among learners with ASD. These "packages" address multiple aspects of writing difficulties, providing a comprehensive approach to intervention.

Sofyan et al.'s study (2024) found that imitation or modeling activities applied through the Q-LED intervention successfully improved teachers' writing practice in the classroom. The

individual teaching approach used by teachers in a focused manner successfully helped students with autism to master the correct writing technique effectively (Hagopian & Nohria, 2021). The use of interventions based on Qalamiy writing aids and LED boards with continuous teacher guidance and attention over time during class writing successfully helped students with autism master writing skills well (Nor Azimah & Mohd Hanafi, 2022).

This technique successfully stimulates the ability of students with autism to write more effectively when this technique is taught to parents to teach and monitor their child's holding and writing techniques at home all the time (Yang & Chen, 2023). The continuous use of Qalamiy and LED Boards at school and at home in practicing this Q-LED intervention can ultimately enable students with autism to continue to focus on practicing the correct method without returning to the wrong pencil holding and writing habits (Zhang et al., 2022).

In addition, the imitation or modeling activities implemented through the Q-LED intervention successfully uncovered the ability of students with autism to focus on the teacher's writing skills, especially in writing skills. Focused individual guidance-based teaching during this writing intervention helped students better understand the process of teaching and learning writing skills. The results of a study by Purnama et al. (2021) showed that students with autism who were exposed to interesting writing skills using technological teaching aids successfully stimulated students to focus more on the writing skills presented by the teacher. Therefore, it is not surprising that the Q-LED intervention successfully helped students to remain consistent in practicing the correct writing method without returning to incorrect writing habits.

An engaging writing intervention that combines hands-on activities (Qalamiy) and autistic students' interest in technology gadgets (LED boards) is one of the main keys used by teachers to attract autistic students' interest in writing activities. Erlia's study (2021) found that teachers' determination to diversify teaching mediums in the classroom according to students' interests successfully produced a positive impact on student learning, especially in terms of writing skills. The results of the Petrovych et al. (2021) study support the Q-LED study that this innovative study successfully breathed new life into the teaching and learning process of writing in the classroom.

Research increasingly highlights the importance of collaborative efforts between families and educators in addressing these needs (Mazon et al., 2020). Moreover, family and teacher involvement play a huge role in supporting children with ASD who struggle with handwriting. Therefore, the roles of teachers and parents need to be strengthened through full cooperation so that the implementation of writing interventions carried out at school and at home can help autistic students master these writing skills better.

The use of LED Boards and Qalamiy as writing aids has successfully helped strengthen the hand muscles and focus of students with autism in line with the VAKT approach. The Modeling method used by teachers to show how to use LED Boards and Qalamiy helps students with autism write correctly. The learning is neatly organized to make it easier for students with autism to follow the writing learning intervention session through the process of observation, remembering, imitating behavior and motivation.

The VAKT (Visual, Audio, Kinematic & Tactile) model was used in this study to maximize the sensory and psychomotor development of students. The study by Nordin et al. (2024) found that the use of the VAKT Model successfully stimulated the sensory motor development of students with autism to function more actively and well (Ganesan et al., 2023). In addition, Rohadi & Alias (2021) found that the behavior of students with autism was more positive towards the Q-LED writing intervention because it focuses on a conducive environment, emotions, mental and social development. The variety of writing approaches applied to students with autism must be appropriate according to the disability so that the intervention applied can have a positive impact on their teaching and learning process. The implementation of this study was conceptualized in the conceptual framework of Figure 1.0.

Figure 1 Conceptual Framework

Research Methodology

This qualitative study used a case study design. Data were obtained from a checklist before and after the intervention using teaching aids (Qalamiy + LED Board), interviews with parents and analysis of student work. This study involved two autistic students aged 14 and 15 years old and had not yet mastered the skill of writing letters. The selected student categories were retarded and autism. The Q-LED intervention was carried out for three months to see the effectiveness of the intervention.

