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Original Article

Impact of Dynamic Assessment on ADHD Learners' Knowledge of L2 Vocabulary and Working Memory: A Case Study

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Abstract

Within the field of second language learning, the need to provide equal access to L2 education has directed modern educators' attention to the potentials of Dynamic Assessment (DA) for students with learning disabilities. The purpose of the present single case study was to explore the effects of interactionist DA on ADHD L2 learners' knowledge of vocabulary and working memory capacity. A 13-year-old female EFL learner with the combined type of ADHD voluntarily participated in this study as an elementary student. During each session, a few new vocabulary items were taught through providing mediations relying on a regulatory scale from the most implicit to the most explicit emerging from the interactions between the mediator and the learner. The microgenetic analysis of DA protocols led to the development of an inventory of mediations consisting of different forms of implicit and explicit prompts. The results of the study demonstrated that DA could contribute to the learner's vocabulary knowledge with a number of fluctuations in some DA sessions, while it did not improve her working memory capacity. The findings of this study provide further insight into teachers' perception of how ADHD learners can learn an L2 and, at the same time, call for policy makers' and materials developers' greater attention to the progressive mediations required to help ADHD learners develop a higher level of self-regulation functioning through dialogic and social interactions.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD), Dynamic assessment (DA), L2 Learner, Vocabulary, Working Memory

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1. Introduction

Recently dynamic assessment (DA) has received increasing attention from researchers in different educational fields as an alternative to traditional assessment. One of the most important purposes of dynamic assssment is to predict academic achievement and identify students who need support so that instruction can be modified to allow them to gain their full potential (Cho et al., 2017). In fact, DA is an appropriate diagnostic tool for children whose cultural, linguistic, and learning experiences might be different from those reflected by standardized test content. It is reported that through mediation, children can learn to perform language-related tasks more successfully (Peña et al., 2007). In fact, mediational intervention has the potential to minimize the impact of test bias on children with various cultural and linguistic backgrounds (Mann, 2014).

Static assessment is appropriate for the evaluation of past learning products; however, it cannot measure changes within individuals, distinguish between poor performance caused by cognitive deficiencies or limited educational opportunities, or identify low performing students (Daniel, 1997). In contrast, as a promising approach that incorporates teaching and learning methods, DA aims to identify the language learning potential of students by assessing how they respond to specifically modified language interactions and provide predictions about their future language learning progress (Lantolf & Poehner, 2011). Recent research also suggests that DA is particularly suited to identifying the language learning abilities of learners with language disabilities (Hasson & Botting, 2010).

One of the most common learning disabilities associated with language learning in the classroom is the Attention-Deficit Hyperactivity Disorder (ADHD). School-aged ADHD children experience several academic and educational challenges and behavioral problems that might lead to school suspension or expulsion. For instance, failure to follow directions and sustain attention over a specific period of time may repeatedly occur in the class, which can hinder students' achievement and restrict their acquisition of new academic skills (Stahr et al., 2006).

Furthermore, ADHD students deal with some difficulties when learning L2 vocabulary and grammar because some factors such as reduced phonological awareness, low capacity of phonological short-term memory, complex grammatical concepts, and inappropriate teaching methods could interfere with their successful performance in these areas (Kormos & Smith, 2012). Given the rarity of the application of DA among learners

with ADHD in EFL contexts, this study sought to shed some light on the effects of DA on ADHD L2 learner's knowledge of vocabulary and working memory capacity.

2. Literature Review

2.1. Attention Deficit Hyperactivity Disorder

The attention deficit hyperactivity disorder (ADHD) is associated with advancing inappropriate levels of hyperactivity; provision of impulsive motor, emotional, and social responses; absence of inhibition, and permeating inattention (American Psychiatric Association, 2013). According to the American Psychiatric Association (1994), ADHD remains the most commonly diagnosed neurobehavioral disorder and the most widespread chronic health condition affecting young children. ADHD symptoms are commonly observed in school- aged children and often persist into adulthood. The three primary symptoms that define ADHD generally include inattentiveness and/ or distractibility, hyperactivity, and impulsivity (Liu et al., 2018).

