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A Systematic Review of Mathematics Interventions for Primary School Students without Identified Disability

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Abstract
This systematic review investigated the characteristics and impact of effective mathematics intervention for low-attaining students (7-11 years) with no identified disability. A systematic search of two databases yielded 3,993 publications. A total of 10 randomised controlled trial studies from the UK and the US met the inclusion criteria with 80% of the studies demonstrating a positive effect on students' mathematics learning outcomes. These studies focused on improving three mathematics skills: number sense skill, fluency in calculation skill and problem-solving skills. Across the review studies, nine components were identified as essential features of an effective mathematics interventions design. Implications for practice and research are discussed.

Keywords: Systematic Review, Mathematics Intervention, Primary School, Low Attainment

1. Introduction

Mathematics is integral to our daily activities. Proficiency in mathematics provides an opportunity for academic success, and future job prospects (Ofsted, 2021; Department for Education [DfE], 2013). However, despite its importance, report shows that a large proportion of adults (i.e., 1 in 3 adults) have low numeracy skills. This implies that most adults are unable to access, use, interpret and communicate mathematical information and ideas (Economic Co-operation and Development [OECD], 2013; Kuczera et al., 2016). While many adults are identified as having low numeracy skills, this can be traced back to their early years of education (Dowker, 2009; Mazzocco, 2007). Mathematics proficiency at a younger stage is the foundation for future mathematics achievement. Consequently, this has placed a high demand on the increase in numeracy skills among school-age students. For instance, in the United Kingdom (UK), mathematics is a compulsory subject for all students who sit for the Standard Attainment Test (SAT) and General Certificate of Secondary Education (GCSE) (Velthuis et al., 2018). Furthermore, students who do not meet the expected level of attainment are required to re-sit the examination till they pass or are released from this obligation when they turn eighteen years old (Bellamy, 2017). Similarly, in the United States (US), almost all students are required to pass mathematics to graduate from high school (Education Commission of the States (2019) cited in Powell et al., 2021). This makes it necessary to promote mathematics proficiency among all learners, especially students who are at-risk of achieving in mathematics (Ketterlin-Geller & Chard, 2011). Research suggests mathematics intervention as remediation to address the mathematical needs of struggling students (Dunne et al., 2011; Dowker, 2009); however, not all interventions have proven to be effective (DfE, 2018). In this situation, what then makes an effective intervention? The focus of this study is to critically assess mathematics intervention studies to identify 'what works best'. The study will provide evidence to inform educators on planning and implementing an effective mathematics intervention.

1.1. Purpose and Research Questions

Several research syntheses on mathematics intervention have been identified in the literature. Nonetheless, It has been identified that only a limited number of review studies have focused exclusively on mathematics intervention for primary school children without identified disabilities. Many of these syntheses focus on students with identified mathematics difficulties/ learning disabilities (e.g., Schnepel, & Aunio, 2022; Powell et al., 2021; Marita & Hord, 2017; Dennis et al., 2016); all elementary school children (e.g. Simms et al., 2019); specific mathematics topic at different levels of education (Hwang & Riccomini, 2016; Jitendra et al., 2018; Codding et al., 2011; Ennis & Losinski, 2019; Gersten et al., 2009; Hughes et al., 2014; Stevens et al., 2018). To bridge the gap in literature, this systematic review is undertaken to examine the characteristics and impact of effective mathematics interventions for at-risk primary school students (ages 7-11) without identified or diagnosed disabilities.

In this study, *intervention* is described as only school-based instructions or activities that aim to improve underperforming students' attainment in mathematics. The term *characteristic* refers to the features of a mathematical intervention design. Characteristic of interest in this study is the different structures of intervention design; in terms of the resources used, criteria for participants' selection, intervention period, mode of delivery and outcome measures. Specific research questions included the following:

i. What impact does mathematics intervention have on students who are underperforming but have no identified disability?
ii. What characteristics define an effective mathematics intervention for underperforming students?

2. Method

2.1. Literature Search Procedure

This paper reviewed studies published from 2005 to 2020 (i.e., 15 years) that focused on mathematics intervention for underachieving primary school children with no identified disability. *First*, a preliminary search was done iteratively in various databases like Google Scholar, Education Research Complete, Education Resources Information Center (ERIC), Web of Science, EBSCO, Scopus and PsycINFO to identify the key sources and appropriate terms to locate relevant studies (Boland et al., 2017). After, a comprehensive search was done in two electronic databases (i.e., ERIC and PsycINFO via EBSCO interface) using multiple search terms combined by *Boolean operators* (e.g. AND, OR and BUT) to increase the flexibility of the search syntax; *wildcard* (e.g. asterisk sign (*)) to capture words with different characters (e.g. Attain*: attain, attaining, attainment, attainer) and *quotation marks* to identify exact phrases (e.g. 'control group'). The following search syntax was used in each database:

