Applications of Artificial Intelligence and Smart Learning Methods for Children with Autism Spectrum Disorder: A Proposed Interactive Platform

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Abstract

Purpose:The current research aims to reveal the most important applications of artificial intelligence and smart learning methods for children with autism spectrum disorder (ASD) and early intervention from the perspectives of experts and specialists. Method: A total of (35) experts participated in the closed questionnaire related to the first two questions, and (7) specialists participated in the open-ended interview questions related to the third question. The psychometric properties of both tools (questionnaire and interview) were confirmed. Results: The results showed that the "Communication-Autistic" app and the "Card Talk" app were the most used by specialists and experts in early intervention. The "Autism in Saudi Arabia" app was the most used in the field of autism spectrum disorder. The results of applying the Rubric performance evaluation scale for smart components and applications in the proposed autism spectrum disorder platforms from the point of view of experts and specialists showed that the experts had positive comments and suggestions regarding the nature of the smart educational platform. Conclusion: This research emphasizes the importance of adopting, adapting, and launching the proposed educational platform based on artificial intelligence, as it took into account the achievements of existing platforms in this field, developing it, and taking into account the shortcomings and gaps in it by adding some tools, policies, and activities supported by systems for measuring the development of child learning with artificial intelligence..

Keywords: *Artificial Intelligence, Autism Spectrum Disorder, Smart Platform.*

Introduction

Studies and scientific literature in the field of education and learning, particularly for people with disabilities, underscore the significance of utilizing artificial intelligence (AI) across various areas such as managing and evaluating the teaching and learning process, developing life and work skills, and providing lifelong learning opportunities for all.

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by deficits in social communication and interaction, along with restricted and repetitive behaviors. Children with ASD struggle with joint attention, social reciprocity, and using verbal and non-verbal behaviors for communication. These challenges often result in social isolation. Research highlights the importance of early identification and intervention to enhance language, communication, and overall well-being in children with autism. Advanced technologies like AI play a crucial role in improving diagnostic accuracy, timeliness, and quality (Xu, Calhoun, Jiang, Yan & Sui, 2021).

AI strategies represent a new trend in providing programs and services that assist children, particularly those with special and additional needs, in acquiring skills and methods to improve and simplify their lives. AI programs can accommodate individual differences among children, modify their behavior, develop their skills, and offer a support system based on their preferences for reinforcement methods provided by the program, thus helping them overcome daily life challenges posed by their disabilities. From this perspective, AI applications in education, especially for children with disabilities, have garnered widespread attention. United Nations expert Gerard Quinn emphasized that humanity should harness the best aspects of AI to benefit people with disabilities by providing adaptive learning platforms tailored to their needs (Quinn, United Nations).

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Over the past twenty-five years, significant advancements in AI in education have introduced next-generation science skills and standards into the learning process. By integrating original practices with new proposals, an interactive environment suitable for addressing children's problems is created, increasing student motivation and cooperation with the provided programs, thereby enhancing their importance, impact, and application in their future lives (Roll & Wylie, 2016).

The use of AI technology in the field of autism is becoming more widespread, given its beneficial role in facilitating and improving the behaviors of children with ASD. AI technology applications offer numerous ways and opportunities to integrate these children and can be a supportive tool for their learning (Bone, Goodwin, Black, Lee, Audhkhasi & Narayanan, 2015).

AI-based interventions focus on a set of interconnected elements that influence each other, working in an integrated and consistent manner to approach objectivity in research, experimentation, and result evaluation. This approach emphasizes the integration of theoretical aspects with practical application to produce educational tools that children can benefit from based on the information input into the system before production begins (Colchester, Hagras, Alghazzawi & Aldabbagh, 2017).

AI is one of the most important fields of interactive learning based on computers, aiming to understand the nature of human intelligence by creating computer programs capable of simulating intelligent human behavior. The main goal of AI is to simulate human intelligence using advanced software to solve non-routine problems, train on solving them, or make appropriate decisions (Arpaci, 2019).

AI software helps less experienced children solve problems by providing them with the necessary experiences and facilitates easy transfer of learning in a gradual, interactive way through self-learning and experimentation. Here, the teacher's role is to guide and assist the child in interacting with the AI system (Anderson, 2019).

Many studies have confirmed that AI is efficiently used in diagnosis and providing appropriate feedback for each situation. For instance, the study by Wall, Dally, Luyster, Jung & DeLuca (2012) used an electronic diagnostic questionnaire to diagnose autism in a sample of 891 individuals with autism. The statistical results showed that the verification level of the previous diagnosis compared to the current diagnosis ranged between 93.8% and 99%.

AI applications for children with ASD help them overcome learning obstacles by encouraging their strengths, identifying weaknesses and working to reduce them, understanding the academic system, and determining its desired outcomes while working with the teacher on methods to deal with children with ASD (Lampos, Mintz & Qu, 2021).

Today, Saudi Arabia, under the National Vision 2030, is witnessing a qualitative leap in digital transformation across all fields and government and private institutions. Organizations compete to develop their services, systems, and policies to keep pace with national digital transformation. The National Vision 2030 aims to develop a digital economy supported by innovations, contributing to the development of the Saudi economy.

