

Quality education for sustainability: a systematic review of primary education initiatives aligned with SDG 4

Educación de calidad para la sostenibilidad: una revisión sistemática de iniciativas en educación primaria alineadas con el ODS 4

Educação de qualidade para a sustentabilidade: uma revisão sistemática de iniciativas na educação básica alinhadas com os ODS 4

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KEYWORDS

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ABSTRACT: Concern for sustainability demands the promotion of behaviours and strategies that contribute to the Sustainable Development Goals (SDGs) of the 2030 Agenda. This study analysed experiences in primary education aimed at ensuring Quality education, through a systematic review of articles in English and Spanish following the PRISMA declaration, using the Web of Science (WOS) and Scopus databases. Of the 61 articles identified, 13 were selected and published between 2017 and 2024, mainly in African countries, Asia, and Europe. Quantitative methodology predominated, with interviews as the main data collection instrument.

The results show progress towards equity and gender equality within the framework of Sustainable Development Goal (SDG) 4. However, challenges remain, such as increasing early childhood enrolment and raising family awareness of the importance of early education. The findings highlight the need to strengthen school leadership, governmental support for vulnerable groups, continuous teacher training, and understanding schools as ecological systems. It is also recommended that textbooks be reviewed to ensure their alignment with sustainable development (SD) principles.

PALABRAS CLAVE Educación de calidad; educación primaria; sostenibilidad; medio ambiente; objetivos de desarrollo sostenible.	RESUMEN: La preocupación por la sostenibilidad exige promover comportamientos y estrategias que contribuyan a los Objetivos de Desarrollo Sostenible (ODS) de la Agenda 2030. Este estudio analizó experiencias en educación primaria orientadas a garantizar una educación de calidad, mediante una revisión sistemática de artículos en inglés y español siguiendo la declaración PRISMA, en Web of Science (WOS) y Scopus. De 61 artículos identificados, se seleccionaron 13, publicados entre 2017 y 2024, principalmente en países africanos, así como en Asia y Europa. Predominó la metodología cuantitativa, junto a entrevistas como principal instrumento de recogida de datos. Los resultados ponen de manifiesto los avances en equidad e igualdad de género en el marco del ODS 4, aunque persisten retos como aumentar la escolarización infantil y sensibilizar a las familias sobre la importancia de la educación temprana. Se destaca la importancia de fortalecer políticas de mejorar de la dirección escolar, apoyo a los sectores vulnerables, formación continua del profesorado y la consideración de las escuelas como sistemas ecológicos. Se recomienda, revisar los libros de texto para garantizar su adecuación a los principios del desarrollo sostenible.
PALAVRAS-CHAVE Educação de qualidade; educação básica; sustentabilidade; meio ambiente; objetivos de desenvolvimento sustentável.	RESUMO: A preocupação com a sustentabilidade exige a promoção de comportamentos e estratégias que contribuam para os Objetivos de Desenvolvimento Sustentável (ODS) da Agenda 2030. Este estudo analisou experiências na educação básica orientadas para garantir uma educação de qualidade, por meio de uma revisão sistemática de artigos em inglês e espanhol, seguindo o método PRISMA, utilizando as bases de dados Web of Science (WOS) e Scopus. Dos 61 artigos identificados, 13 foram selecionados, publicados entre 2017 e 2024, principalmente em países da África, Ásia e Europa. A metodologia quantitativa predominou, sendo os registos de entrevistas o principal instrumento utilizado. Os resultados mostram avanços em direção à equidade e à igualdade de género no âmbito dos ODS 4. No entanto, persistem desafios, como a necessidade de aumentar o número de crianças a frequentar a educação pré-escolar e a sensibilização das famílias sobre a importância da educação pré-escolar. Os resultados destacam a necessidade de fortalecer a liderança escolar, o apoio governamental a grupos vulneráveis, a formação contínua de professores e a compreensão das escolas como sistemas ecológicos. Recomenda-se também a revisão dos manuais escolares para garantir a sua conformidade com os princípios do desenvolvimento sustentável.

Introduction

The concept of sustainability has drawn the interest of numerous researchers; the term was coined in the 1987 Brundtland report (Brundtland, 1987), and there is a vast body of scientific literature on this topic. This has led to its incorporation into various fields. In education, UNESCO (2005) declared the decade 2005-2014 as the United Nations Decade of Education for SD with the idea of mobilizing educational resources to achieve sustainability in the near future.

This study focuses on sustainability at the primary education level in schools.

