

Educational Media for Enhancing Sexual Awareness in Children with Intellectual Disabilities: A Systematic Literature Review and Bibliometric Analysis

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<https://doi.org/10.17977/um065.v7.i1.2027.6>

Article history

Submitted: 7 May 2026

Revised: 29 July 2026

Accepted: 4 August 2026

Published: 5 August 2026

Keywords

Augmented reality

Inclusive education

Intellectual disability

Interactive book

Sexual awareness

Abstract

This study aims to analyze global publication trends and synthesize the mapping of design components, focus, and key findings from studies on the development of educational media based on sexual awareness for children with intellectual disabilities. The study was conducted through a systematic literature review from 2010–2026 using a qualitative descriptive approach with bibliometric and meta-aggregation analyses. The results indicate that only a few studies specifically address the development of educational media for children with intellectual disabilities and sexual awareness. Most studies focus on the use of innovative media such as Augmented Reality (AR), and empirically, learner-centered and play-based approaches have demonstrated higher effectiveness in children's engagement and learning outcomes. The limitations identified in the reviewed literature indicate that the educational media currently developed generally still rely on broad validation instruments rather than those specifically designed according to children's developmental stages and socio-cultural contexts. Furthermore, studies have not adequately integrated children's social-emotional focus and interactive technologies such as immersive AR to support contextual and meaningful understanding. The practical implications of this study highlight the importance of developing educational media that are culturally adaptive, relevant to local contexts, and capable of integrating a learner-centered approach with a developmentally sensitive framework in designing focus components, syntax, and social systems for sexual education media that remain underexplored in previous literature.

1. Introduction

Children with intellectual disabilities face complex challenges in understanding basic concepts of the body, including recognizing which body parts may and may not be touched by others. This condition is exacerbated by limited cognitive abilities and weak information processing skills independently. Various studies indicate that individuals with intellectual disabilities are far more vulnerable to sexual violence than the general population, making educational media specifically tailored to their needs urgently necessary to develop (Sainafat et al., 2025). Augmented Reality (AR)-based interactive books emerge as an innovative solution in Indonesia that is highly relevant and not yet structurally implemented in special schools. As a medium that integrates visual, audio, and interactive elements in an engaging manner, this technology can help children with special needs understand sexual awareness material more concretely and contextually. However, the currently available curriculum has not specifically accommodated the needs of children with intellectual disabilities. The absence of educational media that are user-friendly for children with intellectual disabilities has made the delivery of sexual awareness material less effective (Maharani et al., 2025). Moreover, the phenomenon of sexual violence among children with intellectual disabilities has not been adequately explored academically because many cases remain undisclosed due to communication barriers, social stigma, and limited family support for reporting incidents. According to data from the Indonesian Child Protection Commission (KPAI), victims of sexual violence often experience difficulties in recognizing harmful actions, understanding personal boundaries and privacy, and processing traumatic experiences due to previous irrational thought patterns (Marlina et al., 2023).

Interactive books, as a form of learning media, have significant potential in delivering sexual awareness materials and attracting the attention of children with special needs. Media that supports active learning

engagement and allows gradual learning simulation has become increasingly important, especially in the digital era, to stimulate progressive understanding. The integration of Augmented Reality (AR) technology into interactive books introduces a new dimension in learning, where digital content can be directly presented through smart devices, creating a more immersive and contextual learning experience for children with intellectual disabilities (Putra et al., 2026). AR technology integrated with interactive books enables children to visually, auditorily, and experientially interact with learning content. The use of AR in presenting virtual objects within real-world environments in real time is considered highly suitable for children with intellectual disabilities who require concrete and direct visual representations. Previous studies have confirmed that the application of AR in inclusive education settings can reduce communication barriers and significantly increase students' active participation (Ramadhan et al., 2021).

Nonetheless, the development of AR-based media specifically designed to deliver sexual awareness material for children with intellectual disabilities remains highly scarce in scientific literature. This gap reflects a real need for educational media innovation that considers not only technological aspects but also pedagogical, ethical, and content suitability tailored to the developmental characteristics of children with intellectual disabilities. User-centered design media development is key to the successful implementation of this technology in special education environments (Azhar et al., 2023). Based on the description above, there is a strong urgency to develop an Augmented Reality-based interactive book media designed specifically to enhance the sexual awareness of children with intellectual disabilities. The development of this media is expected to provide a concrete solution to the limitations of existing learning media, while offering a tangible contribution to improving the protection and well-being of children with intellectual disabilities through appropriate, safe, and meaningful sexuality education (Zhang et al., 2026).

The urgency of this systematic and accessible model is reinforced by research findings on post-sexual abuse management for deaf women (The Importance of Sign Language Use in Post-Sexual Abuse Treatment Models) (Marlina et al., 2022). The study emphasizes that communication barriers are the primary obstacle for individuals with disabilities in understanding and reporting sexual issues, meaning that provided interventions must utilize specific communication modalities (Marlina et al., 2022). Therefore, the Focus, Syntax, and Social System components in the development of this AR-based interactive book are deliberately designed to overcome these barriers, ensuring that sexual awareness messages can be concretely understood by children with intellectual disabilities.

In addition to communication modalities, the integration of technology in structuring these learning components is also supported by global research trends. A bibliometric study on Technological Pedagogical Content Knowledge (TPACK) in science education (Technological Pedagogical Content Knowledge in Chemistry Education) asserts that mastering the technological aspect (Technological Knowledge) has now become a crucial, inseparable part of pedagogical strategies and content knowledge mastery (Marlina et al., 2023). Through this framework, the development of an Augmented Reality (AR)-based interactive book acts as a concrete embodiment of TPACK, where the visual utilization of AR technology is specifically designed to facilitate the delivery of sexual awareness content for children with intellectual disabilities.

Therefore, learning about sexual awareness for children with intellectual disabilities requires an approach that is not only concrete and engaging but also well-structured. In this context, the use of an Augmented Reality (AR)-based interactive book is designed not merely as entertainment media, but as an integral part of a directed learning model. A learning model itself serves as a instructional reference implemented based on specific systematic learning patterns (Marlina, 2019). In order for the implementation of this AR-based interactive book to achieve optimal results for children with intellectual disabilities, its development must refer to the main components of a learning model.

On that basis, the main components of the learning model are fully integrated into this study to produce an AR-based interactive book development product that is valid, practical, and effective in improving the sexual awareness of children with intellectual disabilities. Through this development, this study is expected to provide both theoretical and practical benefits. Theoretically, this research contributes to the development of special education, specifically in the field of technology-based learning media development for children with intellectual disabilities. Practically, the results of this study can be utilized by special education teachers as an innovative learning media reference, by parents as a guide in providing sexuality education at home, and by educational technology developers as a reference in designing inclusive, safe AR applications tailored to the needs of children with special needs.

