A SYSTEMATIC REVIEW OF STUDIES ON ONLINE EDUCATION FOR AUTISM SPECTRUM DISORDER

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ABSTRACT

The novel coronavirus (2019-nCoV) outbreak caused a paradigm change in education and made it necessary to conduct educational activities through online learning environments (OLEs). This sudden shift also affected special education practices for learners with autism spectrum disorder (ASD). The present study aims to investigate the current issues in online education studies relating to individuals with or involved with (i.e., parents or teachers) ASD. For this purpose, a literature search was carried out to review the relevant studies conducted from 2010 to 2019, and 19 studies were selected based on predefined research criteria. Content analysis was performed to analyze the reviewed articles considering the following domains: publication year, country, field, purpose, research methods, instruments, results, and suggestions. Results indicated that the publication rates of studies pertaining to individuals with ASD, their parents and teachers increased after 2014, and although OLEs are found to be beneficial in meeting the needs of the target group, several improvements are needed to make them more useful and adaptable.

Keywords: Online learning, special education, autism spectrum disorder, review, research trend.

INTRODUCTION

Online education has become a necessity rather than an option, especially in the face of the recent novel coronavirus (2019-nCoV) outbreak (Telli Yamamoto & Altun, 2020). Thanks to the recent developments in education, learning activities can now be delivered in a flexible and personalized manner, anytime and anywhere. Thus, educators were able to remotely plan and offer K12 and higher education courses during the outbreak.

The reflections of online education technologies are particularly visible in special education practices, an area which incorporates various promising strategies for addressing the needs of individuals with special needs including those with autism spectrum disorder (ASD) in an efficient and specific manner (Odluyurt & Cattik, 2018). In view of the differences in contemporary education, there remains the need to implement

these practices in the least restrictive educational environments. In this context, a personalized and flexible curriculum that incorporates the latest technological innovations and developments can offer valuable opportunities to increase effectiveness and efficiency in education (Sani-Bozkurt, 2017).

Individuals with ASD

ASD is a neurodevelopmental disorder characterized by five diagnostic criteria (American Psychiatric Association [APA], 2013). Main symptoms are lack of social communicationinteraction and exhibition of atypical behaviors (Hyman & Levy, 2013), along with communication impairment. Individuals diagnosed with ASD also have difficulty in understanding the feelings of others (Hyman & Levy, 2013), establishing empathy (Travis, Sigman & Ruskin, 2001), making eye contact (Klin, Jones, Schultz, Volkmar & Cohen, 2002), and developing natural speech (Mitchell et al., 2006). In short, it is a developmental disorder that causes impairments in mutual social interaction and communication, and restricted, repetitive behaviors.

Recent developments in the diagnostic procedures led to a remarkable increase in the number of children with ASD (Richardson, 2017). While one out of every 68 children was diagnosed with ASD in 2012, this figure increased to one out of 59 children in 2014 (Center for Disease Control and Prevention [CDC], 2016). In addition to the limited understanding of the possible causes of ASD, etiological factors of the disorder are not well known. Thus, a comprehensive treatment method—other than special education activities—is yet to be developed for this condition (Hanayli, Serbest & Urekli, 2015). In this regard, numerous educational implementations have been applied towards the education of individuals with ASD to improve their quality of life and to meet their needs, such as interacting with others and performing daily routines independently (Stenhoff, Pennington & Tapp, 2020). Carried out within the framework of an individualized education program (IEP) in collaboration with parents, teachers and speechlanguage pathologists, these implementations are reported to have produced many positive outcomes (Stenhoff et al., 2020).

Technological Practices about ASD

Several studies utilizing different educational approaches have been conducted to increase active participation of individuals with ASD into the social life (Virnes, Karna & Vellonen, 2015). Technologybased solutions have also become a prevalent research topic in the field (Kientz et al., 2013). It was concluded that technologybased possibilities could mediate academic skills while supporting communication and social skills (Ganz et al., 2017; Millar, Light & Schlosser, 2006), improving cognitive skills (Richardson, 2017), and reducing atypical behavioral problems of individuals with ASD (Walker & Snell, 2013).

Online Education and Online Learning Solutions for ASD

First attempts of distance education can be traced back to the correspondence courses provided for students at a physical distance from the instructor in the 1800s. In parallel to the developments in web technologies, most distance education activities shifted to OLEs after the 2000s. Online learning broadly refers to learning activities offered in OLEs and is difficult to define explicitly due to interactions that take place among numerous variables during the learning experience (Moore, Dickson-Deane & Galyen, 2011). It can either be structured (i.e., formal learning activities planned by someone else or an institution) or unstructured (i.e., informal learning activities managed by learners as in social media). An unstructured OLE may present several obstacles for students (Sun, Tsai, Finger, Chen & Yeh, 2008), such as the inability to manage the learning process. Therefore, an unstructured online learning experience may not promote learning by itself and requires external programmed support (Garrison & Cleveland-Innes, 2005). In this regard, online learning activities should be systematic and planned to allow students effectively experience the learning content. To that end, online environments such as learning management systems, course management systems and virtual learning environments are used in combination with many common denominators (Moore et al., 2011).