Conceptualization of sustainable development

Brundtland (1987) coined the concept of SD, which is a multidimensional concept in which environmental, social, and economic elements are integrated (Pawlosky, 2008). In addition, Abdul *et al.* (2013), Mora *et al.* (2020), and Pérez-Jorge *et al.* (2016; UNESCO, 2021) consider education a key to achieving SD, which in turn adds value to education.

Environmental education actions based on the reality of schools and personalised for students could develop a deep-rooted awareness of respect

and care for the environment. In its report, the International Commission advocates regenerative education as a global public and common good, suggesting a commitment to education as a resource that benefits all humanity. Awareness of this is crucial (Escrivà, 2023; Martínez-Murciano, 2024; Martínez-Murciano y Pérez-Jorge, 2023a; UNESCO, 2021).

Promoting sustainability goes beyond the transmission of theoretical concepts or definitions. It involves incorporating practical activities that allow pupils to experience, from an early age, the values and behaviours associated with SD. This is particularly important in primary education, as it is a crucial stage for acquiring habits and constructing values such as responsibility and commitment. For this reason, many schools promote the creation of school gardens, recycling programmes, and environmental awareness projects integrated into the curriculum. These initiatives foster respect for the environment and enhance critical thinking skills and collaborative problem-solving abilities, which are fundamental for building a sustainable society. Therefore experiential learning at this stage of education constitutes an essential pillar for translating sustainability principles into real and meaningful actions.

The 2030 agenda and sustainable development goals

The 2030 Agenda for SDGs, adopted by all United Nations member states in 2015, was created to ensure peace and prosperity for inhabitants and the planet, now and in the future. The 17 SDGs, are an urgent call to action for all countries. They are at the heart of this agenda (both developed and developing countries) to act as global partners. They recognise that ending poverty and other deprivations should be linked to strategies that improve health and education, promote equality and foster economic growth, while combating climate change and working to conserve oceans and forests. (United Nations, 2024) To achieve the SDGs, five priority areas will be intensified: policy advocacy, transformation of learning environments, strengthening the capacity of educators, empowering and mobilizing youth, and accelerating action at the local level (UNESCO, 2023a).

Goal 4: targets 4.1. and 4.7

Goal 4 of the SDGs is to ensure inclusive and equitable education and promote lifelong learning opportunities for all (UNESCO, 2024). Target 4.1 of SDG 4 aims to ensure that, by 2030, all children complete primary and secondary education. This includes providing free, equitable, and quality education, and ensuring that relevant and effective learning outcomes are achieved (United Nations, 2023). As indicated in Target 4.7, global citizenship education plays a significant role in the 2030 Agenda for Sustainable Development. Citizenship education is relevant in primary and secondary education; teachers must be adequately trained. (Pérez-Jorge *et al.*, 2017; Pérez-Jorge *et al.*, 2020). SDG 4 aims to achieve education for all. Primary education students are introduced to the SDGs as the goals aimed at ending extreme poverty for all and addressing climate change issues.

A critical and engaged approach to learning is adopted, promoting the importance of quality education for all (United Nations, 2024; UNESCO, 2023b). Genuine equality between male and female students is essential (Carvalho *et al.*, 2024; Obadahun *et al.*, 2024).

Conceptualization of quality education

Quality education includes having a healthy and well-nourished student body that is prepared to learn and participate, supported by their families and communities in safe, nurturing, and peaceful environments. Schools should have inclusive,

child-centred processes facilitated by competent and self-directed teachers and produce real outcomes encompassing knowledge, skills, and attitudes that support life and contribute to equity and positive social participation (UNICEF, 2000).

Aiming at a transformative, inclusive education that allows coexistence and favours sustainability is relevant (Ruiz-Ruiz *et al.*, 2021; Jahan and Rasheed, 2024). It is important to promote early learning in environmental education. One way to achieve this is to conduct didactic experiences on SD both in the primary education classroom and in the training of primary education degree teachers (Aguirregabiria García-Olalla, 2020; Pérez-Jorge, 2002; Torres-Porras & Arrebola, 2018).

Following the guidelines of the SD Agenda 2030 will help transform education and move it towards excellence. Students must also feel comfortable in the classroom and have adequate conditions, space, attention, and supportive atmosphere (Quesada-Chaves, 2019).