Based on the urgency of sexual violence phenomena and the limitations of accommodative educational media for children with intellectual disabilities, this study systematically reviews global literature to address several key questions. First, this study maps the trends and developments in the scientific research landscape regarding the use of Augmented Reality (AR) in special education, particularly to facilitate sexual awareness learning for children with intellectual disabilities. Second, the analysis is directed toward identifying the design characteristics, pedagogical principles, and main components of AR-based learning media identified by the

literature as effective for improving their sexual awareness. Finally, this research explores the gaps found in the current literature to formulate comprehensive conceptual recommendations for developing an Augmented Reality-based interactive book that is both relevant and user-friendly for children with intellectual disabilities.

2. Method

2.1. Research Design and Data Sources

This study employs a systematic literature review approach to examine the development of augmented reality-based interactive books for enhancing the sexual awareness of children with intellectual disabilities. This method aims to systematically identify, evaluate, and synthesize relevant literature to obtain a comprehensive overview of the practices, challenges, and interventions in developing augmented reality-based interactive books to improve sexual awareness in children with intellectual disabilities. The review process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines developed by Snyder (2019), thereby promoting consistency and minimizing bias to ensure transparency, objectivity, and rigor in the literature selection process.

The PRISMA approach in this study comprises three main stages: identification, screening (including eligibility assessment), and literature inclusion. Each stage is meticulously conducted to ensure that the analyzed sources possess validity, relevance, and a clear contribution to the development of augmented reality-based interactive books for enhancing the sexual awareness of children with intellectual disabilities. The detailed workflow is illustrated in the PRISMA flowchart.

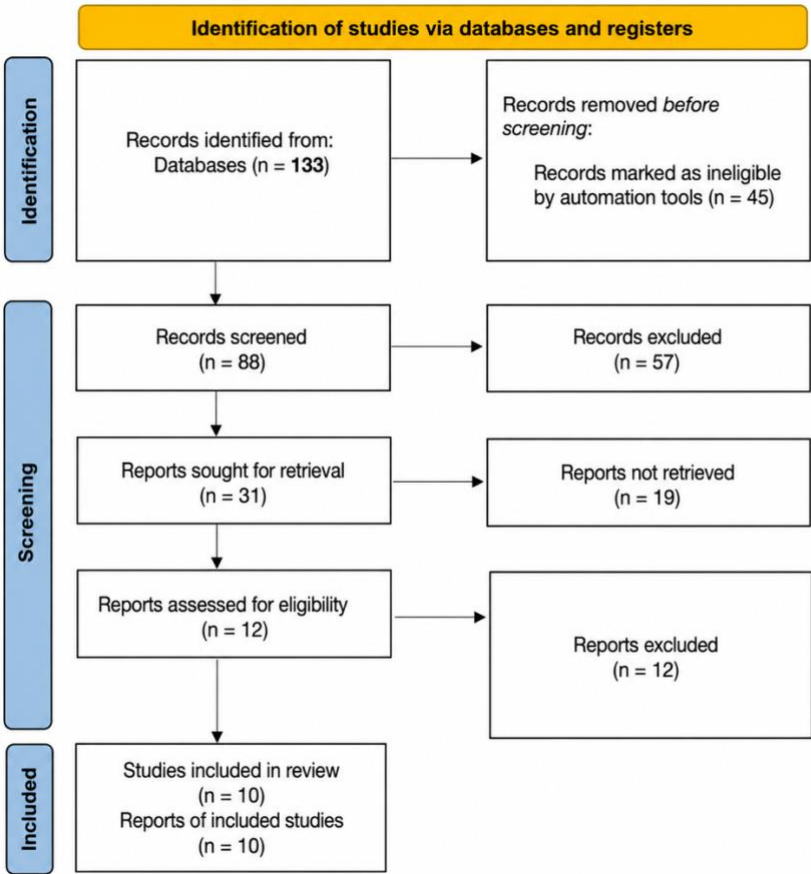


Figure 1. PRISMA Flowchart

2.2. Database

A literature search was conducted using the scopus.com academic database, which aggregates articles from various scientific journals, offering broad and diverse coverage. The selection of this database ensures access to multidisciplinary research, allowing for a comprehensive review of the topic explored in this study. This timeframe ensures the inclusion of recent and relevant studies. A structured literature search was performed using the scopus.com database, utilizing structured search terms to capture a comprehensive range of studies related to augmented reality-based interactive books for improving the sexual awareness of children with intellectual disabilities.

The literature search process in this study was conducted by developing a search string strategy divided into three main components. The first component focuses on the research subjects, which includes the terms "intellectual disability" or "developmental disabilities". The second component focuses on the educational intervention, utilizing a combination of the keywords "sex education", "body safety", or "abuse prevention". Meanwhile, the third component focuses on the type of media or approach utilized, incorporating terms such as "technology", "media", "visual", "book", "intervention", or "program". These three groups of keywords were then combined using Boolean operators to ensure that the articles retrieved from the database were highly relevant to the focus of the study.

2.3. Data Inclusion and Exclusion Criteria

In conducting a systematic literature review, a crucial initial step is defining the study's scope to ensure the analysis remains focused and relevant. Therefore, researchers established standard benchmarks to distinguish between eligible articles and those to be eliminated. The detailed inclusion and exclusion criteria used as the primary guidelines in this literature selection process are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria for Literature Selection

No	Category	Criteria
1	Exclusion Criteria	Document type limited to books
		Publications written in languages other than English
		Publications published outside the period of 2016 to May 2026 publication range, accessed on Friday, May 22, 2026, at 01:00 AM GMT
2	Inclusion Criteria	Document type limited to journal articles
		Articles written in English
		Articles published within the period of 2016 to May 2026 range, accessed on Friday, May 22, 2026, at 01:00 AM GMT

2.4. Data Analysis

Secondary data extracted from literature searches across various reference sources were analyzed descriptively. Descriptive analysis was employed to systematically map and synthesize research trends, design characteristics, pedagogical principles, and identified gaps in the literature regarding the development of augmented reality-based interactive books for children with intellectual disabilities. The analysis process was structured based on the research questions formulated in this study, enabling the researchers to critically evaluate findings from diverse previous studies and formulate sound conceptual recommendations for future media development.