There are a number of online educational solutions designed for individuals with ASD (Ardic, 2015), some of which can be delivered synchronously (Shire, Worthman, Shih & Kasari, 2020) or asynchronously (Tsiopela & Jimoyiannis, 2017). For example, mobile technologies backed by artificial intelligence and online education solutions (Rad & Furlanello, 2016; Hanayli, Serbest & Urekli, 2015) may improve living conditions, provide equal opportunities and facilitate access to learning initiatives considering individual differences (Sagdic & Sani-Bozkurt, 2020). Additionally, they can increase students' interest and motivation towards learning materials and tasks (Virnes, Karna & Vellonen, 2015).

Theoretical Orientations for the Current Study

Special education is a process in which experts in different disciplines and parents are actively involved. While designing instruction, therefore, it is also necessary to consider the needs of people in the learning environment of individuals with special needs. In this respect, this study has benefited from the following theoretical frameworks emphasizing the role of individuals who may contribute to the educational development of individuals with ASD: "zone of proximal development" (Vygotsky, 1978) and "ecological systems theory" (Bronfenbrenner, 1992).

According to Vygotsky (1978), social interaction with experienced instructors is remarkably crucial for meaningful learning. The community in which the child grows up helps children make meanings of facts, which paves the way for the rise of a theoretically important principle, "zone of proximal development" (Vygotsky, 1978). It is a critical concept that links to the difference between what a child can accomplish individually and what a child can accomplish with external support from an experienced one. The "zone of proximal development" implies the importance of guidance and assistance provided by skilled partners in the development and learning of individuals with ASD. The participation of special education practitioners (e.g., teachers, therapists, technicians, healthcare providers) in the process of designing learning and teaching activities is therefore of utmost significance to achieve more efficient, effective and engaging results.

The second theoretical framework that emphasizes the significant role of environmental support for individuals with ASD is the ecological system theory (Garbacz, McIntyre & Santiago, 2016). This theory claims that individual development could not be sufficiently explained without considering the proximal and distal social systems (Bronfenbrenner, 1992). It consists of five systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem. Among these systems, the microsystem refers to direct interactions between individuals and those in the proximal setting of these individuals (Bronfenbrenner, 1992). In other words, a child's development is influenced by people, groups, or institutions that are directly connected with the child. These arguments imply that the success of educational applications for ASD depends critically on the rapport between parents and special education institutes. One way of doing that is to train parents to develop adequate skills for sustaining their children's education outside.

PURPOSE OF THE STUDY

OLEs provide substantial learning and teaching opportunities for individuals with ASD, their parents and practitioners by offering a flexible learning setting in which learners are able to customize the learning environment and access learning materials at anytime and anywhere (Civril, Arugaslan & Yakut, 2013). With the support of parents and practitioners, online education offers an alternative pathway for specialeducation students who otherwise have no means to attend specialeducation institutions and participate in learning activities (e.g., those living in rural areas or in the case of a global pandemic) (Heitzman-Powell, Buzhardt, Rusinko & Miller, 2014; McDonald & Lopes, 2014).

Despite several studies on the subject, the literature lacks sufficient coverage of online learning opportunities. Advancements in online solutions towards individuals with or involved with ASD will certainly contribute to the development of new practices in the field (Richardson, 2017). Consequently, it is believed that reviewing the current literature from different perspectives (demographic, methodological, findings and suggestions) may extend our understanding of the online learning issues in the field and shed light on the problems faced by individuals with ASD.

Thereby, this study aims to reveal the trend in ASD literature about online education for ASD considering the following dimensions: country, publication year, journal, purpose, method, variable, target audience, instruments, results, and suggestions. In line with the purpose of the study, the following research questions were addressed to determine research trends, reveal potential gaps in the field and provide guidance for future studies:

(1) What are the demographic characteristics of the studies? (i.e., *distribution of studies by years, countries, and journals*)

(2) What are the purposes of the studies?

(3) What are the methodological findings (i.e., *research design, variables, target groups, and instruments*) of the studies?

(4) What are the findings of the studies?

(5) What are the suggestions of the studies?

METHOD

A literature review was conducted to examine the online learning issues for ASD. Reviewed articles was analyzed by content analysis, a method widely used by researchers to classify data into certain themes and codes (Fraenkel & Wallen, 2000), to project trends in the field for the given subject.

Sampling

A systematic review of the literature published on ASD related online education between 2010 and 2019 (until the end of the year) was performed. The reason for selecting the last decade was to observe the trends and technological advancements in the field. Revealing the technologies introduced and the research methods used in ASD related online education over the recent years in light of the findings obtained from relevant studies may guide researchers in further exploring the future needs in the field.

Research Procedure

The procedure comprised three stages: planning, literature review, and reporting. The planning phase began by selecting relevant research databases, identifying the search criteria, and determining the categories required for analysis. After that, a systematic review was conducted based on the search criteria. All publications were analyzed using predetermined categories, followed by a detailed report.