This research comes at a time when Saudi Arabia, under the National Vision 2030, is witnessing a qualitative leap in digital transformation across all fields and government and private institutions. Organizations compete to develop their services, systems, and policies to keep pace with national digital transformation. The National Vision 2030 aims to develop a digital economy supported by innovations, contributing to the development of the Saudi economy and achieving sustainable development goals. Therefore, investing in AI has become one of the most prominent goals and aspirations of Saudi Arabia across its various institutions and sectors, especially in the education sector.

The research problem emerged from the urgent need to employ modern, intelligent digital technologies such as AI applications in early intervention for children with ASD. Current intervention methods in centers and schools may not meet the special and additional needs of this age group (3-7 years), necessitating the

use of smart applications that offer diagnostic, educational, intervention, guidance, and entertainment methods in an attractive, exciting, and innovative way for children with ASD, relying on AI applications.

The need for this research was also enhanced by the recommendations of the United Nations Human Rights, which urged countries to incorporate disability perspectives into their AI strategies and explicitly consider disability when purchasing AI products and services (www.ohchr.org).

This research aims to provide a systematic proposal for smart learning supported by AI applications and automation (early intervention) for children with ASD. To achieve the research objectives, the research team reviewed related literature and studies. Based on this review, a list of AI concepts and applications for early intervention in ASD for children aged 3 to 7 years will be developed.

This research idea came in the context of UNESCO's emphasis on the importance of disseminating AI applications and techniques in education, particularly in teaching, qualifying, and training people with disabilities. The goal is to enhance effective smart digital skills between humans and machines in all areas of life, work, and learning, and to reinforce their pioneering role in AI in the field of education in general.

The research problem can be identified through the following main question:

- What is the proposed conceptualization for a smart platform based on AI applications?

This main question branches into the following sub-questions:

- What are the most used AI applications for early intervention in the training and rehabilitation of children with ASD from the perspective of experts?

- What are the most used AI platforms for ASD from the perspective of experts?

- What are the most important tools provided by AI-based platforms?

- What are the specifications of the proposed AI-based learning platform?

Therefore, this study aimed to:

- Identify the most important AI platforms for children with ASD.

- Identify the most used AI applications in the training and rehabilitation of children with ASD.

- Identify the most important standards that should be available in an AI platform for children with   ASD.

- Identify the most important educational and diagnostic tools that should be available in the electronic platform according to the opinions of experts, specialists, and practitioners.

- Identify the most important specifications of the proposed AI-based learning platform.

Significance of the Study

The theoretical significance of the study lies in exploring AI-based platforms for teaching and training children with ASD. Since AI has become a fundamental element in the educational field, especially in educating children with disabilities, this study will draw attention to the importance of these platforms and their development for the benefit of children with disabilities. The practical significance of the study is that it will propose a conceptualization for an AI-based platform to teach, train, and rehabilitate children with ASD.

Operational Definitions

Smart Educational Platforms: A set of integrated online interactive services that provide teachers, parents, and other participants in the educational process with information and tools to support and enhance education and its management (Thomson, 2010). Operationally defined as the smart educational platforms studied in the current research, which provide interactive educational environments, tools, and diverse media directed at children with ASD.

Artificial Intelligence: A set of techniques and problem-solving methods that mimic intelligent behaviors derived from humans or nature, making the solution intelligent and variable (Sadiq, 2016). Operationally defined as the AI applications used in the proposed educational platform for children with ASD.

Autism Spectrum Disorder (ASD): A neurodevelopmental disorder that affects social communication, interaction, and behavior. Operationally defined as the children with ASD targeted by the current research.

Study Boundaries

Spatial Boundaries: The spatial boundaries of the current study are limited to rehabilitation centers and early intervention institutes for children with Autism Spectrum Disorder (ASD) in the Riyadh region.

Temporal Boundaries: The temporal boundaries of the study are confined to the period during which the data was collected, specifically between November and December 2023.

Subject Boundaries: The subject boundaries of the study are defined by the nature of the study procedures and the psychometric properties of the study instruments.

Theoretical Literature and Previous Studies

Autism Spectrum Disorder (ASD) has seen a significant increase in its prevalence over the past two decades, alongside a discourse filled with discussions and misinformation. This discourse has primarily taken place online, which is the main source of information for parents seeking information about autism. One potential tool for navigating through this information is ChatGPT-4, an AI-based communication program in the form of questions and answers.

Despite the promise shown by ChatGPT, no experimental work has evaluated its feasibility as a tool for providing information about autism to caregivers. The responses provided by ChatGPT were evaluated, including basic information about autism, myths/misconceptions, and resources. The results indicate that ChatGPT was largely correct, concise, and clear, but it did not offer much actionable advice, which was also limited by inaccurate references and hyperlinks. Researchers concluded that ChatGPT-4 is a viable tool for parents seeking accurate information about autism, with opportunities for improving actionable advice and reference accuracy (McFayden, Bristol, Putnam & Harrop, 2024).

Children with Autism Spectrum Disorder (ASD) often exhibit irregular and unpredictable behaviors. Most of the time, they are unable to communicate effectively in their language. Instead, they communicate using hand movements and sign phrases. For this reason, it may be difficult for caregivers to understand their patient's needs, although early detection of the condition can make this much easier. Assistive technology and the Internet of Things (IoT) can mitigate the absence of verbal and non-verbal communication in the community. IoT-based solutions use machine learning (ML) and deep learning (DL) algorithms to diagnose and improve patients' lives.