There are three types of ADHD: a) the predominantly inattentive type: it is difficult for the ADHD individual to arrange or finish a given task, to follow instructions or conversations, and to pay attention to details; b) the predominantly hyperactive-impulsive type: the individual talks and fidgets to a large extent, finds it difficult to sit still for a long time, and feels restless and impulsive, which could lead to interjecting others frequently, grabbling things from people, or speaking at unsuitable times; c) the combined type: the patient shows impulsive and hyperactive behaviors and suffers from inattention and distractibility (American Psychiatric Association, 1994).

According to Sousa (2001), approximately 8% to 10% of school-aged children are affected by ADHD. It is also noted that boys are about three times more likely than girls to be diagnosed with this disorder. The presentation of symptoms in boys and girls with ADHD differs significantly. Typically, boys with ADHD exhibit externalized symptoms such as impulsivity and hyperactivity, while girls with ADHD display more internalized symptoms like low self-esteem and inattentiveness. Boys tend to express their frustration through physical aggression, whereas girls tend to internalize their pain and anger by exhibiting verbal aggression, which puts them at a high risk of developing depression, anxiety, and eating disorders (Rucklidge, 2010).

ADHD individuals may experience difficulties in all aspects of life. For example, they are greatly vulnerable to aggression, poor academic performance, retention, peer and family relations, and anxiety and depression and suffer from difficulties in adult social relationships, marital life and employment (Barkley, 2006). ADHD children, in particular, often suffer from low motivation, impaired self-regulation, and emotional self-control. Several studies in related fields have reported on cognitive impairments in memory, executive functions, spatial abilities, and language skills (Goldstein & Schwebach, 2004).

On the other hand, individuals with ADHD usually have to face several challenges in foreign language learning stemming from the connection between their academic skills (spelling, reading) and cognitive deficits (e.g., memory, attention, and phonological processing (Leons et al., 2009). The process of language development entails learning a wide range of vocabulary and grammatical structures, mastering phonological representations, and developing the knowledge of orthography and pragmatics (Kaldonek-Crnjakovic, 2018). Obviously, second language learning does not occur naturally; it rather imposes a great burden on working memory and, hence, poses a considerable challenge to ADHD learners. This is because the cognitive aspects of processing auditory and visual stimuli in both bottom-up and top-down processes are typically impaired in these individuals (Cain & Bignell, 2014).

Moreover, learners may experience difficulties in distinguishing between words with similar sounds, decoding written texts, and pronouncing and remembering polysyllabic words. ADHD learners may also have problems in simultaneously recalling the necessary vocabulary, conjugating verbs, and maintaining appropriate word order (Leons et al., 2009). According to Simon (2000), ADHD L2 learners are likely to struggle with following vocabulary, grammar, and pronunciation rules simultaneously, which can hinder their ability to speak with linguistic accuracy at a normal rate of delivery.

2.2. Dynamic Assessment

The theoretical basis of DA is rooted in Sociocultural Theory. According to SCT, an individual's responsiveness to mediation that aligns with their current ability level shows cognitive functions that are still developing (Poehner, 2007). Individuals are consistently mediated by social practices, cultural artifacts, and different activities, even when working

independently. In such cases, their cognitive functions are mediated by their interactions with the world (Vygotsky, 1986).

According to Lantolf and Poehner (2003), the Zone of Proximal Development (ZPD), as the core of sociocultural theory, serves as the main theoretical foundation of DA. ZPD essentially represents the difference between individuals' current level of ability and their potential to perform a task with the assistance of a more skilled individual or guidance from adults. Based on Vygotsky's (1987) view of the ZPD, a learner's response to mediation can demonstrate their abilities in the process of development and consequently provides a complete image of their developmental path.

