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Mini Review

Assistive Technologies and ASD: Gaps between Policy and Practice

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INTRODUCTION

According to the Egyptian Social Solidarity Ministry, the number of students with autism spectrum disorder (ASD) is estimated to be 800,000 in 2021. This cosmic number means that, in mainstream public school classrooms, there are probably 3-6 students with ASD. Henceforth, special education teachers, as mandated by the law on the Rights of Persons with Disabilities which was enacted by Abdel Fattah El Sisi, the president of the Arab Republic of Egypt in 2018, should be familiar with "effective assistive technologies to better support students with ASD". However, teacher preparation programs (TPPs), which are developed by the Ministry of Education (MoE), offer a number of special education courses, focusing on general concepts, knowledge, and information [1]. In addition, courses which are centered on modern developments and trends in assistive technologies are strikingly absent. Hence, pre-service educators are "[provided] with inadequate knowledge about the incorporation of assistive technologies" [2].

In addition to TPPs, professional development programs created by the MoE in partnership with educational agencies (EAs) and offered to teachers in public schools are limited in scope. For instance, professional development programs, after the passage of the law on the Rights of Persons with Disabilities, shed light on improving the learning of students with disabilities, bolstering their autonomy, and maximizing their cognitive aptitudes [2]. However, none of these programs were devoted to the incorporation of assistive technologies in inclusive settings; as a result, special education teachers "exhibit inadequate knowledge in utilizing effective assistive technologies".

Teachers' inadequate knowledge in employing assistive technologies negatively affects the learning of students with ASD. Students with ASD, as underlined by [3], are deprived of meaningful opportunities to enhance their social interactions, improve their turn-taking and role-switching abilities, recognize emotions from facial and vocal expressions, ameliorate their eye contact, comprehend people's body language, initiate conversations, practice problem-solving skills and reinforce their emotional expressions. Furthermore, students with ASD are incapacitated to bolster their independence, enhance their writing abilities, maximize their learning and retention of vocabulary, diminish challenging behavior, augment their engagement, and improve their levels of comprehension [4-7]. In light of the aforementioned implications on the social and academic gains of students with ASD, the aim of this paper is fourfold:

(a) Elucidating the law on the Rights of Persons with Disabilities,

(b) Highlighting the barriers, which hinder educators' use of assistive technologies,

(c) Introducing iPads as an effective assistive technology for pupils with ASD and

(d) Recommending suggestions for ameliorating TPPs and professional development programs in Egypt.

The Law on the Rights of Persons with Disabilities

Approved and enacted by Abdel Fattah El Sisi, the president of Egypt, in 2018, the law on the Rights of Persons with Disabilities comprises an array of legal rights for people with disabilities in several life domains, including education. In fact, the law prohibits educational institutions from excluding applications of students on the basis of disability and imposes a strict penalty on schools' personnel breaching such a provision. As mandated by the law, educational institutions are obliged to adopt policies, which support students with disabilities, and to incorporate assistive technologies in order to accommodate their diverse needs. Also, the law urges educational institutions to provide high-quality instruction, using research-based methodologies, and reasonable accommodations for students with disabilities to attain universal integration in schools and higher education institutions [8]. Although the law enforces the use of assistive technologies to address the diverse needs of students with disabilities, teachers, due to massive barriers, are hindered from effectuating this provision [2].

Barriers Hindering Educators' Use of Assistive Technologies

One of the barriers, which hinder special education teachers' use of assistive technologies, is TPPs [2]. In Egypt, TPPs are delivered by esteemed faculty members at higher education institutions, such as Cairo University, Alexandria University, and Zagazig University, with the aim of equipping pre-service teachers with the needed

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skills, knowledge, and expertise to deliver high-quality instruction to students with disabilities in inclusive settings. To accomplish such a purpose, pre-service teachers enroll in a number of courses, which are primarily centered on specialized instruction, inclusive education, and the psychology of exceptional children. Yet, courses, focusing on assistive technologies, are noticeably absent from any faculty of education in Egypt. Accordingly, teachers' inadequate competencies, as posited by [2], are attributed to TPPs which provide little information about assistive technologies.