((primary OR elementary OR Year-3 OR Year-4 OR Year-5 OR Year-6 OR second grad third grad* OR fourth grad* OR fifth grad*) AND (school* OR educat* OR class* OR teach* OR instruct* OR train* OR program*) AND (math* OR numeral OR number sense OR arithmetic* OR algebra OR geometry OR addition OR subtraction OR multiplication) AND (Achieve* OR attain* OR perform) AND (quasi OR experiment* OR random* OR trial OR "control group" OR "posttest ") NOT ('special education need*' OR disabilit*))*

In addition to this, the search was limited to only peer-reviewed articles published in the English language from January 1 2005 to May 27 2020. Also, database filters were used to narrow down the search to retrieve relevant studies that can answer the review questions. For instance, in the ERIC database, subjects like science instruction, reading skills, reading achievements, and many others were excluded from the search. This was because the present study focused on only mathematics intervention studies, and therefore, any unrelated subjects that were likely to retrieve extraneous information was excluded. Again, this review focused on only primary school students and as such, education levels like kindergarten, middle school or higher education were expelled from the search. Similarly, in the

PsycINFO database, search filters like population, age group, subject, publisher, publication status, and methodology were applied to narrow the search results. For example, out of the ten publishers found in the PsycINFO database (i.e., ProQuest Information & Learning, Elsevier Science, Taylor & Francis, Sage Publications, Wiley-Blackwell Publishing Ltd., American Psychological Association, Springer, Blackwell Publishing, Heldref publications and Warwick & York), this was narrowed to only three publishers (i.e., Taylor & Francis, Sage publication and American Psychological Association). These publishers were selected based on the preliminary search which informed the author about the publications to retrieve relevant studies for the review.

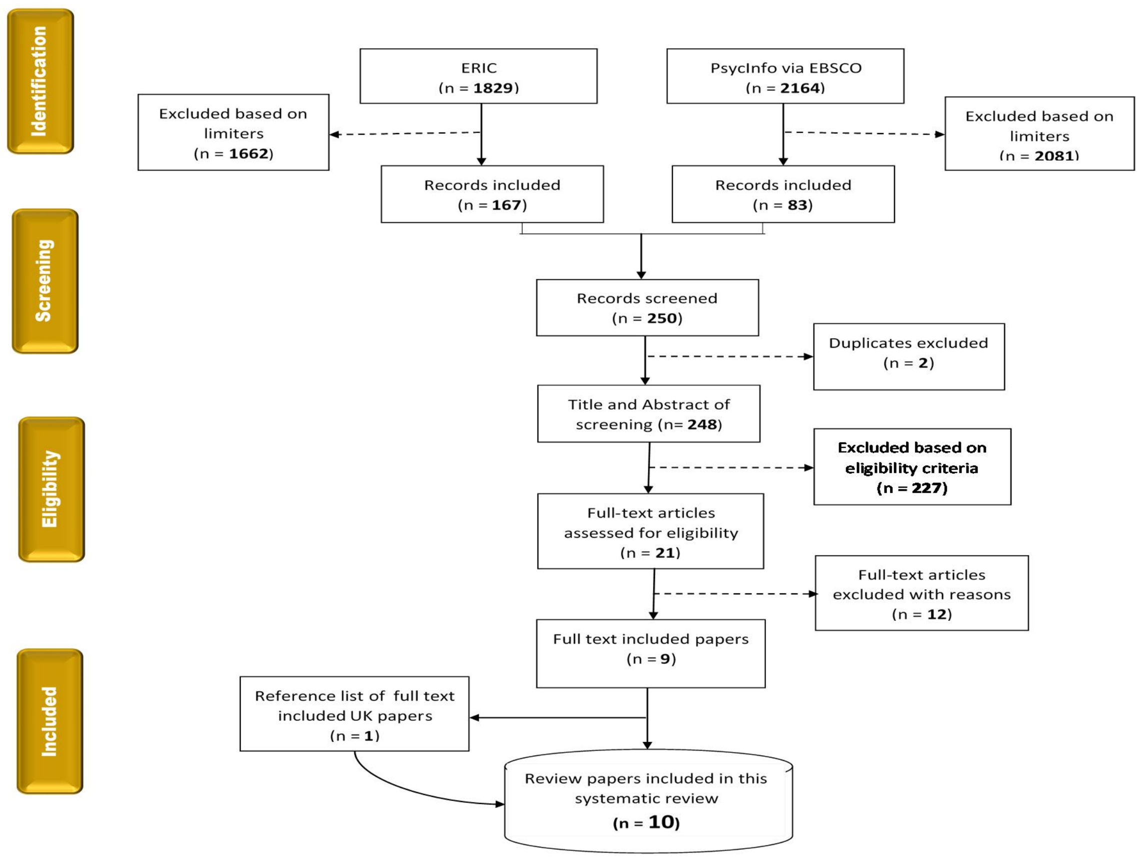

Figure 1. A flow diagram of the study selection process adapted from Moher et al. (2009)

