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A SYSTEMATIC META-ANALYSIS OF NON-OVERLAPPING DATA ON TECHNOLOGY-ASSISTED INTERVENTIONS FOR INDIVIDUALS WITH SPECIFIC LEARNING DISABILITIES

Ersin Ateş[1i],
Barbaros Görkem Şinikoğlu[2]
[1]Istanbul Aydın University,
Turkey
[2]Ministry of National Education,
Turkey

Abstract:
Scientific evidence-based practices and technology-based interventions in special education have become increasingly preferred among experts, researchers, and teachers due to their effectiveness, ease of implementation, ease of measurement, and benefits in achieving outcomes. During the COVID-19 pandemic, the use of online or program-based interventions, including computers, smartphones, and tablets, has increased. The integration of technology-based programs and applications with special education practices has become a critical issue. This study evaluates scientific research that employs single-subject research designs to investigate technology-based interventions for students with learning disabilities. The effectiveness of these interventions is assessed through a systematic review of electronic indexes, inclusion criteria, effect size calculations, and analyses based on WWC (What Works Clearinghouse) and qualitative indicators (Kratochwill, 2013). The effectiveness of the interventions is described using non-overlapping data analysis methods such as Improvement Line Overlap Factors (ILOF) and Improvement Rate Difference (IRD) (Rakap, 2020). The study aims to: (1) Identify the research designs used in studies that explore the use of technology in learning disabilities, (2) Determine the interventions implemented in these studies and the technological functions they are based on, (3) Examine how the technologies employed affect the performance of students with learning disabilities, and (4) Calculate the effect sizes of technology-based interventions using ILOF and IRD to determine their effectiveness. In this context, a systematic review of the literature was conducted in detail. The literature review revealed that most of the studies were published between 2010 and 2020. Additionally, it was found that the majority of the studies utilized single-subject research methods, particularly multiple-baseline designs. The participants were typically students in formal education settings, particularly those receiving instruction in inclusive classrooms. For the descriptive analysis of the reviewed studies, **DigitizeIt** software

[i]Correspondence: email hezarfenegt@gmail.com

(digitizeit.xyz) was used for graphical analysis, while the **ILOF and IRD effect size calculation program** available at http://www.singlecaseresearch.org/calculators/ird (Vannest *et al.*, 2011) was employed for effect size calculations.

Keywords: specific learning disability, technology-based interventions for specific learning disabilities, assistive technology, computer-based applications in specific learning disabilities, effect size, descriptive analysis

1. Introduction

The field of special education encompasses various subfields, among which Specific Learning Disability (SLD) emerges as a distinct type of disability due to its specificity in terms of prevalence and subtypes. According to the definition provided by the American Psychiatric Association (APA, 2020), SLD refers to a deficiency in one or more conditions with a neurological basis, characterized by significant deficits in particular scholastic or academic skills, especially those related to written or expressive language acquisition.

The causes of learning disabilities have been attributed to perceptual deficits, brain damage, or minimal brain dysfunction. However, no conclusive evidence has been reported to support the notion that physiological impairments such as visual impairment or hearing loss, as well as intellectual disabilities, mood disorders, environmental, cultural, or economic factors, directly contribute to the symptoms of learning disabilities. In terms of diagnostic criteria, learning disabilities are identified when an individual's actual performance on an achievement test is significantly lower (typically by two standard deviations) than expected based on their intelligence level, age, and formal education grade.

Similarly, the Turkish Ministry of National Education (MEB) defines individuals with learning disabilities as those who require assistance to overcome difficulties in reading, writing, and mathematics (MEB, 2010). Learning disabilities are classified into three subcategories: dyslexia, dyscalculia, and dysgraphia (APA, 2013). The Ministry of National Education emphasizes challenges in reading, writing, and mathematics in its definition of learning disabilities and has developed support education programs within the framework of its special education services, focusing on preparatory learning, writing instruction, and mathematics education (MEB, 2010).

As a result of significant technological advancements in the 2000s, the use of technology and technological tools has become widespread across various fields. Education and technology are two fundamental aspects that play a crucial role in human life. Both dynamics serve as essential foundations for facilitating human life, enabling communication with the surrounding environment, and establishing dominance over one's surroundings (Alkan, M., Tekedere, H., & Genç, 2003).