Quality education involves healthy, well-supported students in safe, inclusive, and nurturing environments with competent, student-centred teachers. It fosters knowledge, skills, and attitudes that promote equity and societal participation (UNICEF, 2000). Quality education emphasizes skills development, gender equality, proper infrastructure, resources, and qualified teachers (UNESCO, 2023b). Transformative, inclusive education supports coexistence and sustainability (Ruiz-Ruiz *et al.*, 2021; Jahan and Rasheed, 2024) and integrates early environmental education through didactic experiences in primary education classrooms and teacher training (Aguirregabiria and García-Olalla, 2020; Pérez-Jorge, 2002; Torres-Porras and Arrebola, 2018).

Conceptualization of teacher training

When considering teacher training, we must continue to provide adequate preparation to raise awareness about education for SD. Education professionals must understand both educational theory and the subject/discipline they intend to teach. Teachers need to have the tools to feel confident in the classroom and to be able to teach all students, so their continuous training is entirely necessary (Martínez-Murciano and Pérez-Jorge, 2023b; Serrano Arenas and Ochoa Cervantes, 2023).

Conceptualization of gamification

Children learn by playing, which is a motivating and natural way of learning. The use of technological resources for playful learning -known as

gamification—is increasingly widespread. In schools and universities, visual programming languages are used (Martínez-Murciano and Pérez-Jorge, 2022, 2024). The aim is to maintain creativity and encourage the development of students' talents (TEDxYouth (2011); Aprendemos juntos 2030, 2018). Why not use gamification for education in SD, from early childhood education to university?

Objectives

The main objective of this study is to promote quality primary education because although enrolment in this educational stage in developing countries has reached 91 %, 57 million children are still out of school. More than half live in Africa, and half live in war zones. One hundred and three million young people worldwide are out of school, and the gender gap continues, with more than 60 % of them being women (The World You Want, 2024).

The specific objectives are to identify the actions carried out in primary education to

achieve quality education and in which areas these actions are promoted, and to assess the interest that achieving quality education arouses in the field of research.

Materials and methods

Programmes that promote SD in educational centres tend to focus on different fields. Therefore, studies are sought that address specific areas of target 4.1 or 4.7 of goal 4 of the SD Agenda 2030 and not those that talk about other SDGs. In addition, the studies considered were selected for the primary education case, where the study focuses on improving the quality of education.

The studies on these programmes were intended to provide educational innovation. Therefore, at the beginning of this study, criteria were established for the inclusion and exclusion of documents to ensure an adequate selection of sources, as shown in Table 1.

Table 1. Inclusion and exclusion criteria

Inclusion	Exclusion
<ul style="list-style-type: none">• Studies in English and Spanish.• Papers published up to November• Papers focused on primary education• Research papers.• Studies focused on Targets 4.1 or 4.7 of SDG 4.	<ul style="list-style-type: none">• Studies in languages other than English and Spanish.• Documents from other educational stages.• Reflection articles.• Articles that do not base their results on the target 4.1 and/or 4.7 of Goal 4 of the SDG.

Source: own elaboration

Type of study

The methodology used in this study was both mixed and interpretative. It involved a systematic review of the scientific literature related to mixed and interpretative research topic using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement. Databases and articles on the scientific production developed about the experiences carried out in Primary Education (PE) to achieve quality education were analysed.

The PRISMA statement guides systematic review studies' conceptual and methodological development (Páramo, 2020). It accesses the scientific literature on a topic. It seeks to create valid and objective conclusions (Olarte-Mejía and Ríos-Osorio, 2015). It aims to serve as a starting point for other researchers in the field. Specifically in this study, we will detail the experiences that are being carried out in different countries to achieve SDG 4 (quality education in primary education)

The research question guiding the research process is: To what extent do primary education practices promote quality education in line with SDG 4?

Review of the selected bibliography

To ensure the rigor and appropriateness of the topics, an initial process was carried out to identify the keywords most frequently used in the studies that address this line of work and analyse their relevance and appropriateness to the objective of our study. This process is specified in point 2.4, which is useful for guiding future research work. Initially, the search strategy was very general and showed too many documents that did not represent or fit the objective of this study.

Boolean OR and AND were used, specifically the combinations used for the search were: ("Primary education" or "elementary school") AND Goal 4. Specifically, the first terms were entered and later combined using Boolean markers; the

initial search was performed for all educational stages. The PE was considered the stage of interest mainly because it is the stage at which most studies have been carried out. The combination for the final search was: ("Quality education" OR "GOAL 4") AND ("Primary education" OR "Elementary school") AND ("Sustainable Goals" OR "Sustainable Development Goals" OR SDGs)).

Resources

Two electronic databases from the library's search engine were used for the documentary search strategy in this study. From this database, documents from the Web of Science (WOS) and Scopus were accessed, which are estimated to be the central databases that house research in the educational field.

