Randomized Evaluation of Reading Skills: an Opportunity for Systematic Literature Review

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ABSTRACT

In the context of public policies, randomized evaluation of the impact of public programs and policies is fundamental because it provides the most credible and reliable way to learn what works and what does not in education to reduce poverty and improve the well-being of individuals and society. There is an urgency in the literature emerging during the pandemic to develop each student's reading skills since there is no development without literacy. For this reason, research studies report randomized control trials (RCT) for comprehensive reading programs that are of great interest to the educational system. This article aims to analyze the characteristics of these studies and the trends of new contributions to education. To achieve this, we conducted a systematic literature review (SLR) of 63 articles published between January 2015 and January 2019 in the Web of Science (WoS) and Scopus databases. We explored three themes using seven questions. The themes were a) Impact evaluation and randomized control trial (RCT), its approach and criteria; b) innovation and technology in reading programs; and c) the use of technology in the social appropriation of knowledge. The findings showed an increase in randomized control trials in impact evaluation, the need to optimize the quality of these studies, and the challenge of integrating innovation and technology in reading programs. We concluded that increasing and optimizing the impact evaluation approach in these topic research contributes in a substantive way to researchers and government decision making and to advance in the path of achieving a fair, equitable and quality education for all.

CCS CONCEPTS

• General and reference • cross-computing tools and techniques • evaluation

KEYWORDS

Randomized Control Trial, Public policy, Reading skills, Primary education, Systematic literature review, Innovative education, Higher education.

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1 INTRODUCTION

In recent years, the use of experimental methodology has emerged as the central means to evaluate the interventions of international collaborations. The use of randomized control trial (RCT) has become one of the most widely used means by experts in international organizations to measure the impact of developmental interventions [1,2]. Its presence in the evaluation of innovative educational programs has increased. The relevance of developing students' reading skills has provided opportunities to design studies of innovative reading programs with impact evaluations that consider technologies, the social appropriation of knowledge, and the

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evidence about what fosters reading comprehension and learning. Globally, assessment with RCT is fundamental to build knowledge about the effectiveness of development programs, provide sustainability to public policy, and ensure individual and collective well-being.

2 LITERATURE REVIEW

The basic idea of a randomized controlled trial in this SRL consists of giving all units within an eligible population the same probability of receiving the treatment [3,4,5]. As Figure 1 shows, randomization offers treatment to one group of individuals (treatment group) and (not to another (control or comparison group) [6]

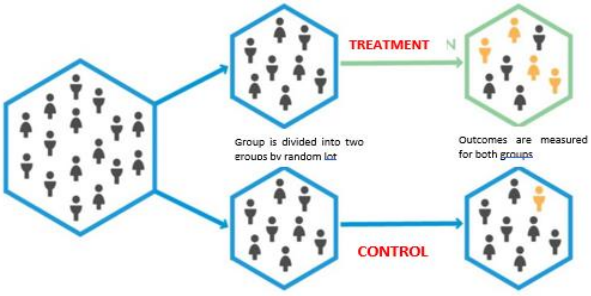

Figure 1. *Design of a randomized control trial (RCT)*

When effective treatment is appropriately implemented, it can be replicated and expanded to a larger population with similar success[7,8]. Close monitoring of the process has been found to enrich its results. Thus, authors [9,10] propose enriching impact evaluation with other evaluation methods, mixed methods analysis [11], and social appropriation of knowledge [12].

Today, the main goal of all Latin American and Caribbean countries should be to improve the literacy and skills of all their children and young people to recover and accelerate the learning lost due to the pandemic [13], [14]. The evidence says that a reading program that develops children's initial reading competency supported by a model that emphasizes phonological awareness, the alphabetic principle, and simultaneous text comprehension will achieve the desired learning goals [15, 16, 17, 18].

Also, innovative strategies using technology in reading programs, including social knowledge appropriation, will reduce inequities and respond to new societal demands by offering each student quality and relevance of educational offerings [19, 20]. Technology facilitates socializing or "popularizing" the knowledge obtained from research, programs, and public policies [21]. Generating innovative public policies to develop reading skills becomes a priority; evaluating their impact is now a requirement for countries [22]. In this context, this study presents a systematic review of the literature (SRL) on the latest trends in impact evaluation studies, including RCT, of public policies to develop reading skills.