DA is also viewed as a method addressing the long-standing challenge of early identification of second language learners at risk for learning disabilities (Grigorenko, 2009). In other words, DA is particularly suited for recognizing L2 learners' disabilities (Lantolf & Poehner, 2011) and can provide information that is difficult to obtain otherwise (e.g., through static assessment), especially in certain clinical settings. For instance, in a case study on DA, Ebadi and Naderi Farjad (2017) explored the impact of the presence of the mediator and the use of thought-provoking questions, translation, and mnemonic strategies on behavioral and cognitive deficits in a learner with schizophrenia. Their findings indicated that the learner did not reach a fully independent level as there were instances of incorrect usage of L2 forms and continued reliance on the mediator's assistance.

In another study, Alony and Kozulin (2007) examined the effects of DA procedures on the vocabulary skills of children with Down syndrome. They found that DA of receptive vocabulary revealed certain underlying abilities that had been underestimated by traditional static assessment. Similarly, Camilleri and Law (2014) investigated the effect of DA on the vocabulary knowledge of preschool children with language impairment. The learners were given varying degrees of assistance in identifying the target item, ranging from independent identification to verbal feedback. The results demonstrated that dynamic assessment exercises a positive effect on the vocabulary knowledge of children with poor language skills.

Furthermore, Petersen et al. (2017) investigated the potential contribution of DA of narratives to identifying language impairment in bilingual students. They developed a narrative-based DA protocol that involved assessing the students' initial narrative skills, providing explicit instruction, and then reassessing their narrative skills to determine their

ability to benefit from instruction. Their findings revealed that narrative-based DA was an efficient and accurate procedure for identifying language impairment in bilingual students. Finally, Rashtchi and Laleh (2015) investigated the efficiency of film-based DA in promoting the writing skills of deaf children in Iran. They found that the use of films had a positive impact on deaf children's writing ability. The children showed improvement in various aspects of writing including content, organization, and grammar.

2.3. Working Memory in ADHD Learners

Working memory is a cognitive system with limited capacity that plays a crucial role in the temporary storage, maintenance, processing, and manipulation of internally held-information to guide behavior (Rapport et al., 2013). Impairments in executive functions in relation to self-regulation, behavioral inhibition, and working memory have gained great attention as correlated neurocognitive deficiencies (Willcut et al., 2005) and as core features associated with ADHD (Barkely, 2006; Rapport et al., 2008). Research indicates that students with ADHD with executive function deficits exhibit lower levels of academic performance compared to their peers without ADHD (Biederman et al., 2004).

Additionally, weaknesses in executive functions can serve as predictors for academic outcomes in individuals with ADHD (Miller & Hinshaw, 2010). Deficiencies in executive functions can result in limited attention and ability, problems in generating strategies, difficulties in effective utilization of feedback, and inflexible thinking patterns (Anderson et al., 2001). Karalunas and Huang-Pollock (2013) also proposed that phonological working memory deficits observed in children with ADHD may be attributed to difficulties in lower-level cognitive processes that are responsible for converting visual stimuli into phonological codes. Hence, examining lower-level processes is an essential prerequisite for gaining a comprehensive understanding of the phonological working memory deficits experienced by ADHD learners.

Moreover, Mirtinussen et al. 2005 evaluated existing evidence on verbal and visuospatial working memory in individuals with ADHD. They found that ADHD individuals may exhibit more severe impairments in their visuospatial working memory. However, it is important to note that the working memory system is complex, and impairments may occur at specific levels and not at others. For example, deficits in the central executive component may result in a dysexecutive syndrome (Baddeley, 1986),

which appears to share some features of the executive issues observed in ADHD individuals (Brocki et al., 2008).

Nowadays, the population of students with specific learning disabilities such as ADHD is constantly increasing (Tsagari & Sperling 2017) especially in mainstream schools. According to the National Institute of Mental Health (2016), children with ADHD can attend main stream schools and may not necessarily require special educational services. However, it is important to note that these learners often face mental and cognitive challenges in normal classes. This is particularly true in the context of the study in Iran, where ADHD learners are placed in the same classes with normal students.