The checklist for this study was adapted from the Evaluation Tool of Children's Handwriting-Manuscript (ETCM-M) and modified according to the level of autism functioning. The checklist was used before and after the intervention to see the effectiveness of using Q-LED on students. In addition, interviews with parents were transcribed to answer questions about the effectiveness of the Q-LED intervention in increasing teachers' handwriting practice in the classroom. The students' work was also compared at the end of the study to see changes in writing and the students' potential to write letters correctly.

Table 1.0
Style of Pencil Grip

Student	Category	Style of Pencil Grip (Before intervention)
A	Austism	Dinamik Quadrupod
B	Autism	Lateral Tripod

Findings

Checklist

Tables and Figures

The checklist in Table 1 shows the inability of the autistic student to write correctly before the student was given the Q-LED intervention. Table 2 shows the changes in the writing of autistic students after the Q-LED intervention was given. The change in writing towards a better direction shows that the Q-LED intervention can help improve the writing of autistic students to a better level.

Based on observations and checklists, student A was found to be able to write and copy letters and numbers well. However, the wrong way of holding the pencil causes this student to have difficulty copying quickly and correctly. This student needs guidance on writing dotted lines in each writing and copying activity given to him to practice the correct writing momentum. This student is also sometimes confused with the position of the letters n, m, x and y. This student also often misses the letters l, o and p when writing. The attitude of pressing the pencil while writing and repeating the written word several times until the writing is clear causes this student to be slow to complete the worksheet even if he only copies a few lines of simple sentences.

Limited focus while writing also causes student A to have problems writing well. In fact, the severe anxiety problem also caused student B to not be able to write well. This student will shiver when the teacher reprimands mistakes while writing and repeatedly apologizes to the teacher because of feelings of guilt. This situation caused him to be unable to write any letters until the feeling of anxiety disappeared. Therefore, the Q-LED method was chosen to help student B focus on writing better with a calm and fun atmosphere.

Meanwhile, student B, although he has mastered the skills of writing and copying letters and words, he has not yet mastered the correct writing format. This student can copy correctly when the dotted line intervention is given, but will return to the original writing when not given the dotted line exercise. Student A is still confused to form the letters b, d, l and m during the writing process. Wrong pencil grip technique is also one of the reasons why this student A has difficulty writing well. The strong grip of the pencil caused student A's fingers to swell and made it difficult for this student to write due to pain.