This systematic literature review on impact evaluation and randomized control trials of innovative reading programs provides the key to narrowing the gap in developing countries that see a significant decline in their progress. Thus, the objective of this article is to analyze the most recent empirical evidence published, [23] focusing on answering the following questions: What theoretical postulates underlie the development of reading? What theoretical assumptions are behind impact evaluation? What criteria or standards are behind the impact assessment used? In what sector or context has the impact evaluation been successful? To what type of innovation does the item related correlate? What technology was used in the research? Which indicator of social appropriation of knowledge does the article expose? Which countries and which publishers are behind these studies on impact evaluation, particularly RCT? What future research and questions could be formulated based on this categorized review?

This study is an overview of the state of the art of educational innovation and public policies in early reading. The systematic mapping study was conducted on articles published from January 2015 to December 2019, following various methodologies. The document presents the context, methodology, results, data analysis, and conclusion covering the findings and areas of opportunity for future research.

3 METHODOLOGY

The central focus of this study involved a systematic literature review (SLR). This method includes the formulation of questions, the literature search, the delimitation of criteria, and the establishment of an analysis protocol that allows the evaluation and interpretation of available research related to a thematic area, which in this case is the impact evaluation of public policies on reading [24]. To carry out this study, we considered several methodological ideas [25, 26] and developed a protocol with defined steps to work on scientific reports on the area of study. Five phases were followed to analyze the articles rigorously and systematically:

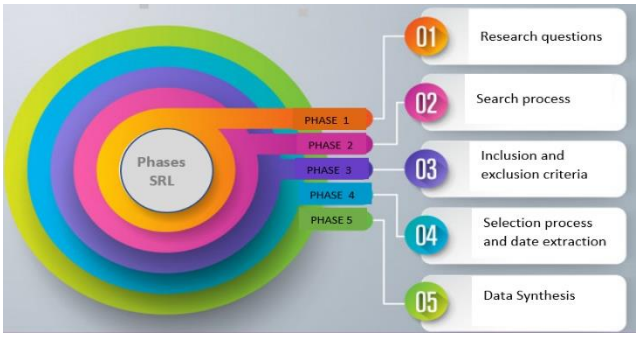

Figure 2 Systematic literature review protocol

According to [27], the systematic review begins (phase1) with the research questions to analyze the characteristics of socio-educational studies that have been published in recent years (2015-2019). As seen in Figure 3, seven research questions arise from the opportunity to identify research gaps and possibilities for future research [28, 29,30,31].

Research topics and questions

Topic	Research questions RQ	Possible answers
Impact evaluation design drawn from articles on reading development programs.	RQ1- What theoretical postulates are behind the development of reading?	Skills Model Holistic or Integral Model Balance Model
	RQ2- What are the theoretical assumptions behind the impact assessment?	Experimental- and Quasi-experimental Design Non-experimental Design Mixed-Method Design Theoretical Design
	RQ3-What criteria or standards are behind the impact assessment used?	Prospective or Ex-ante Design Retrospective or Ex-post Design
	RQ4--In what context has the impact assessment been successful?	Reading Performance General Skills Performance System reform management
Innovation and technologies present in articles on impact assessment and readability	RQ-5 What type of innovation is the article related to?	Process Product Service Knowledge
	RQ-6 What type of technology was used in the research?	Adaptive technology Open Technology Disruptive Technology Smart Technology
Social appropriation of knowledge present in impact assessment and reading articles	RQ-7 Which indicator of social appropriation of knowledge is the article related to?	Science and technology learning. Participation in the public sphere. Inclusion of vulnerable groups. Strengthening school educational practices Building capacity for the social appropriation of science and technology.

Figure 3 . *Research questions and possible answers*

The search for articles (phase 2) was conducted in the two databases, Scopus and Web of Science (WoS). The search strings are presented in the integrated Excel worksheet https://doi.org/10.5281/zenodo.4625922

The key to this methodology is defining the criteria for inclusion and exclusion (phase3**).** We were guided by the work of Kroll et al. [32] and Subhash and Cudney [33]. This study included articles that integrated educational policies, reading programs, impact evaluation, educational innovations, technology and social appropriation of knowledge in their title, abstract or keywords. The studies had to be published between January 2015 and January 2019, written in English or Spanish, and be open access. The exclusions were duplicated articles, books, book chapters and speeches, articles in Q-rated journals, and articles not in Spanish and in English.