Indeed, students with ADHD may need suitable learning environments, and different learning opportunities that take into account their unique learning needs. In some cases, special schools or specialized programs may be necessary to provide the level of support required to help these students succeed academically and socially. Moreover, there is a need for teachers who have the necessary knowledge and skills to effectively teach students with learning disabilities. EFL teachers should also be trained to help these students overcome learning problems because lack of teaching expertise can negatively impact the academic progress of ADHD learners and contribute to the escalation of stressful classroom atmosphere (Silver, 2004; Turketi, 2010).

To the best of the researchers' knowledge, no study has addressed the efficacy of DA in improving ADHD learners' knowledge of different L2 components and skills and related cognitive constructs. Therefore, the present study attempted to examine the impact of dynamic assessment on ADHD student's knowledge of L2 vocabulary and working memory capacity. In order to delve deeply into the study, the following questions were formulated:

1. To what extent does the employment of DA affect ADHD L2 learner's vocabulary knowledge?
2. To what extent does the employment of DA affect ADHD L2 learner's working memory capacity?
3. In what ways does the employment of DA contribute to ADHD L2 learner's vocabulary
   knowledge?

3. Methodology

3.1. Design and Context of the Study

This study employed a single-subject research design while collecting both quantitative and qualitative data on the effects of DA on ADHD L2 learner's vocabulary knowledge and working memory. Minimal quantitative analysis was used in the form of descriptive reports of the learner's performance on the tests and the frequency of the mediations provided by the mediator. The interactionist DA approach and a microgenetic methodology were also employed to provide the treatment to the participant; hence, the researchers mainly followed a qualitative approach for data collection and analysis. The present study was conducted during the summer of 2019 at a private language school in Tehran, Iran.

3.2. Participant

This case study was carried out with a single 13-year-old participant with ADHD, called Sahel, chosen based on a convenience and purposive sampling procedure. She was a seventh-grade student attending a regular private high school in Tehran (Iran) and a monolingual speaker of Persian. She had been diagnosed with ADHD at the age of nine. The participant was predominantly inattentive and demonstrated impulsive/hyperactive symptoms (combined type). Throughout the study, she was receiving psychopharmacological treatment. As an elementary learner, she attended English classes 2 sessions a week, each lasting 90 minutes. Her classes continued for 59 sessions with 10 sessions devoted to the DA of vocabulary. Different skills and subskills were taught and practiced in the class with a primary emphasis on vocabulary.

Based on the researchers' observations, Sahel hated group learning and found it difficult to concentrate in such settings. However, she was highly intelligent and motivated to learn English. In the class, she struggled with maintaining focus on a single task and frequently shifted between incomplete activities, having problems sitting for long periods and following the teacher's instructions. Sahel also tended to talk excessively about unrelated topics, daydreamed and exhibited impatience and fidgety behavior, such as playing with her pencils, glasses, and hair as well as swinging her feet. Moreover, she often forgot to complete her homework or bring assignments to the class and expressed a dislike for written work. She was also very poor in math, physics, Arabic, Persian literature, dictation, and writing, and her performance on paper and pencil language tests was extremely poor. It

is emphasized that prior to the treatment, the researchers received the parents' signed consent as to their child's participation in the study prior to the treatment.

3.3. Instrument

The following instruments were used to achieve the purposes of this study.

3.3.1. Working Memory Test

The Working Memory Test Battery for Children (WMTB-C) was used to assess the participant's working memory capacity. WMTB-C is appropriate for individuals aged to 5 to 15 years old. It evaluates all three components of working memory, including the central executive, phonological loop, and visuospatial sketchpad (Gathercole & Pickering, 2001). This test comprises 9 subtests that measure various aspects of working memory (Table 1). In this study, the L1 paper-pencil version of the test, developed by Arjmand Nia (2016), was employed to assess the student's working memory capacity as a pre-test and a post-test. The Cronbach's alpha reliability of this test is equal to 0.95.