2.5. Documents Included in the Analysis

Following the screening and eligibility processes, 10 documents that met the inclusion criteria were selected for further analysis. Figure 1 illustrates the selection process. The dataset was merged into a CSV file for bibliometric analysis using RStudio and Bibliometrix. This approach integrates empirical and systematic literature, thereby providing insights regarding augmented reality-based interactive books for enhancing the sexual awareness of children with intellectual disabilities.

2.6. Quality and Credibility

Based on the data audit results in Table 2, the quality and credibility of this dataset are assessed to be exceptionally high, meeting the academic rigor standards for bibliometric analysis and Systematic Literature Review (SLR). This high credibility is demonstrated by the standardization of international bibliographic parameters and metric transparency, which presents a consistently missing data trend from 2020 to 2026. In terms of completeness quality, this dataset possesses robust primary data integrity; 12 out of 15 core parameters including crucial components such as title (TI), author (AU), abstract (AB), publication year (PY), source journal (SO), total citations (TC), and DOI (DI) recorded a 0% missing percentage, achieving an "Excellent" rating.

Despite local limitations within the keyword parameters specifically a 10% missing data rate in Author Keywords (DE) rated as "Good" and 40% in Keywords Plus (ID) rated as "Poor" the keyword co-occurrence analysis remains valid by focusing on the DE elements. The sole data anomaly found was within the Science Categories (WC) element, which was "Completely Missing" (100% missing data); consequently, this parameter was deemed incredible and was eliminated from subsequent analysis stages. Overall, these limitations in non-primary elements do not diminish the validity of the study. The dataset is declared highly eligible and reliable for use, as all its fundamental components are perfectly clean and free from information bias risks.

As a tactical mitigation step to ensure methodological credibility, the structural and conceptual mapping in this study was strictly shifted from co-citation analysis based on subject categories (WC) to keyword co-occurrence analysis (co-word analysis) focusing entirely on Author Keywords (DE), as well as citation

performance analysis (TC) to map the document kinship network (document coupling). This decision was made to maintain visualization quality, where screening optimization ensures that data reduction in the WC and ID variables does not compromise the validity of knowledge cluster formation (visualization of similarities); instead, it enhances analytical precision regarding real literature dynamics. Consequently, this strategic adjustment serves as evidence of scientific rigor, ensuring that the interpretation of the research's intellectual structure is free from data bias, remains capable of projecting the scientific landscape objectively and credibly, and is able to explore emerging themes with reliable accuracy without the risk of distortion caused by the missing secondary data.

Table 2. Completeness of Bibliographic Metadata

Code	Metadata Element	Missing Amount	Percentage (%)	Status
AB	Abstract	0	0%	Excellent
C1	Affiliation	0	0%	Excellent
AU	Author	0	0%	Excellent
CR	Cited References	0	0%	Excellent
RP	Corresponding Author	0	0%	Excellent
DI	DOI	0	0%	Excellent
DT	Document Type	0	0%	Excellent
SO	Journal	0	0%	Excellent
LA	Language	0	0%	Excellent
PY	Publication Year	0	0%	Excellent
TI	Publication Year	0	0%	Excellent
TC	Total Citation	0	0%	Excellent
DE	Keywords	1	10%	Good
ID	Keywords Plus	4	40%	Poor
WC	Science Categories	10	100%	Missing

2.7. Data Analysis

The type of data analysis used is thematic analysis with a narrative synthesis approach. This approach was chosen because the data obtained from the included studies are qualitative and descriptive quantitative, and show diversity in methodology, context, and forms of augmented reality-based interactive books to increase sexual awareness in children with intellectual disabilities.

3. Results and Discussion

3.1. Results

3.1.1. Main Findings

Based on the synthesis process conducted on the articles meeting the inclusion criteria, variations in methodology, research question focus, and essential main findings were identified. A comprehensive summary of these key findings is presented in Table 3. Generally, the data synthesis indicates that sexuality education and sexual violence prevention interventions for individuals with intellectual disabilities require highly structured, concrete, and active subject engagement-based approaches.

The results of the systematic synthesis of ten global articles (2020–2026) indicate a strong methodological and substantial urgency regarding the importance of transforming sexual awareness learning media for children with intellectual disabilities. The majority of the literature, utilizing both participatory qualitative approaches (co-design) and experimental designs, consistently emphasizes that the low level of knowledge regarding sexual violence prevention within this group is a tip-of-the-iceberg phenomenon, which is further exacerbated by cultural taboos and educator discomfort. Empirical findings from these various studies prove that conventional, abstract lecture-based interventions tend to fail in overcoming children's cognitive barriers. Conversely, the implementation of digital technology innovations based on concrete visual stimulation and user-centered design (user-centered design) is proven effective in increasing active engagement, clarifying the understanding of personal boundaries (personal boundaries), and strengthening children's communication modalities in reporting danger. Accordingly, concrete and interactive visualization is identified as the most critical core outcome indicator (Core Outcome Set) to bridge abstract information-processing barriers while simultaneously cutting down children's vulnerability to sexual violence.

Table 3. Main Findings from Articles Included in the Synthesis

Author & Year	Title	Design	RQ Focus	Key Findings
(Gjertsson et al., 2026)	Maybe rape is illegal?" how adolescents with intellectual disabilities experience a sexual violence prevention intervention	Qualitative (Case Study / Phenomenology)	How do adolescents with intellectual disabilities understand and experience sexual violence prevention interventions?	Interventions increase basic legal understanding, but adolescents require concrete visualization to differentiate between consensual interactions and violations of personal rights.
(Frawley & O'Shea, 2020)	Nothing about us without us': sex education by and for people with intellectual disability in Australia	Participatory-Based Qualitative (Co-design)	How effective is sex education designed directly by and for individuals with intellectual disabilities?	The principle of user-centered design is highly crucial. The active involvement of people with disabilities produces media that is much more user-friendly and applicable.
(Lam et al., 2022)	Challenges in the delivery of sex education for people with intellectual disabilities: A Chinese cultural-contextual analysis	Descriptive Qualitative / Context Analysis	What are the cultural and contextual barriers in delivering sex education for individuals with intellectual disabilities?	Social stigma and cultural taboos cause sexual awareness materials to often be delivered implicitly/latently. Interactive learning media is needed to bridge this communication barrier.
(Gil-Llario et al., 2023)	People with intellectual disabilities' sexuality from three different perspectives: Parents, professionals, and themselves	Mixed-Methods Survey	What is the cross-perspective among parents, professionals, and individuals with intellectual disabilities regarding their sexuality?	There is a misalignment of perception; teachers/parents often feel unprepared or uncomfortable. Structured learning instruments that align the perceptions of these three parties are required.
(Frawley et al., 2024)	Sexuality and relationship education programmes for people with intellectual disability: innovations and challenges	Systematic Review / Program Evaluation	What are the latest innovations and main challenges in implementing sexuality and relationship education programs?	Digital technology innovations (such as the integration of guided visual elements) are proven to strengthen children's active engagement, but the challenge lies in the standardization of pedagogical content.
(Greene et al., 2024)	Development of a sexual consent intervention for adolescents with intellectual and developmental disabilities	Development (R&D) / Quasi-Experiment	How to develop an effective intervention to teach the concept of sexual consent to adolescents with disabilities?	Developing modules that include personal boundaries requires repeated stimulation. Concrete visual representations significantly help bridge abstract cognitive barriers.
(Mansur et al., 2024)	Assessing sexual-abuse prevention knowledge and related factors among adolescent girls with intellectual disabilities in Padang: a cross-sectional study	Quantitative Cross-Sectional	What factors influence the level of sexual violence prevention knowledge among adolescent girls with intellectual disabilities in Padang?	The general knowledge level is still low (tip of the iceberg phenomenon). Communication barriers and the limitations of locally specific learning media heighten their vulnerability.
(Estruch-García et al., 2025)	An Affective-Sexual Education Program for People With Moderate Intellectual Disabilities: Analysis of Its Effectiveness in the Spanish Context	Experimental (Pre-Post Test Control Group)	Is a structured affective-sexual education program effective in increasing the understanding of individuals [with	Empirically structured programs are proven to increase the ability to recognize abusive acts and change inappropriate sexual behaviors. (Completed contextually)