Sundas, Badotra, Rani, and Gyaang (2023) provided a comprehensive review of ASD technologies in IoT device settings in this research. Identifying important trends in IoT-based healthcare research is the primary goal of this review. There is also a technical classification to organize current articles on ASD algorithms and methodologies based on various factors such as artificial intelligence, SS networks, machine learning,

and IoT. Based on criteria such as accuracy and sensitivity, statistical and operational analyses of the examined ASD technologies are presented.

Recent advancements in Artificial Intelligence (AI) offer promising opportunities for its use in children's healthcare. This is particularly relevant for the early identification of developmental issues where timely intervention is crucial. AI holds potential as a valuable tool for the early detection of such developmental problems. The methodological review by Reinhart, Bischops, Kerth, Hagemeister, Heinrichs, Eickhoff, and Meissner (2024) aimed to compile and evaluate the current literature on the use of AI in monitoring child development, including potential clinical outcomes and the acceptability of these technologies by various stakeholders.

The systematic review relied on a literature search encompassing databases such as PubMed, Cochrane Library, Scopus, Web of Science, Science Direct, PsycInfo, ACM, and Google Scholar (covering the period from 1996 to 2022). All articles addressing the use of AI in monitoring child development or describing the related clinical outcomes and opinions were included. The results indicated that out of 2814 identified articles, 71 were finally included. Seventy studies reported on the use of AI, and one study addressed user acceptance of AI. No article reported on the potential clinical outcomes of AI applications. The articles showed a peak from 2020 to 2022. Most studies were from the United States, China, and India (n=45) and predominantly used pre-existing datasets such as electronic health records or speech and video recordings. The most used AI methods were support vector machines and deep learning (Reinhart et al., 2024).

The following section presents the key studies that the researchers were able to access, which are similar to and related to our current study:

Al-Ashram's study (2023) identified the factors associated with employing AI technologies in the education of individuals with Autism Spectrum Disorder (ASD) from the perspective of specialists, in light of certain demographic variables such as gender, workplace, educational level, job title, and years of experience. The research sample consisted of 350 specialists in the field of special education from both government and private sectors. The researcher used a questionnaire divided into two parts: the first part included demographic data, and the second part consisted of four dimensions related to factors associated with AI in the field of autism. The study results indicated that the factors associated with employing AI technologies, in order of importance, were the required facilities for using AI, the attitude towards using AI, awareness of the characteristics and features of AI, and finally, the perception of the importance and benefits of AI. The study also revealed differences in the specialists' perception of the factors associated with employing AI in the education of individuals with ASD according to the study variables. Based on the results, the study provided several recommendations for specialists and related entities involved in the education and rehabilitation of individuals with autism to consider these factors to facilitate the employment of AI in their education.

The study of Makari and Ajwa (2023) explored the reality of employing AI applications and their challenges in the rehabilitation of individuals with special needs, specifically those with Autism Spectrum Disorder (ASD) and intellectual disabilities, from the perspective of their teachers and specialists. It also aimed to reveal the attitudes of teachers and specialists towards the use of AI applications in the rehabilitation of children with special needs. The study sample consisted of 227 teachers of children with ASD and intellectual disabilities in special needs schools and centers. The study tools included a scale for the reality of employing AI technologies for individuals with special needs, a scale for attitudes toward their education and rehabilitation, and a scale for the educational challenges of employing AI in their education. The study results indicated that the reality of employing AI applications in the rehabilitation of individuals with special needs (ASD and intellectual disabilities) from the perspective of their teachers and specialists was at a moderate level. The challenges were ranked as follows: financial and technical challenges, educational and instructional challenges, security and privacy challenges, and social challenges, with the challenges being significant. Regarding the attitudes of teachers and specialists, they were highly positive. The study also concluded that there were no significant differences in the employment of AI technologies, their challenges, and the attitudes of teachers based on the variables of specialization (ASD or intellectual disability), years of experience, and gender.

Hamed and Al-Adawi's study (2023) aimed to explore the attitudes of individuals with disabilities towards using AI technologies to develop their communication skills. This study falls under the category of descriptive exploratory research. A purposive sample of individuals with disabilities was selected, and the study employed a survey method, relying on the Diffusion of Innovations theory. The study found that there were high levels of knowledge about AI technologies among the surveyed individuals with disabilities. The motivations for using AI technologies included their significant role in integrating individuals with disabilities into society and enhancing their capabilities to interact with others. Additionally, the study revealed that the sample group had a high usage rate of the Chat GPT robot. There was a correlation between the motivations for using AI technologies and the extent to which the respondents benefited from them. Furthermore, a relationship was found between the respondents' use of AI technologies and their attitudes towards using the Chat GPT robot, with differences observed among the respondents based on demographic factors.

Abdullah, Ali, and Muhammad's study (2022) examined the effectiveness of a language enrichment program based on an AI application in developing listening skills in children with autism spectrum disorder (ASD) and examined the sustainability of this program's impact on this group of children. The research employed an experimental method with a single-group design, using both pre-test and post-test measurements. The core sample consisted of nine children with autism, aged between 4 and 8 years, who were attending the Kayan Center for Training, Rehabilitation, and Early Intervention for Children with Disabilities during the 2021/2022 academic year. The research applied a listening skill scale (illustrated) for children with autism spectrum disorder (developed by the researchers), the Childhood Autism Rating Scale (CARS 2) for diagnosing autism, and the Stanford-Binet Intelligence Scales, Fifth Edition (adapted by Mohamed Taha and Abdel-Mawgoud Abdel-Sami, 2011). Additionally, the study utilized a language enrichment program based on an AI application to develop listening skills in children with autism (developed by the researchers). The results indicated the effectiveness of the language enrichment program based on an AI application in enhancing listening skills in children with autism spectrum disorder. The findings also suggested that the impact of this program remained evident among these children one month after its implementation. Based on the results, the study provided several recommendations and proposed further research.