Table 1.
Subtests of WMTB-C

Working Memory Component	Subtest
Phonological loop	Digit Recall
	Word List Recall
	Non-word List Recall
	Word List Matching
Visuo-Special sketchpad	Block Recall
	Mazes Memory
Central executive	Listening Recall
	Counting Recall
	Backward Digit Recall

3.3.2. A Vocabulary Knowledge Scale (VKS)

A Vocabulary Knowledge Scale (VKS) (Wesche & Paribakht, 1996) was used to determine the participant's (Sahel) familiarity with the words both as pre-test and post-test. VKS is a point self-report consisting of five rating options ranging from total unfamiliarity, to word recognition and having some idea of its meaning, to the ability to use the word accurately in a sentence (Wesche & Paribakht, 1996). The first two categories assess the testees' familiarity with the target word form, and category 3 estimates whether they have any idea

of the meaning of the target word. However, categories 4 and 5 evaluate their ability to use the target word correctly in a sentence.

The VKS pre-test in this study consisted of 209 vocabulary items, which covered all the words in the textbook. It was used to select 84 words that were completely unknown to the participant. Moreover, A VKS post-test similar to the pretest was administered to measure the effects of the treatment.

3.3.3. Instructional Materials

Project 1 (Hutchinson, 2013) was used as the textbook in the class (based on the regulations of the language institute). This book aims to make the learning process enjoyable and motivating for teenagers by using interesting texts, topics, and activities. The audio CD contains all the listening materials (e.g., songs, vocabulary) used in the class. This book consists of 6 units focusing on all skills and subskills. All 6 units were covered in this study.

3.4. Data Collection Procedure

Initially, the required data about the participant's medical and educational background, foreign language knowledge, and home life were meticulously collected, and the parents' signed consent as to their child's participation in the study was obtained. Prior to administering the pre-tests, the mediator-teacher (one of the researchers) met with the participant to establish a friendly relationship with her. Based on the participant's academic files, she had difficulty sitting still, remaining quiet, and concentrating on a single task in her classes. Generally, the teacher tried to reduce distractions, get rid of dangerous things (e.g., scissors, metal ruler, mechanical pencils) in the room, and provide frequent breaks to help Sahel better focus and regulate her behavior. All the DA sessions were audio-recorded for later analysis, and the teacher kept a diary to record every single detail of the experiment.

The mediations emerged out of dialogic interactions between the mediator and the learner. The mediational moves were presented from the most implicit to the most explicit. Each DA session lasted for 15 to 20 minutes depending on the mood and cooperation of the participant. At the outset of the study, a VKS vocabulary test and a working memory test were administered as pre-tests. Due to Sahel's inefficient cooperation and lack of concentration, the VKS vocabulary test was administered in three sessions, and the working memory test in three sessions, each lasting around 20 minutes. Initially, the teacher offered

some instructions in Persian, and then Sahel was given the opportunity to practice each sub-test over 3 to 4 trials.

Following the pre-tests, Sahel participated in 10 DA sessions focusing on vocabulary. A total of 84 words that were unknown to Sahel were studied using the main textbook. During the interactive phase, the learner and the mediator became involved in dialogic interactions and a variety of activities (e.g., matching, completing, labelling, and doing crosswords) with the mediator offering mediations at different levels of assistance. The interactions continued until the student provided the correct response to each problem. The following excerpt from a DA session shows the dialogic interaction between the mediator and the student.

M: Label the school subjects with the words from the box. Look at part 2.

M. What school subject is it?

S. Map.

M. Map? Is map a school subject?

S. No. History?

M. Are you sure?

S. I don't know.

M. What can you find in a map?

S. Countries, cities.

M. Good. What school subject is about these issues?

S. Biology?

M. Biology? What school subject is about cities or countries?

S. I can't remember. Can you tell me its first letter?

M. It starts with (G).

S. Oh, teacher. Geography?

M. Yes. Correct.

An inventory of mediational moves that emerged from the vocabulary DA sessions is given in Table 2. It is emphasized that this mediation typology emerged based on data analysis and did not impose an apriori prescriptive hierarchy of mediational moves upon the mediator.