Search Strategy

In this study, journals indexed in four databases that dealt primarily with educational issues, namely, Web of Science, EBSCO, Education Resources Information Center (ERIC), and Scopus were reviewed (Price & Maushak, 2000). The following keyword combination, in which AB refers to the abstract section of the articles, was employed to identify relevant studies:

> *AB ("distance education" OR "e-learning" OR "webbased learning" OR "online learning" OR "webbased training" OR "online education" OR "webbased education") AND AB ("ASD" OR "autism spectrum disorder" OR "autism").*

As per the inclusion and exclusion criteria presented in Table 1, only the studies published in English were taken into account and proceedings, dissertations and book chapters were excluded from the scope of the study.

Table 1. Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Available in full text	Proceedings, dissertations, and book chapters
Peer-reviewed	Articles are about distance education, not about online education
Published between 2010 and 2019	
Original research article	Non-English
Articles must include implications for ASDrelated online education	Not available in full text

Study Selection Process

The initial literature search yielded 117 articles in all indexes. 36 duplicate articles were excluded from the list, and the remaining 81 articles were taken into consideration. During the initial analysis procedure, the abstract sections of these articles were screened by three researchers. Following abstract screening, relevant articles were identified based on the consensus of researchers, resulting in the selection of 19 articles about the topic. The selection process is summarized in Figure 1.
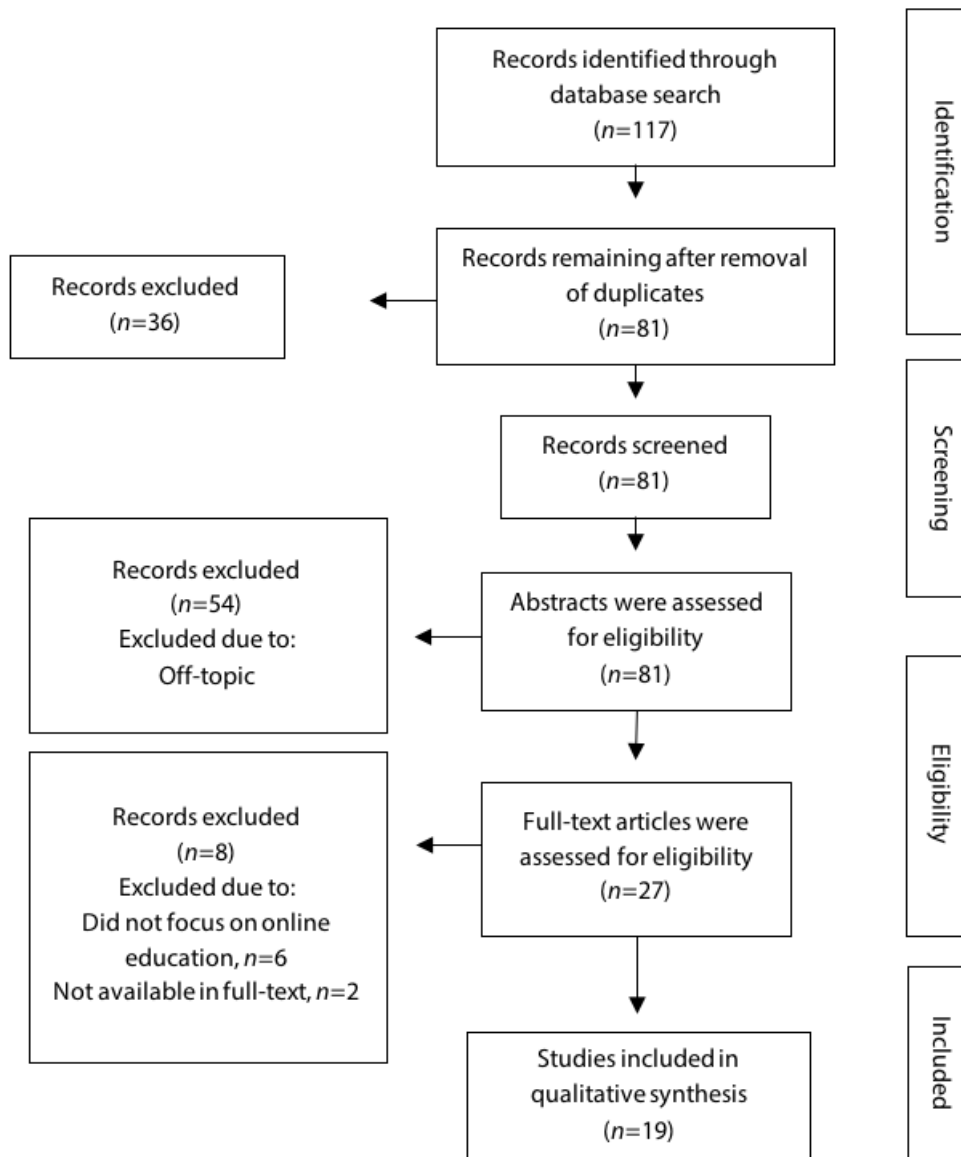

Figure 1. PRISMA Flow Diagram for Results of Systematic Review

Identifications of Categories for Qualitative Synthesis

Key categories for the topic were identified by the researchers through discussion. Subsequently, relevant articles were reviewed broadly, and the following categories were selected for evaluation: publication year, country, journal, topic, purpose, method, instruments, findings, and suggestions. These categories were selected to reveal the trend and assess further aspects of the field.

