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Review

Teachers' Knowledge Regarding Autism Spectrum Disorder (ASD): A Systematic Review

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Abstract: The increasing number of students with autism spectrum disorder (ASD) in mainstream education environments require teachers to know how to identify their needs, being capable to adapt their education processes and make their inclusion easier. The purpose of this study is to conduct a systematic review about teachers' knowledge of ASD, including teachers from any stage and specialization. The research has been conducted from four databases (Web of Science, Scopus, PsycInfo and Google Scholar) during the period of 2015–2020. In total, 25 articles were analyzed. The results show that, in general, teachers' knowledge of ASD is poor. It depends on the education stage (being higher in early childhood teachers and in university professors), prior training and possible prior contact with students with ASD.

Keywords: autism spectrum disorder; ASD; inclusive education; systematic review; teachers' knowledge

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1. Introduction

The world is rapidly changing, and within the education field this generates some questions regarding the needs of every single student [1]. Commitment to inclusive education has increased for everyone—regardless of disability—since UNESCO's Salamanca Statement. Adherence to an inclusive rights-based perspective is associated with a greater presence of students with disabilities, including autism spectrum disorder, in regular classrooms [2]. All teachers play a crucial role in the inclusion of children, teenagers, and young people. Teachers' knowledge about ASD is necessary as many of them can act as knowledge broadcasters of social change towards an inclusive education [3]. In this way, sustainable education, and the purpose of ensuring inclusive and equitable education, as well as promoting lifelong learning opportunities for every single person are key points for high-quality education of students with special needs [4]. Sustainable goals require that teachers have the appropriate tools to handle this new and current reality. That is why teachers, as the focal providers of education, must be aware of the benefits of adopting inclusive approaches in education. This awareness depends on intensive training, continuing professional development and improving their knowledge [5].

1.1. Definition of ASD and Prevalence

Autism spectrum disorder (ASD) is a heterogeneous neurodevelopmental disorder characterized by persistent deficits in social communication, social interaction and restricted and repetitive patterns of behavior, interests or activities [6]. The prevalence of ASD is reported to be increasing worldwide and is currently estimated to affect 1/100 individuals [7,8]. However, the rate varies depending on the study and the country where studies are carried out. For instance, the prevalence in the United States is estimated to be 1/59 [9]; in Spain, 1/100 in children who are 10 and 11 years old [10]; in the United

Kingdom, 1/64 [11]; in Italy, 1/87 [12]; and in Denmark, 1/125 [13]. Other organizations suggest that the prevalence is even higher: from 1/54 [14] to 1/36 individuals [15].

The differences among prevalence could be caused as a result of cultural and economic factors [16]. What is fairly clear is that the prevalence of ASD has increased exponentially in recent years [16–19] and this increase is not only attributable to the increase in the incidence of the disorder, but also to changes in diagnostic criteria, comorbidity with other diagnoses, practices used in detection and diagnosis, special education policies, the availability of services, and knowledge and awareness levels regarding ASD, among others [16,20].

1.2. Inclusion of Students with ASD in Ordinary Settings

The increase in ASD prevalence within recent years has meant a parallel increase in the number of children and young students with ASD educated in mainstream preschools, primary schools, high schools and universities [21,22]. There is a high probability that pre- and in-service teachers will find students with ASD in their classroom. For that reason, it is important that teachers' training includes competencies in working with and teaching children and young students with ASD [23,24]. Indeed, some studies point out that this training is a necessity for all mainstream school professionals [22].

The inclusion of individuals with ASD in the same educational environment with typically developing children promotes positive outcomes in terms of social and cognitive development [21]. In fact, policymakers of many educational systems have followed these recommendations offering schooling options in regular classes where there are available services according to the needs of a child with ASD [21,25].

However, although there are many benefits in inclusive education, such as accessibility to general education curricula and opportunities for interactions, this situation may cause multiple challenges for students with ASD and their teachers [26]. Therefore, teachers need to be equipped with appropriate knowledge about special education and inclusive environments, so that they are more competent in teaching students with ASD [27].

1.3. Teachers' Knowledge of and Moderators That Possibly Influence ASD

The fact that teachers have knowledge about ASD is beneficial in order to provide an adequate social and educational setting in which students with ASD are included. Constructive knowledge positively impacts daily practices in mainstream and special education settings [22,28]. Specifically, experts note that teachers who work with students with ASD should have knowledge about etiology, specific characteristics [29], assessment and diagnosis [6,25,30], individual learning differences that present with these students, social interactions, treatments [29], and some strategies for early inclusion in mainstream environments.

However, traditionally it was considered that the best settings for the care and education of students with any kind of special need are those where specialists are located, because they know the specific support that is needed. It is necessary to end this kind of thinking as inclusion affects all teachers and not only specialists [31]. Given the situation, it is imperative to empower teachers and to teach them communication and social skills as well as the know how to address problematic behaviors, or to correct negative attitudes toward students with ASD among others [32,33].

In general, teachers (in every single stage of education and no matter their specialization) need some professional and scientific training on inclusive education [25,34,35]. Knowledge is a relevant predictor of teachers' ability and awareness to provide inclusive learning opportunities to pupils with ASD, helping them obtain better access to the early screening and identification process [36–38].

In this way, some studies have focused on initial training of pre-service teachers in order to prepare them for an inclusive concept of education [39–41] or have analyzed if teachers are specialized in ASD or in inclusive education [25,34,35]. Other studies focused on the potential relationship between experience and knowledge [42] or whether the stage

in which teachers carry out their job affects knowledge of ASD [25,43]. Finally, there is also some research aimed at analyzing if any correlation exists between culture and knowledge [44] or if the instrument used to assess knowledge matters [35].