In phases 4 and 5, the search and extraction of articles were completed and placed in an Excel sheet. The database search produced 200 results in WOS and 178 in Scopus. Subsequently, 60 duplicates were removed from the Scopus registry and 21 excluded because of the language. Quality criteria were applied to abstracts and keywords to identify the articles in education and social studies that would integrate impact assessment of public reading policies. This ensured that impact evaluation practices would be localized. Finally, 63 articles were selected for the SLR, and as shown in figure 4, the following data were extracted: authors, title, DOI, abstract,

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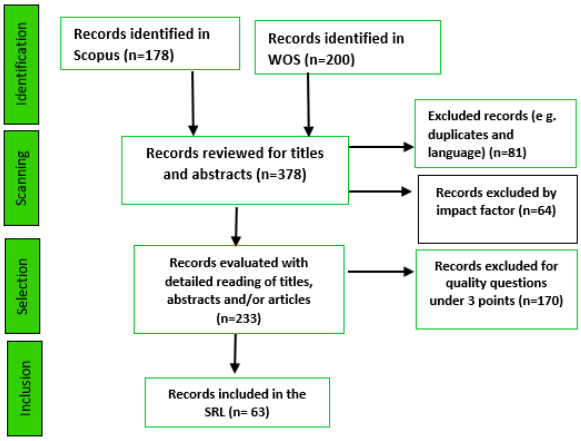

Figure 4. The *systematic literature review (SLR) prism*

A data extraction form specifically for the seven SLR study questions was used to support the content analysis of the articles based on the study questions. To synthesize the responses, we developed classifications for the possible graphical representations presented in this report. We analyzed terms, keywords, and concatenation of categories and subcategories to locate intersections of interest. The synthesis of the data can be found in the integrated Excel worksheet: https://doi.org/10.5281/zenodo.4625922

4 RESULTS

For the results report, the general contextual information of the 63 articles was required: The geographical distribution of the authors who publish in the field of impact assessment and RCT and innovation and technology in public reading policies is mainly in North America (56%) (see figure 5), with the United States (47%) and Canada (6.3%) standing out, followed by Europe (17%), Asia (16%), and Oceania (Australia 8%). In South America and the Caribbean, the articles comprised 3.0%, and the geographical distribution of the authors was in Brazil and Uruguay.

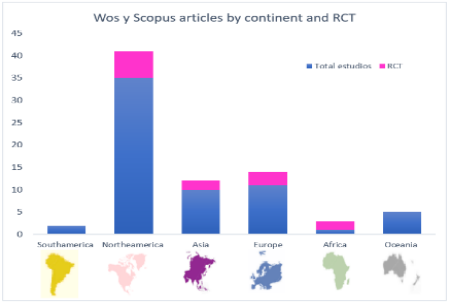

Figure 5. *Geographical distribution of the authors*

Figure 5 presents the number of publications generated by continent and country from 2015 to 2019 on this topic and RCT studies in each continent. In South America and Oceania, there were no RCT studies in WOS and Scopus on this subject between these dates.

RQ 1 What are the theoretical postulates behind reading development?

The research results show that 46% of the articles on reading programs decreased from 2015 to 2019. Figure 6 shows that 90% of the total reading studies were based on the balanced model of reading [34, 35, 36] and only 10% on the dexterity model [37,38,39]. Within the balanced or interactive model (figure 3), the most prevalent strategy is Reading Comprehension (73%) [40]. The figure also shows motivation for reading strategies (17%) [41]. Finally, the strategies least present in the studies were children's knowledge of reading strategies (6.7%) and automatic word recognition (3.3%)

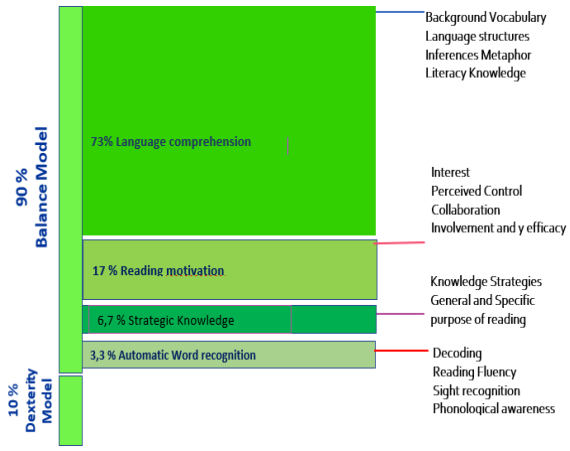

Figure 6. *Comprehensive Reading learning model in the Systematic Literature Review*

RQ 2 What are the theoretical assumptions behind the impact evaluation?