2.2. Eligibility Criteria

The initial search from the two databases yielded 3,993 journal articles. After filtering using search limiters and expanders, 250 articles were assessed against five criteria. Thus, 1. It is a mathematics intervention and published in a peer-reviewed journal; 2. It is a primary report of empirical research conducted in a mainstream primary school in the UK or US; 3. It focus on 7–11-years old children with low attainment but not identified with special educational needs and disabilities (SEND); 4. The research design is a randomised controlled trial (RCT); 5. The study address more than one mathematics topic/concept (i.e., intervention that focused on a single topic like fractions or multiplication did not qualify for this review). The studies that satisfied all the criteria were included in the review sample.

At the Initial stage of the screening process, duplicates of 2 publications were erased and 248 publications were screened in two stages. The first stage of the evaluation assessed only the title and abstract, which resulted in the exclusion of 227 publications for failure to meet one or more of the criteria. The remaining 21 publications were then examined in full text, resulting in the exclusion of 12 publications. Finally, the reference lists of the remaining 9 articles were also checked and 1 paper was recorded from the reference lists. Overall, 10 publications met the criteria for this review. **Figure 1** above illustrates the search and selection process for this study.

3. Results

In this review, ten (10) RCT studies on mathematics intervention emerged from the search and screening procedures (***see*** **Table 1 and Table 2 below**). These publications spanned 12 years (2007 -2019) with the majority (80%) of the publications from the US. The studies involved approximately 14,529 primary school children with a minimum of 51 participants whose ages ranged from 7-11 years. While all the publications for the review were designed to improve the performance of low attainers of mathematics, different intervention strategies and approaches were discovered across studies. For instance, the publications were varied in terms of the participants' selection criteria, delivery method, facilitators, resources, mathematics contents covered, intervention length and outcome measures. Similarly, participants' characteristics were different in these studies; the condition for selecting participants was dependent on individual study (e.g., *cut-score points*: 40th percentile, 26th percentile, 350 points); instructional resources varied from curriculum materials to technology and manipulatives which dominated. Of the 10 studies, 80% demonstrated a significant result favouring the intervention.

In general, the synopsis of the publications for this review shows substantial heterogeneity. Given this, it is arduous to synthesise and make comparisons across the publications. Therefore, the results of this review are presented based on the mathematics skills which the interventions focused on improving. In this study, three mathematical skills (i.e., number sense skill, fluency in calculation skill and problem-solving skills) were identified which are discussed below.

Table 1. Percentile Description of Included Studies

Study Characteristics	**Percentage**
Study context	
US	80%
UK	20%
Year of publication	
2005-2010	70%
2011-2015	20%
2016-2020	10%
Participants (Grade & age)	
Grade 3; 8-9 years	50%
Grade 5; 10-11 years	10%
Combined grades: 7-11years	40%
Target mathematics skills	
Number sense	40%
Problem-solving	20%
Fluency in calculation	30%
Intervention length (Total hours)	
< 10	10%
10-20	20%
> 30	60%
Not reported	10%
Number of delivery sessions	
10-20	20%
20-30	10%
> 30	70%
Instructors	
Teachers	50%
Research assistants (RAs)	20%
Teaching assistant (TAs)	20%
Both RAs and TAs	10%
Resources	
Manipulatives	80%
Curriculum material	10%
Technology	10%
Delivery method	
One-to-one	40%
Small group	30%
Peer assisted	10%
Not reported	20%
Fidelity implementation	
Reported	90%
Not reported	10%
Outcome results	
Significant	80%
Minimal significance	20%
Follow-up results	
Significant	20%
Insignificant	20%
Not reported	60%