Data Analysis

Content analysis, a qualitative research technique, was employed for relevant studies based on predefined categories. Researchers jointly classified the articles and selected three different studies. Each researcher analyzed the studies separately, after which consensus was reached on the creation of the derived themes/codes. Initial codes/themes were generated from the relevant parts of the studies. The researchers then checked the reliability of the codes and themes by taking feedbacks from two experts with Ph.D. in educational sciences. The following formula calculated the percentage agreement of experts "reliability = number of agreements/ total number of agreements + disagreements) x 100" as suggested by Miles and Huberman (1994: 64). Accordingly, the agreement level of codes and themes was 96% and 92%, respectively, which were considered acceptable for the current study. The final version of the codes/themes was prepared based on the consensus of researchers. Finally, graphics, frequency and cross tables were drawn to reflect the rates of categories, reveal the trends and to better understand the matter.

FINDINGS

The results of the study were divided into five sections, including findings addressing the demographic characteristics, purposes, methodological considerations, results, and suggestions for future research. Each section was presented under a subheading and supported with figures or tables, as follows.

Demographic Characteristics of the Studies

Demographic characteristics of the studies were addressed under three groups: trend by years, distribution by countries, and distribution by journals.

The Trend of the Studies by Years

The trend curve of 19 articles is presented in Figure 2. Accordingly, the number of studies was at a minimum level between 2010 and 2013, reached its maximum level in 2014, and remained within the range of 3 to 4 in the following years.
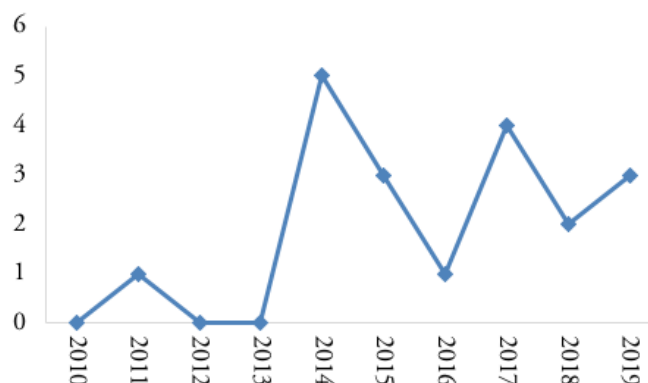

Figure 2. The Trend Curve of the Studies by Years between 2010 and 2019
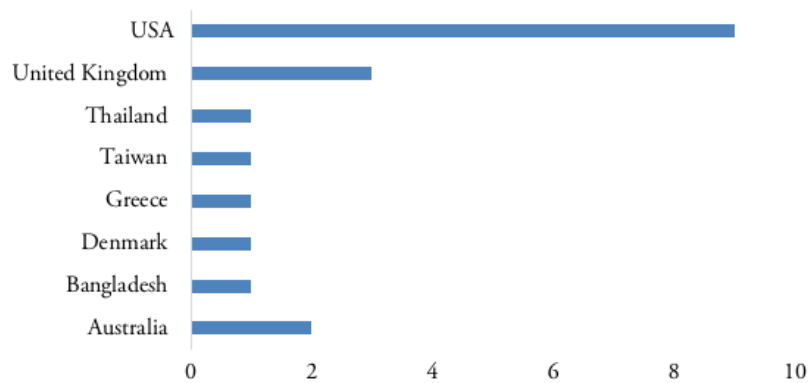
Figure 3. The Distribution of the Studies by Countries

Distribution of the Studies by Countries

The distribution of the studies by countries is presented in Figure 3. It was observed that online education solutions for ASD were employed the most in the United States of America (USA) and the United Kingdom (UK), followed by Australia. Additionally, some studies included findings for which no counties were specified.

Distribution of the Studies by Journals

The studies were indexed in journals addressing different fields including computer sciences, educational psychology, educational technology, special education, consultation, and health education. The details and distribution of journals across fields are presented in Table 2. It was found that most of the relevant studies were published in journals pertaining to special education (36%) and educational technology (36%), followed by educational psychology (10%). The share of all other fields was 5%.