1.3.1. Teachers' Knowledge of ASD and Experience

Apart from providing initial knowledge of ASD, it is contended that having experience and prior contact with people diagnosed by ASD has positive implications in teachers' knowledge [45]. For that reason, in-service teachers usually know more about ASD than pre-service ones. In South Korea, to reduce those differences, pre-service training programs to prepare special education teachers require them to finish a traineeship. A full-time practicum for one month should be completed during the last year of training, so that they can learn effective instructional methods, test their own suitability for their chosen career, deepen their knowledge and develop their concept of education. Experiences such as practicums and volunteer opportunities are important mechanisms for providing pre-service teachers with opportunities to apply their new knowledge in practical teaching situations [42]. A study with Greek teachers showed that work experience with children with ASD improved their knowledge in managing students with ASD [46]. Moreover, relationships between teachers and pupils were improved thanks to experience [47].

1.3.2. Teachers' Knowledge of ASD and Specialization

Inclusive education depends on teachers' specialization and training. Specializing in ASD after graduating is a positive way to better know the disorder and hold an important advantage for students' outcomes. Even ASD training for novice in-service teachers saw an increase of their knowledge regarding the disorder [48]. Teachers who are supportive of inclusion and have sufficient training can play a critical role in making real inclusion easier [49]. In addition, mainstream teachers (from primary and secondary stages) assume a lack of knowledge [26,50,51] and misconceptions [28,52] about educating students with special needs. They do not feel competent nor confident when teaching students with ASD [26,50,53]. It is probably because of the lack of specialization [26]. Consequently, some look for knowledge attending specific courses or may also benefit from additional training by specialist staff [49].

1.3.3. Teachers' Knowledge of ASD and Stages

Knowledge is also linked to the relevant stage that the teachers are working within. It is beneficial for teachers to have good or adequate knowledge about ASD for improving the educative experience through adaptive settings, time management assistance, and to help identify potential stressors. In this regard, primary school settings are more prepared than secondary high school settings to include students with ASD [25,54]. Teachers at the primary stage seem to have a higher knowledge level regarding ASD. However, post-primary school teachers' knowledge is poor. Some research has outlined that transitions are crucial moments to strengthen inclusion. In fact, the transition from primary to secondary education is a major shift supposing considerable social, emotional, academic, and organizational challenges [43]. For that reason, teachers must be educated in order to help students with ASD [26]. Regarding the university stage, the number of university students with autism is increasing, and it is crucial that these students can access adequate support [55,56]. However, a survey revealed that campus members, including faculty professors, had limited knowledge about ASD [57].

1.3.4. Teachers' Knowledge of ASD and Culture

Teachers' knowledge is correlated with the culture and country where the assessment is carried out. Some research has found differences in teachers' knowledge about ASD across countries, especially because of differences in access to training and

consequently a lack of knowledge. A study comparing self-efficacy, stress, social support, coping and burnout from teachers in France and Quebec working with students with ASD [44] pointed out the differences existing between the two countries regarding training, experience, educational requirements, and knowledge.

While in France it is required that teachers have a specific one-year course to work with children with special needs, only around 10% of primary and secondary school teachers in Hong Kong (China) completed special education training in the last decade [27]. In addition, knowledge of ASD in Ethiopia is relatively low across education and social professionals because they still subordinate matters like health to traditional customs and beliefs (responding with spiritual, cosmological, ecological, or social factors, for example) [58]. Another investigation [29] assessing Malaysian teachers' knowledge reported lack of knowledge to support students with ASD in the mainstream schools. There is a need to consider education systems and the cultural environment when studying the knowledge of teachers regarding ASD [29,44,58].

1.3.5. Teachers' Knowledge of ASD and Methods and Instruments Used for Assessment

Methods and instruments used in order to measure teachers' knowledge regarding ASD are quite important. Identifying reliable assessment methods to quantify knowledge of ASD is a crucial step toward increasing global ASD knowledge [35]. According to a review of this topic [35], the most commonly used measures for assessing knowledge were the Autism Knowledge Survey (AKS) [59], the Knowledge about Childhood Autism among Health Workers (KCAHW) Questionnaire [60], the Autism Knowledge Questionnaire (AKQ) [45] and the Autism Inclusion Questionnaire (AIQ) [51]. Moreover, most of the articles they reviewed utilized quantitative instruments (responses to vignettes, checklists, multiple choice, true/false or yes/no, and Likert scale response options), while only 3 out of 44 articles applied interview protocols, short answers, or responses to questions about a vignette. Therefore, they did not gather significant qualitative data regarding teachers' knowledge and instruments and methods used for assessment.

1.4. Early Literature about Teachers' Knowledge Regarding ASD

Early research literature has already collected articles examining teachers' knowledge regarding ASD. A review carried out in 2020 [61] built a conceptual framework of teachers' knowledge through 11 studies. The authors concluded that early childhood teachers have a lack of knowledge identifying students with ASD. They contended that early childhood teachers' knowledge of ASD was important, so that they could identify early signs. This review considered that early childhood teachers must have a higher degree of training in ASD in order to intervene as soon as possible.

Another review analyzing pre- and in-service teachers' knowledge [62] gathered studies relating to three mental disorders, among which we could find five investigations about teachers' knowledge of ASD. Three out of five were focused on in-service teachers; and two, on pre-service teachers. Results showed that pre-service teachers have lower knowledge about autism, no matter their specialization nor the university where they had studied.

1.5. Objective

After having carried out a bibliographic search, we found that there is a significant lack of reviews on our subject of research. The particularity of our study lies not only with updating previous reviews, but also in illustrating the focus of the study. In this way, our study excludes other kinds of professionals that are not responsible for educational functions (for example, nurses [61]). It also puts the focus of attention on the ASD diagnosis, differentiating itself from other neurodevelopmental disorders [62] and covering all stages of education from early childhood, primary, secondary, and university levels (as students with ASD often reach higher educational levels).

In this article we carry out a systematic review of the scientific literature to analyze teachers' knowledge regarding ASD (from any stage and speciality) during recent years. This review aims to contribute towards building a consistent framework for teachers' knowledge of ASD focusing on the relationship of some moderators as follows: experience, specialization and training, educational stage, and culture. It also expands on past reviews and updates previous conclusions of literature reviews about teachers' knowledge of ASD.