Author & Year	Title	Design	RQ Focus	Key Findings
			moderate intellectual disabilities]?	
(Brown et al., 2026)	One Size Does Not Fit All'. The Voices of Professionals Regarding the Delivery of Relationships and Sexuality Education to Children and Young People With Intellectual Disability: Findings From a UK-Wide Qualitative Study	Qualitative (National Qualitative Study)	What are the perspectives of professionals regarding delivery approaches for sexuality education that cannot be generalized?	Conventional approaches fail because the characteristics of each child are unique. A user-centered approach and the integration of adaptive immersive technology are highly needed to customize the depth of material individually.
(Paulauskaite et al., 2025)	Stakeholder perspectives on Relationships and Sex Education outcomes for students with intellectual disability to inform the development of a Core Outcome Set: a qualitative study	Consensus Qualitative (Focus Group Discussion)	What are the agreed-upon Core Outcome Sets by stakeholders for the success of sex education?	The main outcomes that must be achieved include increased self-awareness (body safety), the ability to report danger (communication modalities), and a meaningful understanding of self-protection.

3.1.2. Demographic Distribution Results

This study analyzes 10 research articles concerning the development of Augmented Reality (AR)-based interactive book media to increase children's awareness, published within the timeframe between 2020 and 2026. The data in Figure 2 shows a positive and significant Annual Growth Rate reaching 20.09%, which indicates an escalation of academic interest as well as a high urgency toward the integration of immersive technology in contemporary educational media. A total of 45 authors contributed to these publications, where not a single article was written individually (0 authors in single-authored articles). The level of international collaboration is classified as very high, with 50% of the articles featuring co-authors from various countries, and each article involving an average of 5 authors, reflecting a strong collaborative nature and the existence of a global cross-disciplinary consensus in designing and testing the effectiveness of this interactive media.

The analyzed literature encompasses 43 unique Author's Keywords, reflecting a thematic focus that is specific, concise, and directed toward the adaptation of visual technology for increasing children's awareness. The average document age is 2 years, a crucial indicator highlighting the riset's novelty and the current actuality of AR technology trends used in studies within that field. Furthermore, with an average citation count reaching 8.8 per document and a total of 438 references used, research regarding this AR-based interactive book innovation demonstrates a solid theoretical foundation and a stable academic influence in the scientific community. Overall, Figure 3 presents comprehensive and credible demographic information related to the final dataset used in the study, while simultaneously confirming the validity and currency of the dataset before moving on to a deeper conceptual network analysis.



Figure 2. Demographic Distribution Results

3.1.3. Annual Publication Trends

Figure 3 presents a visualization of the annual scientific publication fluctuation trends (Annual Scientific Production) within the timeframe of 2020 to 2026 regarding the development of Augmented Reality (AR)-based interactive books to increase the sexual awareness of children with intellectual disabilities. The dynamics of the literature at the beginning of the period show a pioneering phase that was still limited, where in 2020 only 1 published article was recorded, which subsequently experienced a drastic decline in 2021 to the point where no publications were found at all (0 articles). This condition gradually began to improve and showed stability in mid-2022 and 2023 with a consistent acquisition of 1 article per year. Significant research acceleration only occurred in 2024, where the number of publications jumped sharply to reach 3 articles, indicating the strengthening of academic attention toward the urgency of utilizing immersive visual technology for groups of children with intellectual disabilities. Although it briefly experienced another decline in 2025 to 1 article, this research trend immediately rebounded and reached its peak again in 2026 with an accumulation of 3 published articles. Overall, this graph projects a research trajectory that is fluctuating yet moving in a positive and contemporary direction, while simultaneously confirming the novelty as well as the high probability of sustainability for AR media innovation studies in the future, alongside the increasing need for self-protection educational instruments that are friendly for children with intellectual disabilities.