Table 2. Summary of Included Studies

	Authors	Intervention summary	Sample	Age	Exp. group	Control group	Math content	Delivery	Instructor	Staff training	Duration	Session	Resource	Outcome result	Follow-up result	Country
1.	Holmes & Dowker (2013)	The study assessed the impact of 'Catch-Up Numeracy' on students' mathematics abilities. Students were randomly assigned to three groups: The **intervention group**: Catch-Up Numeracy approach A '**matched-time' control group (MTCG)**: received support in the same way as the intervention group but not using Catch Up Numeracy approach. A '**no-intervention' control group** received only their usual classroom lessons	440	***Mean age:*** 8 yrs and 8 months old	348	CG= 42 MTCG= 50	Numeracy skills	one-to-one	TAs	Yes	15min x 2 lessons per week for 30 weeks ***NB:*** *(Intervention length was not stated in paper. It was retrieved from Education Endowment Foundation website)*	60	Manipulatives	Significant	N/A	UK
2.	See et al. (2019)	The study assessed the impact of 'Math Count (MC)' on students struggling with basic maths skills. Treatment group was taken out of the classroom for the MC sessions and control students carried on with their usual lessons in the classroom.	305	7 - 11 years	152	153	Number skills	1-to-1	TAs	Yes	30 min. × 3 session per week for 10 weeks	30	Manipulative; Digital device	Minimal	N/A	UK
3.	Rutherford et al. (2014)	This study assessed the effectiveness of Spatio-Temporal Math (mathematics computer software and instructional program) on students' mathematics skills. This intervention focused on supporting children to visualise mathematics concepts.	≥ 13, 000	7-11 years	N/A	N/A	Mathematical reasoning	Self-paced	Teachers	Yes	90 min. per week for 2 years	136	Spatio-temporal Maths software, Computers	Minimal	1st year = minimal gain 2nd year = no gain	US

	Authors	Intervention summary	Sample	Age	Exp. group	Control group	Math content	Delivery	Instructor	Staff training	Duration	Session	Resource	Outcome result	Follow-up result	Country
4.	Ketterlin-Geller et al. (2008)	This study assessed the effect of two mathematics intervention programs on student achievement. Students were stratified into three groups: Knowing Math intervention (KMI) (*adopted from Ma & Kessel, 2003*), Extended Core intervention (ECI) (designed by classroom teachers and the research team)	51	10 – 11 years	44 KMI =17 ECI= 27	8	Basic Arithmetic skills	Small group	Teachers	Yes	30-45 min. x 4 days per week for 16 weeks	64	School district's curriculum	Significant	N/A	US
5.	Fuchs et al. (2009)	The study assessed the effect two tutoring practices among students with mathematics difficulty. Students were assigned to three groups: two intervention groups (Number Combination tutoring and Word Problem tutoring) were evaluated against each other and against a no-tutoring control group	133	*Mean Age:* 8.94 years	86 WP= 42 NC= 44	47	Fluency in calculation	N/A	RA	N/A	20 - 30 min x 3 sessions per week for 16 weeks	48	Manipulatives	Significant. .	N/A	US
6.	Fuchs et al. (2010)	The study assessed the effects of strategic counting instruction, with and without deliberate practice (DP) with those counting strategies, on number combination (NC) skill. Comparison was made between the two variants strategic counting instruction and the no tutoring group.	150	*Mean age:* 8.37 years	100 DP= 51 NDP =49	50	Fluency in calculation skills	1 - to-1	RA		20–30 min x 3 days per week for 16 weeks	48	Manipulatives	Significant	N/A	US

	Authors	Intervention summary	Sample	Age	Exp. group	Control group	Math content	Delivery	Instructor	Staff training	Duration	Session	Resource	Outcome result	Follow-up result	Country
7.	Menesses et al. (2009)	The study evaluated the academic gains of reciprocal peer tutoring (RPT), nonreciprocal peer tutoring (NRT), and a control group. The NPT condition consisted of one-way peer tutoring in which one student was always the tutor and the other students were always the tutee. In RPT, students switched roles between tutee and tutor within the same session.	59	7 - 10 years	RPT =15 NPT =28	16	Fluency in Basic math facts	Peer tutoring	Teachers	Yes	3 min x 3 tutoring sessions per week	15	Manipulatives	Significant. :	No significant gain after 3 weeks	US
8.	Jitendra et al. (2007)	The study assessed the effects of two interventions in promoting mathematical problem solving and mathematics achievement. That is single strategy (schema-based instruction; (SBI) and a multiple-strategies (general strategy instruction, (GSI) **NB:** Comparison group of the study was not treated as a control group.	88	9-10 years	SBI= 45 GIS= 43	-	Problem-solving Skills	N/A	Teachers	Yes	25 min x 5 days per week	36	Manipulatives	Significant.	Maintained performance after 6 weeks	US
9.	Griffin & Jitendra- (2009)	The study compared mathematical word problem-solving performance and computational skills of students who experienced schema-based instruction (SBI) with students who received general strategy instruction (GSI).	60	*Mean age:* 8.97	30	30	Problem-solving skills	N/A	Teachers	Yes	100 min per a week for 18 weeks	20	manipulatives	Significant	Significant gain after 12 weeks	US