Education is the process of revealing the innate potential of individuals and transforming these potentials into abilities, ultimately contributing to the development of strong, mature, creative, and constructive individuals. Technology, on the other hand,

acts as an assistant by enabling the efficient, systematic, and effective use of the knowledge and skills acquired through education (Erişen&Çeliköz, 2007).

Due to this close relationship between technology and education, accessible information sources, teaching and learning methods, instructional strategies and techniques, as well as curriculum content, are now being planned and archived through technology-supported modeling rather than traditional written documentation. Moreover, access to supplementary e-resources has significantly increased (Ersoy, 1997).

One of the fundamental challenges in today's education system is the presence of individuals with learning difficulties and deficiencies across various domains. While technology-based and technology-supported educational methods have contributed to progress in areas where individuals experience learning difficulties, the technologies employed for specific learning disabilities—such as dyslexia, dyscalculia, and dysgraphia—vary accordingly (Adam & Tatnall, 2002).

With the advancement of technology, assistive technologies that facilitate the learning process of individuals diagnosed with reading difficulties (dyslexia), which is a subdimension of Specific Learning Disabilities (SLD), have become increasingly common. These assistive tools vary in their structures and the tasks they support. Examples of such assistive technologies include reading pens, audiobooks, portable readers, text-to-speech tools, and spelling programs (Adam & Tatnall, 2008).

Furthermore, there are many applications available for individuals with dyslexia on platforms such as Google Play and the Apple Store, which serve as software resources for devices running on IOS and Android operating systems. Programs like I See Sam (Academic Success For All Learner, 2014), Sight Word Snapper (Fagbokforlaget, 2011), Read Quick, Alphabetics (Action Now, 2012), Re-Word It Lite (Brodskaya, 2012), Booksy (Tipitap Inc, 2013), and G'Night Safari (Polk Street Press, 2012) have been reported by researchers to contribute to the improvement of skills such as reading fluency, reading comprehension, and analysis through features like phonological awareness, word frequency lists, word-per-minute races, phonemic awareness, and interactive visual and audio recordings.

For individuals with writing difficulties (dysgraphia), another subdimension of Specific Learning Disabilities, there are also several assistive technologies available. Computer-based writing programs are among the most frequently used assistive technologies for individuals with writing difficulties. Programs that provide real-time word and grammar checks during the writing process are particularly effective (e.g., Microsoft Word, Apple Pages). Additionally, assistive 'word processors' that can be used for correct letter usage, spelling, and word writing during the writing process are portable and highly beneficial technologies. Another technology that assists with writing difficulties is speech-to-text programs and tools that convert voice commands into written form. The use of smart pens is also considered a very useful assistive technology, as they allow individuals with writing difficulties to record and transcribe notes in environments where taking notes is challenging, such as during lectures, conferences, or presentations (Brodin & Lindstrand, 2003).

In terms of arithmetic difficulties (dyscalculia), a wide range of technology-based assistive tools have also been developed. One of the most well-known tools for arithmetic difficulties is the abacus (counting tool), which dates back approximately 3,000 years. The operations performed using the abacus are now represented by modern calculators with advanced computational capacities. With the help of calculators, individuals with arithmetic difficulties can easily perform operations, verification, and control. Additionally, computer-based programs specifically designed for individuals with arithmetic difficulties are available, such as Electronic Mathematics Work Sheets, which have gained attention in recent years for their functionality (Brodin & Lindstrand, 2003). These program-based applications also provide speech-to-text support, considering the needs of individuals with comorbid diagnoses. Electronic math worksheets can be read by writing programs, and the user can dictate equations or arithmetic expressions to be entered into the program via microphone support (Adam & Tatnall, 2008).

Research has shown that technology-based interventions and studies offer subjects more opportunities for practice (Butterworth &Laurillard, 2010; Zhang, 2000), provide more optimal instant and rapid feedback (Muhammed & Kanpolat, 2010), and support subjects in self-monitoring their learning processes. The effectiveness of these interventions, along with single-subject and quasi-experimental modeling, is crucial for understanding how individuals' performance in reading, writing, and arithmetic can improve, which will be addressed in future research. Therefore, the meta-analysis conducted aims to answer the following research questions:

1) What are the demographic, descriptive, and methodological characteristics of technology-based interventions applied to individuals with Specific Learning Disabilities?
2) What skills are covered by technology-based interventions applied to individuals with Specific Learning Disabilities?
3) Do the effects of technology-based interventions for individuals with Specific Learning Disabilities meet scientific criteria for evidence-based practices?