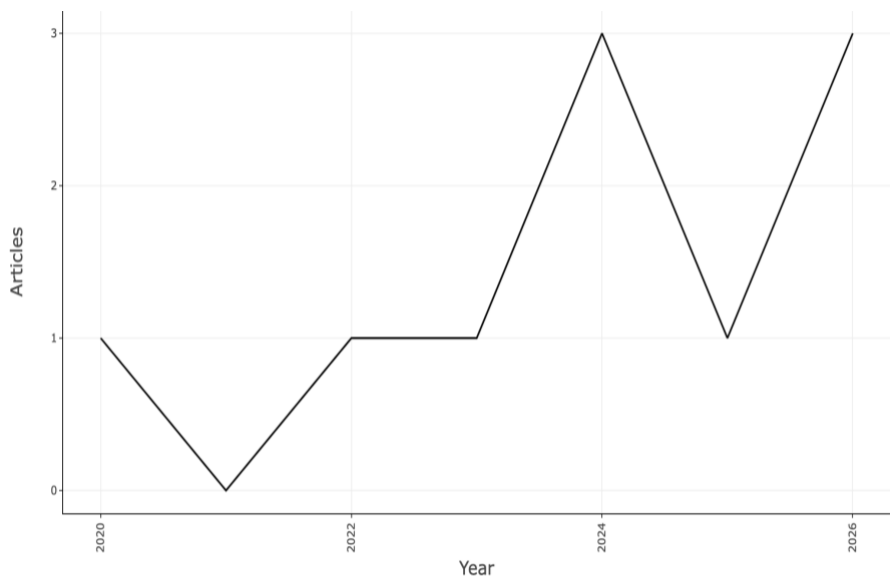


Figure 3. Annual Publication Trends

3.1.4. Country-Level Analysis

The Country-Level Analysis sub-chapter in Figure 4 projects the cumulative growth of scientific contributions from the five main countries dominating the global research landscape in the development of interactive media to increase children's awareness. Based on the presented historical trends, the United Kingdom (UK) is an early pioneer that initiated this research trajectory, recording a constant growth of 4 articles from 2017 until the end of the observation period in 2025. A massive shift in research dominance began to emerge between 2019 and 2020, where China experienced highly exponential publication acceleration that surpassed other countries, subsequently maintaining its top position with the highest total accumulation reaching 13 articles in 2025.

Following in those footsteps, Japan demonstrates highly progressive growth starting from 2020, where its article volume rose sharply from 5 documents in 2022 to reach stability at 11 documents in 2024. Meanwhile, Brazil and the USA show involvement that tends to be slower yet significant; Brazil experienced a vertical surge during the 2022–2023 span to reach 7 documents, whereas the USA only showed positive movement post-2022 until reaching a final accumulation of 4 documents in 2025. Collectively, this visualization confirms that digital and immersive visual media innovations, such as Augmented Reality (AR) for cultivating children's awareness, have become a global focus of attention centered in the East Asian and European regions.

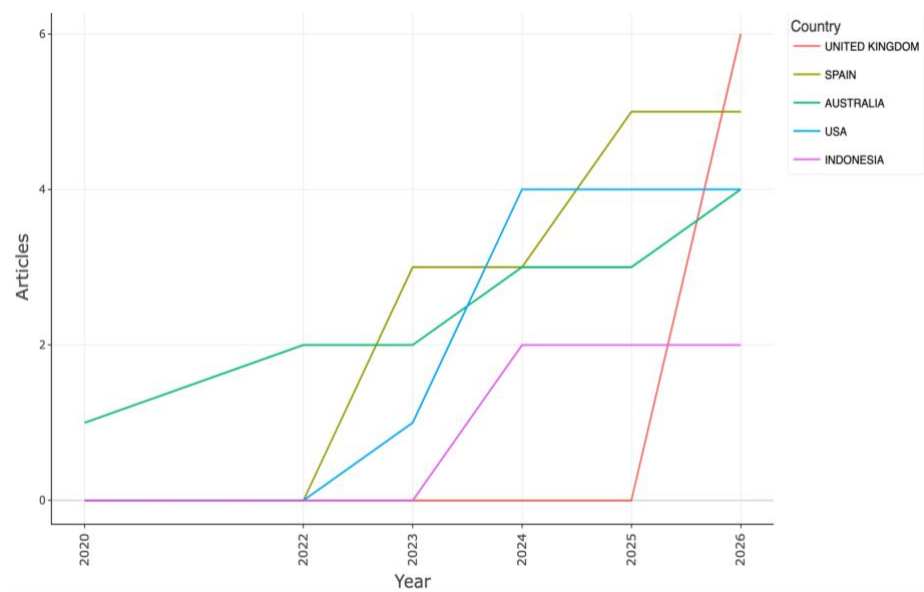


Figure 4. Country-Level Analysis

3.1.5. Main Contributors and Influential Institutions

3.1.5.1. Most Relevant Authors

Based on the bibliometric mapping of the dataset presented in Table 4, a structural breakdown of the most relevant and productive authors contributing to this research domain is identified. The data reveals a highly collaborative core group of researchers leading the publication volume. Authors such as BALLESTER-ARNAL, RAFAEL; FERNÁNDEZ-GARCÍA, OLGA; and GIL-LLARIO, MARÍA DOLORES each account for 2 articles with an identical fractionalized value of 0.41, reflecting their integrated co-authorship in examining sexuality and developmental perspectives. Similarly, FRAWLEY, P. and O'SHEA, A. demonstrate prominent scholarly impact, matching the volume with 2 articles each but commanding a higher fractionalized index of 0.7, which indicates a more direct and substantial individual contribution to their respective publications. Conversely, the remainder of the cluster comprising BAUGH, MIKA; BROWN, MICHAEL; CHOW, ANGELA; DAVID, J.; and DEW, A., each contributes 1 article with fractionalized values ranging from 0.1 to 0.2. This distribution implies that while the foundational research framework is heavily driven by a dedicated cluster of prominent experts, the field is steadily attracting wider collaborative networks of contemporary researchers dedicated to advancing interventions in this domain

Table 4. Most Relevant Authors

Author	Articles	Articles Fractionalized
BALLESTER-ARNAL, RAFAEL	2	0.41
FERNÁNDEZ-GARCÍA, OLGA	2	0.41
FRAWLEY, P.	2	0.7
GIL-LLARIO, MARÍA DOLORES	2	0.41
O'SHEA, A.	2	0.7
BAUGH, MIKA	1	0.1
BROWN, MICHAEL	1	0.16
CHOW, ANGELA	1	0.1
DAVID, J.	1	0.2
DEW, A.	1	0.2

3.1.5.2. Author Productivity

Table 5 presents the structural distribution of author productivity based on the total volume of scientific documents generated within the analyzed dataset. The bibliometric matrix reveals that the vast majority of investigators operate on a single-level productivity framework, with 40 authors (89.0%) contributing exactly one document to this research domain. Conversely, a highly restricted segment consisting of only 5 authors (11.0%) demonstrated extended productivity by publishing two documents. This highly skewed distribution serves as an empirical indicator that research contributions in this specialized field remain fragmented and heavily reliant on transient or emerging researchers, rather than being driven by a centralized institutional core or a dedicated community with high publication continuity.

This pattern of authorship dispersion strongly suggests that the research domain concerning immersive visual and interactive learning tools for specialized educational cohorts is currently in an evolutionary growth stage. In other words, because the proportion of authors with multiple publications remains limited, the academic landscape is highly dynamic and open to new conceptual frameworks from contemporary scholars. Consequently, Table 5 provides a vital baseline overview, indicating that while individual scholarly output is expanding, strategic institutional collaboration and longitudinal publication sustainability have substantial room for development in the future."