2. Materials and Methods

This systematic review was carried out taking into account the preferred reporting items for systematic reviews and meta-analysis guidelines [63]. The search strategy was designed to be as extensive as possible in order to identify all possible eligible studies, which were then refined by applying inclusion and exclusion criteria.

2.1. Information Sources and Search Strategy

The search for and compilation of analyzed articles were carried out through a sequenced research process in Web of Science (WoS), Scopus, PsycInfo and Google Scholar databases. We conducted a search for the following keywords, delimiting any field of the bibliographic record except full text, language filters, type of publication and period of time: "autis*", "teacher" and "knowledge". The first search produced 130 results in WoS, 117 in Scopus and 116 in PsycInfo. In the case of Google Scholar, we made an exploratory search of the first 20 sites.

2.2. Eligibility Criteria

A systematic search of empirical articles focused on the assessment of teachers' knowledge of ASD was conducted to identify relevant studies to the current review. The inclusion criteria used in this review was the same for the different searches carried out in each database, including: (a) empirical studies that evaluate pre- or in-service teachers' knowledge of ASD (no matter the stage, specialization, or country); (b) the research was limited to scientific articles published in peer review journals (therefore other types of publications were excluded); (c) from 2015 to 2020; and (d) in English, Spanish or French. We did not include articles involving other diagnoses apart from ASD, or not including pre- and/or in-service teachers.

2.3. Study Selection

Two of the authors independently applied the inclusion and exclusion criteria. After removing duplicated studies, a total of 45 studies were initially screened. After reading the abstracts, 17 studies were excluded for not meeting some of the inclusion criteria stipulated in the review. The remaining 28 articles were read in their entirety. After that, another 3 studies were discarded because they did not meet some of the inclusion criteria. The review was finally made up of a total of 25 studies. The search and selection processes are summarized in Figure 1.

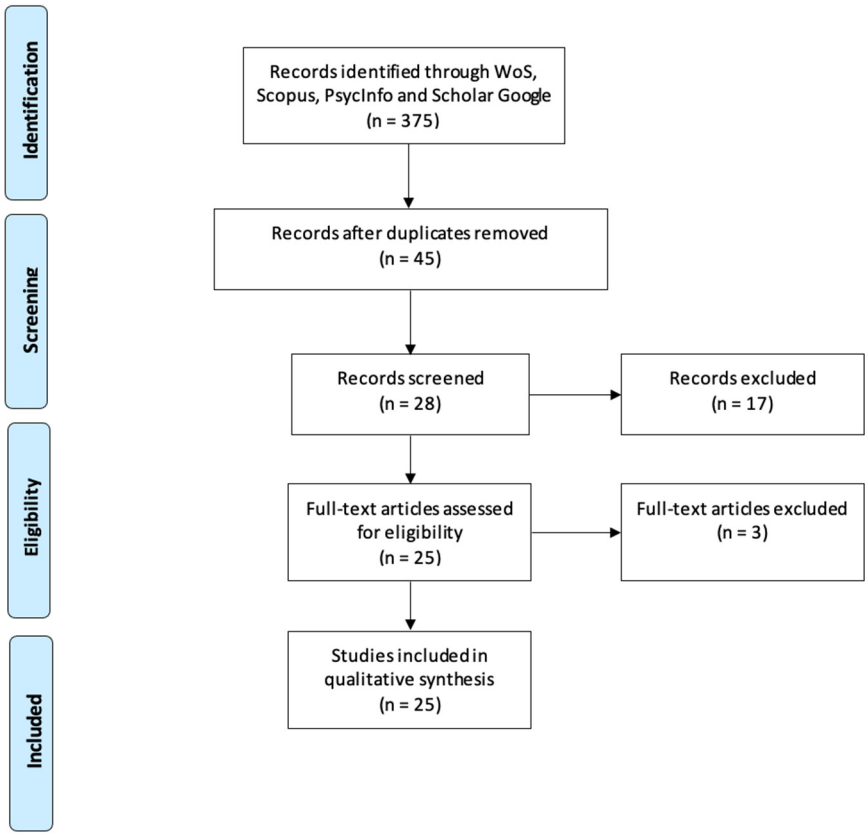

Figure 1. Flow chart process.

2.4. Data Collection Process and Data Items

All 25 studies were independently reviewed by two of the authors. After identifying all relevant articles, information was extracted in each study and synthetized in Table 1 and Table 2. We examined: the country, a brief description of the sample, the instrument used to assess knowledge, and a brief summary of the results. After independent reviews, cases in which there was some divergence in data collection were discussed and solved by consensus.

Table 1. Studies included in the review of in-service teachers' knowledge regarding ASD *.

Study	Objective	Sample	Instrument	Results and Conclusions
[64] Tanzania	To explore teachers' knowledge of teaching children with ASD.	*n* = 16 (PST); G = 14 females and 2 males; Age: ranged between 27 to 55 years; EXP = not specified; TR = not specified.	16 face to face interviews. The questions were grouped into four categories that assessed knowledge regarding ASD.	Majority of PST were less knowledgeable about ASD and its associated features. In the beginning of the research, teachers did not understand the meaning of ASD (62.5%).
[65] South Africa	To improve knowledge of ASD conducting a school-based awareness study focusing on what educators know about ASD.	*n* = 50 (educators); G = not specified; Age: 46.3; EXP = 19.29; TR = one educator in each of the 5 primary school selected had regular training on disorders.	Translated to isiZulu KCAHW questionnaire [60].	Teachers had a fair level of knowledge of ASD. The mean total score for the sample was 13.08 out of 19. Above 19.6% of teachers participating scored on the questionnaire less than 10 points; 49% scored 13 points; 23.5% scored 15 or more and 2% scored above 17.
[66] China	To assess the knowledge that ECT possess regarding typical child development and ASD.	*n* = 471 (ECT); G = 467 female and 4 males; Age: <20 years (4.4%); 20–24 (21.9%); 25–29 (17.4%); 30–34 (19.1%); 35–39 (14.6%); 40–44 (12.9%); 45–49 (4.8%); >50 years (4.4%); EXP = 16%; TR = 83%.	A questionnaire designed by the authors. It consisted of 17 items with three options in the answers "true/false/don't know".	Knowledge of ASD among ECT in China is lacking. Most of the teachers (83%) were unable to provide accurate responses to half of the questionnaire items pertaining to ASD. Majority of them did not know associations or treatments to help people with ASD.