The study by Chaddad, Li, Lu, Li, Okuwobi, Tanougast, and Niazi (2021) summarized and discussed radiomic techniques used to analyze autism spectrum disorder (ASD). Currently, the limited radiomic work on ASD is related to the variability in morphological features of brain thickness, which differs from texture analysis. These techniques rely on imaging shape features that can be used with predictive models to forecast autism spectrum disorder. This review explores the advancements in ASD-based radiomics, providing a brief description of ASD and the current non-invasive technology used for classification between ASD and healthy control (HC) subjects. Additionally, new radiomic models employing deep learning techniques are described using artificial intelligence. To consider texture analysis using deep convolutional neural networks (CNNs), it is proposed to integrate further investigations with additional validation steps at various MRI sites.

To investigate the reality of using educational applications of artificial intelligence among special education teachers and their attitudes towards them, from the perspective of teachers at Al-Noor Institute in Jeddah. Al-Ghamdi and Al-Farany (2020) used a descriptive-analytical methodology to achieve the objectives. The sample consisted of 27 teachers from Al-Noor Institute, selected purposively from the study population. A questionnaire was designed as a data collection tool, consisting of 40 items distributed across four domains. The results showed that the domain of the importance of using educational applications of artificial intelligence received a "strongly agree" rating from the special education teachers. The domain of obstacles to using educational applications of artificial intelligence, as well as the domain of attitudes towards using educational applications of artificial intelligence, received an "agree" rating. Meanwhile, the domain of knowledge and skills related to the use of educational applications of artificial intelligence received a "neutral" rating.

The article by Anagnostopoulou, Alexandropoulou, Lorentzou, Lykothanasi, Ntaountaki, & Drigas (2020) emphasizes the significant role that artificial intelligence (AI) applications play in the early detection of

autism spectrum disorder (ASD) and how new techniques can assist families, doctors, and children in the lengthy and challenging evaluation process. For instance, AI can reduce waiting times for assessments and allow for the processing and classification of larger volumes of data. Furthermore, according to research findings, the success rates and accuracy of these applications are very high. Consequently, they can be valuable in the diagnostic process by helping doctors make more informed decisions and gain a clearer understanding of the child's abilities and needs.

Ali (2019) conducted a study aimed at highlighting artificial intelligence (AI) applications that can be utilized for diagnosing and training children with autism spectrum disorder (ASD). The study discusses various AI tools, such as robots capable of diagnosing ASD and providing training for these children both at school and at home. The paper emphasizes the need for further research to demonstrate the role of AI applications in training children with ASD, including examples like the Q T robot, interactive boards, SIRI, and Alexa. The research also explores future ideas for using AI applications within the home to create environments that assist these children in learning daily life skills. Additionally, the study suggests improving the ability of individuals with ASD to perform specific tasks and collaborate effectively in work settings, which can aid in their full integration and harnessing their latent potential. The paper calls on policymakers, specialists, and researchers to support the development of AI-focused educational institutions and to focus on AI applications in education and special needs.

To explore the topic of artificial intelligence (AI) and its connection to autism spectrum disorder (ASD), Sideraki & Drigas (2021) addressed the concept of AI, including related concepts and extensions. The research covers various fields where AI is utilized and introduces the concept of autism, analyzing its relationship with technology. As AI research progresses, its role in diagnosing various disorders, including autism, becomes increasingly prominent. Innovative methods, including machine learning and other techniques, are highlighted for their effectiveness in diagnosing autism. The study also reviews research on AI's role in the treatment and intervention of autism, including the use of AI techniques such as robotics, virtual reality (VR), and chatbots. These technologies are emphasized for their importance in enhancing and supporting children in areas such as speech and social development, where they may face challenges.

Commentary on Previous Studies

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder often associated with significant healthcare costs. Typical diagnostic methods for ASD are time-consuming, so early detection can reduce these costs and help mitigate the progression of the condition. Artificial Intelligence (AI) is increasingly being studied for its positive impacts on ASD assessment, including machine learning, fuzzy logic, natural language processing, neural networks, mobile applications, robotics, interactive boards, and interactive chat programs. These technologies offer substantial potential in diagnosing ASD and other neurodevelopmental disorders.