Table 2. Distribution of Journals across Fields

Journal	%	Field
Soft Computing	5	Computer sciences
Psychology in the Schools	5	Educational psychology
Acta de Investigacion Psicologica	5	
Australasian Journal of Educational Technology	11	
International Journal of Web-Based Learning and Teaching Technologies	5	
International Review of Research in Open and Distance Learning	5	
Journal of Computers in Education	5	Educational technology
Open Learning	5	
Universal Access in the Information Society	5	
Journal of Autism and Developmental Disorders	11	
Behavior Analysis in Practice	5	Special education
Disability, CBR & Inclusive Development (DCIDJ)	5	
Focus on Autism and Other Developmental Disorder	5	
Research in Autism Spectrum Disorders	5	
Sexuality and Disability	5	
Journal of Educational and Psychological Consultation	5	Consultation
British Journal of Midwifery	5	Health education

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Purpose Statements of the Studies

The purposes of the articles were grouped as follows; (a) revealing the attitudes or experiences of individuals with ASD towards online courses (Adams, Simpson, Davies, Campbell & Macdonald, 2019; Meyers & Bagnall, 2015; Richardson, 2017; Stichter, Laffey, Galyen & Herzog, 2014), (b) developing a tool to increase the effectiveness of online education or evaluating the existing ones formatively (Chu, Tsai, Liao & Chen, 2018; Ohrstrom, 2011; Tsiopela & Jimoyiannis, 2017), (c) providing online training for practitioners and parents of children diagnosed with ASD, who have difficulty in accessing special education services (Curtiss & Ebata, 2016; Fisher et al., 2014; Hall, 2018; Heitzman-Powell et al., 2014; Karr, Brusegaard, Koly, van Edema & Naheed, 2017; Pantermuehl & Lechago, 2015; Wilczynski et al., 2017), (d) offering online education for supporting parents of children diagnosed with ASD (Kitson-Reynolds, Kitson & Humphrys, 2015), (e) providing online education to enable individuals with ASD acquire or improve certain academic or developmental skills, (Jeekratok, Chanchalor & Murphy, 2014; Pistoljevic & Hulusic, 2019; Stichter et al., 2014), and (f) evaluating current online education initiatives from a curriculum and user perspective (Chase, 2014; Sam, Cox, Savage, Waters & Odom, 2019; Stichter et al., 2014). Furthermore, the purpose statements of the studies included a number of additional focal points and key terms such as 'individuals with ASD', 'parents', 'online learning and education', 'skill acquisition', 'intervention methods', 'experience of individuals with ASD in online learning environments', and 'online learning solutions for practitioners.' These are shown in the wordcloud given in Figure 4.

Figure 4. Word-Cloud for Purpose Statements

Methodological Issues

Methodology sections of the reviewed articles were examined and they were evaluated under four categories: research methods, variables, target group, and instruments.

Research Methods

Various research methods were used in the reviewed articles to meet different purposes. In general, it was observed that experimental studies (*n*=6) were employed to teach a particular skill or examine the effectiveness of an intervention. Additionally, some of the studies (*n*=3) used a designbased research framework to understand how to design an OLE for individuals with ASD or relevant people. There were also studies (*n*=2) that focused on the formative evaluation of a new or existing online technology. Finally, the research methods used to describe a particular situation, raise awareness towards a problematic situation, examine online learning experiences in-depth, evaluate an online learning curriculum, and understand online learning situations included surveys (*n*=4), reflection report (*n*=1), phenomenology (*n*=1), concept paper (*n*=1), and case study (*n*=1).

Variables

The independent variables of the studies were online learning programs (n=1), online games and social stories (n=1), online learning support (n=1), online feedback (n=1), ebook with serious games (n=1), disability rate of ASD (n=1), and experience in social environment (n=1). On the other hand, the ability of practitioners to employ applied behavior analysis (ABA) (n=2), the ability of practitioners providing privacy education (n=1), the degree of acquiring developmental skills (n=1), academic achievement (n=2), and social skills acquisition (n=1) were selected as dependent variables.

Target Group

Target groups were individuals with ASD, their parents and practitioners (e.g., special education teachers). The articles (n=9) generally focused on individuals with ASD in different developmental periods, such as children and adults. The children's age in reviewed articles ranged from 2 to 7, and the adults were between 17 and 21. However, some of the studies (n=8) paid more attention to practitioners who were closely related to individuals with ASD.

Table 3. The Number of Participants in Studies

Participants	n>=10	n<10	N/A
Individuals with ASD	8	3	0
Parents	1	1	1
Teachers		1	1
Technicians/therapists	1	2	0
Health care providers			1

Note: n, the number of participants in a study; N/A, not available

The number of participants was categorized into three groups of 'greater than or equal to ten', 'less than ten', and 'not available' as shown in Table 3. In general, it was observed that the number of participants was greater than nine. Some studies did not report the number of participants. Additionally, both individuals with ASD and teachers took part together in two of the studies.

Instruments

A variety of qualitative and quantitative instruments were employed in the articles. While some of the studies used existing instruments developed by other researchers in the field, most of them utilized instruments specifically developed by the authors themselves. There were also two or more instruments in many of the studies. Most commonly used data collection instruments were questionnaire (n=13), tally sheet (n=5), observation form (n=2), survey (n=2), intervention protocol (n=2), achievement test (n=1), a software library for recognizing facial expressions (n=1), cost form (n=1), system logs (n=1), and survey including openended questions (n=1).

Findings on Results

The findings obtained from the reviewed articles are presented in Table 4. The results were categorized based on target audience and the variables examined, in order to increase understandability (Table 5).