Procedure

A comprehensive search for studies was conducted using the selected keywords incorporated into the search equation. After identifying the studies, the inclusion criteria were applied to exclude documents that did not meet the established requirements.

Prior to the final selection phase, an initial screening was conducted to remove duplicate articles, which was carried out in two stages. Firstly, the Mendeley reference manager was used to automatically detect matching records (by comparing titles, authors, and years of publication). Secondly, a complementary manual

review was undertaken, comparing titles and authors and examining abstracts when necessary to confirm whether the records referred to the same study. This procedure was carried out independently by the authors of this study, resolving any discrepancies through consensus.

After the duplicates were removed, the titles and abstracts of the remaining documents were screened, selecting those that met the established analysis criteria. Subsequently, a full-text reading of the selected documents was conducted to decide their inclusion or exclusion.

A total of 13 valid studies were ultimately selected, based on previously established and relevant criteria for this research.

The document selection process was as follows:

- In Scopus, 53 papers were retrieved using the following search string: ("Quality education" OR "GOAL 4") AND ("Primary education" OR "Primary school") AND ("Sustainable Goals" OR "Sustainable Development Goals" OR SDGs)).
- In Web of Science, 21 papers were retrieved using the exact search string.
- In Dialnet, 2 papers were found using the exact search string.

After eliminating 15 duplicate documents, 61 were excluded because they did not fulfill the inclusion criteria. Finally, 13 documents were selected for analysis.

The detailed search process is illustrated in Figure 1.