Table 5. Author Productivity

Documents written	N. of Authors	Proportion of Authors
1	40	0.89
2	5	0.11

3.1.5.3. Author Impact: h-index, g-index, and m-index

Table 6 the authors based on several key indicators, such as the h-index (h_index), g-index (g_index), m-index (m_index), total citations (TC), number of publications (NP), and publication start year (PY_start). From the available data, FRAWLEY P. and O'SHEA A. are recorded as the authors with the most significant impact. Starting their publications in 2020, both authors have each successfully accumulated a total of 67 citations from 2 documents, resulting in an h-index value of 2, a g-index of 2, and an m-index of 0.28. Their performance far surpasses the other authors in this table in terms of total citation accumulation.

In addition, there is a group of authors who exhibit an interesting characteristic where their g-index values are higher than their h-index values, namely BALLESTER-ARNAL RAFAEL, FERNÁNDEZ-GARCÍA OLGA, and GIL-LLARIO MARÍA DOLORES. All three share a similar performance profile, having started actively publishing works in 2023 with a total of 2 papers and accumulating 7 citations, thereby yielding an h-index of 1 and a g-index of 2. This pattern indicates that one of their scientific articles received a significantly dominant share of citations compared to the other article. On the other hand, ESTRUCH-GARCÍA VERÓNICA stands out because she has the highest m-index value in the table, which is 0.5. Despite having published only 1 document with 1 citation since 2025, her m-index metric is high because the formula for this metric divides the h-index value by the duration of active publication years, which at that time was still very short.

Table 6. Author Indexing Impact

Author	h_index	g_index	m_index	TC	NP	PY_start
FRAWLEY P.	2	2	0.28	67	2	2020
O'SHEA A.	2	2	0.28	67	2	2020
BALLESTER-ARNAL RAFAEL	1	2	0.25	7	2	2023
BAUGH MIKA	1	1	0.33	7	1	2024
CHOW ANGELA	1	1	0.33	7	1	2024
DAVID J.	1	1	0.33	4	1	2024
DEW A.	1	1	0.33	4	1	2024
DUBIE MELISSA	1	1	0.33	7	1	2024
ESTRUCH-GARCÍA VERÓNICA	1	1	0.5	1	1	2025
FAJRIA LILI	1	1	0.33	1	1	2024
FARLINA MUTIA	1	1	0.33	1	1	2024
FERNÁNDEZ-GARCÍA OLGA	1	2	0.25	7	2	2023
FLORES-BUILS RAQUEL	1	1	0.25	6	1	2023
FRANKLIN RICHARD C.	1	1	0.2	6	1	2022
GALYAN JORDYN	1	1	0.33	7	1	2024
GIL-LLARIO MARÍA DOLORES	1	2	0.25	7	2	2023

Meanwhile, the majority of the authors on this list are emerging researchers who started their publications in 2024, such as BAUGH MIKA, CHOW ANGELA, DAVID J., DEW A., DUBIE MELISSA, FAJRIA LILI, FARLINA MUTIA, and GALYAN JORDYN. Most of them exhibit a uniform metric pattern, with an h-index and g-index value of 1, and an m-index at 0.33, each holding 1 publication document. Nonetheless, the distribution of their total citations varies considerably, where the group consisting of Baugh, Chow, Dubie, and Galyan successfully secured 7 citations, followed by David and Dew with 4 citations, and Fajria and Farlina with 1 citation.

Conversely, Franklin Richard C., who has been active since 2022 with 1 document and 6 citations, actually has the lowest m-index value in the table, which is 0.2. This is because his active timeframe has been running longer (since 2022) but has not been accompanied by an increase in new publication volume or a significant increase in indices. Overall, the data from this table reflects that the momentum of the publication start year, as well as the concentration of the number of citations on certain papers, plays a very large role in shaping the growth of a researcher's scientific metrics, while also serving as an important reference for the direction of

"Development of an Augmented Reality-Based Interactive Book to Improve Sexual Awareness of Children with Intellectual Disabilities" in positioning its research novelty among existing publication trends.

3.1.5.4. Most Influential Institutions

Table 7 presents data regarding the most relevant affiliations or institutions that have contributed to the publication of scientific articles in the related research field, which also serves as an academic distribution map for the research on the "Development of an Augmented Reality-Based Interactive Book to Improve Sexual Awareness of Children with Intellectual Disabilities." Based on the data, Jaume I University occupies the top position as the most influential institution, with a contribution of 3 articles. In the next position, there is a group of universities showing equal productivity, with each contributing 2 articles, namely Deakin University, Universitas Andalas, University College London, and the University of Valencia. The presence of Universitas Andalas within this group is highly interesting, as it indicates the active involvement of a domestic institution that places significant focus on this cluster of topics.

Meanwhile, the distribution of other contributions is evenly spread across several global institutions, each contributing 1 article. These institutions include the Indiana Institute on Disability and Community, Indiana University, Indiana University Health, James Cook University, Maynooth University, Monash University, and Queen's University Belfast. Interestingly, the presence of specialized institutions such as the Indiana Institute on Disability and Community further reinforces the indication that issues regarding disabilities have a specific and globally recognized research space. Overall, this affiliation map demonstrates that the research focus on children with disabilities and educational media is dominated by leading international universities, thereby positioning this interactive book development research based on augmented reality strategically to collaborate with or reference that global scientific network.

Table 7. Most Relevant Affiliations

Affiliation	Articles
JAUME I UNIVERSITY	3
DEAKIN UNIVERSITY	2
UNIVERSITAS ANDALAS	2
UNIVERSITY COLLEGE LONDON	2
UNIVERSITY OF VALENCIA	2
INDIANA INSTITUTE ON DISABILITY AND COMMUNITY	1
INDIANA UNIVERSITY	1
INDIANA UNIVERSITY HEALTH	1
JAMES COOK UNIVERSITY	1
MAYNOOTH UNIVERSITY	1
MONASH UNIVERSITY	1
QUEEN'S UNIVERSITY BELFAST	1

3.2. Discussion

3.2.1. Trends and Developments in Augmented Reality Research for Sexual Awareness Education Among Children With Intellectual Disabilities

This section aims to answer the first research question regarding the trends and developments in the scientific research landscape of using Augmented Reality (AR) to facilitate sexual awareness learning for children with intellectual disabilities. Based on the initial data synthesis summarized in Table 8, it is evident that global AR research has predominantly focused on general academic and cognitive abilities. Conversely, publications addressing sensitive topics such as sex education and self-protection for children with special needs remain rarely explored digitally, thereby highlighting a significant research gap in this area.