Over the past five years, studies have been categorized into three main areas involving AI technologies, children with special needs, and their educators. These categories are:

1. **Studies on Using AI Technologies for Diagnosis and Behavioral Modification in Children with ASD**: Research such as Ali (2019) highlights AI applications for diagnosing and training children with ASD. Studies by Anagnostopoulou et al. (2020), Chaddad et al. (2021), Shahamiri et al. (2022) emphasize AI's role in early diagnosis of ASD. Desouki (2020) underscores the importance of AI applications designed for individuals with special needs. El-Sharkawy (2021) discusses the emergence of platforms providing various services, including training and educational services during the COVID-19 pandemic, with the Tapradar platform aimed at diagnosing and rehabilitating individuals with ASD. Abdel-Magid et al. (2022) demonstrate the effectiveness of AI applications in enhancing social communication among children with autism, while Mohammed et al. (2022) highlights the effectiveness of AI applications in learning to reduce stereotypical behaviors in autistic children. Abdullah et al. (2022) showed the efficacy of an AI application in developing listening skills in children with autism. Finally, McFayden et al. (2024) found that ChatGPT-

4 is a practical tool for parents seeking accurate information on ASD, with opportunities for improved usability and reference accuracy.

2. **Studies Related to the Use of AI Technologies from the Perspective of Educators and Specialists for Children with ASD**

Several studies have examined the reality of using AI technologies from the perspective of teachers and specialists working with children with Autism Spectrum Disorder (ASD): Ghamdi & Al-Frani's study (2020) aimed to explore the use of AI educational applications by special education teachers and their attitudes towards these technologies from the perspective of teachers at Al-Noor Institute in Jeddah.

Al-Shanqeeti's research (2022) investigated teachers' attitudes toward using interactive chatbots in teaching students with disabilities in Madinah. Also, Al-Ashram's study (2023) identified the factors associated with the employment of AI technologies in the education of children with ASD from the perspective of specialists. Makkari & Ajwa (2023) investigated the reality of using AI applications and the challenges associated with their implementation in the rehabilitation of individuals with special needs, specifically those with ASD and intellectual disabilities, from the viewpoint of their teachers and specialists. And Saleh (2023) understands the current state of educational AI applications for individuals with disabilities and the challenges faced from the perspective of their teachers. Al-Yemahi (2023) focused on the reality of using educational AI applications for individuals with disabilities in the UAE and the challenges from the perspective of their teachers. Hamed & Al-Adawi (2023) explored the attitudes of individuals with disabilities towards using AI technologies to develop their communication skills.

3. Systematic Reviews on AI Techniques and Autism

Several systematic reviews have analyzed previous studies linking AI technologies to ASD: Ghosh et al . (2021) Sundas et al(2023) . Reinhart et al (2024) .

These reviews indicated a significant increase in studies related to AI technologies and their applications for individuals with special needs, particularly ASD, between 2022 and 2023. The reviews attributed this rise to the importance of these technologies and their positive impact on early diagnosis and behavioral modification in ASD, alongside the increasing prevalence of the disorder among children.

Method

Research Method

The descriptive-analytical method was employed as it is the most suitable for the nature and objectives of the current research. This method was used to identify the applications of artificial intelligence and smart learning methods for children with Autism Spectrum Disorder (ASD).

This study was approved by the Ethics Committee /Institutional Review Board (IRB) of the Chemistry department, Collage of Science, Princess Nouah bit Abdulrahman University, No. 23-0743, October 23, 2023. As well as the consent of the study participants was also obtained and the participants provided informed consent to participate in this study.

Research Population and Sample

The study population consisted of:

Experts and specialists from rehabilitation and early intervention centers for individuals with Autism Spectrum Disorder in health and educational centers in Riyadh.

Experts and specialists from faculty members at public and private universities and health centers in Riyadh.

Experts and specialists from artificial intelligence agencies and centers in Riyadh.

The study sample consisted of 35 experts, specialists, and practitioners in the field of education and rehabilitation for children with Autism Spectrum Disorder. These participants were selected using a convenient random sampling method. Table (1) shows the distribution of the study sample based on its variables.

Research Methodology

The research utilized a mixed-methods approach, combining quantitative and qualitative methods. The quantitative part involved a closed questionnaire administered to 35 experts, while the qualitative part included open-ended interviews with 7 specialists. The psychometric properties of both tools were confirmed.

Research Tools

1. Questionnaire

A questionnaire was developed to identify the most prevalent artificial intelligence applications, platforms, and educational tools related to children with Autism Spectrum Disorder (ASD).

Construct validity of the study instrument

validity of the construct, the study tool was applied to an exploratory sample, and the To verify the Pearson correlation coefficient was calculated between the item and the domain to which it belongs. Tables (2) and (3) show these results

the correlation coefficients between the paragraph and the field to which Table (2) shows the values of which are statistically ,(0.82-it belongs. The correlation coefficients with the field ranged between (0.49 significant and are acceptable values for conducting this study

shows the values of the correlation coefficients between the paragraph and the (3) Table domainto which are ,(0.72-which it belongs. The correlation coefficients with the field ranged between (0.37 .this study statistically significant and are acceptable values for conducting

Stability of the study tool

-To verify the stability of the study tool, reliability was calculated using the Cronbach Alpha method for internal consistency, as the tool was applied to a survey sample, and the reliability coefficient for while the reliability coefficient for the items on ,(0.86) artificial intelligence applications items was the (0.75) social intelligence platforms reached

- Survey interviews with experts and specialists in the field of education rehabilitation and training of ended -A questionnaire was constructed containing open .autism spectrum disorder children with questions through which questions were asked to experts about the most important educational tools .that should be available in the proposed educational platform

Expert Interviews: A set of questions related to AI applications was developed. This tool was constructed based on the theoretical literature related to AI platforms and the available expertise of the researchers in the field. The content validity of the tool was established by presenting it to a panel of judges specializing

in Autism Spectrum Disorder and AI programming. This tool consisted of six open-ended questions answered directly by the experts, and their responses were recorded.