Table 4. Findings on Results

Study	Findings
Adams et al., (2019)	Individuals with ASD stated that asking questions in an OLE is challenging, and such environments are more insecure compared to facetoface education. On the other hand, they provided positive opinions regarding the flexibility and usability of the environment.
Chase, (2014)	A rubric was developed for the assessment of the elearning curriculum based on the following criteria: learning and motivation status, issues regarding data collection and reporting, use of explicit language and understandability, use of uptodate technology, transformability, polymorphism (multimodal), focus and structure, supporting technology.
Chu et al., (2018)	The emotional state of an individual with highfunctional ASD is crucial while interacting with an OLE. In this regard, this study proposes an online technology that can detect anxiety, apprehension, and anger during online training. The study reported that the proposed system provides valid results in terms of perceiving an individual's feelings.
Curtiss & Ebata, (2016)	Despite recent significant advances in social media's role in education, it was found that users preferred to access learning content via email for reasons of privacy. The study indirectly showed that online support could be useful for accessing information.
Fisher et al., (2014)	The applied behavior analysis technicians using the proposed virtual learning program have recorded significant improvement in the application of behavior reduction skills.
Hall, (2018)	This study focuses on a project called "Teleconsultation" designed to meet the consultation and transitional care needs of military parents of children diagnosed with ASD. In this context, brief information regarding recovery methods, struggle with stress, care coordination, and behavioral counseling are presented through an online learning management system.
Heitzman-Powell et al., (2014)	It was reported that parents with access to webbased education and telemedicine technology increased their knowledge of applied behavior analysis (ABA) strategies and improved their implementation of ABA strategies to their children.
Jeekratok et al., (2014)	It was reported that webbased educational games and social stories are generally useful in enabling individuals with ASD learn certain behaviors.
Karr et al., (2017)	The online familyeducation program was found to be culturally sensitive, appropriate for learning units, and difficult in terms of learning content.
Kitson-Reynolds et al., (2015)	The study does not include specific results as it is a reflection paper. However, it emphasizes that healthcare professionals may raise significant awareness for supporting women and parents who have to live with ASD, with the help of elearning environments.
Meyers & Bagnall, (2015)	The study reveals that the characteristics of the learning environment are not suitable for the interests and learning needs of the participant with ASD.
Ohrstrom, (2011)	Focusing on the system design of the HANDS (Helping Autismdiagnosed teenagers Navigate and Develop Socially) elearning environment, the study supports that OLEs could be suitable for young people with ASD and highlights the importance of theory and practice for an effective design.
Pantermuehl & Lechago, (2015)	The study provided positively similar results in terms of the treatment of individuals with ASD with open observation methods, both verbally and online, via Skype.
Pistoljevic & Hulusic, (2019)	Serious games and elearning principles could be used for fast and effective skill and knowledge acquisition for different types of learners.
Richardson, (2017)	The study showed that students with ASD tend to perform on an equal basis with their typically developing peers in the OLE
Sam et al., (2019)	The study focused on intervention practices and produced positive developmental and learning outcomes for individuals with autism from the AFIRM (Autism Focused Intervention Resources and Modules) project.
Stichter et al., (2014)	The study revealed that the social competence curriculum for ASD could be given in 3D through a virtual OLE
Tsiopela & Jimoyiannis, (2017)	The study proposed a theoretical framework for an OLE, aiming to improve the performance and prevocational skill development of individuals with ASD.
Wilczynski et al., (2017)	An online training with coaching and feedback was found effective for knowledge acquisition and treatment fidelity.

Individuals with ASD. The studies conducted with individuals with ASD aimed to eliminate their daily social and communicational problems and improve their academic achievement. It was revealed that individuals with ASD positively benefited from OLEs and developed their social and communicative skills

(f=9). However, the participants' views about OLEs revealed that they encountered various problems in communicating with teachers, understanding instructional materials, and receiving instant feedback; thus, they did not find the relevant environments to be sufficiently useful (f=3). Individuals with ASD reported that they preferred facetoface learning environments for such reasons, adding that they could only trust online environments to a certain extent, on account of the difficulties of accessing the learning content. Moreover, only a few studies provided positive findings on the usefulness of these environments.

Table 5. Frequency Table Evaluating Results Based on Target Audience

| | Themes of results | | | | | |
| | Learning/ Awareness | | Experiences/ Opinions | | OLEs | |
	Positive	Negative	Positive	Negative	Useful	Useless
Individuals with ASD	10	1	5	1	1	3
Parents of children with ASD	2		2			1
Teachers	1		1			
Technical staff	1				1	
Healthcare pro-viders	1					

Parents of children with ASD. The studies conducted with parents indicate that parents were supported to the greatest extent possible on certain matters including: (a) understanding their children's needs better, (b) trying to eliminate their children's behavioral problems, (b) helping them fulfill their communication needs, (iv) recognizing and fulfilling the responsibilities of having a child with ASD, and (v) stress management. Positive findings were obtained about learning (f=2) and parents experiences towards OLEs (f=2). However, one study pointed out that parents experienced learningrelated problems due to inappropriate learning content. Nonetheless, parents generally supported distance and flexible curriculums.

