

Mapping Research Trends in Physics Education: A Systematic Mapping Review of Three Leading Journals 2015–2025

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Abstract: *This study maps research trends in physics education research (PER) from 2015 to 2025 using a Systematic Mapping Review (SMR) approach, with Scopus as the primary data source. The corpus was built by searching, per journal, three leading discipline-specific journals Physical Review Physics Education Research, European Journal of Physics, and Physics Education restricted to document type (article or review) and publication language (English). This process identified 644 records; after screening for the 2015–2025 publication window (78 records outside this range were excluded) and checking for duplicates (none found), 566 articles were retained for analysis (Physical Review Physics Education Research, $n = 206$; Physics Education, $n = 190$; European Journal of Physics, $n = 170$). Data were analyzed using bibliometric methods in RStudio and Python to examine publication trends, authorship, most-cited documents and authors, and international collaboration. Annual output rose unevenly but substantially over the period, from 21 articles in 2015 to a peak of 117 in 2025, with a first surge to 58 articles in 2020. Output was fairly evenly distributed across the three journals rather than dominated by any single outlet. The single most-cited article in the corpus was a tool paper on smartphone-based physics experiments (Staacks et al., 2018, 263 citations), and Singh, C. was both the most prolific (28 papers) and most-cited (883 total citations) author. Overall, the review contributes to the discourse on PER by mapping publication patterns, citation impact, and collaboration structure in the field, and by pointing to directions for further, more geographically complete research.*

Keywords: *physics education research, bibliometric analysis, systematic mapping review, Scopus, research trends*

Abastrak: *Penelitian ini memetakan tren penelitian dalam bidang pendidikan fisika (Physics Education Research/PER) selama periode 2015–2025 menggunakan pendekatan Systematic Mapping Review (SMR), dengan Scopus sebagai sumber data utama. Korpus penelitian dibangun melalui penelusuran pada tiga jurnal utama yang secara khusus berfokus pada bidang pendidikan fisika, yaitu Physical Review Physics Education Research, European Journal of Physics, dan Physics Education, dengan pembatasan pada jenis dokumen artikel atau ulasan serta bahasa publikasi Inggris. Proses penelusuran menghasilkan 644 rekaman; setelah penyaringan berdasarkan periode publikasi 2015–2025, sebanyak 78 rekaman di luar rentang tersebut dikeluarkan, dan tidak ditemukan duplikasi, sehingga diperoleh 566 artikel untuk dianalisis, yang terdiri atas Physical Review Physics Education Research ($n = 206$), Physics Education ($n = 190$), dan European Journal of Physics ($n = 170$). Data dianalisis menggunakan metode bibliometrik dengan bantuan RStudio dan Python untuk mengidentifikasi tren publikasi, kepengarangan, dokumen dan penulis dengan jumlah sitasi tertinggi, serta pola kolaborasi internasional. Hasil menunjukkan bahwa jumlah publikasi meningkat secara tidak merata tetapi cukup signifikan, dari 21 artikel pada 2015 hingga mencapai puncak 117 artikel pada 2025,*

dengan peningkatan awal menjadi 58 artikel pada 2020. Distribusi publikasi relatif merata pada ketiga jurnal dan tidak didominasi oleh satu jurnal tertentu. Artikel yang paling banyak disitasi dalam korpus adalah artikel tentang pengembangan perangkat eksperimen fisika berbasis telepon pintar oleh Staacks et al. (2018), dengan 263 sitasi. Sementara itu, Singh, C. merupakan penulis paling produktif dengan 28 artikel sekaligus penulis dengan jumlah sitasi tertinggi, yaitu 883 sitasi. Secara keseluruhan, penelitian ini berkontribusi pada pemetaan perkembangan PER melalui identifikasi pola publikasi, dampak sitasi, dan struktur kolaborasi, sekaligus menunjukkan peluang untuk penelitian lebih lanjut dengan cakupan geografis yang lebih luas.

Kata Kunci: pendidikan fisika, penelitian, analisis bibliometrik, tinjauan pemetaan sistematis, Scopus, tren penelitian

Introduction

Physics education research (PER) has matured into its own discipline over the past two decades, moving from a set of scattered pedagogical experiments into a self-sustaining research community with dedicated journals, international conferences, and doctoral programs (Docktor & Mestre, 2014). Dedicated outlets now serve this community, most notably Physical Review Physics Education Research (PRPER), launched jointly by the American Physical Society and the American Association of Physics Teachers (American Physical Society, n.d.), alongside longer-running venues such as the European Journal of Physics and Physics Education. Alongside this institutional growth, the scope of these journals has also broadened well beyond any single pedagogical model or narrow disciplinary focus: recent work spans curriculum design and problem-solving assessment (Burkholder et al., 2020), equity and gender in physics learning (Doucette & Singh, 2024; Keblbeck et al., 2024), how teachers make instructional decisions (Holmes et al., 2020), the use of generative AI tools to support prospective teachers' task development (Küchemann et al., 2023), and conceptual understanding across educational levels. Docktor and Mestre (2014) captured much of this breadth in their synthesis of discipline-based physics education research, which remains a key reference point for the field a decade later. This institutional maturation — dedicated journals, recurring international conferences, and a growing number of doctoral programs explicitly framed around PER — signals that the field has moved well past its early years as a set of isolated pedagogical experiments conducted by individual instructors, and now functions as a self-sustaining research community with its own publication infrastructure, career pathways, and ongoing internal debates about method, rigor, and disciplinary identity.