[67] Pakistan	To assess the knowledge of PST about children with ASD and their ability to identify them.	*n* = 233 (PST); G = 94.9% female and 5.1% male; Age: 38.6; EXP = not specified; TR = not specified.	Self-administered questionnaire. It included items about teachers' knowledge regarding ASD and about the identification of students with disabled children.	Knowledge regarding ASD was particularly deficient.
[68] Pakistan	To assess knowledge regarding ASD among school teachers and evaluate factors influencing their knowledge.	*n* = 73 (PST); G = 90.4% females and 9.6% males; Age: 34 years; EXP = not specified; TR = 67.1%.	Self-administered questionnaire, based on validated scales used in [69,70].	Wide gaps were identified in teachers' knowledge about ASD. Experience and contact with children with ASD were the only factors that influenced their knowledge.
[71] Malaysia	To provide a preliminary study about the current teachers' knowledge of ASD among PST.	*n* = 120 (PST); G = 94 female and 26 males; Age: not specified; EXP = 52.5%; TR = 17.5%.	Adaptation of [66] in China and [72] in Singapore questionnaires. The final version used in the study was adapted for a Malaysian cultural context. It consisted of 17 "true/false/don't know" items.	There is certain lack of knowledge of ASD among teachers. Although 75.7% stated they had heard about ASD, not all really knew the characteristics of ASD (70% could report the specific characteristics of ASD), and some of them still confused ASD with other diagnoses.

[73] UK	To understand Nigerian teachers' level of knowledge about ASD.	*n* = 177 (PST); G = 151 females and 26 males; Age: 21–30 (8); 31–40 (51); 41–50 (65); older than 51 (53); EXP = not specified; TR = not specified.	Adapted version of KCAHW questionnaire [60]. The authors of the current study suggest that a score of 0–6 indicates a low knowledge of ASD; a score of 7–12 indicates a moderate knowledge; and a score of 13 and above indicates accurate knowledge of ASD.	The total mean score on the adapted KCAHW questionnaire was 10.81 out of 16. Teachers demonstrated a generally accurate knowledge of ASD. Only 27 teachers (in total 15% of participants) answered all questions correctly.
[74] Pakistan	To assess and compare the knowledge about ASD among mainstream and SET teachers.	*n* = 163 (64 from special schools); G = 155 females and 8 males; Age: 35.04; EXP = not specified; TR = 77.9% (127).	The questionnaire was based on previous literature [37]. Knowledge about ASD was assessed by "yes/no" questions with a "don't know" option included.	SET obtained a higher score than PST (20 vs. 14.78 out of 31, respectively). There was low knowledge in both groups of teachers. In fact, 90.8% of teachers participating said that there is a need for ASD training.

[75] Turkey	To examine teachers' general knowledge about ASD, to explore their knowledge about evidence-based practices in ASD, and to examine their training needs in children with ASD.	*n* = 478 (92 ECT, 105 PST, 126 middle school, and 155 ST); G = 277 female and 201 males; Age: 37.3 years; EXP = 4.2% of participants have a relative with ASD and 15.7% have taught pupils with ASD; TR = 27.8.	Survey based on prior literature [59]. It had three sections: one to explore teachers' knowledge about causes of ASD, one to investigate teachers' general knowledge and perceptions of ASD and one to evaluate teachers' knowledge about effective practices for ASD.	Turkish teachers' knowledge and perceptions about ASD appear to be relatively poor. Although many questions to evaluate teachers' general knowledge of ASD were answered correctly by the majority of teachers who participated, raising scores above 80%, however, there were some misconceptions about ASD and characteristics of children who have the disorder.
[76] Saudi Arabia	To assess the knowledge of school teachers regarding ASD.	*n* = 248 (PST); G = 155 females and 93 males; Age: 38.25; EXP = 31.9; TR = not specified.	AKQ [45]. It contained 30 items to ask about knowledge of ASD. There were three options to answer, "true/false/don't know".	PST have a weak level of knowledge about ASD (an average of 48.7%). Previous contact with students with ASD affects the level of knowledge of PST. There is a need for training special education teachers in the identification and management of children with ASD.

[77] China and UK	To investigate whether general teaching experience and culture influence impacts on teachers' knowledge of ASD.	*n* = 110 (from China and UK). China (*n* = 59; 55.9% PST and 44.1% ST); G = 53 females and 6 males; Age = 32.24; EXP = 28%; TR = 38.4% UK (*n* = 51; 74.6% PST and 25.4% ST); G = 46 females and 5 males; Age = 38.1 years; EXP = 80.5%; TR = 62.8%.	AKQ [45].	There were no significant differences of ASD knowledge between primary and secondary school teachers. Culture did not affect knowledge of ASD, but experience seems to be relevant: UK teachers had more knowledge of ASD than their Chinese counterparts (the scores were 13.75 vs. 10.47). Experience impacted knowledge of ASD: teachers who had prior contact with children with ASD showed higher levels of knowledge regarding the disorder (14.12 vs. 9.78).
[78] Iceland	To assess knowledge of ASD among Icelandic PST.	*n* = 863 (PST, 12.2% of them were special education teachers); G = 89.5% female and 10.5% male; Age = 33.9% ≤ 40; 67.5% ≤ 50; EXP = 84.1%; TR = 53.8%.	Questionnaire created especially for the study by the authors. It contained 41 items rated as "agree/disagree".	Teachers' knowledge was fairly good. Special education teachers obtained higher scores than PST (15.25 vs. 13.98). There were significant differences between the correct answers from teachers with or without experience in teaching children with ASD (14.27 vs. 13.42); and between teachers with or without additional training related to ASD (14.66 vs. 13.54); ($p < 0.01$ in all comparisons).