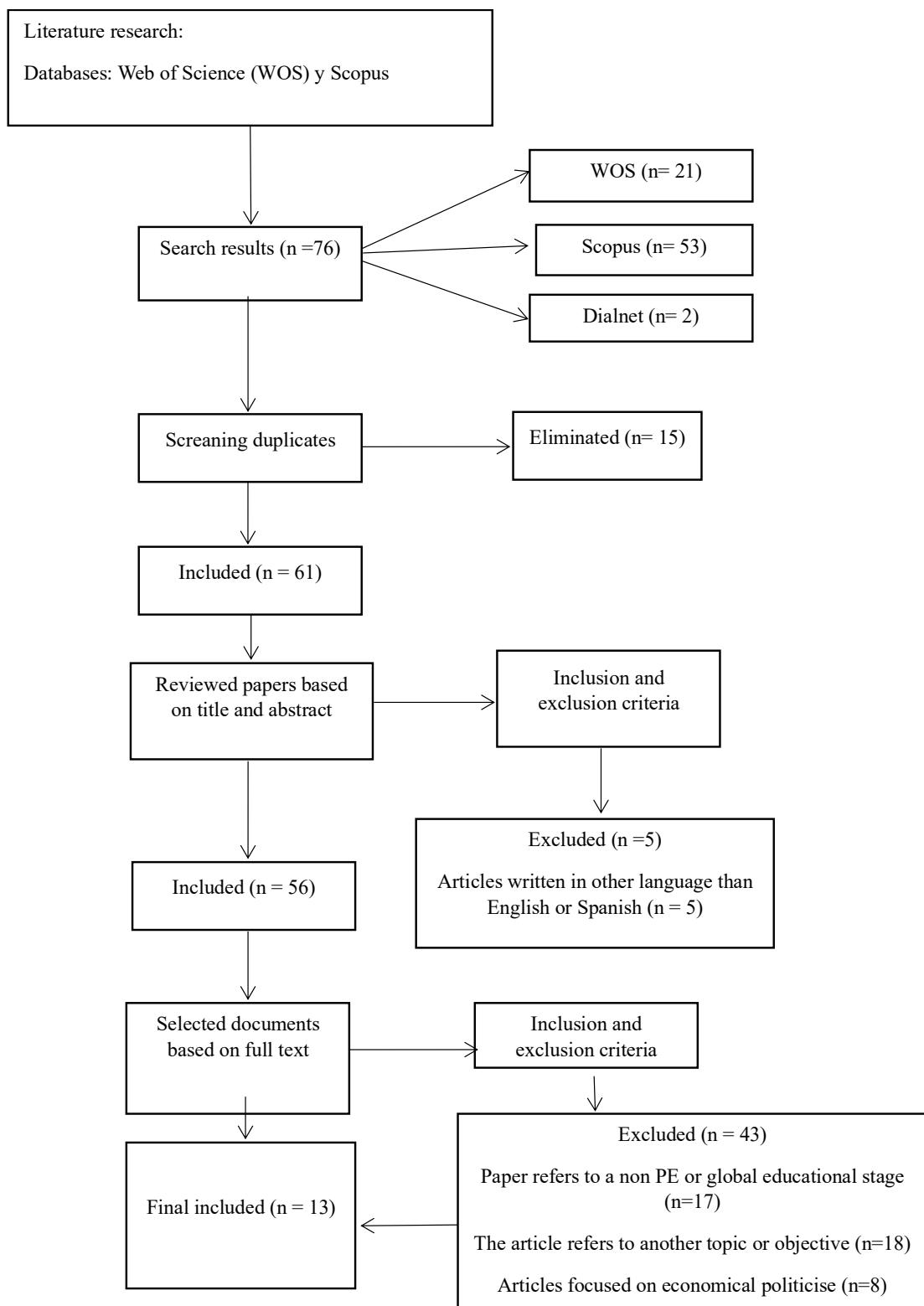


Figure 1. Search flowchart.

Following the final selection of full-text articles, a quality assessment was conducted on the 13 included studies. The evaluation was based on key criteria: clarity of objectives, appropriateness of methodology, description of participants, transparency of data collection instruments, relevance to SDG 4 (particularly targets 4.1 and/or 4.7), and evidence-based results.

Only documents that had undergone peer review were considered eligible for inclusion. Two researchers independently assessed each article to ensure consistency, and any discrepancies were resolved through consensus.

No studies were excluded based on the outcomes of this quality assessment. However, the evaluation served to contextualize the interpretation of the findings, providing a more accurate understanding of the strength, reliability, and potential limitations of the available evidence.

Results

The 13 articles selected for the review were research studies published in English and Spanish.

Although the literature search extended up to November 2024, the selected studies were written between 2017 and 2024, which ensured up-to-date results on SDG targets 4.1 and 4.7 in PE. The studies were mainly conducted in countries of Africa (6), and also in Asia (4) and in Europe (3).

Six studies used quantitative methodology (46.15 %; N = 6), 4 qualitative (30.76 %; N = 4), gamification (7.7 %; N = 1), and two were mixed studies (15.39 %; N = 2).

Some assessment instruments overlapped across studies, with 6 used in the 13 selected articles. These were four interviews (28.56 %; N = 4), two questionnaires (15.38 %; N = 2), Three surveys (21.42 %; N = 3), three Observation (21.42 %; N = 3), 1 game (7.14 %; N = 1) and 1 objective exams (7.7 %; N = 1). All the information is detailed in Table 2, which lists the authorship, year of publication, purpose, sample, country, methodology with evaluation instrument, and main results.

Table 2. Summary of the main characteristics and results of selected studies

Author	Objectives	Sample	Country	Method	Results
Hoang et al. (2020)	Improving the quality of the educational curriculum of primary schools in Vietnam by developing a curriculum evaluation tool.	School head teachers, teachers, and administrators.	Vietnam	A qualitative tool: 48 interviews and a bibliography. Documental Analyses (normative)	Countries must create their own rubric to evaluate their educational curriculum.
Donkoh et al. (2023)	To identify the effects of educational management on quality education in rural and urban primary schools in Ghana, and the impact of the use of the internet	745 urban and 471 rural head teachers and teachers of primary education	Ghana	A quantitative methodology, such as a survey	Educational management and internet facilities positively impact the quality of education in urban and rural primary schools, with the absence of internet weakening this effect. Higher educational quality is observed in urban schools compared to rural ones in Ghana.
Lee et al. (2020)	Achieve quality teaching through best practices supporting improvements in early literacy instruction in sub-Saharan Africa, such as teacher training for SDG 4.	20 primary school teachers who receive literacy training.	Mozambique	A qualitative mixed-methods approach, including Individual interviews with teachers and observation of their professional practice in the primary classroom. Bibliography.	Teachers improved the students' reading and writing skills by applying the knowledge acquired in literacy training.