2. Method

The purpose of this meta-analysis is to: (1) identify the methodological characteristics and research designs of studies that utilize technology in addressing learning disabilities, (2) determine the interventions applied in the articles included in the review and identify the technological functions upon which these interventions are based, (3) examine how the technology-based interventions affect the performance of students with learning disabilities, and (4) calculate the effect sizes using the ILOF (Improvement in Learning Outcomes for Students with Disabilities), IRD (Improvement Rate Difference), and the effect size formula proposed by Parker, R. I., Vannest, K. J., & Brown, L. (2009) to assess the effectiveness of these interventions. This research covers peer-reviewed articles published between 2009 and 2021 that include technology-based intervention programs

for individuals diagnosed with Specific Learning Disabilities. The meta-analysis consists of three phases: (a) literature review, (b) article selection, and (c) analysis.

2.1 Inclusion Criteria for the Studies Reviewed

In this meta-analysis, the following key criteria were established to determine whether the studies should be included in the descriptive analysis:

2.1.1 Inclusion Criteria

a) Studies published after the inclusion of the ILOF, IRD (Parker, R. I., Vannest, K. J., & Brown, L., 2008) effect size calculation method in the literature.
b) Studies involving participants of formal education age.
c) Studies with participants diagnosed with Specific Learning Disabilities (SLD).
d) Studies where a technology-based intervention program was applied to address deficiencies in reading, writing, and arithmetic.
e) Studies using a single-subject research design.
f) Studies published in national or international peer-reviewed journals.
g) Studies that describe the findings of technology-based interventions applied to individuals with Specific Learning Disabilities separately.

2.1.2 Exclusion Criteria

a) Studies published before the inclusion of the ILOF, IRD (Parker, R. I., Vannest, K. J., & Brown, L., 2008) effect size calculation method in the literature.
b) Studies written as reviews, analyses, or reports.
c) Studies that involve technology-based intervention programs for individuals with Specific Learning Disabilities, but focus on parameters such as functionality, preferences, relationships, and attitudes from the perspective of participants or practitioners rather than learning outcomes.
d) Studies that do not describe the findings of technology-based interventions for individuals with Specific Learning Disabilities separately.

3. Literature Review

In the process of selecting the articles for this meta-analysis, the following search engines were used: ULAKBİM, Education Resources Information Center (ERIC), Web of Science, Wiley Online Library, SAGE Journals, SpringerLink, Taylor & Francis Online, Google Scholar, and Oxford Academic. A comprehensive literature review was conducted by entering keywords in both Turkish and English into these search engines. The retrieved articles were included in the meta-analysis after being checked against the inclusion criteria and indexed journal profile pages from Web of Science.