Another barrier to teachers' use of assistive technologies is professional development (PD) programs [1,2,9,10]. To further elaborate, PD programs, which shed light on the incorporation of assistive technology devices, are not offered to special educators. Instead, they are provided with outdated PD programs, which predominantly revolve around using smart boards as a means of instruction [10]. Furthermore, contends that special educators are massively underprepared to employ assistive technology devices in general education classrooms due to a lack of PD programs, which are centered on such a scope [11]. In addition to [10] and [12], [9] underscore that special educators yearn for PD programs, in which they properly learn how to skillfully implement assistive technologies in their subject areas, so as to better accommodate the needs of students with disabilities. In conclusion, teachers are obviously not familiar with effective assistive technologies, which are being employed to address the needs of students with disabilities in general, and students with ASD in particular.

iPads: An Effective Assistive Technology for Pupils with ASD

Under the law on the Rights of Persons with Disabilities, educators are mandated to employ assistive technologies in general education classrooms to accommodate the needs of students with disabilities [8]. In fact, assistive technologies are considered as "any item, equipment or product system, whether acquired commercially or customized, that is used to increase, maintain or improve functional capabilities of individuals with disabilities". iPads, an example of an assistive technology device, have been proven to markedly improve the academic gains of middle school students with ASD in English language arts [11,13-18].

To further elaborate, [19], using a multiple baseline design, examined the use of iPads to improve picture-to-word matching for a student with ASD. A middle school pupil, who was reported to say 15 meaningful words, to attend to pictures, to respond to disparate commands, to understand 50 words, and to sporadically incorporate two-word phrases, was the sole participant in the study. Prior to launching the study, the researchers administered a picture-to-word, a picture-to-picture, a word-to-word and a word-to-picture matching assessment to evaluate the participant's performance. In the study, the research participant received an iPad which included twelve pictures from three different categories: clothes, animals, and food. The participant was requested to answer four matching tasks: picture-to-picture, word-to-picture, picture-to-word, and word-to-word. As a means of rewards, contingent social reinforcement was mainly provided for on-task behavior, and non-contingent tangible reinforcement was offered at the end of each task. During matching tasks, the participant was given 10 seconds to respond to a prompt; in case the participant did not respond or incorrectly responded, graduated guidance was provided to elicit a correct answer. Furthermore, follow-up measures for matching picture-to-picture, word-to-word, picture-to-word, and word-to-picture were incorporated. In an attempt to monitor the student's progress, an independent observer traced the total number of correct responses during matching activities. Having analyzed the data, the researchers highlighted that the participant demonstrated 0% correct responses during baseline sessions, 83% correct responses during the intervention, and 75% correct responses during follow-ups for word-to-picture matching. Moreover, the participant produced 0% correct responses during baseline phases, 83% correct responses during the intervention, and 100% correct responses during follow-ups for word-to-word matching. Besides, the participant made 0% correct responses during baseline phases, 83% correct responses during the intervention, and 75% correct responses during follow-ups for picture-to-word matching. Accordingly, the aforementioned results indicate that the participant's performance across all four matching combinations outstandingly improved after the intervention.

Examined the effects of iPads on the vocabulary use of students with ASD using a single-subject multiple baseline design [20]. Three middle school students, who were diagnosed with ASD, participated in the study. Before launching the study, the researcher assessed the pupils' level of vocabulary by administering a test, consisting of three pictures of verbs and nouns without prompts or cues and asking them questions, like what is happening in the picture? Having assessed the research participants' vocabulary levels, the researcher distributed iPads to the pupils; the iPads encompassed a plethora of different pictures, and the students were asked to incorporate verbs and nouns to describe them in 10 seconds. When the students incorrectly answered the question within the allotted time frame, a verbal prompt was utilized to guide them. If the students, with the use of the verbal prompt, mistakenly answered the question, the researcher, in this case, implemented the direct demand technique by calling the students' names and requesting a response to the question. In an attempt to accurately monitor the research participants' progress, the researcher administered weekly assessments at the end of the sessions. In addition, the researcher obtained the assessments' scores of pupils with ASD, who were not involved in the current study and were in the same grade-level as the research participants, with the intent of comparing them. Having analyzed the data, the researcher underlined that the results of the weekly assessments showed remarkable improvements in the students' vocabulary level. Further, their scores, compared to their grade-level counterparts, were exceptionally higher as a result of the intervention.