[79] Saudi Arabia	To assess the knowledge towards including children with ASD in their regular classrooms.	*n* = 79 (PST and special education teachers from 2 schools); G = not specified; Age = 29.2; EXP = 48'1%; TR = 41,8%.	A questionnaire consisting of 15 items (converted into a percentage out of 100). It was an adaptation of [59] with "true/false/don't know" response options.	Most participants (82.3%) had a low level of knowledge about ASD. Only 2.5% of participants had a good knowledge level. Experience was the only demographic background with an effect on teachers' knowledge of ASD. Participants revealed the lack of opportunity to attend training programs to increase their professional development and awareness of ASD.
[80] Malaysia	To identify the factors related to special education teachers' knowledge of ASD.	*n* = 87 (special education teachers); G = 69% females and 31% males; Age: < 24 years (5.7%); 25–34; (58.6%); 35–44 (29.9%); 45–54 (4.6%); > 55 (1.1%); EXP = not specified; TR = 47.1%.	An adaptation of [81] survey assessing knowledge on ASD.	Most of the special education teachers participating could identify more than five facts correctly (80.4%). Moreover, the majority of participants could identify major ASD features associated with social communication deficits and atypical play and behavioral patterns.
[82] China	To investigate primary school teachers' knowledge of ASD.	*n* = 386 (PST); G = 78.6% females and 21.4% males; Age: <30 (141).; 30–39 (82);40–49 (102); >49 (51); EXP = 42.4%; TR = not specified.	Autism Stigma and Knowledge Questionnaire (ASK-Q [83]). It contained 49 questions covering 4 areas: diagnosis, etiology, treatment and stigma.	The average score for knowledge of ASD in this study was 53.9%. Better teachers' ASD knowledge correlates with a more positive attitude towards students with ASD.

* ECT = Early Childhood Teachers; PST = Primary School Teachers; ST = Secondary Teachers; CE: College Educators (Professors and Mentor Teachers); SET: Special Education Teachers; G = Gender; TR = Training in ASD; EXP = Experience with Children with ASD.

Table 2. Studies included in the review of comparing different teachers' knowledge groups regarding ASD *.

Study	Objective	Sample	Instrument	Results and Conclusions
Pre-service teachers				
[84] Jordan	To investigate levels of knowledge among pre-service SET.	*n* = 56 (pre-service SET: sophomore (9), junior (24) and senior (23) grade); G = 40 (71.4%) females and 16 (28.6%) males; Age: not specified; EXP = not specified; TR = during this research a training program was conducted.	The authors developed a 40-item test, which covered the basic domain of the training program. There were multiple choice and "true or false" questions.	The participants' scores compared to their results of the pre-test (16.66/40 means low level of knowledge) were significantly better ($p < 0.001$) in the post-test (21.91/40 means moderate level of knowledge). There were no statistical differences between the participants at different year levels.
[85] Spain	To examine pre-service teachers' knowledge, gaps and misconceptions about ASD and to compare them between first and last year pre-service teacher students.	*n* = 866 (pre-service teachers: 435 in their first year at university; 431, in their last year. Seventy-five of them were pre-service SET); G = 726 females and 140 males; Age: 20.13 (1st) and 23.45 (4th); EXP = 23.2% (1st) and 23.7% (4th); TR = 0.7% (1st) and 1.4% (4th).	Adaptation of AKQ [45].	Fourth-year students had higher levels of knowledge and fewer gaps than the first-year students, although they also had more misconceptions ($p < 0.001$). Pre-service SET obtained more knowledge ($p < 0.001$) and fewer misconceptions ($p = 0.003$) than pre-service PST. Training and experience had influence on their knowledge, misconceptions and gaps.

[86] UK	To offer a baseline assessment of knowledge of ASD on trainee teachers.	n = 326 (pre-service mainstream teachers); G = 85% females and 15% males; Age: 18–20 years old; EXP = 69%; TR = not specified.	AKS [59]. It was a Likert-style questionnaire updated to reflect new knowledge informed by the criteria of [6].	The mean score of AKS was 38. Levels of knowledge were comparatively high among participants, although the evidence suggests that there is a need for training to develop trainee teachers' self-efficacy and confidence in their pedagogical practice.
Studies comparing pre- and in-service teachers				
[87] Malaysia	To identify the level of knowledge of SET in educating children with ASD.	n = 312 (pre-service and in-service PST or ST specialized in special education); G = 86.9% females and 13.1% males; Age: 84% were 20–40 years old; EXP = pre-service ($\bar{x}$ = 2.29) or in-service ($\bar{x}$ = 1.83); TR = pre-service ($\bar{x}$ = 2.14) and in-service ($\bar{x}$ = 1.83).	Adaptation of a questionnaire [88]. It contained 32 items presented under three categories: preparation in ASD, knowledge and teachers' self-reported competence in teaching children with ASD.	Participants had a good knowledge about some characteristics of ASD. However, there were high levels of misinformation regarding the characteristics of ASD among teachers. The findings of this study highlighted the importance of in-service training. In total, 77.6% of participants have students with ASD but have a lack of experience and training.
Studies comparing different professionals from the educational field ("different professionals" means in this study special education teachers, psychologists, speech language pathologists, social workers, directors of special education centers, members of special education committees, counselors, occupational therapists, behavior specialists, administrators and paraprofessionals, apart from pre- or in-service teachers).				

[89] USA	To examine variables associated with the self-efficacy for working with students with ASD (like knowledge, experience and training).	n = 80 (different professionals); G = 72 females and 8 males; Age = not specified; EXP = 0.048 (B); TR = −0.059 (B).	AKQ [45].	Scores on the knowledge questionnaire were significantly higher following the training (11.28 vs. 12.38; $p < 0.001$). High correlations were found between prior training and knowledge about ASD (the higher level of training, the more knowledge about ASD). Knowledge, experience and training in ASD were associated with teachers' self-efficacy. Experience with students with ASD was not correlated with knowledge about ASD.
[90] USA	To explore pre-service ECT's knowledge of ASD and compare it to the perceptions of mentor teachers.	n = 87 (pre-service teachers and mentor teachers). Pre-service teachers (n = 81): G = 81 female; Age: not specified; EXP: 84%; TR: 100%. Mentor teachers (n = 6): G = 6 female; Age: 26–32 years (33%), 33–40 years (17%), 51–60 years (33%). One participant did not provide their age; EXP: 100%; TR: 33%.	AIQ, [51].	Percentage of correct responses to the knowledge items of pre-service teachers increased as they progressed through the program (first test, 78%; second test, 80%; and third, 83%). Pre-service teacher knowledge total scores were lower than mentor teachers (80% vs. 93%).