Statistical Methods Used

Mean, standard deviation, and percentages, T-test, -One-way ANOVA -Qualitative analysis of open-ended questions.

Results and Discussions

intelligence Results related to the first question: What are the most commonly used artificial applications for early intervention in the rehabilitation and training of children with autism spectrum disorder To answer this question ?From the experts' point of view.frequencies and nd Table 4 shows these resultspercentages of artificial intelligence applications were extracted, a.

Autism) application and -It is noted from Table (4) that the (Communication   (the Card Talk) application are the most widely usedapplicationsof artificial intelligence for early intervention in the rehabilitation and training of children with autism spectrum disorder fromthe point of view of experts, they obtained the highest frequency of (25) with a percentage of (71.4%). Table (4) also shows that the Autism BASICS: Learning app and theBabnoor Autism Speech Therapy app received the lowest of (57.1%). The researchers attribute these results to these platforms related frequency of (20) with a rate It has easy procedures and by to early intervention with a high rating. They are characterized containa and administrative wide variety of programs and standards. It also has various educational tools and it is easy to use by families.

Results related to the second question: What are the most used artificial intelligence platforms in autism spectrum disorder from the experts' point of view? To answer this question, the frequencies and percentages of artificial intelligence platforms were extracted, and Table (5) shows these results.

It is noted from Table (5) that the (Autism in Saudi Arabia) platform is the most used artificial disorder from the point of view of experts, as it received the intelligence platform for autism spectrum highest frequency of (25) and a percentage of (%71.4) . Table (5) also shows that the Madad platform obtained the lowest frequency of (15) and a percentage of (42.9%). The researchers attribute these results to these platforms with high evaluation, which are characterized by the ease of their procedures and the inclusion of a large and diverse group of programs and standards related to children with autism spectrum disorder, as well as the availability of various educational and administrative tools.

Results Related to the Third Question**:** The third question included several sub-questions answered by seven experts specialized in the rehabilitation and training of individuals with Autism Spectrum Disorder (ASD). The objective was to identify the key features that these experts believe should be included in a proposed educational platform. Below is an analysis of the experts' responses to the questions:

The Third Question: What are the essential tools provided by AI-based platforms, such as educational tools, self-assistance (daily living skills), speech training, standardized measures, non-standardized measures, student performance records, and video clips?

Question 1: Are there applications that use artificial intelligence in the education, rehabilitation, and training of children with Autism Spectrum Disorder?

All experts answered "Yes," indicating that they are keeping up with developments in the field of ASD rehabilitation and training.

Question 2: What are the most important AI applications you have used related to the rehabilitation and education of children with Autism Spectrum Disorder? Please list important smart applications (iPads, games, websites, YouTube) that assist parents in dealing with their children.

The sample respondents indicated that YouTube channels were the most frequently used and effective compared to other applications for individuals with Autism Spectrum Disorder. This is attributed to the quality of YouTube's recommendation system, which personalizes content for each user and their interests. Additionally, some respondents mentioned that applications like "Taa," "Bab Noor," "ABA Genie," and "Teaching Autism" were among their preferred tools.

Question 3: Regarding the most important tools provided by the AI-based platform, such as educational tools/self-help (daily living skills)/speech training/standardized measures/non-standardized measures/student performance records/video clips.

The sample respondents indicated that the most crucial tools included the ability to filter and exclude content, such as educational videos, personal experience clips, and daily logs. Additionally, the platforms provided tools for reading and writing skills and speech training for children with Autism Spectrum Disorder (ASD). According to the respondents, these platforms also offered educational visual tools to train children with ASD in daily living skills (self-help) and provided measures that help teachers continuously assess the progress of children with ASD. Moreover, behavior analysis and modification plans were available.

Question 4: This question inquired about the positive impact of educational platform tools on children's performance and the areas with the most significant impact (educational, daily living skills, or educational entertainment).

The responses indicated that the impact was positive, with the most influential areas being peer skill acquisition through imitation and modeling, as well as the entertainment aspect and the development of basic educational skills. One expert noted that these platforms acted as more engaging tools for children with Autism Spectrum Disorder (ASD) compared to traditional methods. However, another expert pointed out that it is challenging to answer this question definitively as it requires practical studies, observations, and results to measure the effectiveness of these applications on children with ASD. This suggests a need for further research into the effects of these platforms on children with ASD. Despite this, based on my experiences with some children, these tools are beneficial and also act as a more engaging medium for children with autism compared to conventional training methods.

Question 5: Are there any tools that you would prefer to be included in the proposed platform?

Experts responded that it is crucial to provide various assessment tools and a curriculum that trains children with Autism Spectrum Disorder (ASD) and serves as a guide for parents and teachers. An example provided was the curriculum "Exceptional for Living." Additionally, they emphasized the need for diverse behavioral modification plans based on Applied Behavior Analysis (ABA), with a collection of pre-prepared plans (a plan bank) for quick utilization. Experts also highlighted the importance of including educational entertainment tools that address behavioral issues in children with ASD.

Question 6: What are the most suitable strategies for utilizing AI applications in the rehabilitation of children with Autism Spectrum Disorder?