The designs behind impact evaluation are experimental, mixed-method, and non-experimental [9]. Of the 63 studies selected, 44% were experimental, non-experimental, 55%, and mixed type, 4.8%. While non-experimental studies were the most prevalent until 2018, these decreased significantly in 2019.

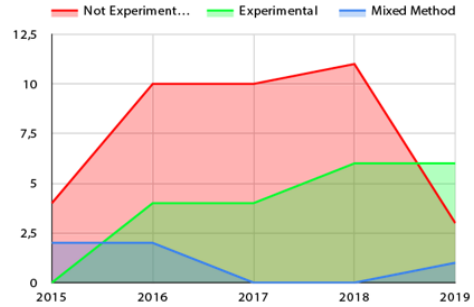

Figure 7. *Research method in articles with impact assessment*

Figure 7 exhibits that all studies on this topic published in WOS and Scopus decreased during 2015-2019. Within the group of impact evaluation studies, Figure 8 shows that the only ones that increased over time were those using the randomized experimental design called Randomized Control Trial (RCT) such as [43]. The quasi-experimental [44, 37] and mixed methods recovered incipiently in 2019 [41, 45, 46, 47]. In recent years, there has been an increase in the number of studies on this subject that complement the RCT with other types of evaluations: 23% with mixed-method analysis and monitoring programs and 8% with process evaluation and ex-ante simulation.

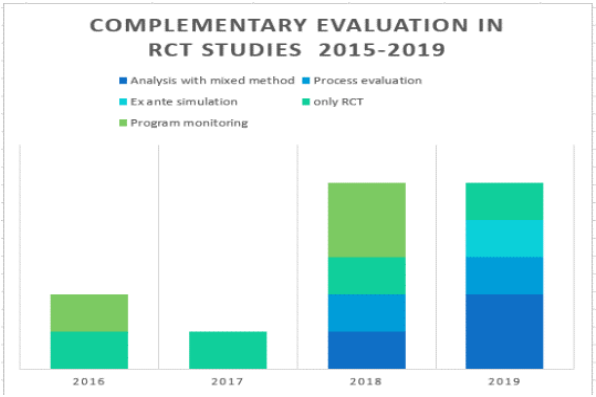

Figure 8. *Randomized control Trail in reading studies*

RQ3 What criteria or approach is behind the impact evaluation used?

There are different types of methodological designs to estimate the impact: experimental, quasi-experimental, and non-experimental. The latter, most of the time, arises as a complementary design [48]. In this review, 32% corresponded to impact assessment, of which 52 % were RCT, 29% quasi-experimental, and 5% mixed-method, among others.

The literature described above describes two impact evaluation approaches: 90% of the studies were prospective [e.g., 49] and 10% retrospective [e.g., 40]. For RCT, 100% were prospective studies. In turn, 80% of the articles with impact evaluation and RCT enrich

their design process evaluation, mixed-method analysis of results [e.g., 49], and incorporating a monitoring program [48] to ensure the fidelity of the evaluated program.

Gap key	N° of article	Recommendations for future studies with RCT design
Longer-term effects	201	To understand the longer-term effects on alternative student outcomes such as school culture and student mobility, safety, discipline, graduation, and dropout rates.
Process assessment and monitoring	35, 36 20	Measures of program implementation fidelity, ways of registering, multiple time points of reading ability, and tests of the mechanisms of change.
Assessment procedures	25	Explore ways to improve reading instruction and testing procedures.
Impact analysis	33	Allow for more robust and complete analyses.
Instruments	43	Assessments sensitive to second language learners and ethics considerations in the design
Methodology	42, 67	• Increasing the number of participants to make the results more meaningful.
Topics	38 47 70 76	• Academic self-beliefs of children growing older as mediators of program outcomes. • Design incentives to be more optimally targeted in their effects. • Components of individualization lead to reading improvements (e.g., one-on-one instruction and types of activities). • Exploratory model to determine the ideal frequency, duration of reading, mechanisms behind any improvement, and benefits optimization.