Table 1.0

Checklist of Pupils Before Q-LED Intervention

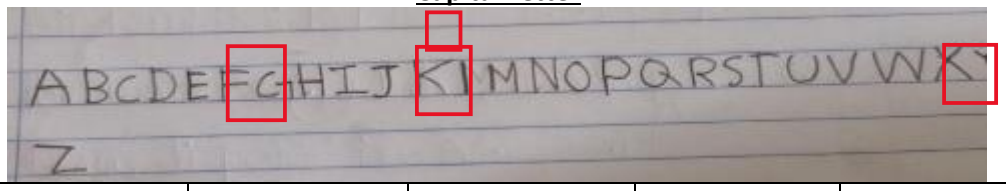
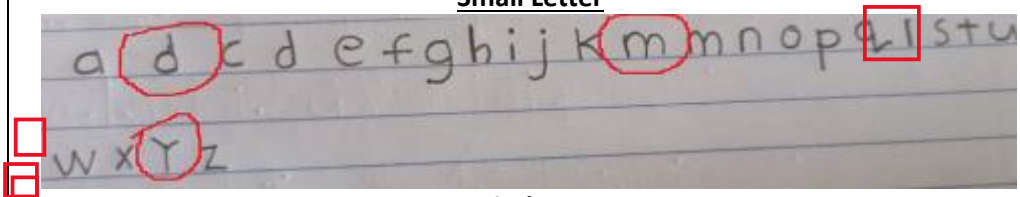
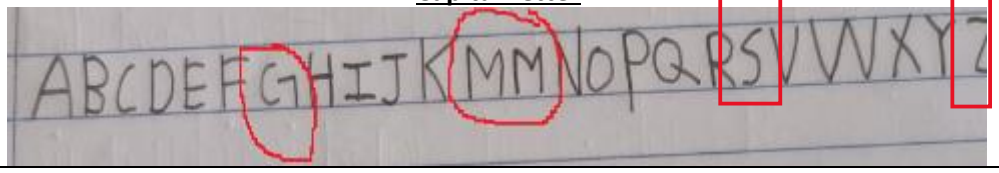
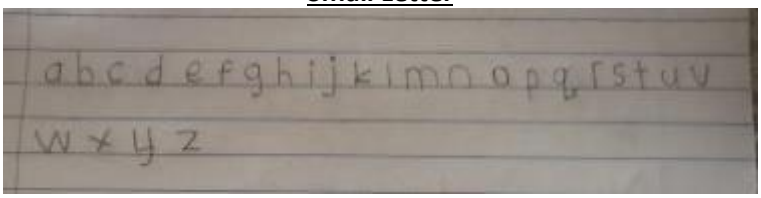
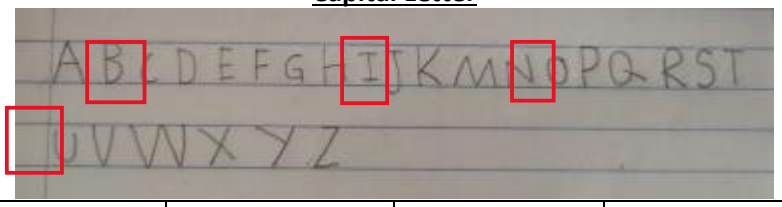
Student	Letters Writings		Writing / Copying Words	Writing / Copying Phrases	Writing / Copying Sentences
	Small	Capital			
A	Need guidance writing dotted lines **a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u , u, v, w, x, y, z**	Need guidance writing dotted lines A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U , U. V, W, Y, X, Z	Can write words but still confused with the procedure of writing small and capital letters.	Can write phrases but still confused with the procedure of writing small and capital letters.	Can write sentences but still confused with the procedure of writing small and capital letters.
Writing Samples	**Small Letter**  **Capital Letter** 				
B	Need guidance writing dotted lines. **a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u , u, v, w, x, y, z**	Need guidance writing dotted lines **A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U , V, W, Y, X, Z**	Able to write words but still confused with the procedure of writing small and capital letters.	Able to write phrases but still confused with the procedure of writing small and capital letters.	Able to write sentences but still confused with the procedure of writing small and capital letters.
Writing Samples	**Small Letter**  **Capital Letter** 				

Table 2.0 shows the changes in the writing of autistic students after the Q-LED intervention was applied to them. The results of the checklist found that student A can write letters well but the problem of wrong pencil grip due to anxiety problems prevents this student from forming letters well during the writing process. The results show that student A can write small letters (a,b,c,d,e,f,g,j,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z) and capital letters (A,B,C,D,E,F,G,J,I,J,K,L,M,N,O,P,Q, R,S,T,U,V,W,X,Y,Z) well without dotted line guidance after the Q-LED intervention was given.

While student B showed a very good change in the writing process after the Q-LED intervention was given. Before the intervention, student B could only write with the guidance of tracing letters using the dotted line method. After the Q-LED intervention, student B was able to write letters well either when copying or answering written questions. The results of the checklist also show that student B is able to write with the correct pencil grip and copy the text well without the need for specific guidance one by one in forming letters.

Table 2.0
Checklist of Pupils After Q-LED Intervention

Student	Letter Writing		Writing / Copying Words	Writing / Copying Phrases	Writing / Copying Sentences
	Small	Capital			
A	No need for guidance in writing dotted line letters **a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u , u, v, w, x, y, z**	No need for guidance in writing dotted line letters A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U , V, W, Y, X, Z	Able to write words but is still confused with the procedure of writing small and capital letters sometimes.	Able to write phrases correctly but still needs reinforcement so that students do not return to the original writing.	Able to write sentences but still confused with the procedure of writing small and capital letters.
Writing Samples		**Small Letter**  **Capital Letter** 			
B	No need for guidance in writing dotted line letters. **a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q,**	No need for guidance in writing dotted line letters. **A, C, D, E, F, G, H, I, J, K, L,**	Able to write words correctly but still needs continuous reinforcement so that students do not return to	Able to write phrases correctly but still need continuous reinforcement so that	Able to write sentences correctly but still need continuous reinforcement so that the