Author	Objectives	Sample	Country	Method	Results
Liu and Shiau (2020).	Raise awareness through SD Training by proposing an evaluation framework for elementary school teaching. Materials for SD.	20 teaching or SD experts to propose the evaluation framework, and 5 teachers for the case study.	Taiwan	Mixed methodology: quantitative and qualitative. A bibliographic review, interviews, and Delphi and AHP questionnaires analysed the framework, with a sustainability scorecard created and a Taiwanese school case study presented.	The sustainability scorecard created provides a convenient way to evaluate SD teaching materials in a school. Current textbooks can be modified following this framework
Lucas-Oliva et al. (2022)	Achieving equity in education: Assessing equity and parity in Andalusian schools and their relationship with mathematical and linguistic performance.	79.806 students of 1598 public schools and 494 private schools	Spain	A quantitative methodology. Descriptive statistics on the Escala tests (Writing, Calculation, and Reading in Andalusia) for mathematical reasoning, linguistic communication, and a family context questionnaire.	Greater school effectiveness translates into greater equity and parity in student outcomes.
Molina-Ayuso et al. (2024)	Achieving quality education through technology by developing computational thinking activities in mathematics to enhance learning.	66 students in the 5th grade of primary school, aged between 9 and 11, from 3 schools.	Spain	Mixed: quantitative and qualitative with a quasi-experimental design. Teachers were trained in Scratch, and students engaged in geometry activities for three months. Semi-structured interviews were conducted with teachers and paired interviews with students.	Participants consider the inclusion of resources that fosters computational thinking essential for quality education, and advocate for a methodological shift in the classroom and emphasize the importance of initial Scratch training for teachers.
Mukherjee et al. (2022).	Establishing a roadmap for school governance to achieve SDG 4 in India	21 public and private rural primary schools.	India	A quantitative methodology, such as a survey	Strong school governance at the basic level is absolutely necessary, and it is sorely lacking in public schools in rural India.
Sá et al. (2023)	Assessing the effectiveness of a serious game on ecological footprint, developed through EDR, in raising sustainability awareness in primary education	20 students in the 3rd year of primary school.	Portugal	Methodology. Gamification Creation of the game, Sustainability in play through interactivity, multiple participants, different validations, and multidisciplinary collaboration.	The relevance, appropriateness, and effectiveness of the EDR approach in developing educational resources to raise awareness of the impact of choices and the importance of balanced consumption.
Andries et al. (2022)	Determining the size of teaching spaces in Nigerian rural schools and assessing overcrowding to ensure adequate study space for quality learning.	1900 rural primary schools	Nigeria	A qualitative methodology - Instruments: satellite Earth Observation (EOE) and Nigerian government data. In a sample of 1900 randomly selected rural primary schools.	81,4 % of surveyed schools were overcrowded, based on Nigeria's Federal Government standard of at least 1.2 m ² of classroom space per student.

Author	Objectives	Sample	Country	Method	Results
Vanner (2019)	Determining whether gender equality and equity in education are being implemented in the performance of primary schools in Kenya.	31 students and 13 teachers from two primary schools in Kenya.	Kenya	A qualitative methodology. Participant observation and interviews	Some teachers proactively advocated for gender safety in the two schools, while others exercised and reinforced various forms of gender-based violence, indicating the existence of competing gender narratives.
Wang et al. (2021)	Examining whether student performance on computer-based tests declined during the pandemic and whether future tests hinder the achievement of SDG 4.	381 students (199 boys and 182 girls), approximately 11 years old.	Taiwan	A quantitative methodology: Experimental design with objective multiple-choice tests.	Test takers were shown to perform better on multiple-choice computer-based tests.
Iddrisu et al. (2017)	Examine the factors influencing school enrolment and dropout in Ghana to inform policies that improve attendance and support SDG 4.	Boys and girls between 6 and 19 years old.	Ghana	A quantitative approach based on a desk review of the Ghana Living Standards Survey (GLSS 6).	Family resources, parental education, income, and the gender of the household head affect children's schooling decisions. Educated parents are more likely to enrol their children, underscoring the importance of adult education as student numbers decline with each transition.
Elom et al. (2024)	Investigating the impacts of information and communication technologies and electricity access on children's education in Africa to determine if quality education can be achieved.	Documentation from the World Bank's World Development Indicators Database. (Banco Mundial, 2023)	25 African countries *	A quantitative methodology through data analysis.	While having electricity at home did not increase enrolment in primary schools, internet use did, and ICT use improved academic performance.

Note: *Algeria, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Egypt, Djibouti, Ethiopia, Ghana, Lesotho, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Niger, Nigeria, North Macedonia, Rwanda, Senegal, South Africa, Tanzania, Togo and Uganda. Source: own elaboration

The 13 studies analysed, published between 2017 and 2024 and conducted primarily in African countries, as well as in Asia and Europe, proposed various strategies aimed at strengthening the achievement of SDG 4 targets 4.1 and 4.7 in primary education. The following is a synthesis of the approaches and scopes adopted.

Regarding curriculum quality and resources, Hoang et al. (2020) proposed an evaluation tool that enables schools to adapt their educational programmes to principles of quality and relevance aligned with SDG 4. Liu and Shiau (2020) developed a sustainability scorecard for assessing teaching materials, strengthening the integration of competencies linked to Target 4.7.