When asked about the most suitable strategies for employing AI applications, experts agreed that play-based learning is highly effective with children, including those with disabilities. Given the significant individual differences among children with ASD, experts did not recommend a specific strategy but emphasized the importance of acknowledging these differences. They suggested that each child has a preferred learning style, and thus, it is essential to consider individual, environmental, and cultural

differences when selecting and implementing strategies. The focus should be on acquiring, applying, and generalizing skills within the child's living environment.

Question Four: What are the specifications for the proposed AI-based learning platform?

Regarding the question about the proposed smart learning platforms that rely on artificial intelligence and are aimed at teachers and parents of children with Autism Spectrum Disorder (ASD), based on the team's review of available platforms and expert feedback, we propose the following educational and administrative tools for the proposed smart platform:

A- Platform Description:

The main objectives of the platform (its basic components, user interface, interaction tools, databases).

B- The basic functions of the platform:

- Designing individual educational plans based on analyzing the child's behavior.

- Adaptive interaction tools such as (smart voice or video conversations).

- Providing immediate feedback to parents and teachers about the child's progress.

C- The technologies used:

- Artificial intelligence technologies such as natural language processing (NLP) to develop verbal and non-verbal communication skills, applications based on images and symbols, and computer vision (COMPUTER VISION)

- Using sensors to analyze the child's emotions and behavior.

- Games and interactive activities specifically designed to stimulate children with autism spectrum.

- Virtual and augmented reality.

D- Detailed components of the platform:

1. Initial Information: This includes all relevant family information (parents, siblings), residence and contact details, health information (developmental history, family medical history), educational information, family observations, and specialists involved.

2. Educational and Instructional Programs: Both global and local programs that assist teachers of children with ASD in selecting suitable programs for the children (with consideration for intellectual property rights), through purchasing these programs or obtaining permission to add them to the proposed platform.

3. Training and Rehabilitation Strategies: Strategies for training and rehabilitation and methods for implementing these strategies with children with ASD.

4. Standardized and Non-Standardized Measures: In various educational fields (cognitive, communication skills, motor skills, social and emotional skills), as well as self-help skills, including global measures used to identify different types of children with ASD (concerning the intellectual property of the owners of these measures).

5. Individualized Education Plans (IEPs): Providing suggested templates and templates developed by specialists and teachers for children with ASD to address their educational and behavioral needs.

6. Behavioral Modification Plans: Either ready-to-use plans covering various behavioral issues or models for behavior modification plans developed based on the child's needs.

7. Behavior analysis and monitoring applications allow parents and teachers to monitor a child's behavior and analyze their needs, such as the COGNOA smart tool for early detection of autism spectrum disorder and tracking a child's development.

8. Evaluation Templates: Suggested models for assessing various educational or behavioral skills of children with ASD, with the option to modify these templates according to the needs of the child's teachers.

9. Using BRAIN POWER analytical techniques to improve a child's feelings and behaviors.

10. Session Monitoring Templates: Models to track the child's sessions with the multidisciplinary team, allowing the child's family and the team to review the goals being worked on. These could be broadcast directly to families or the multidisciplinary team while respecting the child's and teacher's privacy.

11. Skills Evaluation Models: Templates for evaluating the skills covered in training, educational, and rehabilitation programs to save time for teachers, with the possibility of adjustments to suit the child's condition and goals

12. Educational Entertainment Programs: Programs with educational and recreational aspects, preferably designed by special education professionals specifically for children with ASD, covering both entertainment and educational content.

13. Daily Reports: Daily electronic reports sent to parents and other members of the multidisciplinary team via email or any system ensuring delivery to those involved with the child.

14. Attendance System: A system for tracking the attendance and absence of children with ASD, sending electronic notifications to parents regarding their child's arrival at school or the center to provide reassurance.

15. Smart intervention tools that include smart visual and visual display to alleviate autism symptoms.

16. Simulated educational environments to improve social interaction skills such as ROBOKIND MILO THE ROBOT to improve social skills by teaching children how to recognize emotions and social interaction.

17. Using SOCIAL SKILLS BUILDER that helps children learn social skills using simulated scenarios.

18. Interactive gaming applications based on machine learning technologies: Example: "Endless Reader" to improve reading and language in a fun way.

19. Games based on virtual and augmented reality (VR/AR).

20. Provides an interactive simulation environment that helps children learn social skills and interact with the environment. Example: "Floreo": uses virtual reality to improve social interaction.

21. Social skills improvement applications

22. Emotion tracking and expression analysis applications.

23. Relies on computer vision to analyze facial expressions and child behaviors.

24. Examples: "Empatica E4": A device that tracks the child's physiological activities such as heart rate and sweat to analyze his emotional state.

25. "HARKLA": A device with an application that analyzes children's behavior to determine their level of stress or motivation.

26. Interactive AI Robots.

27. Robots designed to interact with children and motivate them to learn and play.

28. Examples: "Kaspar": A robot designed to support children with autism spectrum disorder in developing social skills.

29. "NAO Robot": Used to help children develop language and social interaction skills.

30. Adaptive Personal Learning Applications.

31. Relies on machine learning techniques to adapt educational content to the individual child's needs.• Examples: "ABC Mouse": An interactive educational platform that provides personalized educational activities for children.

32. DreamBox Learning": Provides math content that adapts to the child's progress.

33. Parent and Teacher Support Applications.

34. Provides analytical data on the child's performance and suggestions for improving their education. Examples: "Superpower Glass": An application based on artificial intelligence to analyze emotional signals in children to help parents and teachers.