Figure 9. *Gaps and recommendations in RCT studies*

Within the context, studies gaps categorized in Figure 9 are mostly related to the RCT design.

RQ4. In which sector or context has the impact assessment been successful?

In this SRL, impact evaluation, particularly RCT, has focused primarily on literacy and reading skills development [49,50,51]. Figure 10 shows how education research (particularly in reading skills) has advanced due to the scientific rigor in the methodology used in this type of assessment [39,52].

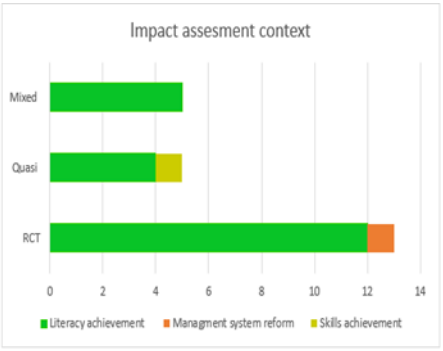

Figure 10. Randomized control trial (RCT) in reading studies

Within the context of RCT, 62% of the studies in reading have been conducted with struggling readers [52, 53], and 38% considers the whole regular group of students [e.g., 50, 54].

RQ 5 What type of innovation is the article related to?

According to authors such as García -Peñalvo et al., innovation is fundamental in public policies and can be differentiated into four themes: products, service, process, and knowledge [55],

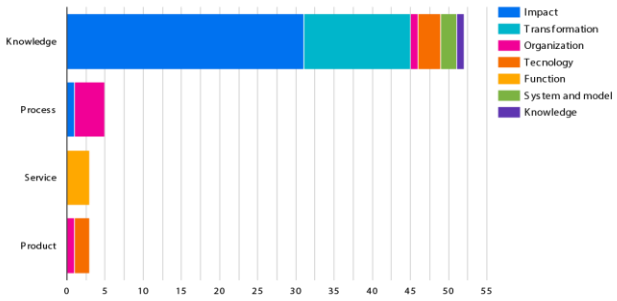

Figure 11. *Four themes of innovation*

In the 63 studies shown in Figure 11, we can see that the type of innovation focuses primarily on the generation of knowledge , the impact of this type of innovation on society [35] to produce transformations [56, 57], generating new systems and models [58], and using technology [59] in some cases. Innovations also appear in educational processes, services, and products to a lesser extent.

RQ6: What type of technology was used in the research?

Technology is present in 27% of the studies. In table 5, 65% corresponds to intelligent technology, including smart tools and devices, cloud computing [60], e-learning [44], and m-learning [33]. Twenty-four per cent use adaptive technology, introducing systems that adapt to societal needs and foster learning [61]; 12% report technology that gives open access for knowledge dissemination [33, 62]. In the 13 studies with RCT, only two of them used technology (both were intelligent technology).

RQ7 To which indicator of social appropriation of knowledge (SAK) does the article correlate?

The social appropriation of knowledge is relevant in social development and innovation [63] and education [64]. The 63 articles of this study (see Figure 12) evidence initiatives that allow identifying the presence of appropriation indicators; 40% building capacity for the social appropriation of science and technology [e.g. 65, 66], 35% reinforcing school practices [67, 68], 20% inclusion of groups in vulnerable situations [69], and 5% learning from Science [70].

Knowledge appropriation indicator	Impact evaluation article	Transfer of knowledge	Knowledge management
Strengthening school educational practice	33,20,35,71,76, 25, 34,	33,20,35, 71, 76	25,34
Capacity-building for the social appropriation of science and technology	42,43,46,47,67,201,26,113	42,43,46,47,67,201,26,113	
Inclusion of groups in situations of vulnerability	22,24,38,70		22,24,38,70
Learning in science	7		7

Figure 12. Per cent of indicators of the social appropriation of knowledge

5 DISCUSSION

The study presented here does not pretend to be exhaustive about the publications on impact evaluation and RCT of reading programs. This review has been directed only to the publications indexed in two databases, Scopus and WOS. Although they have the broadest coverage, they leave aside other databases with articles that have also contributed to the area. The methodology and results provided in this study reflect the intention to contribute to research on the impact evaluation of public programs or policies for reading in elementary education. The purpose is to offer evidence and support so those in power can make relevant decisions to curb the effects of the pandemic at the school level. Some challenges that arise from this systematic literature review are the following: Measuring the impact of any public policy and applying RCT design are increasingly fundamental principles of any government when making policy decisions. Of the continents, Figure 5 shows that Latin America had only 3% of the published articles related to reading programs and none with RCT. However, to develop reading skills, it is highly relevant to evaluate the impact of the programs, and RCT is a rigorous way.