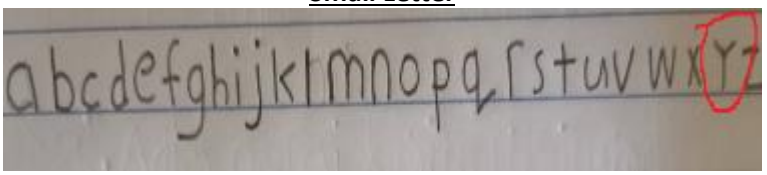
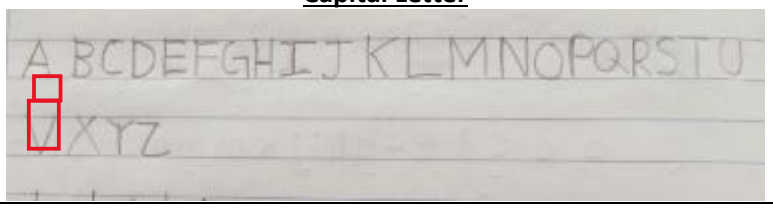
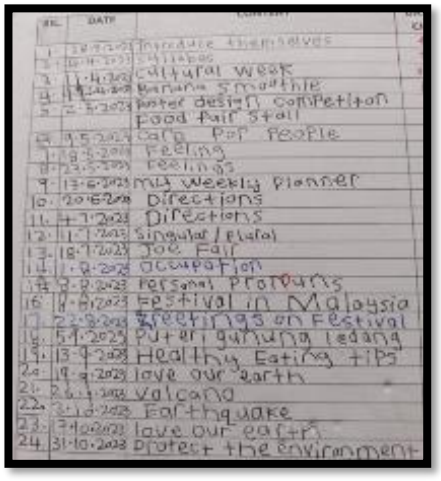
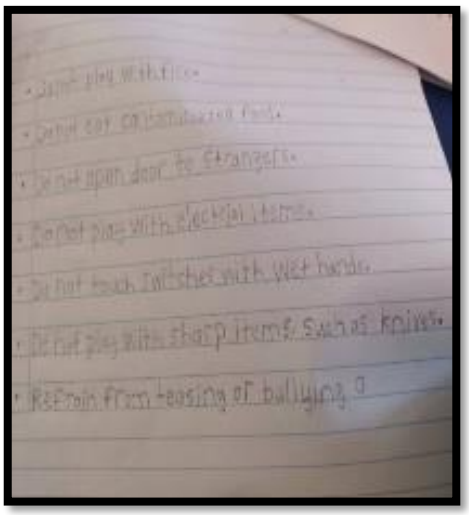
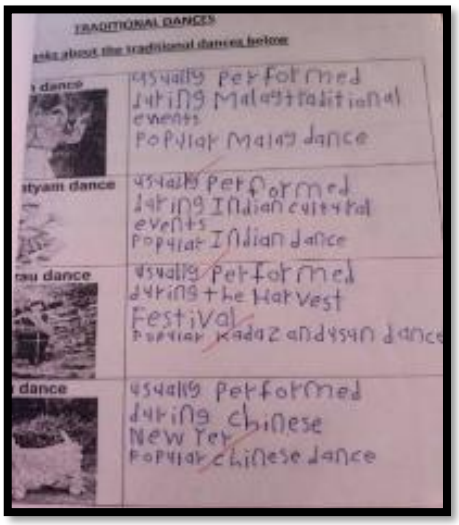
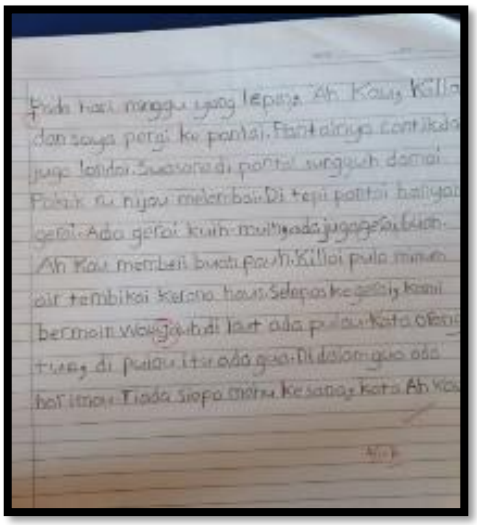
	r, s, t, u , u. v. w. x, y, z t, u, u. v. w. x. z	**M, N, O, P, Q, R, S, T, U, U. V. W. X. Z**	the original writing.	students do not return to the original writing.	student does not return to the original writing
Writing Samples		**Small Letter**  **Capital Letter** 			