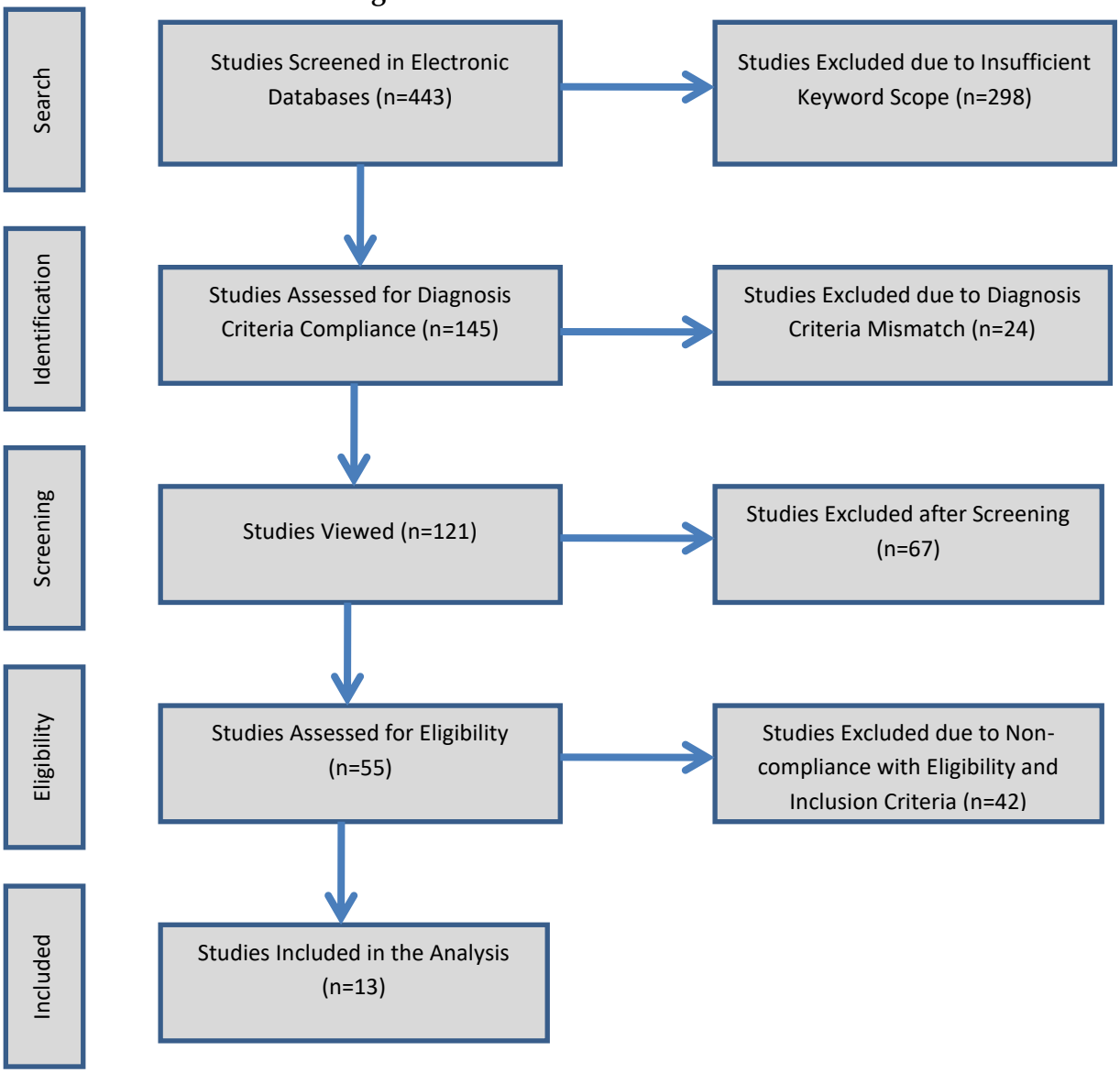
The key terms used in the literature review were "Learning Disabilities," "Specific Learning Disabilities," "Learning Difficulties," "Assistive Technology Intervention," and "Computer-Assisted Intervention." Terms like dyslexia, dyscalculia, and dysgraphia

were excluded from the keyword search chain because individuals diagnosed under these subcategories may not be classified as such in both Turkey and abroad. In the literature, subcategories of specific learning disabilities are generally referred to as deficiencies in reading, writing, and arithmetic, and thus, the inclusion criteria were determined based on this categorization.

The search using the defined keywords resulted in 443 studies. The titles, abstracts, and keywords of the retrieved articles were examined, and studies such as books, reports, reviews, descriptive articles, and meta-analyses were excluded. A detailed review of articles published between 2009 and 2021 in key journals—such as Journal of Computer-Assisted Learning, Journal of Special Education, Journal of Special Education Technology, Behavior Modification, Remedial and Special Education, Learning Disabilities Research & Practice, Learning Disabilities Quarterly, and Disability and Rehabilitation: Assistive Technology—was conducted.

The screening process was carried out by the first and second authors, who reviewed the articles for consistency with the inclusion criteria and achieved consensus before including them in the study. The final list of articles included in the meta-analysis is marked with an asterisk (*) in the reference section. The literature review process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines proposed by Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009), and the ideal flowchart is shown in Figure 1.