We emphasize the importance of ensuring that this proposed platform respects the privacy of the child and their family and the rights of the teachers and maintains the intellectual property rights of the programs and measures included.

Conclusion

The research concludes that interactive platforms that rely on smart learning tools and artificial intelligence to help children with autism spectrum disorder learn and develop their smart learning abilities develop the abilities of children with autism spectrum disorder. This is done by providing a number of smart activities and applications such as the (Communication - Autism) application and the (Communication Card) application, which are the most widely used artificial intelligence applications for early intervention in the rehabilitation and training of children with autism spectrum disorder from the point of view of the experts interviewed. This platform is also distinguished by the proposed specifications in the ease of its procedures and its inclusion of a large and diverse group of programs and measures, in addition to providing various educational and administrative tools from policies and governance, and is characterized by its ease of use by families.

Recommendations

The researchers recommend the following:

Calling for investment in such smart platforms to improve the smart and modern life of children with autism spectrum.

Adopt and Launch the Proposed AI-Based Educational Platform: The proposed platform should be adopted and launched as it incorporates current advancements in existing platforms and adds new tools.

Develop AI Applications and Websites in Arabic: Develop AI-supported applications and websites in Arabic that include systems for measuring child development.

Conduct Studies on the Effectiveness of Applications: Carry out studies to evaluate the effectiveness of applications for children with Autism Spectrum Disorder (ASD) and their impact.

Ensure Family Involvement:** Educational platforms should include features that ensure active family participation through a smart system that keeps them updated on their child's training and rehabilitation progress.

Respect Intellectual Property and Privacy: Educational platforms must respect the intellectual property rights of the programs used and maintain the privacy of the multidisciplinary team working with children with ASD.

Acknowledgments

Data Availability Statement

The data files analyzed during the current study are available from the corresponding author on reasonable request.

Funding

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Table 1. Distribution of the study sample according to the variables of gender specialization educational level, and experience

variable	Level/category	the number	percentage
Sex	male	8	%22.9
	feminine	27	%77.1
	the total	35	%100
Specialization	psychology	20	%57.1
	special breeding	15	%42.9
	the total	35	%100
Educational level	Bachelor's	18	%51.4
	Postgraduate	17	%48.6
	the total	35	%100
Experience	Less than 5 years	8	%22.9
	10-5	6	%17.1
	15-11	13	%37.1
	or more 15	8	%22.9
	the total	35	%100

Table 2. Values of correlation coefficients for items on artificial intelligence applications

Paragraph number	Correlation coefficient with domain
1	** 0.73
2	** 0.49
3	** 0.63
4	** 0.51
5	** 0.72
6	** 0.82
7	** 0.77
8	** 0.73
9	** 0.67
10	** 0.62

(0.01) Statistically significant at the significance level**

Table 3. Values of correlation coefficients for items on artificial intelligence platforms

Paragraph number	Correlation coefficient with domain
1	** 0.59
2	** 0.57

3	** 0.55
4	** 0.44
5	** 0.60
6	** 0.64
7	** 0.72
8	** 0.52
9	** 0.37
10	** 0.50

(0.01) Statistically significant at the significance level**

Table 4. Frequencies and percentages of the most used of artificialintelligence applications for early intervention in the rehabilitation and training of children with autism spectrum disorder From the experts' point of view

Artificial intelligence applications	Frequencies and percentages used in early intervention		
	Important	**AverageImportance**	**not important**
Language therapy for children	23	11	1
	%65.7	%31.4	2.9
application Communication_autism	25	10	0
	%71.4	%28.6	0
Leeloo AAC - Autism Speech App	22	12	1
	%62.9	%34.3	%2.9
CardTalk	25	9	1
	%71.4	%25.7	%2.9
Speech Blubs: Language Therapy	24	9	2
	%68.6	%25.7	%5.7
Splingo - Speech & Language	21	13	1
	%60	%37.1	%2.9
Autism BASICS: Learning app	20	13	2
	%57.1	%37.1	%5.7
AutoSpark: Kids Autism Game	24	9	2
	%68.6	%25.7	%5.7
Otsimo| Special Education	22	11	2
	%62.9	%31.4	%5.7
Babnoor Autism Speech Therapy	20	13	2
	%57.1	%37.1	%5.7

Table 5. Frequencies and percentages of the most commonly used artificial intelligence platforms Autism spectrum disorder from the experts' point of view

	Frequencies and percentages used in early intervention

intelligence Artificial platforms	Important	Average importance	not important
Noda platform	18	13	4
	%51.4	%37.1	%11.4
ECHO Autism	21	13	1
	%60	%37.1	%2.9
Autism in Saudi Arabia	25	8	2
	%71.4	%22.9	%5.7
Autism Families Association (digital platform)	22	13	0
	%62.9	%37.1	0
Rushd platform	22	13	0
	%62.9	%37.1	0
Madad platform	15	19	1
	%42.9	%54.2	%2.9
Anab platform	21	13	1
	%60	%37.1	%2.9
Online Autism Platform	24	9	2
	%68.6	%25.7	%5.7
The CentralReach Autism and IDD Care Platform	22	13	0
	%62.9	%37.1	0
Simple Steps Autism	23	12	0
	%65.7	%34.3	0