Table 2.

Mediation Typology

1. Request to look at the picture
2. Request for verification
3. Repeat the erroneous response with a questioning tone
4. Ask thought-provoking questions
5. Provide synonyms or antonyms
6. Provide examples
7. Cue the learner with the first letter of the word
8. Provide translations
9. Provide the correct response

At the end of the intervention sessions, the same VKS pre-test and working memory test were given as post-tests to the participant to evaluate the extent to which DA had affected her vocabulary knowledge and working memory capacity. For the reasons mentioned earlier, the VKS and working memory post-tests were administered over 6 sessions (VKS in three and the working memory test in 3 sessions).

3.5. Data Analysis Procedure

The participant's performance was analyzed to assess the correctness of her sentences and the types of prompts required during the tasks. Field notes and audio recordings were analyzed qualitatively to obtain information about the mediations and the participant's attention focus, behavior, and interest in the course of the treatment. All the interactions were audio-recorded, transcribed verbatim, and reported.

4. Results

4.1. Quantitative Analysis

4.1.1. Vocabulary

To examine the first research question, the participant's vocabulary scores on both the pre-test and post-test were computed and compared (Table 3).

Table 3.

Sahel's Vocabulary Scores Gained on the Pre-test and Post-test

Participant	Vocabulary pre-test (out of 209)	Vocabulary post-test (out of 209)
Sahel	125= 59.80%	193=92.34%

As presented in Table 3, Sahel answered 125 (59.80%) items correctly on the pre-test, while she could answer 193(92.34%) of them correctly on the post-test, indicating an increase in her word knowledge from the pre-test to the post-test.

4.1.2. Working Memory

In order to answer the second research question, WMTB-C was used both as a pre-test and a post-test to measure the participant's working memory components (Table 4).

Table 4.

Sahel's Working Memory Component Scores on the Pre-test and Post-test

	Central Executive	Visuospatial Sketchpad	Phonological Loop
Pre-test	77	72	110
Post-test	63	72	109
Total	140	144	219

As demonstrated in Table 4, the central executive scores on the pre-test (77) and post-test (63) were to some extent different. Sahel's central executive score on the pre-test was higher than that on the post-test, while her visuospatial sketchpad (72) and phonological loop (pre-test (110), post-test (109)) were almost the same. She performed better on the pre-test. Working memory impairments were apparent across all three components with the largest magnitude deficits in the central executive function. Therefore, it was concluded that DA had not contributed to her working memory capacity.

4.2. Qualitative Analysis

In this study, the data were analyzed from a microgenetic perspective as the general methodological framework for data analysis. The reason behind using this method was that it allows tracing of the learner's development over time (Ableeva, 2010). This phase focused on the frequency and quality of mediations for the participant based on Aljaafreh and Lantolf's regulatory scale (1994) (Appendix 1). This scale presents three different developmental stages at five transitional levels with levels 1 to 3 representing other regulation, level 4 focusing on partial self-regulation, and level 5 demonstrating self-

regulation. All the sessions involving mediated interactions (DA1, DA2, ….) were coded to identify the various mediational moves that comprised the typologies. The learner's performances at different points in time were compared and analyzed, and the mediation typology was developed based on the explicitness of each move by the mediator in the vocabulary tasks. (Table 5).

Table 5.

Level of Explicitness of Mediational Moves

Learner	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
Sahel	3,3,3,3,3	3,2,4,3,3,4	3,3	4,3,3,3,3,3	4,4,3	3,4,3,3,2,4	3,3	3,3	2,2,3,3	3

As illustrated in Table 5, Sahel required the fewest forms of explicit mediation in DA10, DA3, DA7 and, DA8, while she required more of them in DA1, DA2, DA4, DA6, and DA9. She received more explicit forms of mediation in DA5, while she received mediations at the same level of explicitness in DA3, DA7, and DA8. She was partially dependent on other-regulation in DA5, while she was completely dependent on the mediator in DA9. Table 6 presents the total and average numbers of prompts required by Sahel each session.