[91] Turkey	To investigate knowledge of ASD among teacher candidates who were enrolled in preparation programs.	*n* = 504 (pre-service teachers: 146 ECT; 130 PST; 103 guidance and psychological counseling; 125 SET); G = 323 (64%) female and 181 (36%) males; Age: 22.61; EXP = not specified; TR = not specified.	Adaptation of [81] questionnaire. It included 14 items to evaluate teacher candidates' knowledge about ASD.	Turkish pre-service teachers (including pre-service SET) had no adequate knowledge in the area of ASD. Among the most extended misconceptions about ASD, participants thought that the lack of maternal responsiveness and social issues were the main causes of ASD (10–19%).
[92] USA	To gather information about ASD knowledge and stigma in university students and a community sample.	*n* = 478. University students (*n* = 153): G = 85.6% females and 14.4% males; Age: 21 years; EXP = 120. Community sample (*n* = 325): G = 65.3 females and 33.7 males; Age: 45.58 years; EXP = 260.	ASK-Q [83].	Most participants (95.39%) showed adequate knowledge of ASD and limited stigma towards ASD. Mean scores were higher for participants who reported knowing someone with ASD ($p = 0.006$).

[93] Ireland	To explore teacher knowledge and understanding of Asperger's syndrome.	*n* = 126 (secondary education teachers: ST (51%), vocational teachers (33%), community teachers (14%) and comprehensive teachers (2%)); G = 95 females and 31 males; Age: 20–28 years (23); 29–38 (52); 39–48 (26); 49–58 (18) >58 (5); EXP = 79.4%; TR = 50%.	Adaptation of Knowledge of Asperger's Scale (KASP, [94]). It contained a total of 34 items on a Likert-type scale, with 1 as "strongly disagree" and 10 as "strongly agree".	Teachers' level of knowledge and understanding was low. Participants answered incorrectly on 47.61% of items about general information, 53.98% about interventions and 68.84% of diagnostic questions. A more solid foundation of knowledge is required. Teachers with previous training scored 2.85% better.
[95] USA	To identify college educators' knowledge of ASD.	*n* = 150. First study (n = 18; CE): G = 33,3% female and 66,7% male; Age: 50.17. Second study (*n* = 132; CE): G = 50% females and 50% males; Age: 50.12.	First study. Semi-structured interviews. Second study. A survey consisting of ASD knowledge items (Likert-type, yes/no, and open-ended).	Results revealed that ASD is still an "invisible" disability at faculties. There is also a lack of knowledge among some college educators who need to learn a great deal of information related to working with students with ASD.

* ECT = Early Childhood Teachers; PST = Primary School Teachers; ST = Secondary Teachers; CE: College Educators (Professors and Mentor Teachers); SET: Special Education Teachers; G = Gender; TR = Training in ASD; EXP = Experience with Children with ASD.

To carry out a deeper analysis, Table 3 was included to gather crucial information. We designed an indicative classification of the studies reviewed from the percentage (or score) obtained by the instrument used in each article. Although the natural distribution of percentages ranged from 0 to 100, we decided to establish three ranges according to the results obtained: 30–50%; 50–70%; 70–90%, due to the fact that there was no study included that scored under 30% or above 90%. Two of the studies did not have quantitative data because of the characteristics of the instruments employed to measure knowledge. However, we considered offering qualitative conclusions.

Table 3. General information about studies reviewed depending on level of knowledge *.

Knowledge	Studies	Country	Spezialization	Instrument
Low (30% < 50%)	[66,68,71,75,76,79,84–86]	China, Pakistan, Malaysia, Turkey, Saudi Arabia (2), Jordan, Spain, UK	PST, ECT, HST, special education teachers, CE	Questionnaires
	[64,95]	Tanzania, USA	PST, CE	Interviews
Medium (50% < 70%)	[65,67,73,74,77,78,80,82,91]	South Africa, Pakistan (2), UK (2), China (2), Iceland, Malaysia, Turkey	PST, HST, special education teachers, different professionals	Questionnaires
High (70% < 90%)	[87,89,90,92,93]	Malaysia, USA (3), Ireland	PST,ST,CE,special education teachers, different professionals	Questionnaires

* ECT = Early Childhood Teachers; PST = Primary School Teachers; ST = Secondary Teachers; CE: College Educators (Professors and Mentor Teachers); SET: Special Education Teachers; G = Gender; TR = Training in ASD; EXP = Experience with Children with ASD.

3. Results

Twenty-five articles were identified in this review. The studies were grouped into two tables according to whether or not all the participants involved had experience working as teachers. Table 1 consists of 15 studies in which in-service teachers participated; in Table 2, we found 10 studies whose participants were mixed, studies involving only pre-service teachers, others with both (pre-service and in-service teachers), and even articles involving other educational professionals who do not fit into either of the previous two groups.

Table 3 gathers information from all of the studies reviewed. We divided them depending on percentages scored of participants' knowledge level. There were two studies that measured knowledge through interviews [64,95]. They did not show percentages, but did give qualitative data. Studies reviewed that compared knowledge of ASD before and after intervention training [84,89,90], teachers from different countries [77] or teachers from different specializations [74,75,79,90,92,95] are set out in Table 3. In the case of studies with a pre- and post-test, we wrote down the first test result; in the other two situations, we calculated the average among article results. Eleven studies [64,66,68,71,75,76,79,84–86,95] revealed low levels of knowledge regarding ASD among their participants; nine studies [65,67,73,74,77,78,80,82,91] reported medium knowledge, and five studies [65,87,89,90,92] described a high level of knowledge.