	Authors	Intervention summary	Sample	Age	Exp. group	Control group	Math content	Delivery	Instructor	Staff training	Duration	Session	Resource	Outcome result	Follow-up result	Country
10.	Fuchs et al. (2008)	The study assessed the effects of schema broadening instruction (SBI) tutoring, with and without SBI classroom instruction on At- Risk students' math problem solving and, on their learning, relative to Not At-Risk peers. Participants were assigned to traditional or supported problem-solving instruction (Hot Math, schema broadening instruction	243	8-9 years	80 classes	40 classes	Math problem-solving	Small group	Teachers & RA	Yes	20–30 min x 3 per week for 16 weeks	48	Manipulatives	Significant	N/A	US

CG=Control group; DP=Deliberate practice; ECI=Extended core intervention; Exp.=Experimental; GSI=General strategy instruction; KMI=Knowing math intervention; MC=Math count; MTCG= Matched-time control group; N/A=Not available; NC=Number combination; NDP= Non-deliberate practice; NRT=Non-reciprocal peer tutoring; Ras=Research assistants; RPT=Reciprocal peer tutoring; SBI=Schema-based instruction; TAs= Teaching assistants

3.1. Number Sense Skills

Four publications (i.e., Holmes & Dowker, 2013; See, et al., 2019; Rutherford et al., 2014; Ketterlin-Geller et al., 2008) focused on developing number sense skills. Thus, the ability to understand basic arithmetic principles like number comparisons, knowledge of numbers and figures, understanding quantities, oral counting, addition and subtraction of two- or three-digit calculation and place value (OECD, 2013, p. 4). All studies targeted students with low performance in mathematics, nevertheless, participants' selections varied across studies. In all, instructors were trained before the intervention, fidelity implementation was assessed, and the outcome was significant but minimal for some studies.

For instance, Holmes and Dowker (2013) and See et al. (2019) study from the UK used manipulative material to improve students' general mathematical skills. Participants were selected based on teachers' descriptions. In both studies, teaching assistants (TAs) delivered the intervention in a one-to-one session. The interventions were implemented over a total of 15 hours duration. However, the frequency and the specific time for each session were varied (**see Table 2**). In Holmes and Dowker's (2013) study, they examined the effect of the 'Catch up Numeracy' intervention on students' numeracy skills. The intervention covered content on factual knowledge (addition facts), procedural knowledge (understanding how to use algorithms to solve arithmetic problem) and conceptual knowledge (understanding the principles in arithmetic and making a relationship in different facets). Results showed remarkable progress. Similarly, See et al. (2019) evaluated the impact of the 'Maths Count' intervention on mathematics skills in numbers (i.e. comparing numbers, place values, interpreting mathematical signs, reading and writing numbers in numerals and words). While TAs were the instructors, a digital tool assisted in planning, recording and monitoring students' progress and outcomes. The outcome of the intervention showed that 'Math Count' intervention was effective on students' general mathematics skills and attitude, however, the effect size was minimal.

On the contrary, Ketterlin-Geller et al. (2008) study focused on the use of language to examine the effect of two mathematics interventions (i.e., Knowing Math and Extended Core) on students' basic arithmetic principles. The contents covered were place values, numbers and operations, and multiplication strategies related to rational numbers. Participants were students who performed below the 40th percentile grade-level district-wide mathematics screening test administered in 2004 (p.36). The intervention was delivered by teachers in a small group session and lasted for 48 hours which was spread out into 64 tutoring sessions. In Rutherford et al. (2014) study, they assessed the effect of 'Spatio-Temporal Math', a computer-based intervention on students' mathematical concepts, which included many different modules (e.g., two and three-digit addition and subtraction calculation and place value up to 1000, fractions). Participants were students who scored below 350 points in the California Standards Test (CST). Teachers assisted students in computer-assisted instruction in a one-to-one session. Among all the review publications, this study used only computer software to deliver the intervention. More so, it was the largest study in terms of participants (i.e., approximately 13,803 students) and the duration for the intervention (i.e., 136 sessions in 2 years). The study outcome showed a significant improvement in mathematics achievement; but follow-up results revealed a minimal increase after a year and no significant gain after the second year.

3.2. Fluency in Calculation

There are three articles in this review (Fuchs et al., 2009; Fuchs et al., 2010; Menesses & Gresham, 2009) from the US that focused on developing students' fluency skills in arithmetic. All the studies evaluated two intervention groups against one control group. Also, fidelity implementation of these studies was reported, instructors were trained, and manipulatives were used to deliver the intervention. The overall outcome of these studies was significant with an increase in the academic scores of all the experimental groups to the control group.