Teachers. Teachers' views about OLEs developed for individuals with ASD were also examined. Teachers reported positive opinions about the prevalence of online education facilities designed for individuals with ASD, based on their observations of students.

Technical staff. It was revealed that the participants who provide technical support or work as technical staff in the field of special education found OLEs to be useful and beneficial (f=1).

Healthcare providers. A study conducted on midwifery students emphasized the importance of OLEs in informing parents about ASD, raising awareness towards ASD, and providing sufficient information on the matter. Participants of this environment were considered to understand that each individual may have different views of ASD.

Findings on Recommendations

Recommendations of the studies were examined under 7 categories. The frequencies of these categories are presented in Table 6.

Table 6. Recommendations Provided in the Studies

Recommendation category	f	References
Expanding the audience and conducting new research	6	Kitson-Reynolds et al., (2015); Karr et al., (2017); Pantermuehl & Lechago (2015); Pistoljevic & Hulusic (2019); Tsiopela & Jimoyiannis (2017); Wilczynski et al., (2017)
Development of OLEs	3	Adams et al., (2019); Karr et al., (2017); Pistoljevic & Hulusic (2019)
Making OLEs more useful	2	Meyers & Bagnall (2015); Jeekratok et al., (2014)
Evaluation of OLEs	1	Heitzman-Powell et al., (2014)
Instructional design for OLEs	1	Meyers & Bagnall (2015)
Focusing on specific and individual needs	1	Jeekratok et al., (2014)
Supporting studies for individuals with autism in higher education	1	Richardson (2017)

It was found that the recommendations mainly focused on the generalization of OLEs to a broader audience and application range, covering more participants. Other frequently emphasized recommendations included development of OLEs for ASD, and modification of OLEs to increase their usefulness for the target group.

DISCUSSION

In this chapter, certain critical results obtained in the light of the findings were classified based on research questions and discussed.

Trends in Demographic Issues

Although a remarkable increase was observed in the number of related studies after 2014, this increase may still be regarded as quite limited considering the current conditions in education, which may be explained by the fact that most special education applications depend on facetoface instructional strategies requiring considerable planning to conduct online. Nevertheless, it may be concluded that online education provides a great opportunity for those with no access to special education services. In support of this notion, there remains the need for a paradigm shift in specialeducation methods to be better prepared for unexpected situations such as the Covid19 pandemic. In this regard, online education could provide a pedagogical and technical infrastructure to promote learning in special education.

Most of the studies reviewed in this paper were carried out in the USA and the UK. Reports indicate that approximately one out of every 68 children was diagnosed with ASD in the USA in 2012 (CDC, 2016). This rate was increased to 1 in 54 for eight-year-old children in the USA in 2016 (CDC, 2020). From a financial point of view, it is estimated that about $223 billion were spent on ASD-related issues in the USA in 2020, and a dramatic increase in the costs was expected in the upcoming years (Blaxill, Rogers & Nevison, 2021). Research points out that this figure may be reduced by 2/3 through early diagnosis and intervention. It may well be said that the proliferation of individuals with ASD in the society and the high cost of support packages provided for such individuals paved the way for numerous studies to be carried out in practice. As for the UK, it is estimated that public and private funding organizations invested almost £21 million in ASDrelated research in the UK between 2007 and 2011 (Pellicano, Dinsmore & Charman, 2014). Studies show that both countries give prominence to academic studies aiming to raise public awareness on ASD, underlining the urgent need to evaluate personal, familial, social and economic dimensions of the increase in the number of individuals with ASD in the USA and UK (Buescher, Cidav, Knapp & Mandell, 2014).

Trends in Methodological Issues

Examining the target group and the distribution of participants in the studies reviewed revealed that most studies focused on individuals with ASD and their parents in an effort to improve communication skills,

social behaviors, and academic achievement of the growing numbers of individuals with ASD and ensure their integration into the society. As there are no known treatments for ASD other than special education (Caglayan, 2013), the studies mainly focused on offering individuals with ASD and no means to access special education services a learning opportunity via technologybased applications. These applications not only contribute to learning, but also enable individuals with ASD to access education in their homes without having to attend specialeducation institutions (Chen, 2012).

This study revealed that online learning activities were provided for parents living in rural areas without access to healthcare centers, who generally face several challenges in stress management, struggling with obstacles and contributing to the development of their children with ASD. It may be inferred that OLEs could be a more beneficial option for these people in dealing with unexpected situations and acquiring adequate learning opportunity (Fisher et al., 2014; Karr et al., 2017).

It is known that most studies on special education are singlesubject studies due to low schooling rates and the difficulty of accessing the related individuals in practice (Horner et al., 2005). Most studies reviewed for this paper had more than ten participants. The relatively high number of participants may be attributable to the instruments used in OLEs (e.g., log records and online questionnaires) and the fact that OLEs facilitate accessing these individuals.