3.1. Teachers' Knowledge of ASD and Moderators That Possibly Influence ASD

Overall, in this review we found a lack of knowledge in most of the articles reviewed coinciding with prior reviews [61,62] and other studies [45]. We found that most of the articles revealed low [64,66,68,71,75,76,79,84–86,95] or medium [65,67,73,74,77,78,80,82,91] levels of knowledge about ASD among their participants, coinciding with prior studies [21,25,36,37]. Indeed, most of the studies showed misconceptions [75,85,91] and gaps, or a lack of knowledge [71,77,85,95]. This is a discouraging obstacle for social inclusion, with

a potential lack of skills and abilities that teachers could have to adapt settings and methodologies [32,33].

3.1.1. Teachers' Knowledge of ASD and Experience

Most of the studies reviewed evaluated knowledge of participants' experience as follows: four studies analyzed the role of experience [76,77,79,92], and four studies kept in mind training and experience [68,78,85,87]. Only three of the studies, which showed low levels of knowledge about ASD among their participants, had taken into account these two variables [68,76,79]. Subsequently, there is not enough assessment of knowledge without considering other variables. Training [5,22–24,29,39–41,47], practical experience [45,47,51,72] and prior contact with students with ASD [45] are crucial.

3.1.2. Teachers' Knowledge of ASD and Specialization

Three studies carried out an intervention training program during the assessment process of knowledge with accurate information [84,89,90]. In all three studies, participants' levels of knowledge improved; teachers involved in those studies increased their knowledge after the test thanks to the training. Two studies [89,90] remained at a high level of knowledge, and one of the studies [84] changed from a low level to a high level. At a quantitative level, scores improved by more than 4% [90] or 7% [89] to more than 13% [84]. Regarding participants' specializations, 8 out of 11 studies that revealed low knowledge results did not involve special education teachers [64,66,68,71,75,76,86,95]. In contrast, all of the studies with higher levels of knowledge did involve pre- or in-service special education specialists such as special education teachers [74,78–80,84,85,87], psychologists, counselors or occupational therapists [89,91].

3.1.3. Teachers' Knowledge of ASD and Stages

Regarding the stage in which participants work, we found that teachers with previous training showed higher levels of knowledge. In eight out of 11 of the studies with lower results, PST and ECT participated [64,66,68,71,76,79,85,86]. Regarding studies with higher levels of knowledge, three out of five involved pre-service teachers [87,90,91]; two studies involved college educators [90,92]; and one out of five included secondary education teachers [65]. The other study [89] showed high levels of knowledge gathered from different specialists (special educator teachers, counselors or psychologists). All studies included in the medium level of knowledge group involved PST teachers. That could be because most of the studies involving PST, ST and CE only appeared in 24% of the studies reviewed (6 out of 25).

3.1.4. Teachers' Knowledge of ASD and Culture

The 25 studies took place in 13 different countries around the world. The USA was where most of the studies were found [89,90,92,95]; Malaysia [71,80,87] and Pakistan [67,68,74] contributed three studies each; China [66,82], Saudi Arabia [76,79], Turkey [75,91] and the UK [73,86] carried out two studies each; and Tanzania [64], South Africa [65] Iceland [78], Jordan [84], Spain [85] and Ireland [93] conducted one study each. Only one study compared teachers' knowledge from different countries (China and the UK, [77]). We found that three out of four studies carried out in the USA reported higher knowledge level (from three of the five studies with a higher level of knowledge in this review). In contrast, the two studies from Saudi Arabia reported a low knowledge level.

3.1.5. Teachers' Knowledge of ASD and Methods and Instruments Used to Measure ASD

Only one out of 25 studies used an interview in order to evaluate teachers' knowledge [64] and only one combined an interview and a questionnaire [95]. Most of the studies used a questionnaire [23]. Among the more frequently used were AKQ [45], AKS [59],

KCAH [60], ASK-Q [83]. AIQ [51], and KASP [94]. Twelve studies created their own questionnaire to evaluate teachers' knowledge [66–68,71,74,75,78–80,84,87,91].

4. Discussion

The aim of this review was to build a consistent framework about teachers' knowledge of ASD, updating and expanding previous literature conclusions.

The conclusions drawn from the studies included in this review on teachers' knowledge of ASD are strongly disappointing. If we want to aspire to build more inclusive schools in which the optimum conditions for the education of all students, including those with ASD, are available, it is a necessity to intensify efforts in teacher training.

Previous literature [5,22–24] and some of the studies reviewed here [54,56,74,76,79,86,87,93,95] contend that it is necessary to provide additional training to improve knowledge of ASD and to overcome misconceptions and lack of information. It is important to consider this pressing need for training not only for pre-service teachers in teacher training colleges [39–41,96], but also lifelong learning for in-service teachers of mainstream schools, universities and other educational placements [25].

We can also draw some positive conclusions from this review. It appears that, if specific efforts are made in teacher training, this has an effective impact on the improvement of teachers' knowledge [84,89,90]. Therefore, we agree with previous literature contending that training increases teachers' levels of knowledge and inclusion [5,21–24]. Only one of the studies that reported low levels of knowledge [84] considered carrying out an intervention program to evaluate and improve knowledge.

To date, some of the studies that have investigated teachers' knowledge levels show that mainstream teachers of pupils with ASD often report lack of specific training, preparation [25], confidence [21,36] and knowledge of the disorder [23,37]. We also found some differences between mainstream pre- or in-service teachers and special education pre- or in-service teachers. We reaffirmed that special education teachers have higher levels of knowledge than mainstream teachers. Therefore, our results coincide with those of [28,45] probably because special education teachers and other specialists (such as social workers, counselors, psychologists, etc.) spend more time with students with ASD or have had specific training at college. For that reason, although we live under a paradigm of inclusion at a legislative level [21,25], we still find practices related to the integration paradigm. We consider that differences in knowledge between mainstream and special education teachers could have repercussions on practices that segregate and exclude mainstream educators from their responsibility to educate children with ASD.