Two of the studies (Fuchs et al., 2009 and Fuchs et al., 2010) assessed the efficacy of two tutoring protocols (i.e., number combination (NC) and word problem (WP) on remediating mathematics difficulty. The studies focused on developing fluency with NC, thus, the basic arithmetic problems (e.g. 5 + 4 = 9; 12 – 8 = 4) that can be solved through counting or decomposition strategies or committed to long-term memory for automatic retrieval while WP required the use of texts to identify missing information, construct the number sentence, derive calculation problem for finding the missing number and finally solve that calculation problem (i.e. 5 + b =35; b+2=14). Participants for these studies were selected in two stages. The first selection involved students whose score was below the 26th percentile in calculation and 39th percentile in WP test. Students who met this criterion were qualified for the next stage of selection. Again, the second stage selected students with mathematics difficulty as well as mathematics and reading difficulties (i.e., students whose scores in a reading and abbreviated IQ measure were below the 39th percentile and 26th percentile respectively). Among all the review publications, only these two papers explicitly described their participants as ''students with mathematics deficit'. Since this review is focused on only learners with no identified disability, there was the need to clarify participants' status. Therefore, consultation was conducted with the authors, who clarified that the participants were low attainers in mathematics (Fuchs, 2020). Also, participants' characteristics were similar to the other publications in this review, hence, its inclusion in this review. Research assistants (RAs) delivered 48 tutoring sessions with a total period of 24 hours and the outcome revealed a substantial improvement in students' fluency skills in calculation. However, the WP group produced superior results. Despite the analogy of these two publications, their tutoring approach were varied. For instance, Fuchs et al. (2009) wholly dedicated one intervention group to redress NC and incorporated computerised NC practice, and the other group used drills and practice. However, in Fuchs et al. (2010) study, both intervention groups were engaged in WP tutoring, and the focus to remediate NC was limited to counting strategies.

In contrast, Menesses and Gresham (2009) used a peer tutoring approach to improve students' fluency skills in basic mathematics facts (e.g., 7x6=42). Participants were selected based on their performance in a computerised math probe measure on addition, subtraction, multiplication, and division calculation. Students whose performance falls at the frustration level as determined by the national benchmark qualified to participate (p. 268). Though this publication focused on low attainers in mathematics, there was no clarification on the cut score measure used to place students at the frustration level. In terms of the intervention approach, the researchers compared two intervention groups (i.e., reciprocal peer-tutoring (RPT) and nonreciprocal peer-tutoring (NPT) with one standard classroom instruction group (control group). The disparity in the two intervention groups was that the RPT tutoring switched between tutee and tutor within the same session while in the NPT, there was a one-way peer tutoring. Among all the review publications, Menesses and Gresham's study had the least intervention duration (i.e., 15 sessions).

Overall, the results of the intervention groups displayed a statistically significant increase in their mathematical fluency. However, three weeks of follow-up test results indicated an insignificant outcome.

3.3. Problem-Solving Skills

As part of this review, three publications (Jitendra et al., 2007; Fuchs et al., 2008; Griffin & Jitendra, 2009) from the US focused on developing students' problem-solving skills using schema-based instruction (SBI). Participants were third-grade students (8-9-year-old). Again, in all the studies, instructors were trained for the intervention, used manipulatives, and assessed students based on standardised measures.

Two of the three studies (Jitendra et al., 2007; Griffin & Jitendra, 2009) employed two strategy instructions (schema-based instruction [SBI] and general strategy instruction [GSI]) to promote problem-solving skills. SBI used a schematic diagram to represent word problems virtually before solving them while GSI involved the use of heuristics and multiple strategies based on Polya's (1945/1990) principles of solving a problem (i.e., read, understand, plan, and solve). GSI was typically textbook instruction. Participants were the lowest-achieving students in a mathematical problem-solving subset of the Stanford Achievement Test-9 (SAT-9 MPS); nonetheless, the authors were not explicit on the cut score points used as well as the delivery mode. The intervention instructors were teachers. In Jitendra et al. (2007) study, the effect of SBI and GSI on problem-solving was assessed. In the study, the two groups received the same extensive instruction to solve the same amount and types of word problems. Thus, no control group received typical classroom instruction. Overall, 36 teaching sessions took place, spending 125 minutes per week. However, the duration of each session was not reported. In the end, SBI improved students' mathematical and problem-solving skills more than the GSI and follow-up results after six weeks of terminating the intervention showed a sustained performance. Griffin and Jitendra (2009) also compared the impact of SBI and GBI on mathematical word problem-solving performance and computational skills. The intervention lasted for 28 weeks with a total of 20 tutoring sessions. The outcome for both groups was significant but higher in SBI.