Launched a study to examine the effectiveness of iPads in supporting pupils with ASD to acquire sight words. A total of four middle school students from Southern New Jersey participated in the study [21]. Prior to conducting the study, data were collected regarding the students' performance on sight word reading. Having retrieved and analyzed the data, the researcher rapidly introduced the intervention and requested the participants to sound out the words, which appeared on their screens; when they were wholly pleased with their performance in sounding out the words, they were instructed to touch their screens to listen to the correct pronunciation of the words. Next, the students, after completing the aforementioned activity, were asked to read the words, appearing randomly on their screens. To motivate the research participants to read quickly, they were offered a plethora of reinforcers, like candy, for every set number of words uttered correctly. In an attempt to monitor students' progress, a checklist was continuously utilized to record the rate and accuracy of the participants' performances on sight word reading and compare their progress over the course of the study. After analyzing the data, Emerson highlighted that the highest percentage of academic gains on reading sight words, before

introducing the iPads, was 20%, while the highest percentage of academic gains on reading sight words, after introducing the iPads, was 65%. Also, the average accuracy gains on reading sight words, before the intervention, was 2% while the average accuracy gains on reading sight words, after the intervention, was 51.25%. Accordingly, the results indicated that iPads extensively improved the research participants' rate and accuracy in sight word reading.

Carried out a study to assess the effect of iPads on story comprehension of students with ASD [22]. A total of 30 middle school students participated in the study: 15 diagnosed with ASD and 15 neurotypical counterparts. Prior to launching the study, the research participants sat for the Peabody Picture Vocabulary Test, which assessed their vocabulary skills. Then, Marble and her colleagues divided the research participants into an experimental and control group. In the experimental group, the pupils with ASD received their iPads and read an array of books, including Pete the Cat: Pete at the Beach, Pete the Cat: Too Cool for School, and Pete and the Bad Banana; after reading each book, several language abstraction questions, which encompassed matching and selective analysis, appeared on the research participants' screens. After correctly answering all the questions, they had a 10-minute break as a means of reinforcement; they, apart from the researcher- directed activities, engaged themselves in several activities. In contrast to the experimental group, the neurotypical peers, in the control group, utilized paper books to read the aforementioned stories and answered the language abstraction questions orally. To evaluate the impacts of iPads and paper books on the research participants' levels of comprehension, the researchers administered an exam, which encompassed language comprehension questions. Having analyzed the data, the researchers ascertained that the participants in the experimental group performed better than the control group. Henceforth, iPads considerably impinged reading comprehension levels of the students with ASD.

Launched a case study to examine the effect of iPads on the performances of students with ASD in an array of content areas that support English language arts skills [23]. A total of 19 middle school students with ASD who received instruction in self-contained classrooms were the research participants in the study. Prior to introducing the intervention, the research participants sat for the Assessment of Basic Language and Learning Skills, which predominantly assessed their performances in reading, writing, and spelling. Having administered the assessment, the researcher distributed iPads to the students who were requested to practice reading, writing, and spelling using a wide range of applications on their iPads. To further explain, the participants were asked to utilize an application called BrainPop, which offered an array of engaging activities in the aforementioned skills. Also, they were requested to incorporate an application called Puzzle Spelling Words, which guided them to complete a series of word and picture puzzles, and to spell words. Besides BrainPop and Puzzle Spelling Words, the students were instructed to utilize an application called Vocabulary Spelling City, which encompassed disparate types of activities, including interactive spelling tests, and word or sentence scrambles. Finally, they made use of an application called Locabulary, which aided them to construct sentences from a menu of moods; assistance needed, and self-created lists using auditory and printed words. At the end of the academic year, the research participants sat for the Assessment of Basic Language and Learning Skills to meticulously evaluate their performance in English language arts skills after administering the intervention. Concidine [23], having analyzed the collected data, adjudged that, compared to their pre-test scores, the research participants' post-test scores showed exceptional improvement in reading, writing, and spelling. Therefore, the academic gains of students with ASD in English language arts skills were much greater with the use of iPads.