Culture is a potential variable influencing knowledge. However, the only study that compares teachers from at least two countries [77] contends that culture does not affect ASD knowledge. We cannot lose sight of the commitment that all countries must assume for teachers' training. Training in an inclusive education is an investment for the betterment of future generations, as it is the door to a future inclusive society. All countries must act in order to achieve sustainable social development [5]. Training and human resources are expensive, in economic terms, but no educational system should leave behind any group of students, and especially, in the case of ASD, if we consider that the prevalence is increasingly high [4,5].

4.1. Practical Implications

The conclusions of this study result in at least three practical implications for initial training of pre-service teachers and the continuous training of in-service teachers.

The first conclusion drawn from this study is the difference in the level of knowledge about ASD that exists between special education and mainstream teachers. This result can be read in two ways: it is positive, as specialist teachers seem to be truly trained and prepared to address the educational needs of students with ASD; however, from the point of view of educational inclusion, this is clearly a negative result, as mainstream teachers, who spend most of their time with these pupils, are not trained enough.

Students with ASD spend a lot of hours in regular classrooms, attended by mainstream teachers. Therefore, those teachers are privileged agents to strengthen inclusive education principles in the everyday life of the classroom. This goal is hampered by the lack of knowledge of general teachers. It is therefore necessary to continue to train good specialists in special education in initial and in-service teacher training, but it is also imperative to redouble efforts in the training of mainstream teachers, who spend more time with students with ASD and who are evidenced to have a lower level of knowledge about ASD.

The second conclusion is that, among the results of this review, it has also been shown that teachers who report having had educational experiences or contact with people with ASD have a greater knowledge about the diagnosis and could better adapt education to students with ASD. Therefore, we believe that initial and in-service training of teachers on ASD should not be based solely on the study of the explanatory theory of ASD and the corresponding educational intervention, but it is also necessary to add as much practical training as possible. The ideal situation would probably be to ensure that during school traineeships, pre-service teachers would have the opportunity to participate in regular classes attended by children with ASD. If it is not possible, it would be desirable for those responsible for teacher training (for example, professors at university) to include in their lessons, on the one side, real case exercises in which successful inclusive educational practices are carried out; and on the other side, unsuccessful cases, so that teachers in training could identify barriers to inclusion and make suggestions to reduce these barriers to better adapt education for children with ASD.

Finally, the detailed analysis of the results obtained by each of the studies in this review can help to identify the specific areas in which teachers already have a certain level of knowledge, or conceptual gaps and misconceptions. Through this analysis, we consider that it is necessary to establish in the training curriculum for mainstream teachers a solid theoretical basis on what ASD is and, in addition, to develop concrete practical strategies for teachers to be able to: (a) identify ASD symptoms as early as possible in the classroom to carry out an evaluation to rule out a diagnosis of ASD if it is needed; (b) design inclusive educational settings with adaptations to address potential educational needs of children with ASD in the sensory and communicative field and to promote their maximum inclusion in schools; and (c) to propose educational measures to encourage students with ASD to achieve the highest possible level of knowledge and educational success.

4.2. Future Research

On the basis of the conclusions drawn from this review, we can point out some new potential lines of research. First, we believe that it is necessary to continue to deepen the study of teachers' knowledge about ASD, focusing on misconceptions and gaps (not only on teachers' knowledge). It is imperative that teachers leave behind possible misconceptions that may be harming the education of children with ASD, so that classroom day-to-day education practices could be truly inclusive. Therefore, it is a key issue to study to identify what are the more common misconceptions, and to design training programs addressed to reducing or eliminating them.

Second, it is also essential not to study ASD knowledge in isolation, but in relation to other relevant variables such as self-efficacy or attitudes towards inclusion. These variables are correlated [53] and it is necessary to continue researching to better understand their relationship.

Third, future studies assessing teachers' knowledge of ASD should consider using instruments to gather qualitative data. Until now, teachers' knowledge regarding ASD has been mainly measured considering quantitative data almost exclusively. Future studies with the aim of assessing teachers' knowledge should take into account open responses to analyze not only quantitative, but also qualitative data.

We also believe that there is a need of carry out more pre- and post-test studies, in which it could be evaluated to what extent the increase in knowledge about ASD of teachers affects their educational practices on a day-to-day basis.

Finally, it would also be advisable to complete this qualitative review with a meta-analysis, which quantitatively measures the results of the studies.

4.3. Limitations of The Study

The present review has some limitations that should be considered when interpreting the conclusions.

First, the review only includes articles published in scientific journals. No other publications have been included, nor have research groups been surveyed in this area to include unpublished research. For this reason, publication bias may influence conclusions in this review [96].

In addition, the present review has shown the difficulty of comparing the results of different studies analyzing the same topic, due to the use of instruments of different characteristics. Twelve out of 25 studies reviewed used self-instruments developed specifically for the study. Some of these instruments offered two response options (true/false), while other instruments also offered participants the choice among these two answers and "I don't know" as a third option, which makes it possible to differentiate between misconceptions and lack of knowledge. This different approach to the instruments has an obvious impact on the interpretation of the results, which prevents a clear comparison of conclusions in different studies.

Along the same lines, there does not seem to be widespread agreement in the studies about what specific content (theoretical knowledge, identification of ASD, causes, intervention, etc.) should be included in the teachers' knowledge assessment instruments, which creates further difficulties for the joint assessment of the results obtained from the studies analyzed.

Finally, as previously stated, the studies included in this review assess teachers' knowledge of ASD from an almost exclusively quantitative approach that has not been supplemented or enriched with a qualitative analysis based on methods such as interviews or discussion, or through an observational analysis that gives a degree of practical skills that promote teachers in the classroom.

5. Conclusions

Teachers' knowledge of ASD is generally poor. It seems that the level of knowledge depends on the stage teachers work in, prior experience and possible prior contact with students with ASD [45]. Studies involving pre-service teachers and specialists (such as special education teachers or counselors) achieved higher levels of knowledge than those studies involving only mainstream teachers. We can conclude that there is a need for training in pre-service and in-service teachers at every single education stage in order to achieve inclusive education and sustainability objectives.

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