Table 6.

Frequency of Mediational Moves

Mediations	DA1	DA2	DA3	DA4	DA5	DA6	DA7	DA8	DA9	DA10
1. Request to look at the picture	2	4	2	2	1	5	1	1	4	0
2. Request for verification	3	7	2	1	0	0	0	3	1	0
3. Repeat the erroneous response with a questioning tone	0	0	0	2	2	2	1	4	5	2
4. Ask thought-provoking questions	0	13	4	5	3	5	1	0	0	1
5. Provide synonym or antonym	1	0	0	0	0	0	0	0	0	0
6. Provide example	1	2	2	0	0	0	0	0	1	0
7. Cue the learner with the first letter of the word	3	2	0	1	0	1	2	0	2	0
8. Provide translation	0	0	0	0	0	0	0	0	0	0
9. Provide the correct response	0	0	0	0	0	2	0	0	0	0
Total number of mediations	10	28	10	11	6	15	5	8	13	3
Average number of mediations	1.11	3.11	1.11	1.22	0.66	1.66	0.55	0.88	1.44	0.33

As illustrated in Table 6, the number of mediations fluctuated in some sessions. In fact, the participant required and resorted to more prompts and mediations in some sessions. A clear decrease in the number of mediations was observed in DA5, DA7, and DA10, and she showed improvement during the last assessment session concerning the number of mediations. In other words, given the mediational moves during DA5, DA7, and DA10, Sahel was closer to independent performance and required less assistance from the mediator.

The number of the mediational prompts *(ask thought-provoking questions)*, which had amounted to 13 in the second DA session, fell to 1 during DA10. Furthermore, the mediation *(request for verification*), which had amounted to 7 in DA2, fell to 0 during the last DA session. The number of explicit mediations decreased to 0 in the last session, and the mediator relied mostly on implicit types of mediation. Therefore, it was concluded that DA had contributed to Sahel's independent performance.

5. Discussion

The aim of the present study was to investigate the effects of DA on ADHD L2 learner's knowledge of vocabulary and working memory capacity. The findings of the study demonstrated the efficacy of DA in improving ADHD L2 learner's knowledge of vocabulary. However, the analysis of mediator-learner's interactions revealed some differences in the learner's levels of internalization during the DA sessions. In fact, the results are in line with several studies reporting the contribution of DA to at-risk learners' development in the learning process. As mentioned before, Ebadi and Naderi Farjad (2017) reported the positive impact of DA on a schizophrenic L2 learner's cognitive and intellectual functioning over time. Furthermore, Camilleri and Law (2014) demonstrated that the use of DA could improve the vocabulary knowledge of preschool children with language impairment. Alony and Kozulin (2007) also showed the superiority of DA over static assessment in the enhancement of receptive vocabulary of young children with the Down syndrome.

The analysis of the collected data also revealed that DA did not enhance Sahel's working memory capacity. Working memory impairments were evident in all three components with the most significant deficits observed in the central executive function. It has been previously reported that ADHD individuals suffer from certain deficits in working memory, especially in their central executive function (Martinussen & Tannock, 2006) and

visuospatial sketchpad (Barkley, 1997). The reason could be attributed to the nature of DA itself. According to Saunders (2018), DA may be less effective in this respect since its focus is primarily on enhancing encoding processes, rather than providing the learners with memory aids to improve memory capacity.

Other reasons might have been the types of the mediations provided by the mediator and the duration of the study, which lasted for five months. The researchers believe that any judgment about the effects of mediation types on changes in executive function requires further study. However, according to Poehner (2005), DA focuses on the mediator's interactive dialogues with the learners to identify developmental changes that may have happened over time. Therefore, a longer study of the variables of this study could lead to different results.