Investigated the effect of iPads on the phonological awareness of English language learners (ELL) who were diagnosed with ASD [24]. Three middle school students participated in the study. Prior to launching the study, Chai and his colleagues administered the Peabody Picture Vocabulary Test and The Test of Reading Ability to appropriately assess the research participants' literacy performances. Having administered the aforementioned exams, the researchers distributed iPads to the students who were requested to launch an application called Touch Sound; in fact, this application aimed at teaching initial phonemes to the research participants via an array of engaging activities. At the beginning of every lesson, the students were presented with a picture of an object, whose name began with the target phoneme on the top row of their iPad screens, and three pictures of other objects on the bottom row; the name of one of the three objects on the bottom row started with the target phoneme, and the other two objects did not. At this point, the pupils were requested to touch the word that started with the same phoneme in 5 seconds only. If the research participants correctly responded to the question, they automatically received a verbal praise. In case of a wrong response, they were provided with corrective feedback instantaneously. Once the students reached 100 correct responses, they were instantly re-directed to delay sessions. In effect, the delay sessions were equivalent to the aforementioned activities in time frame and nature of questions, which were unprompted. In the delay sessions, if the research participants correctly responded to the questions, they received a verbal praise. If they did not, a prompt, as a means of guidance and help, appeared on their screens. At the end of every session, a paper-and-pencil test was administered to the pupils, who were instructed to underline the picture of an object whose label began with the same phoneme as the given object on their test. Having analyzed the data, Chai and his colleagues pinpointed that the students' scores in the pre-tests were 66.67%, 33.33%, and 66.67%. In contrast to their pre-test scores, their post-test scores were 80.87%, 100%, and 92%. Henceforth, the aforementioned scores emphasize that the participants mastered the target phonemes after the intervention was introduced.

Investigated the impacts of iPads on the vocabulary use of students with ASD. A total of three middle school students with ASD participated in the study [25]. Prior to initiating the study, the researchers administered a test to the students to meticulously assess their vocabulary use; the test comprised a 45-second video and, after watching it, the participants were requested to describe it using verb and noun phrases. In addition, a check-list was incorporated to record correct and incorrect responses. Having administered the pre-test, the researchers evenly distributed iPads to the students, who were instructed to launch an application called I Communicate; this application encompasses a wide range of engaging activities, which help in enriching the research participants' vocabulary levels. Similar to the pre-test, one of these activities, which was employed in the study, entails watching a 45-second video and describing its content in 10 seconds. If the participants did not respond correctly within the allotted time frame, the researchers adhered to a prompt sequence: point prompt, verbal model, and direct demand. In the point prompt, the researchers mainly pointed to the picture on the participants' iPads to evoke a correct response. If the research participants did

not answer correctly even after incorporating the point prompt, the researchers, in this case, utilized the verbal prompt, in which they modelled the noun or the verb phrase. In case the researchers did not receive a correct answer after implementing the verbal prompt, they purposefully incorporated the direct demand method, in which they called the participants' names to grab their attention and demand them to correctly answer the question. To systematically monitor the research participants' improvement during the intervention, a check-list was employed to record their correct or incorrect responses. After analyzing the data, the researchers postulated that the participants' verb and noun use, during the pre-test, was 33%, 55%, and 37.5%, while their verb and noun use, after introducing the intervention, was 100%, 100%, and 75%. Thus, the research participants, with the use of iPads, exhibited exceptional improvements in their use of noun and verb phrases.