Figure 2 shows the change in writing before and after the Q-LED intervention applied to both students with autism. The results of the student's writing are neater, organized and follow the correct writing format. The observation results also show that autistic students are more careful to form letters when copying after the Q-LED intervention is given. The potential of autistic students to write letters with a pencil grip and the correct method is increasing after the Q-LED intervention is used. The findings of the study show that the fine and gross motor drills of autistic students consistently also help these students master writing skills well.

Figure 2
Changes in Writing Before and After The Q-LED Intervention are Given

Student	Before intervention	After Intervention
A		

B		

Interview

The following are the results of interviews with the relatives of students with autism who were used as study respondents. The following are the results of the interviews conducted to answer the study questions:

Theme 1: Q-LED intervention helps improve the ability of students with autism to write letters well.

Question 1: Has the Q-Led intervention succeeded in improving the ability of students with autism to write letters well?

Student A

> "…..Thank God, teacher, Ashraf can now hold a pencil the right way with the help of the Qalamiy writing aid….he can write well but he is slow to write…he likes to write with pressure…his writing now looks more beautiful than before….I am happy, teacher, with this method, I see that he has started to know the writing procedure…after the period, he has to start with a capital letter…then there has to be a period at the end of the sentence…."

Student B

> "… Adam, the way he holds the pen is correct, teacher...after you gave him the Q-LED, now he can write letters according to the correct method but according to his mood…slowly…but his writing is very beautiful…I am grateful that the teacher taught this method to my son….

The results of the interviews showed that both students with autism successfully mastered the skills of writing letters using the correct method through the Q-LED intervention. Therefore, it can be proven that the Q-LED intervention successfully helped students with autism to hold a pencil and subsequently write using the correct method.

Theme 2: The method of imitating (embracing) letters through LED Boards successfully trains students with autism to form better.
Question 2: Has the method of imitating (embracing) letters through LED Boards successfully trained students with autism to form better?

Student A

> "…for me, my child is more focused on writing when the teacher has him write on the LED board…maybe because it looks sophisticated and has light...he likes it…when I ask him to write at home, he really tries to write…and I see that he has started writing upper and lowercase letters correctly in the right way…"

Student B

> "…first he brought that thing (LED board) home, he told me the teacher told him to write on this board…I was surprised that he could write on this thing…but I didn't think that this was the teacher's intention to let him focus on writing…but I didn't think that this could make my child write so beautifully…I am grateful that the teacher taught my child this method…"

The use of LED boards in this intervention successfully improved the ability of students with autism to focus on forming writing in a more neat and organized manner. Students with autism were also seen to be able to use the LED boards correctly after being demonstrated by the teacher for continuous use at home.

Theme 3: Parent-teacher collaboration is important in driving the ability of students with autism to master writing skills well.
Question 3: Is parent-teacher collaboration important in driving the ability of students with autism to master writing skills well?

The results of the interview found that the cooperation between parents and teachers influences the ability to write well among students with autism. Students with autism need continuous writing practice at school and at home so that their writing momentum and focus do not go astray.