Figure 1: Literature Review Flowchart



Note: Adapted from Garrote *et al.* / Educational Research Review 20 (2017) 12-23, p.15.

3.2 Coding of Included Articles

The process of including articles in the analysis was carried out based on predetermined inclusion criteria. An inclusion and eligibility form, along with a research review form, was prepared considering the specified inclusion criteria. All selected articles were carefully reviewed by the authors and recorded in the prepared form.

3.3 Descriptive Analysis Phase

The articles included in the meta-analysis study were examined based on the research review form, considering the following aspects: (a) number of participants, (b) chronological age, (c) gender, (d) diagnostic criteria, (e) type of problem, (f) target behavior or skill, (h) research design, (i) intervention applied, (j) implementation setting, (k) generalization and maintenance sessions, (l) reliability, and (m) social validity data. The information obtained from the reviewed studies is presented in Tables 2, 3, 4, and 5.

3.4 Meta-Analysis Phase

The Improvement Rate Difference (IRD), developed by Parker *et al.* (2009), is an index used to calculate effect size in single-case quasi-experimental studies. IRD calculates the effect factor by determining the difference between the progression rates of baseline and intervention session data. The progression rate at a given level is defined as the ratio of the number of data points showing progress to the total number of data points at that level. Although the use of IRD for analyzing single-case studies is relatively recent (Schneider, Goldstein, & Parker, 2008), it follows the same calculation principles as "risk difference," which has long been used to analyze the effects of medical treatments (Armitage, Berry, & Matthews, 2002; Altman, 1999; Sackett, Richardson, Rosenberg, & Haynes, 1997). Risk difference is defined as a summary measure of treatment effectiveness and will be employed in the meta-analysis conducted in this study (Cochrane Collaboration, 2006; http://www.cochrane.org/).

3.5 Inter-Coder Reliability

The first author and the second author, a doctoral student, jointly reviewed the subheadings. Data obtained from 31% (n = 4) of the selected articles were compared, and inter-coder agreement was calculated using the formula: "agreement / (agreement + disagreement) × 100" (Kazdin, 1982). The inter-coder reliability was determined to be 94%, indicating a "highly reliable" outcome.

3. Findings

3.1 Descriptive Characteristics of Included Articles

Table 2: Demographic Characteristics

Studies	Number of Participants / Gender	Chronological Age Level
Hunt, Vaquez (2014)	2 K+1 E	12-13
Mize, Park (2020)	2 K+1 E	9,11-10,6
Straub, Vasquez (2015)	1 K+ 3 E	13-16
Fitzgerald vd.(2012)	2 K+3 E	10,2-13,3
Ciullo vd. (2015)	4 E	10-11
Shin, Bryant (2017)	1 K+2E	13-15
Satsangi vd. (2020)	2K+1E	16
Ledo, Barbetta, Unzuetta (2015)	4E	9-10
Young vd. (2018)	1K+3E	14-15
Chai, Ayres, Vail (2016)	3E	6,6-7,2
Satsangi, Hammer, Bouck (2019)	2K+1E	14-17
Bouck, Park, Stenzel (2020)	1K+2E	12-13
Altun, Kahveci (2019)	1K+2E	11

Upon examining Table 2, the total number of participants is n = 45, with n = 15 female participants and n = 30 male participants.