Launched a study to examine the effect of iPads on the phonological awareness of students with ASD. Three middle school students with ASD willingly participated in the current study [26]. Prior to launching the study, the researcher evaluated the research participants' phonological awareness using index cards; on each index card, a picture of an object, which started with a target phoneme, was placed in the top middle, and three pictures were situated at the bottom of the index card. Out of the three pictures, two acted as distractors, and the remaining one began with the target phoneme. Having administered the pre-test, the researcher distributed iPads to the participants and requested them to launch an application called Touch Sound; such an application was incorporated to teach phonemes to the research participants using a plethora of engaging activities, one of which comprised a picture of an object that started with the target phoneme and was situated in the middle of the screen, and three other pictures that were placed at the bottom. Then, the students were asked to circle one of the three pictures that began with the same sound of the object in the middle of the screen in 5 seconds. If the students correctly answered any of the questions, they instantly received a verbal praise. In case they mistakenly responded to any question, the application instantaneously provided them with corrective feedback. In an attempt to check the research participants' progress, a check-list was employed to record the number of correct and incorrect answers. Having analyzed the data, Chai declared that the students' average responses, prior to the intervention, were 22.22%, 11.11%, and 22.22%. Yet, their average responses, after introducing the intervention, were 100%, 92%, and 94%. Hence, the intervention remarkably ameliorated the students' phonemic awareness.

In conclusion, the aforementioned studies have documented the prominent effectiveness of iPads in ameliorating phonological awareness, vocabulary use, reading comprehension, sight word acquisition, basic literacy skills, and picture-to-word, word-to-word, picture-to-word and word-to-picture matching of students with ASD. To garner these desirable outcomes, TPPs in Egypt should equip pre-service educators with the needed knowledge and skills with respect to the consideration, selection, and implementation of assistive technology devices or software in inclusive classrooms [27].

Recommendations for TPPs and PD Programs

TPPs in Egyptian higher education institutions: In order to better prepare pre-service educators to effectively employ assistive technologies in general education classrooms, [28] recommends that TPPs design a stand-alone, comprehensive course on assistive technologies. In fact, this course, as highlighted by Wojcik and his colleagues, should entail two stages: (a) interactive instruction and summative evaluation, and (b) hands-on experience Figure 1. In stage 1, pre-service educators will be introduced to nine topics on assistive technologies; these topics include: (a) an introduction to assistive technologies, (b) assistive technologies for pupils with ASD, (c) assistive technologies for deaf or hard of hearing pupils, (d) assistive technologies for visually-impaired pupils, (e) assistive technologies for pupils with learning disabilities, (f) assistive technologies for pupils with intellectual disabilities and other health impairments, (g) assistive technologies for pupils with traumatic brain injuries, (h) assistive technologies for pupils with emotional and behavioral disorders, and (i) assistive technologies for pupils with speech impairments. At the end of stage 1, pre-service teachers will sit for a summative exam, which tests their comprehension on the use of assistive technologies in educational settings. After passing the summative test, pre-service teachers will be instantly directed to stage 2, in which they will visit the Special Education Assistive Technology Lab on a weekly basis; such a Lab must be equipped with laptops, devices, mobile technology devices, and software licenses. During their weekly visits, pre-service teachers will be tremendously engaged in an array of hands-on activities using disparate assistive technology devices to better accommodate the educational needs of pupils with different types of disabilities.

PD Programs

PD programs on assistive technologies are of tremendous importance to in-service teachers who, as a result of inadequate training in TPPs, lack the needed knowledge and skills in this scope. Henceforth, [29] thoroughly recommend that public education institutions design effective PD programs so that in-service teachers are substantially enabled to accommodate the disparate needs of pupils with disabilities in general education classrooms. In fact, an effective PD program, as accentuated by [29], is composed of a number of unique features, including introductory and advanced readings, engaging discussions and activities, modelling, and hands-on experience Figure 2. To explain, in-service teachers, in the PD