- Innovation and technology have enormous potential to transform educational policies and programs and open new horizons. Figure 6 shows that innovation focuses primarily on generating knowledge that impacts society and produces transformations. Unesco [71] and Global & Index [72] also state that innovative strategies and technology could be highly relevant factors in narrowing the learning gaps and looking for sustainability and effectiveness in development programs or politics.
- Social appropriation of knowledge (SAK) requires the participation of all stakeholders, knowledge of the program and monitoring of the teaching and learning process. Table 6 shows that the most abundant indicators of SAK in the studies are capacity building, reinforcement of school practices, and inclusion of vulnerable groups. In Latin America, there is a particular interest in the social appropriation of knowledge [73]. Technology and innovation make it possible to answer the demands of the new society by offering each student quality, relevance and equity of educational offerings.
- Concerning the gaps that arise in these studies, many of them relate to the methodology used. McDaniel et al. [74] recommend running from a quasi-experimental design to an experimental design. Also, for a randomized control trial

(RCT), the recommendation is to increase the number of participants to make the results more meaningful [39]. It is also recommended to use longitudinal research designs in reading to clarify causal relationships between reading comprehension growth and motivation, metacognition, and other variables [75,76,77,78,]. It would be good to conduct further studies addressing the relationship between reading comprehension and vocabulary knowledge [79,80].

- It is noteworthy that an experimental design presents ethical challenges. Some studies did not have a control group because of the ethical variable and high costs. Because there is value in conducting this type of research [43], including ethical considerations, experimental design should be considered for future studies.
- Based on the works that have used impact evaluation, it is worth asking how this type of evaluation helps carry out better research in the field analyzed here, at least in comparison with studies that do not use impact evaluations. We should ask: What is the added value of impact evaluation in a study used for public policy decision-making? In which sectors have impact evaluations been successful? Can a mixed-method impact evaluation enrich the interpretation of results? Could a reading program in the framework of educational innovation having technology and knowledge appropriation processes at its core be transferred to other fields? The contribution of this study lies in the possibility of synthesizing the referents of this systematic review and enhancing the impact evaluation as a relevant element of development programs, not only in science but also in areas such as social sciences, education, communications, and other fields [81]. An impact evaluation that includes a high standard of rigor in collecting information could be enriched with other types of evaluations and methodologies such as the mixed-method [41]. Thus, impact evaluation and RCT with mixed methodology help enrich the interpretation of the results contextually, considering the complexity of reality in today's society.
- The differentiating value of this study lies in the findings in the literature about innovation complemented with impact evaluation and RCT in the framework of a mixed methodology. Another value is the innovation of evaluating a reading program with relevant technology and knowledge appropriation processes. Thus, we propose obtaining hard data from the impact evaluation to quantify the impact of a program and then triangulate the information with qualitative data that will allow a more complete and adjusted reading of reality. This approach offers a holistic, evaluative understanding of reality [82] while maintaining the scientific rigor of impact evaluation. This is an opportunity for change and improvement using a mixed-type evaluation model, including impact evaluation, to add far-reaching power to the field of research.

6 CONCLUSIONS

It can be concluded that impact evaluation is present in studies researching primary reading programs; it is increasing through the years with the RCT design. We found a control group and randomized sample selection with an ex-ante approach. In recent years, an approach emerged that complements impact evaluations with other assessments such as process evaluation and mixed-methodology. The latter has emerged as an opportunity for research.

Reading programs have always been indispensable in public policies; now, these are needed to counter losses caused by the pandemic. Innovation is present especially concerning knowledge. The evidence of innovation has increased in primary education, but not in using technology, and even less when looking for the social appropriation of knowledge. This constitutes a challenge for future research and public policy programs on reading. Latin America and the Caribbean present a substantially lower level of research with RCT in reading, constituting an opportunity when thinking about public policies to curb the impact of the pandemic on learning. Today, more than ever, policies are needed to develop reading in children from early childhood to the primary levels of schooling.

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