Table 3/1: Parametric Indicators of the Studies

Study	**Young *et al.*, (2018)**	**Chai, Ayres, Vail (2016)**	**Satsangi, Hammer, Bouck (2019)**	**Bouck, Park, Stenzel (2020)**	**Altun, Kahveci (2019)**
Diagnosis	SLD Dyslexia	SLD Dyslexia	SLD Dyslexia	SLD Dyslexia	SLDDyslexia
Assistive Technology	Computer/ Program-Assisted İntervention	iPad/ Application Supported Intervention	Becoming a Model with Video	Computer/Program-assisted Intervention	Computer/VR-Supported Intervention
Research Design	A-B-A-B	A multiple probe design across behaviours	Multiple probe design between subjects	Multiple probe design between subjects	Multiple probe design between subjects
Target Behavior /Skill	Oral reading fluency skills	Teaching target vocabulary for receptive and expressive language skills	Algebraic topics in the curriculum	Division skill	Ability to solve geometry problems involving cubes, squares and rectangular prisms
Implementation Setting	Computer Lab	İndividual Education Class	School Conference Hall	Special Education Class	Special Education Class
Generalization and Maintenance	+/+	+/+	+/+	+/+	+/-
Inter - Observer Reliability	100%	99.2%	100%	100%	98%
Social Validity	Survey (student)	Survey (teacher)	Open-ended question (student)	One-on-one meeting (student)	-
Findings	An increase in performance in curriculum-based reading skills was observed when Kurzweil 3000 was used to support learning.	An improvement in learning performance was observed for words created using the iPad and Touch Screen Programme and included in the target word pool.	Video model Training was found to increase performance in the acquisition of geometry topics with word content.	There has been an observed increase in the performance of computer/program partitioning.	Using computer/VR virtual glasses and the Leap Motion programme, an increase in geometric problem-solving skills was observed in the subjects.

Table 3/2: Parametric Indicators of the Studies

Study	**Hunt, Vasquez (2014)**	**Mize, Park (2020)**	**Straub, Vasquez (2015)**	**Fitzgerald *et al.* (2012)**	**Ciullo *et al.* (2015)**
Diagnosis	**SLD Dyscalculia**	**SLD Dyslexia**	**SLD Dysgraphia**	**SLD Dyslexia**	**SLD Dyslexia**
Assistive Technology	Computer/Internet-Based Intervention	iPad-Based Intervention	Computer/Internet /Program Based Intervention	Computer/Internet-Based Intervention	Computer/Internet-assisted İntervention
Research Design	Multiple baseline between-subjects design	Multiple baseline between-subjects design	Multiple probe design between subjects	Multiple probe design between subjects	Multiple baseline between-subjects design
Target Behavior /Skill	Proportional reasoning is the ability to develop strategies based on the concept of ratios and proportions.	Oral reading fluency skills	The ability to transfer from text to expression, and from text to writing.	The ability to develop word recognition strategies.	Improve your reading comprehension with the Mind Map method.
Implementation Setting	University Practice Clinic	General Education Class	University Practice Clinic/Online access	General Education Class/Online Access	Individual Education Class (Resource Room)
Generalization and Maintenance	+	+	+	+	+/+
Inter - Observer Reliability	91%	98.7%	100%	97%	90%
Social Validity	Student Survey (Online)	Student Survey	Student Survey	Student Survey	Open-Ended Question (student): Survey (Teacher)
Findings	The computer/Internet-supported intervention was found to increase proportional reasoning performance.	The iPad-supported intervention was found to increase fluent reading performance.	An improvement in writing skills was observed as a result of the synchronous, computer-aided programme intervention.	The online word recognition strategy development intervention resulted in an increase in word use and recognition performance.	Following the computer- and programme-supported intervention, an improvement in mind mapping and reading comprehension performance was observed.

Table 3/3: Parametric Indicators of the Studies

Study	**Shin, Bryant (2017)**	**Satsangi *et al.* (2020)**	**Ledo, Barbetta, Unzuetta (2015)**
Diagnosis	SLD Dyslexia	SLD Dyslexia	SLD Dyslexia
Assistive Technology	Computer/Interactive Programme-supported Intervention	Becoming a Model with Video	Computer/Program-assisted İntervention
Research Design	Multiple Baseline Between-subjects Design	Multiple Probe Design Between Subjects	Multiple Baseline Between-subjects Design
Target Behavior /Skill	Mathematical Problem-solving Skills and Written Problems Involving Numerical skills.	Algebraic Topics in the Curriculum	Content and Word Selection in Structured text Writing and Self-organisation Skills
Implementation Setting	General Education Class	School Conference Hall (configured for one-to-one teaching)	General Education Class
Generalization and Maintenance	+/+	+/+	+/+
Inter - Observer Reliability	100%	100%	100%
Social Validity	Survey (Student/Teacher)	Open-ended Question (student)	
Findings	As a result of the computer- and programme-supported intervention, an increase in performance was observed in both digitising and solving written mathematical problems.	The 12-Stage Video Model Training was found to increase performance in the acquisition of algebra topics related to the curriculum.	Following the computer/program-assisted intervention, improvements were observed in structured text writing, word selection and self-organisation.