On the contrary, Fuchs et al. (2008) assessed the effects of small group tutoring with SBI on mathematics problem-solving. The intervention was delivered by both teachers and research assistants. The procedure lasted for 16 weeks with 48 teaching sessions. Results showed that SBI improved students' problem-solving skills.

In summing up the results of the publications in this review, 80% of the studies reported a positive and statistically significant effect which shows that mathematics intervention has a promising outcome on low-attaining students (Dunne et al., 2011; Dowker, 2009). Nevertheless, its long-term effect would need future research to validate because 40% of the reviewed articles discussed about tracking students' progress with which half reported insignificant. Also, with the participants, more than 50% of the reviewed articles involved children between the ages of 7-9 years. This indicates that early intervention for low attainers in mathematics is pivotal (Dowker, 2004). Moreso, majority (80%) of the interventions were delivered using manipulative. This appears that manipulatives are commonly used to support students' engagement with mathematical ideas (Hodgen et al., 2018). Regarding intervention length, about two-thirds (70%) of the studies were delivered in more than 30 tutoring sessions. However, it should be noted that the duration of each session varied across studies. Again, the longer period of intervention sessions does not guarantee a successful outcome (Wilson & Räsänen, 2014). Evidence can be drawn from this review. For instance, Rutherford et al. (2014) had the longest intervention period (2 years: approximately 136 sessions) but reported a nonsignificant result a year and two years after the intervention. Intervention instructors were mostly teachers (50%) and the mathematics contents covered were based on three skills: number sense (40%), fluency in calculation (30%) and problem-solving (30%).

4. Discussion

Prior to conducting this review, a preliminary search was done to identify any systematic review or meta-analysis study exclusively focusing on low-attaining students without MD/LD. This systematic review was conducted to examine the impact of mathematics intervention on at-risk students with no identified disability. Additionally, given the lack of consensus on 'what constitutes an effective mathematics intervention' (Dowker, 2009), this study aimed to identify key components that educators can consider when designing and implementing effective mathematics interventions.

4.1. Evidence about the Effectiveness of Mathematics Intervention

The outcome of all the publications in this review reported a substantial effect except for two papers which reported minimal gains. This finding has been identified in previous systematic reviews, synthesis and meta-analyses (e.g., Simms et al., 2019; Marita & Hord, 2017; Dennis et al., 2016; Kroesbergen & Van Luit, 2003). Despite these studies having varied participant focuses, their outcomes yielded positive results. This indicates that effective implementation of mathematics intervention improves the performance of low attainers. Additionally, in this review, it was noted that half of the studies did not report on the follow-up of the intervention. Nevertheless, the reported follow-up results indicated that not all interventions have a lasting effect. This indicates the necessity for ongoing monitoring of students' progress following an intervention (OFSTED, 2009). Monitoring students' progress will help to ensure that participants are benefiting from the programme and can also address any potential problem on time.

In all, this review has provided evidence that mathematics intervention improves low attainers' performance. The finding is based on a small-scale review and, there could be other factors that influenced the outcome of the students' performance which were not reported by the authors of the review papers. While the findings of this study align with those of other comprehensive systematic review studies (e.g., Simms et al., 2019; Dietrichson et al., 2020), it's important to interpret the present review in light of the study's limitations (Ryan et al., 2013).

4.2. Characteristics of Mathematic Interventions for Low-Attaining Students

The ten (10) publications included in this review involved 14,529 students underperforming in mathematics. Though all the studies targeted students struggling in mathematics, there was not a single procedure for implementing the intervention. The intervention strategies were varied across studies. For instance, participant selection in the UK studies was based on teachers' discretion while studies from the US selected their participants based on standardised diagnostic assessment. Consequently, there is no universally applicable definition of low attainment, as attainment descriptions vary depending on individual studies and contexts (Dowker, 2004; Mazzocco, 2007). This means participants from two different studies cannot be compared due to the distinct attainment criteria. Also, majority of the interventions utilised manipulatives as their resources. Though, research suggests that manipulatives assist learners in engaging with mathematical skills, educators should be conscious of its prolonged use as it can hinder learners' mathematical development (Hodgen et al., 2018). The current review discovered three theoretical ideas to inspire the strategies and resources used in the interventions. Thus, Schema theory for problem-solving skills; Scaffolding theory for basic arithmetic skills and Concrete-representational-abstract CRA: theory of instruction for fluency in calculation practice. Previous research have identified these skills as part of mathematics topics that students struggle with (Powell et al., 2013; Dowker, 2004; Vukovic & Siegel, 2010). This indicates that the included publications targeted the needs of their participants. In addition to this, intervention duration and sessions were varied across all studies. Though research (e.g., Powell et al., 2021) suggest further studies to understand the extent to which students can be engaged in a mathematical intervention, in this study, it is believed that there is no optimal time for mathematics intervention. This indicates that the duration of an intervention depends on the requirements of the target group. Additionally, this review reveals that the effectiveness of an intervention is not assured by its intensity (Wilson & Räsänen, 2014), as the intervention's impact over an extended period was unsatisfactory.