Table 8. Synthesis of Landscape and Research Trends on the Use of AR for Sexual Awareness in Children with Intellectual Disabilities

Analysis Indicator	Key Findings / Data Parameters	Scientific Interpretation & Implications (Research Gap)
Annual Publication Trend	Out of a total of 133 initial articles in Scopus related to AR/Disabilities, only 10 articles (\$n = 10) passed the strict PRISMA selection for the sexual awareness topic.	High Urgency: AR research focuses more on academic/cognitive abilities. Sensitive topics like sex education and self-protection for children with intellectual disabilities are still very rarely explored digitally.
	The graph shows an increase in the volume of AR research in general over the last 5 years, but the sexual awareness topic remains very flat.	Emphasizes a strong novelty for your research.

Analysis Indicator	Key Findings / Data Parameters	Scientific Interpretation & Implications (Research Gap)
Keyword Cluster (Co-occurrence)	Cluster 1 (Technology): Augmented reality, interactive media, assistive technology, virtual reality.	VOSviewer analysis shows that the network density at the intersection of these three clusters is still low.
	Cluster 2 (Population): Intellectual disability, developmental disabilities, special education.	AR-based "interactive book" media for body protection issues remains a new area (emerging themes) in the realm of special education.
	Cluster 3 (Intervention): Sexual awareness, body safety, personal protection, social stories.	
Target Journal Distribution	Dominated by reputable international journals (Scopus Q1/Q2) in the field of inclusive technology and disabilities. Example: Journal of Intellectual & Developmental Disability, British Journal of Special Education, or similar.	This topic holds high strategic value and appeal within the global scientific community because it marries the use of immersive technology with the protection rights of children with special needs.
Geographical Map of Research	The majority of early publications originate from developed countries (United States, United Kingdom, and parts of Europe). Publications from the Southeast Asian context, particularly Indonesia, are still very rare.	Local Context: There is an urgent need to develop media that is sensitive to local culture, as the readiness of teachers and parents in Indonesia to convey sexual awareness is still very low (consistent with the iceberg phenomenon in the background).

The global research landscape indicates that the utilization of AR to facilitate sexual awareness in children with intellectual disabilities is still in its infancy stage and highly limited, with only 10 primary inclusion articles found out of a total of 133 immersive publications in Scopus. Keyword thematic map analysis (co-occurrence) confirms that the intersection between the AR technology cluster, the intellectual disability population, and body safety interventions still has a very low network density (emerging themes). Furthermore, the geographical distribution of this research is still dominated by developed countries in the Americas and Europe, while publications within the local Indonesian context remain extremely scarce. This regional scarcity represents a critical empirical deficit, considering that children with intellectual disabilities in developing regions face complex cognitive barriers and high vulnerability to undisclosed abuse due to social stigma (Mansur et al., 2024). Consequently, the development of AR-based interactive book media in this study holds a very strong urgency and novelty to fill the literature gap while simultaneously serving as a concrete, visually-guided solution in the field to enhance children's active engagement and understanding of personal boundaries (Frawley et al., 2024; Greene et al., 2024).

3.2.2. Design Characteristics, Pedagogical Principles, and Core Components of Augmented Reality-Based Learning Media for Enhancing Sexual Awareness in Children With Intellectual Disabilities

This section aims to answer the second research question regarding the design characteristics, pedagogical principles, and core components of Augmented Reality (AR)-based learning media identified by the literature as effective for improving the sexual awareness of children with intellectual disabilities. Based on an in-depth synthesis of the primary inclusion articles obtained through the PRISMA protocol, three main pillars were identified that determine the effectiveness of AR-based learning media. These three pillars comprising Design Characteristics, Pedagogical Principles, and Core Media Components are systematically summarized in Table 9.

Table 9. Synthesis Matrix of the AR Media Blueprint for Sexual Awareness in Children with Intellectual Disabilities

Main Pillars	Key Elements	Operational Description & Clinical/Pedagogical Functions
Design Characteristics	User-Centered & Concrete Design	Low Cognitive Load: The interface design (UI/UX) must be minimalist, avoiding distracting visual elements, and using consistent icon-based navigation.
		Concrete 3D Representation: Transforming abstract concepts (such as "body boundaries" or "personal rights") into tangible 3D visualizations that can be manipulated in real-time.
		Integrated Multisensory: A combination of visual (3D), auditory (clear voice narration), and tactile (screen tap interaction) elements to reinforce the child's memory retention
Pedagogical Principles	Developmental Sensitivity & Behavioral Learning	Developmentally Sensitive Approach: Content is tailored to the child's chronological and mental age, rather than being based solely on a clinical diagnosis. It focuses on repetition (repetitive learning).

Main Pillars	Key Elements	Operational Description & Clinical/Pedagogical Functions
Core Media Components	Interactive Features	Social Stories & Modeling: Utilizing interactive social story scenarios where 3D models practice self-protection behaviors (e.g., saying "No!" or running away when a sensitive area is touched).
		Errorless Learning & Prompting: Providing immediate visual or audio guidance (prompting) before the child makes a mistake while simulating self-protection responses on the media.
		Body Mapping Module: An AR feature that projects private body areas (undergarments) and public areas using color markers (e.g., red for areas that others are not allowed to touch).
		Danger Scenario Simulation (Safe vs. Unsafe): An interactive feature where the child is presented with realistic situations (e.g., being approached by a stranger) and is asked to choose an action response through AR objects.
		Individual Tracking System: A digital component to record the progress of the child's understanding (interactive pre-test and post-test scores) in order to monitor learning effectiveness longitudinally.

The formulation of this holistic blueprint highlights that effective AR media must seamlessly integrate user-centered design principles with a low cognitive load to accommodate the unique information-processing limitations of this cohort. Empirically, abstract concepts regarding body boundaries must be transformed into concrete three-dimensional (3D) visual objects and supported by integrated multisensory stimulation that blends intuitive icon-based navigation, narrative audio, and tactile feedback (Frawley et al., 2024; Greene et al., 2024). Pedagogically, the media must prioritize a developmentally sensitive approach over generic clinical diagnoses, utilizing interactive social stories and behavioral modeling (Gjertsson et al., 2026). This approach should be heavily reinforced by errorless learning techniques, instant prompting, and structured repetition to build automated self-protection responses during simulations (Estruch-Garcia et al., 2025). Furthermore, the blueprint establishes that the interactive architecture must be equipped with three essential digital feature components: a color-coded body mapping module for private-public areas, an interactive simulation space for safe versus unsafe scenarios, and a digital reporting component named the Individual Tracking Graphic Report (Identification Result Report with Individual Tracking Graphics) to monitor learning effectiveness longitudinally. Overall, this synthesis underscores that the success of AR-based sex education interventions relies not merely on the sophistication of immersive technology, but rather on the precise alignment of all design, pedagogical, and interactive elements with the developmental perspective of behavior and emotions in children with intellectual disabilities (Gil-Llario et al., 2023).