3.2 Meta-analysis Findings

In this meta-analysis study, ILOF (IRD) (progression rate difference) was calculated for each subject included in the 13 examined studies, as a result of screening. The calculation included the average effect factors of multiple baselines, multiple probes and multiple behaviours, as well as A-B-A-B designs.

Table 5: X̄ILOF (IRD) effect sizes

Research	X̄ İLOF (IRD)	%	Impact Factor Size
Hunt, Vaquez (2014)	1	100%	Very Effective
Mize, Park (2020)	.87	87%	Very Effective
Straub, Vasquez (2015)	.65	65%	Medium Effective
Fitzgerald vd.(2012)	.84	84%	Very Effective
Ciullo vd. (2015)	.89	89%	Very Effective
Shin, Bryant (2017)	.76	76%	Very Effective
Satsangi vd. (2020)	1	100%	Very Effective
Ledo, Barbetta, Unzuetta (2015)	.58	58%	Medium Effective
Young vd. (2018)	.86	86%	Very Effective
Chai, Ayres, Vail (2016)	.84	84%	Very Effective
Satsangi,Hammer,Bouck (2019)	1	100%	Very Effective
Bouck, Park, Stenzel (2020)	1	100%	Very Effective
Altun, Kahveci (2019)	1	100%	Very Effective
All research into ILOF (IRD).	**.87**	**87%**	**Very Effective**

4. Discussion, Conclusion and Recommendations

The research will be discussed from four perspectives: (1) demographic characteristics; (2) descriptive analysis results with parametric indicators of the examined studies; (3) meta-analysis findings; and (4) research questions, which were determined as (5) qualitative indicators. Examining the research in terms of demographic characteristics revealed that a total of 45 subjects diagnosed with learning disabilities participated in the analysed studies. Of these subjects, 33% (15 subjects) were female and 67% (30 subjects) were male. The average age of the participants was 12.3 years, and all of the studies except those conducted by Mize and Park (2020) and Chai, Ayres and Vail (2016) were close to this average. The interventions were aimed at ages when symptoms of specific learning disabilities were experienced most intensely. In terms of the number of participants, it was seen that at least three and at most five subjects participated in the studies. According to Horner *et al.* (2005), if experimental control is established through repetition within the participant, the experimental effect should be observed in the same participant at three different times, and a similar experimental effect of the independent variable should be observed in three different participants (Tekin-İftar, 2012). Examining the demographic parameters of the studies reveals that the number of subjects included in the researchers' meta-analysis study ranged from three to five. All of the study participants (n = 45) were diagnosed with a specific learning disability. Five of the studies included in the review examined sub-dimensions of specific learning disability: 'dyslexia' (reading disability);

one study examined 'dysgraphia' (writing disability); and eight studies examined 'dyscalculia' (mathematical disability). In terms of assistive technology use, eight studies used computer and programme support, two studies used iPad support, two studies used video and recording support, and one study used VR technology. Of the single-subject research designs in the reviewed studies, one used an A-B-A-B design, one used a multiple probe design across behaviours and eleven used a multiple probe design across subjects. In terms of target skills and behaviours, the majority of technology-based interventions focus on mathematics, arithmetic and algebra acquisition. These interventions include proportional reasoning, quantifying written mathematics problems, solving algebra questions related to the curriculum, division skills, and solving questions containing geometric shapes. The examined studies determined the following target skills and behaviours: reading comprehension with mind maps, word selection within structured text, oral reading fluency, target word usage skills in receptive and expressive language, and transfer skills from text to expression and from text to writing. The interventions and applications were generally carried out in general classes, university clinics, and special education classes. There were also applications carried out at home with online synchronous communication. Twelve studies met the criteria in terms of generalisation and monitoring sessions. Altun and Kahveci (2019) conducted a generalisation session with a second researcher but did not conduct monitoring sessions or social validity applications (questionnaires or interviews). All other studies included the social validity dimension using various methods. Student-teacher interviews, open-ended questions, and parent interviews were generally employed, with the Likert-type response content questionnaire being the most frequently used method.