Student A

> "….for me, my child needs additional writing practice at home besides what the teacher gives at school… the teacher can't do it at school if you don't do it at home…he'll forget it tomorrow because they're special education students…so I like it when the teacher calls and shows me how to use this tool to teach my child at home…that's one of the reasons why my child writes so quickly and beautifully…he writes at school and at home…at school the teacher looks at it, at home I look at it…"

Student B

> "…when the teacher invites me to meet to teach him how to write using the LED board, I'm surprised too...he often doesn't bring home schoolwork to do at home…but when the teacher wants us parents to join together to teach the child at home, I like it…I can see my child's shortcomings and I can discuss with the teacher what he doesn't want to do…so when I see my child can write beautifully

now, then I know that the teacher and parents have to sit down together to do something if we want to see the child succeed…"

The results of the interviews showed that cooperation between parents and teachers is very important in developing writing skills among students with autism. Every writing activity at school requires continuous reinforcement at home with parental monitoring so that the intervention applied to the child can successfully produce good results.

Discussion and Conclusion

The use of Q-LED as an innovative intervention in helping autistic students to write well can be realized because reinforcement is given to the correct pencil grip using Qalamiy and the student's focus on copying letters is enhanced by the use of LED Board. The study of Ozdowka et al. (2021) found the idea of interweaving the use of writing aids and technology equipment that focuses on hands-on activities can attract the focus of autistic students to master writing skills better. In addition to student focus, this study also found that the variety of methods in the writing teaching process is interesting and can increase the self-efficacy of autistic students to develop well.

In addition, the consistent use of Q-LED can help increase the interest, motivation and focus of autistic students to master writing skills better. According to Accardo et al. (2020), more than 70% of the effectiveness of writing intervention given to students with autism is influenced by motivational factors. The results of this study also found that the success of writing intervention can be achieved if the focus is given to the student's interest before any teaching activity is planned. This is because interest affects the motivation of autistic students to write better.

An interesting Q-LED intervention using an LED screen and combined with the Qalamiy writing aid helps to increase the momentum of interest and mood of Autism students when writing. The use of technology tools in the process of teaching writing to autistic students was found to be successful in stimulating their senses, fine motor skills and their potential to focus on the content of learning delivered by the teacher. According to Noreen et al. (2020) technology-assisted learning successfully (1) promotes interest and engagement, (2) increases attention and concentration, (3) triggers interaction and communication, and (4) creates a happy and enjoyable learning environment for students with autism.

The study of Desideri et al. (2020) also found that an interesting writing intervention with the help of technological tools can stimulate the senses of autistic students to stay focused on writing consistently. In the context of this study, the use of LED boards in the Q-LED intervention successfully stimulates the senses, improves focus and improves the functionality of autistic students when writing. The potential of students to write independently without assistance can also be realized when the LED board is aspired in this study.

The Q-LED intervention can also be used by students who write with their left hand (left-handed). The results of this study found that left-handed students are able to write well without putting pressure on the pencil and writing. The results of the students' work before and after the Q-LED intervention are evidence that this intervention has succeeded in

improving the quality of writing in a better direction. The study of Hui Ling Ch'ng & Aznan Che Ahmad (2023) supports the Q-LED study that the visual motor skills of autistic students can be developed through brain gym learning activities, visual motor activities, motivation, and continuous guidance from teachers and parents through visual cues, verbal feedback, and hands on handwriting practice.

Q-LED therapy successfully helped autistic students hold a pencil and write letters according to the correct method. The idea of combining writing intervention through LED boards and writing aids (Qalamiy) according to the ability and needs of autistic students has successfully increased the students' writing potential to a better level. In this regard, short-term and long-term planning focused throughout the Q-LED therapy needs to be focused so that the intervention provided is effective and has a positive impact on the writing skills of autistic students.

In conclusion, the Q-LED intervention successfully improved teachers' PDP to a better level. Interventions built based on teaching aids that are appropriate to the level of ability of students with autism have a positive impact on students' writing skills. Combining interesting learning activities needs to be carefully planned by teachers according to the level of ability and readiness of students so that the intervention applied to students can have a positive impact on the teaching and learning process in the classroom.

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