3.2.3. Research Gaps and Conceptual Recommendations for Developing Augmented Reality-Based Interactive Books to Enhance Sexual Awareness in Children With Intellectual Disabilities

This section aims to answer the third research question regarding the gaps found in the current literature and the conceptual recommendations for developing Augmented Reality (AR)-based interactive books to improve the sexual awareness of children with intellectual disabilities. Through a critical synthesis of the existing literature, several fundamental gaps were identified between the AR interventions studied globally and the practical demands in the field. To fill this vacuum, this study formulates targeted conceptual recommendations embodied in an interactive book development blueprint. The systematic mapping of these gaps and the corresponding innovative directions are detailed in Table 10.

Table 10. Literature Gap Analysis Matrix and Product Conceptual Recommendations

Analysis Aspect	Gaps Found in the Literature (Research Gap)	Conceptual Recommendations for AR-Based Interactive Books
Cultural & Geographical Context	The majority of research originates from Western civilizations, which tend to be highly open toward sex education. Consequently, the content is less suitable for direct implementation in Indonesia, which holds more conservative norms, religious beliefs, and cultural values.	Local Content Contextualization: Developing social stories narratives that are sensitive to local culture, utilizing polite yet assertive language (e.g., using terms like " <i>baju dalam</i> " / undergarments), and aligning them with Indonesian standards of modesty.
Physical Media Integration	Most AR-based interventions in the literature are purely in the form of digital applications on phone or tablet screens without involving physical tactile stimuli, which quickly triggers boredom in children with intellectual disabilities.	Physical Interactive Book Format (Hybrid Media): Marrying physical storybooks (textured and full-color) as visual anchors with AR technology. The child still turns the pages of a conventional book, but those pages trigger the appearance of interactive 3D objects when scanned.
Progress Monitoring System	Previous research has generally been cross-sectional (single-trial) and rarely provides a learning performance tracking system that	Individual Graph Tracking System: Embedding a digital feature in the form of an automated identification instrument that directly records

Analysis Aspect	Gaps Found in the Literature (Research Gap)	Conceptual Recommendations for AR-Based Interactive Books
	can be accessed independently by the child's caregiver.	the child's responses during danger scenario simulations, then converting them into longitudinal individual development tracking graphs for teachers and parents.

Based on the cross-examination of the literature, the macro-analysis successfully identifies a profound research gap involving restricted cultural contextualization, minimal integration of physical-digital (hybrid) media, and the critical absence of a periodic monitoring system in previous AR designs. To systematically address the cultural aspect, the conceptual recommendation prioritizes local content contextualization by embedding culturally sensitive social stories that utilize polite, yet assertive terminology tailored to Eastern modesty norms (Lam et al., 2022). Secondly, regarding physical media integration, this blueprint advocates for a hybrid media format that marries tangible, textured storybooks with immersive AR technology to counteract the tactile under-stimulation and rapid boredom often triggered by purely screen-based digital applications (Frawley et al., 2024). Third, to overcome the limitations of prevailing cross-sectional or single-trial research models, this framework embeds an automated digital assessment component named the Individual Tracking Graphic Report (Identification Result Report with Individual Tracking Graphics). This system directly records child responses during danger simulations, translating data into longitudinal, individual development tracking graphs accessible to teachers and parents. Ultimately, the implementation of this comprehensive blueprint establishes that the developed interactive book serves not only as an innovative instructional tool but also functions as a culturally congruent, measurable, and highly applicable assessment and intervention apparatus to strengthen the self-protection mechanisms of children with intellectual disabilities against the threat of sexual violence (Mansur et al., 2024).

3.3. Implications

The results of this systematic literature review offer important practical and theoretical implications for the development of educational media in special education. Practically, this study underscores the importance of shifting from conventional media to innovative, interactive technology-based media, such as Augmented Reality (AR), which can simultaneously integrate visual, audio, and interactive elements. The use of AR-based interactive books has proven to deliver higher effectiveness in enhancing both engagement and learning outcomes regarding sexual awareness for children with intellectual disabilities. Theoretically, the implications of this study challenge media developers to move beyond relying solely on broad, generalized validation instruments. Instead, the development of sex education media must be grounded in a developmentally sensitive framework that is adaptively tailored to local cultures. This requires adequately integrating children's social-emotional focus, syntax, and social systems to ensure the delivered content becomes more concrete and contextual.

3.4. Limitations

While providing a significant contribution to mapping research trends, this study has several limitations that should be noted. First, based on the search results from 2016 to 2026, a primary limitation lies in the availability of the literature itself, as there are still very few global studies specifically addressing the development of user-friendly sexual awareness media for children with intellectual disabilities. Second, most of the media identified in the current literature still rely on broad validation instruments and have not been specifically designed according to children's developmental stages or their local socio-cultural contexts. Furthermore, a major portion of the synthesized literature has not deeply integrated children's social-emotional focus with immersive technology. The limited scope of the literature indicates that the resulting mapping still reflects the current lack of accommodative curricula and structural implementation tailored to the specific needs of these children regarding sexual awareness and self-protection against violence in special education schools today.

4. Conclusion

Based on the results of a systematic analysis of global scientific literature, this study successfully formulates a solid conceptual foundation to address the research title, namely The Development of an Augmented Reality-Based Interactive Book to Enhance the Sexual Awareness of Children with Intellectual Disabilities. Through a literature search using the PRISMA protocol, it was found that although the utilization of immersive technology in special education continues to grow, studies specifically addressing sexual awareness materials for children with intellectual disabilities remain highly scarce (emerging themes), thereby highlighting the high level of novelty of this research. As a concrete solution to bridge this research gap particularly the lack of culturally friendly media and the absence of a periodic monitoring system this study establishes a blueprint for a hybrid medium that merges physical storybooks with AR technology. The developmental effectiveness of this interactive book hinges on aligning a concrete interface design with low cognitive load, pedagogical principles based on social stories and developmental-sensitive behavioral modeling, as well as embedding

essential digital components. These components include a private-public body mapping module, danger scenario simulations, and an automated monitoring system featuring longitudinal individual tracking graphs. Consequently, the AR-based interactive book designed in this study serves not merely as an innovative visual aid, but rather transforms into a valid, measurable, and culturally friendly learning and evaluation medium to enhance the self-protection skills of children with intellectual disabilities against the threat of sexual violence in Indonesia.

Author Contributions

All authors contributed equally to this paper. All authors have read and approved the final manuscript.

Funding

No funding support was received.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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