In single-subject research, the baseline phase requires repetition until stable data are obtained. Although no specific number of sessions is specified, it is recommended that data be collected for at least five sessions (What Works Clearinghouse, 2014). Once the implementation phase has been completed, stable baseline data has been obtained. This is the phase in which independent variables are applied. During this phase, the independent variable must be defined in a functional and repeatable manner. There is no defined implementation period for this phase, but it continues until the criterion is met in the dependent variable and stable data is obtained. The establishment of criteria to determine whether a study is scientifically based has been a topic of discussion among various professional organisations and researchers in special education literature for the last 20 years. While a full consensus has not yet been reached on the concept of scientifically based practices, various publications and reports on the subject exist. For example, organisations such as the What Works Clearinghouse, the American Psychological Association and the Council for Exceptional Children have suggested the following updates: 'Every scientific study must have an effect size calculation' (APA, 2010; Campbell, 2003; Kratochwill *et al.*, 2013). They have thus established their criteria. These criteria demonstrate that research into qualitative indicators and single-subject research in special education constitutes 'scientifically based applications'.

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ILOF (Improvement Rate Difference) is an index created by Parker *et al.* in 2009 to calculate the effect size in single-subject quasi-experimental studies. ILOF calculates the impact factor by determining the difference in progress rates between baseline and application levels in session data. The progress rate at a given level is defined as the ratio of the number of data points indicating progress at that level to the total number of data points. A data point showing progress at the baseline level is one that is equal to or higher than at least one data point at the application level. A data point showing progress at the application level is defined as a data point that is higher than at least one other data point in the graph from the baseline phase. When calculating ILOF (IRD):

a) Overlapping data from the baseline and application phases is found.
b) The data point that should be excluded from the calculation is identified to eliminate overlap between the baseline and application levels.
c) Depending on which level the data is removed from, the calculation is then made.

The effect size calculated using ILOF is expressed as a percentage between 0% and 100%. Values below 50% are considered ineffective or questionable; values between 50% and 69% are considered to represent a medium-level effect; values between 70% and 74% represent effective interventions; and values of 75% and above represent very effective interventions (Parker *et al.*, 2009; Rakap, 2015; Vannest &Ninci, 2015). The strengths of ILOF can be summarised as follows: it can be easily calculated manually; a web-based calculator has been developed for large data sets (http://www.singlecaseresearch.org/calculators/ird); and it can be used in complex, multi-level, single-subject experimental designs. However, it does not take into account the therapeutic tendency in the initiation phase (Rakap *et al.*, 2020). Examining Table 5 reveals that 15% of the 13 studies (n = 2) for which the progression rate effect difference

was calculated had a 'medium-level effect', while 85% (n = 11) had a 'very effective' effect factor. The average of the examined studies was found to be $\bar{X} = 0.87$ and the standard deviation S = 0.14. The homogeneity of the distribution, as well as the fact that S = 0.14, indicates that the average effect factor (X)ILOF (IRD) = 0.87, and demonstrates the consistency of the quantitative indicators.

Given that the oldest study meeting this study's inclusion criteria examining technology-supported interventions for specific learning disabilities was published in 2012, it can be concluded that technological developments, particularly in the realm of computers and tablets, serve as valuable aids for individuals with specific learning disabilities, making life easier for them. According to the results of the effect size calculation, technology-supported applications are seen to be 'very effective'. However, the fact that only one effect size calculation method was used in the index, search engines and scanned journals can be considered a limitation of this study. Further studies are recommended that use different effect size calculation methods, as well as meta-analyses of studies examining various interventions and applications for specific learning disabilities and their sub-dimensions. Another limitation of this study is that technology-supported applications created using single-subject research methods for specific learning disabilities are scarce in our country. Furthermore, it can be concluded that the number of studies on specific learning disabilities using these models should increase in our country.

Conflict of Interest Statement

The authors declare no conflicts of interest.

About the Authors

Assistant Professor Ersin Ateş is a faculty member in the Department of Special Education at Istanbul Aydın University. He conducts studies on special education, language and speech difficulties, and learning difficulties.

Barbaros Görkem Şinikoğlu works as a psychological counseling and guidance instructor at the Ministry of National Education. He conducts studies in the fields of verbal behavior, learning disabilities, and autism spectrum disorders.

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