Furthermore, it was found that the participant performed independently and required fewer mediations in some sessions. According to Poehner (2005, p. 209), "a learner who needs fewer mediations or less explicit mediation at time 2 than at time 1 can be said to be developed". It was also found that her progress was not linear but rather "zigzagged" in Vygotsky's terms (1997). Here, the participant tended to produce more progressive than regressive moves, especially during the last two sessions. The findings also support Vygotsky's view regarding the inconsistent nature of development as a process that involves both regression and progression.

Silver (2004) suggests that, in spite of their inherent learning disorder, ADHD students can still succeed in learning a foreign language when the employed teaching strategies and practices address their specific needs effectively. It is also emphasized that ADHD students usually suffer from attention deficit, lack of motivation, and poor school performance; however, a cooperative and supportive mediator who creates a fine environment by allowing a rethinking time persuades the learner to discover and correct the errors (Ebadi & Naderi Farjad, 2017). Moreover, various external variables may impact the evaluation of the findings and their applicability to individuals with ADHD such as medication category, age, sex, and comorbidity, among others (Assef et al., 2007).

6. Conclusion

The present study highlights the effects of DA on ADHD L2 learner's knowledge of vocabulary and working memory capacity. Based on the results, it can be concluded that DA

can contribute to ADHD learner's knowledge of vocabulary, and self-regulation [as an emerging variable in this study]. However, it is important to note that the participant received a varying number of mediations during the DA sessions. The learner required less assistance in the final sessions but experienced some regression in some DA sessions. The data also demonstrated that DA helped the participant in achieving self-regulation, particularly towards the end of the study, as revealed by the number and types of mediational moves. Moreover, it can be contended that DA did not contribute to the ADHD L2 learner's working memory capacity.

The findings of this study can provide useful guidelines for EFL teachers who work with ADHD students across different age groups and educational levels. This study also underscores the importance of understanding how ADHD can impact language learning and academic performance and provides insights into different types of mediation that can be employed by teachers. Moreover, the findings of the study indicate that it is necessary for teachers to develop some in depth-knowledge of ADHD symptoms, interventions, and challenges. This knowledge can significantly influence the way they interact with ADHD learners and cater for their learning needs. The results can also provide some incentive for material developers to design certain vocabulary activities that could be of great benefit to ADHD L2 learners. They can also inform educational policy-makers about the necessity of providing special educational services and accommodations for ADHD students.

However, the case examined in this research demonstrates that ADHD L2 learners do not necessarily have to be seen as victims of the educational system. ADHD students need special accommodations and services. They may encounter challenges in coping with the heavy curriculum of regular schools. Class size is an important factor for ADHD students or learning disabilities. They also need materials and methods that are specifically designed to fulfill their learning needs. Therefore, if they are to attend regular schools alongside normal students, it could be useful to hold some extra classes for them with trained teachers to help them cope with the social, psychological, and learning challenges that might block their progress in educational settings.

As with all case studies, this single-case study suffered from a number of challenges and limitations. The researchers do not intend to make any generalization based on the collected data.

Moreover, the researchers believe that further research with a larger sample and over a longer period of time, while focusing on other learning disabilities and cognitive impairments, could provide valuable data as to how children at risk could be helped in the process of learning different L2 skills and subskills. Since the participant in this study was female, replicating the same study with male learners might yield some different results that could further enlighten educators as to how to provide for ADHD learners' needs more efficiently in L2 learning contexts.

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Appendix 1

Regulatory Scale

Transitional Levels	Mediational Moves
Level 1	The learner is not able to notice, or correct the error, even with intervention from the tutor.
Level 2	The learner is able to notice the error, but cannot correct it, even with intervention.
Level 3	The learner is able to notice and correct an error, but only under other-regulation.
Level 4	The learner notices and corrects an error with minimal, or no feedback from the tutor and begins to assume full responsibility for error correction.
Level 5	The learner becomes more consistent in using the target structure correctly in all contexts.