A noteworthy finding of the study in relation to the instruments was that questionnaires, tally sheets and observation forms commonly used for measuring skills were used extensively. Questionnaires offer a costeffective way to quickly collect data on a given subject from a large number of participants (Marshall, 2005), which was especially useful for obtaining views about OLEs. Thus, questionnaires were used either as an independent research instrument or in association with other instruments (Boynton & Greenhalgh, 2004). The basis of this finding may be related to the fact that individuals with ASD have social, communicational and behavioral problems which require testing of their skills and making indepth observations to determine the level of improvement achieved. In this context, the reviewed studies mostly benefited from tally sheets and observation forms, and frequently used observation as a qualitative research instrument to enable people to define their behavior before or after an intervention in a detail manner. On the other hand, achievement tests were used as a data collection instrument in experimental studies for examining the effects of OLEs on the academic achievement of individuals with ASD or on increasing the parents' awareness and knowledge, suggesting that these tests were used to measure whether OLEs were useful or not.

Evaluation of Findings

It was found that learning from OLEs and raising awareness produced positive results in terms of the experiences and opinions of individuals with ASD and those who are involved with ASD. This result may be supported by the notion that OLEs should be designed to suit to the needs of the target audience (individuals with ASD and their parents) by examining their characteristics and developing a curriculum that is appropriate (Chase, 2014; Karr et al., 2017; Kitson-Reynolds et al., 2015) and customizable for each individual (McDonald & Lopes, 2014). Today, there are several adaptable/customizable OLEs that can be personalized by users. It is of great importance to ensure that the same educational environments are customizable for individuals with ASD to achieve the highest learning efficiency. Additionally, such learning environments should offer extensive information about the subject domain while avoiding complicated user interfaces to reduce cognitive load and information density (Walkington, 2013). Therefore, to make OLEs more useful and engaging for individuals with ASD, this study suggests that designers should give up traditional design habits and carefully consider the characteristics of individuals with ASD.

Evaluation of Recommendations

It was found that most of the articles recommended increasing the number of participants in future studies. This may be related to the wide range of individual differences in ASD (Meyers & Bagnall, 2015; Wilczynski et al., 2017). Accessing more participants may help improve the external validity of studies. Another frequentlymade suggestion related to the usability issues of OLEs. Although usability guidelines (Zaharias & Poylymenakou, 2009) that could be employed in OLEs for typically developing individuals are available, these should be revised in consideration of the characteristics of individuals with ASD.

Limitations and Further Studies

The APA (2013) reports that individuals diagnosed with ASD make up approximately 1% of the world population, pointing out to an urgent problem that needs to be addressed on a global scale. At a time when most learning activities are shifted to OLEs due to the Covid-19 pandemic, innovative solutions are required to meet the needs of individuals with ASD and those who are involved in providing education for individuals with ASD. This study is limited to 19 articles about OLEs in ASD based on pre-pandemic data. However, largerscale research is likely to be conducted after the pandemic. That said, within the available data framework, it may be suggested that studies on the subject are quite limited and new studies addressing different cultural and individual requirements are needed. Based on the results obtained here, the following recommendations may be offered for future studies:

- Before designing an OLE, a detailed need analysis should be performed to determine learning preferences of individuals with ASD, practitioners, and parents.
- OLEs used in special education should be individually adaptable.
- Special education experts should be informed about online learning solutions and encouraged to use them in practice.
- Innovative OLEs enabling all stakeholders in special education to access individuals with ASD and support their social, communicational, behavioral and academic development are needed.

CONCLUSION

Special education for individuals with ASD is a comprehensive process that requires coordination among experts from different disciplines and demands great dedication. Learning activities are provided through collaborative efforts of teachers, parents, and practitioners. A variety of interventions based on traditional strategies have been found to be useful in improving social, communicational, and academic skills of individuals with ASD. Although the articles reviewed in this study do not offer sufficient evidence to make generalizations about the proposed results, they present important clues about the trends between 2010 and 2019. Accordingly, this study concludes that OLEs can open an alternative channel in special-educational activities for individuals with ASD; however, adjustments are needed to make them more useful, flexible, and adaptable.

Hereunder, it was concluded that (a) the research trend on the subject increased after 2014, (b) most of the studies in the specified period were carried out in the USA, and (c) the research topic intersected along the axis of special education and educational technologies; hence, related studies were published in journals in these fields. Secondly, it was revealed that (a) the studies reviewed generally focused on providing online support to individuals with ASD, their parents, and practitioners who experienced problems in accessing special education services, (b) experimental, review and design-based research methods were frequently employed, (c) the variables used in empirical studies spread over a wide range, (d) the target audience of the studies comprised individuals diagnosed with ASD, their parents, and practitioners, and (e) questionnaires, tally sheets, observation forms were frequently used in the data collection process. Finally, it was found that (a) individuals with ASD had a positive learning experience towards online learning environments, but found some e-learning environments to be useless, (b) parents also had positive gains in terms of learning. Moreover, it was found that the most frequently-stated recommendation themes in the reviewed studies were (a) extending elearning environments to larger audiences and (b) increasing the usability of these environments to accommodate individual needs.

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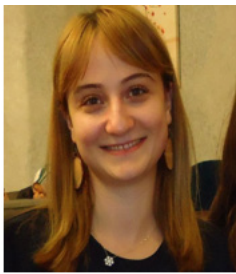
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