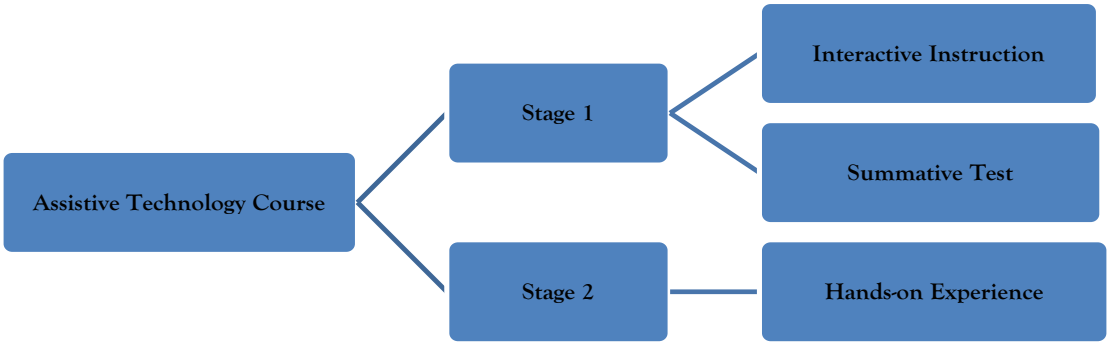

Figure 1: A Proposed Assistive Technology Course for TPPs in Egypt.

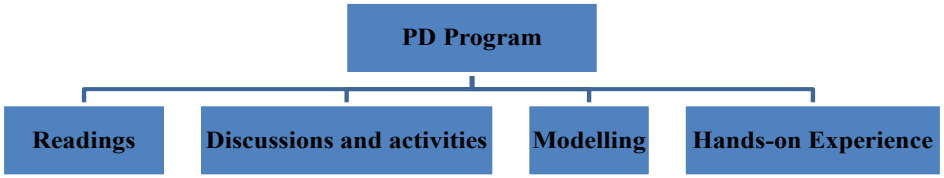

Figure 2: The Unique Features of an Effective PD Program.

program, are obliged to complete a number of readings centered on the most successful assistive technologies which are cited in the literature. Having completed the weekly assigned readings, in-service educators are to be engaged in interactive discussions and activities that will assist them in acquiring the necessary knowledge assistive technologies. Then, as a means of modelling, multimedia clips are utilized so that in-service teachers observe how such technologies are being skillfully employed in real-world settings. Last, to prepare in-service teachers to operate the devices and integrate them within their classroom routine, they will be massively immersed in hands-on experience using various assistive technology devices [30, 31].

CONCLUSION

Given the fact that the number of students with ASD is accurately estimated to be 800,000, special education teachers, as mandated by the law on the Rights of Persons with Disabilities, must effectively employ assistive technologies in general education classrooms to meet their educational needs. Yet, special education teachers exhibit inadequate knowledge in using assistive technology devices due to ineffective TPPs and PD programs. To further explain, TPPs, which principally aim to equip pre-service teachers with the needed expertise and skills to deliver high-quality instruction to students with disabilities in inclusive settings, do not offer any courses which focus on assistive technologies. Besides, PD programs, offered by the MoE in partnership with educational agencies, are outdated, are limited in scope, and do not shed light on incorporating assistive technologies in mainstream schools.

To accommodate the educational needs of students with ASD in inclusive settings, special education teachers must be familiar with successful assistive technology devices, like iPads, which have been documented to positively impinge their academic achievement in English language arts. Enlightening special education teachers about assistive technologies can be accomplished through improving TPPs and PD programs. To begin with, TPPs can better prepare pre-service teachers to effectively utilize assistive technologies by designing a stand-alone course on assistive technology, encompassing engaging instruction and summative evaluation, and hands-on experience. Next, PD programs can equip in-service teachers with the needed knowledge, expertise, and skills in the area of assistive technologies by developing programs that include introductory and advanced readings, interactive discussions and activities, modelling, and hands-on experience. By taking into account the aforementioned recommendations, special education teachers will be empowered to effectively employ assistive technology devices to address the educational needs of students with disabilities.

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