Regarding educational management and governance, Donkoh et al. (2023) demonstrated that effective school management and internet access enhance educational quality (target 4.1), although inequalities persist between urban and rural areas. Mukherjee et al. (2022) highlighted the need to strengthen school governance in rural areas of India. Andries et al. (2022) warned that overcrowding in rural Nigerian classrooms is a critical obstacle to ensuring quality education.

In pedagogical innovation and performance, Lee et al. (2020) showed that teacher training in literacy improves students' basic skills, contributing directly to Target 4.1. Similarly, Molina-Ayuso et al. (2024) indicated that the incorporation of computational thinking fosters

meaningful learning, while Wang *et al.* (2021) found that the virtualisation of teaching did not negatively impact academic performance during the pandemic.

In terms of equity and inclusion, Lucas-Oliva *et al.* (2022) concluded that educational inclusion promotes greater levels of equity in academic achievement, consolidating it as a key strategy for enhancing educational quality. Vanner (2019) pointed out that educational equity remains challenging in contexts marked by patriarchal cultures, such as some African countries. Iddrisu *et al.* (2017) highlighted that socio-economic factors, such as parental education levels, household income, and the gender of the head of household, critically influence school access and retention, underscoring the urgent need for educational policies that guarantee universal, non-discriminatory access to education.

Finally, regarding sustainability and technology, Sá *et al.* (2023) demonstrated the effectiveness of playful strategies in raising awareness about responsible consumption and sustainability (target 4.7). Similarly, Elom *et al.* (2024) identified that internet access fosters learning and improves academic performance, emphasising the importance of ensuring equitable access to information and communication technologies to achieve global educational objectives.

Discussion

Transforming education is essential to align it with the global and sustainable agenda. SDG 4 –particularly targets 4.1 and 4.7– emerges as the backbone of the 21st-century school model (United Nations, 2024). Raising awareness of the importance of educating for sustainability is crucial, fostering critical and reflective thinking that enables individuals to make decisions that respect humanity and the environment (Martínez-Murciano and Pérez-Jorge, 2023a; Sawamura, 2020).

There is a growing concern about promoting responsible environmental habits through education in developing countries, such as many African nations and those with significant pollution issues like India. Efforts to improve early literacy skills and incorporate technology are key to enhancing teaching quality from the earliest stages.

Several studies have stressed the importance of curriculum improvement and governance. Hoang *et al.* (2020), Liu and Shiao (2020), Mukherjee *et al.* (2022), and Wang *et al.* (2021) highlight initiatives in Taiwan, India, and Vietnam to develop evaluation tools, improve educational governance, and integrate sustainability into the curriculum, in line with recommendations by

UNICEF (2000). Iddrisu *et al.* (2017) and Ibarra-Carrasco and Camacho-Rodríguez (2022) also emphasise the role of strong leadership teams in achieving educational equity. As UNESCO (2023b) points out, the social and personal transformation required to advance towards sustainability must be rooted in education.

The role of ICT in improving educational outcomes is another key finding (Pérez-Jorge *et al.*, 2016; Mora *et al.*, 2020). Donkoh *et al.* (2023), Elom *et al.* (2024), Molina-Ayuso *et al.* (2024), and Sá *et al.* (2023) stress the need for universal internet access, which facilitates learning and enhances academic success. Furthermore, Molina-Ayuso *et al.* (2024) recommend integrating visual programming languages such as Scratch across all educational levels, as also proposed by Martínez-Murciano and Pérez-Jorge (2022, 2024). Gamification, supported by ICT tools, is recognised as a powerful educational strategy to enhance motivation and learning, particularly in early childhood (TEDxYouth, 2011; Molina-Ayuso *et al.*, 2024; Martínez-Murciano and Pérez-Jorge, 2023c; Aprendemos juntos 2030, 2018).

Teacher training emerges as a critical element. Lee *et al.* (2020) and Molina-Ayuso *et al.* (2024) underline the importance of equipping teachers with literacy techniques and computational skills. Elom *et al.* (2024) and Iddrisu *et al.* (2017) advocate for continuous professional development to ensure inclusive education for all learners. This is consistent with the recommendations of Escrivà (2023) and UNESCO (2024), who call for multilateral support for teacher education curricula oriented towards sustainability. However, as Escrivà (2023) warns, there is a risk that sustainability discourses may become co-opted by market-driven agendas, potentially diluting their transformative potential.