While heterogeneity remained substantial among the review papers, they all exhibit some common features. The findings of this review show that there is no single approach to designing and implementing mathematics intervention. However, to identify common ground among the publications, we can draw a conclusion regarding the mechanisms to be considered in designing an intervention. As a result, nine key components emerged to guide the design of an effective mathematics intervention. (i.e., *Targeting participants' specific needs, content to cover, resources, delivery method, instructors, intervention length, fidelity implementation, staff training and outcome measures*). Whereas the variations across the publications limit the generalisability of this review, the findings discussed above can serve as a basis for practitioners to plan an effective mathematics intervention for underachieving students with no identified disability.

5. Limitations and Implications

5.1. Limitations

This review included 10 publications from two countries (the UK and the USA). As such, findings may not be generalizable across other countries. Subsequent studies should continue building on the findings presented here to further explore potential variations in different contexts. In addition, the research focused on only published journal articles in two databases (ERIC and PsycINFO via EBSCO interface). This means that any grey or unpublished literature were not included in this study. Also, considering the two databases that information was retrieved from, it is possible that some pertinent literature may have been overlooked for this review. Future research should broaden their search to include other databases and grey literature.

5.2. Implication for Practice

Evidenced-based practice in education is considered appropriate for effective instruction (Hughes et al., 2016). This review identified some implications for educators to consider in planning and implementing effective interventions for primary school children who struggle with mathematics. First, nine elements of an intervention design were identified. Thus, target participants' needs; focus on specific mathematics skills; consider appropriate resources to use; consider the delivery method to adopt, provide specific training for instructors; consider how fidelity implementation will be checked, specify the duration of the intervention and the outcome measures. Previous studies (Powel et al., 2021; Maccini et al., 2007) also suggest educators' use of explicit instruction. Though considering these elements does not guarantee a promising outcome, a systematic and careful plan based on these dimensions will increase the possibility of its success. Again, it is suggested that educators should consider mathematics intervention as a remediation to enhance the performance of struggling students in mathematics. However, its lasting effect is still questionable because there is insufficient evidence from this review to make such an argument. On the contrary, based on the four studies that reported follow-up results, educators are being advised to continuously track students' progress after mathematics intervention to increase its long-term effect. The outcome can also be used to modify future interventions (Powell & Fuch, 2015). In general, due to the absence of a singular approach to delivering effective interventions, educators are encouraged to consistently assess the effectiveness of intervention programmes. Additionally, they should be prepared to adjust and refine intervention methods and resources in order to achieve positive outcomes.

5.3. Implication for Research

The publications identified in this review demonstrated positive results for improving the performance of low attainers with no identified disability. Also, this review identified nine key elements that can assist educators in designing a well-structured and effective mathematics intervention. Nonetheless, this review only focused on RCT studies in the UK and the US. Therefore, to provide strong evidence that can be applied in all contexts, future research should be extended to other countries. Again, researchers should consider research designs other than RCTs (e.g., to include quasi-experimental studies) and analysis practice (e.g., using meta-analysis for synthesis). Additionally, future intervention studies should make a standardised practice to provide a detailed report of the intervention procedure so that interested practitioners can replicate it. Another critical goal for future studies would be to examine the future outcome of an effective mathematics intervention. Thus, future synthesis should add to the literature by examining the long-lasting effect of mathematics interventions for low-attaining students so that effective interventions will be sustained even after the implementation period.

6. Conclusion

This systematic review demonstrated that underperforming students with no identified learning disability benefited from the specified and targeted mathematics interventions. Nine key elements (i.e., identification of target group; mathematics content to be covered; resources; duration; delivery method; instructors; fidelity implementation; staff training and outcome measures) were identified for designing intervention in terms of incorporating specific characteristics in a mathematics intervention. Equally, three mathematical skills (i.e., number sense, fluency in calculation and problem-solving) appeared to enhance students' mathematical learning. Educators are encouraged to use this information as a guide to design an effective mathematics intervention for low-attaining students with no identified disability.

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