Issues of equity and inclusion are equally central. Lucas-Oliva *et al.* (2022), Vanner (2019), and Carvalho *et al.* (2024) highlight the ongoing challenges related to gender equality in primary education, especially in contexts shaped by patriarchal cultures. García Luque (2016), Ibarra-Carrasco and Camacho-Rodríguez (2022), Martínez-Murciano and Pérez-Jorge (2023c), Serrano Arenas and Ochoa Cervantes (2023) propose concrete strategies and resources to promote inclusive citizenship education, a view supported by Donkoh *et al.* (2023), Lucas-Oliva *et al.* (2022), Obadahun *et al.* (2024), and UNESCO (2021).

Another persistent challenge is ensuring enrolment and retention in education. Wang *et al.* (2021) and Iddrisu *et al.* (2017) highlight the urgent need to increase primary school enrolments in

Africa and to sustain learners through higher educational stages. Comenius' vision of universal education (1986) remains a goal yet to be fully realised.

Finally, infrastructure issues must not be overlooked. Andries *et al.* (2022) demonstrate that inadequate classroom space in many rural African schools hampers both learning conditions and emotional well-being. Adequate study environments are essential for fostering quality education. In contrast, Quesada-Chaves (2019) reports better infrastructural conditions in regions such as the Central Pacific, illustrating the disparities that must be addressed to achieve SDG 4 globally.

Conclusions

The findings obtained from the analysis of the selected documents support the initial objectives of this study. Although education in developing countries still differs from that in developed countries, important actions are being taken to achieve SDG 4, particularly regarding equity and gender equality. Based on the evidence reviewed, the following key conclusions can be drawn:

- *Equity and gender equality:* Significant improvements have been made in promoting gender equality in schools, although resistance persists in some contexts to adopting more gender-sensitive educational approaches.
- *Poverty and digital divide:* Developing countries face significant challenges related to poverty, digital access, curriculum development, and infrastructure gaps. In Africa, primary school teachers are primarily trained in basic literacy skills, while teachers in wealthier countries receive training in programming and robotics.
- *Early enrolment:* Increasing school enrolment, especially at early ages, remains a priority to achieve universal access to education. Family awareness of the importance of early schooling is critical to this objective.
- *School leadership:* Effective school leadership and management are crucial to achieving excellence in education, ensuring coherence between planning, implementation, and evaluation processes.
- *Curriculum and assessment:* Both curriculum design and assessment methods are vital for quality education. We need to shift from reliance on final tests to continuous assessment approaches. Online assessment, particularly multiple-choice formats, has proven effective when properly implemented.

- *Sustainability education:* Raising sustainability awareness among primary school pupils is essential. Interactive games based on the Educational Design Research (EDR) approach have demonstrated effectiveness in fostering awareness of the environmental impact of individual choices and promoting responsible consumption habits.
- *Government responsibility:* Achieving SDG 4 targets requires more substantial governmental commitment. Governments should develop curriculum evaluation rubrics tailored to their national contexts and invest in improving educational infrastructures and resources to ensure equity.
- *Teacher training:* Literacy instruction should be based on teachers' strong understanding of child development and lesson planning. Well-trained teachers are better equipped to adapt literacy lessons to students' developmental levels, ensuring more effective learning outcomes.
- *Schools as ecological systems:* It is essential to examine schools as ecological systems with multiple levels of influence. Current textbooks should also be reviewed to ensure alignment with SD principles, making necessary modifications where gaps are identified.

Limitations of the study and future lines of action

The main challenge in this study was identifying empirical research that objectively evaluated progress towards achieving SDG 4 targets in primary education. Most studies analysed are based on highly localised experiences, and their results are not easily generalisable.

Moreover, the regional concentration of research, particularly in African countries, highlights the need to expand future studies to other regions to obtain a more global and comprehensive understanding of the implementation process of SDG 4 in primary education.

We recommend the design of longitudinal studies and mixed methods approaches that allow for the evaluation of the long-term impact of educational interventions, combining quantitative measurements with in-depth qualitative analysis. Similarly, multicentric comparative studies would strengthen the external validity of the findings and facilitate the transfer of good educational practices.

These limitations underscore the need to develop practical models that promote educational quality and foster awareness of SD from the earliest educational stages.

Contributions (CRediT taxonomy)

Contributions	Authors
Conception and design of the work	Authors 1, 2
Documentary search	Authors 1, 2
Data collection	Authors 1, 2
Critical data analysis and interpretation	Authors 1, 2
Version review and approval	Authors 1, 2

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