Yet for all this institutional growth, we still know surprisingly little about the field in quantitative terms. Which topics have risen or fallen out of favor over the past decade? Which specific countries and institutions actually drive the research agenda today, and how are individual researchers connected to one another? These are structural questions about the discipline itself, not about any single study's findings, and they call for a different kind of method than the narrative, outcome-focused reviews that dominate PER. Bibliometric and science-mapping methods which classify and visualize patterns across a corpus rather than synthesizing individual findings are well suited to answering exactly these questions at scale, and have been used productively in adjacent fields to reveal structural patterns that narrative reviews tend to miss, such as how research emphasis shifts over time, how collaboration clusters form and persist, and where geographic concentration and gaps lie, as a systematic review of gamification research in science education has similarly shown for that adjacent field (Kalogiannakis et al., 2021).

A handful of studies have begun applying this kind of computational approach to PER itself, but each is limited in scope or method. Odden et al. (2020) applied topic modeling to eighteen years of PER conference proceedings, tracing how thematic emphasis shifted over time, but conference proceedings capture a narrower and less rigorously vetted slice of the literature than peer-reviewed journal articles. Santoso et al. (2022) extended a comparable computational approach to the Indonesian PER literature specifically, which usefully surfaces national-level patterns but does not speak to the discipline's international core. Bitzenbauer (2021) likewise applied bibliometric methods to PER, but restricted the corpus to two decades of quantum physics education research specifically, illustrating a topically narrow rather than cross-journal scope. Aliyu Bako et al. (2022) reviewed inquiry-based teaching conceptions among Nigerian physics teachers, offering depth on a single pedagogical strand within a single country rather than a structural map of the field. Banda and Nzabahimana (2021) likewise reviewed simulation-based interventions in physics teaching, again narrative and topic-specific rather than mapping-oriented. Taken together, these studies show that most existing overviews of PER are narrative, topic-restricted, or geographically bounded, and that none has systematically mapped the discipline's flagship, discipline-specific journals as a single coherent unit using bibliometric methods. This is the gap the present study addresses: a structural, cross-journal account of how PER as an international field of publication has evolved over the past decade, treating publication volume, authorship and collaboration patterns, and thematic development together rather than any one of these in isolation.

The three journals selected for this review *Physical Review Physics Education Research*, *European Journal of Physics*, and *Physics Education* are consistently identified as the discipline's leading dedicated outlets, and this status is reflected in their current bibliometric standing rather than asserted on reputation alone. *PRPER*, the field's flagship outlet, held a 2025 Journal Impact Factor of 3.5 and a CiteScore of 6.8, placing it in the first quartile (Q1) of the Physics and Astronomy category, and is published as a fully open-access journal under APS's Purpose-Led Publishing commitment (American Physical Society, 2026), a policy choice that, per the broader open-access literature, may itself be associated with elevated citation rates relative to subscription-based venues (Langham-Putrow et al., 2021). *European Journal of Physics*, published by IOP Publishing since 1980 on behalf of the European Physical Society, carries a CiteScore of 1.6 and a third-quartile (Q3) Scopus ranking, while *Physics Education*, also an IOP title, sits in the second quartile (Q2) with an h-index of 38 (Resurchify, 2026a, 2026b). Although their impact metrics differ substantially — a gap that is itself worth investigating, since it may reflect differences in disciplinary reach, open-access policy, or audience size rather than research quality per se — all three are discipline-specific, English-language, Scopus- and Web-of-Science-indexed journals with an explicit editorial mandate for physics education research, which distinguishes them from general science-education or educational-technology outlets that publish physics-education work only incidentally. Restricting the corpus to these three journals therefore trades breadth for a cleaner, more internally consistent unit of analysis, a trade-off discussed further as a limitation in the Methods section. This trade-off is deliberate rather than incidental to the research questions above: because RQ2 and RQ3 ask about collaboration and thematic structure specifically within the discipline's own dedicated publishing venues, diluting the corpus with incidental physics-education content published in general science-education or educational-technology journals would blur precisely the structural signal this review seeks to characterize.

Building on this gap, the present study carries out a Systematic Mapping Review (SMR) of these three leading discipline-specific physics education journals, covering the decade from 2015 to 2025. It is guided by three research questions:

RQ1. How has the annual scientific production of physics education research evolved between 2015 and 2025?

RQ2. Which countries, authors, and institutions have contributed most significantly to this field, and what collaboration patterns exist among them?

RQ3. What are the dominant and emerging research themes in the literature, and how have they developed over time?

The novelty of this study lies in three respects. First, unlike prior computational analyses of PER that examined conference proceedings (Odden et al., 2020) or a single national literature (Santoso et al., 2022), this review is, to our knowledge, the first to apply a systematic mapping methodology jointly across the three principal English-language, discipline-specific PER journals, treating them as a single analytic unit rather than as separate literatures. Second, it integrates three strands of bibliometric analysis — publication-trend, collaboration-network, and thematic-mapping analyses — that earlier PER reviews have typically addressed only in isolation, allowing patterns in one dimension, such as thematic concentration, to be interpreted alongside another, such as who is producing that work and where. Third, by explicitly quantifying geographic representation across 312 of the 566 articles for which author-affiliation data could be recovered, the review provides an evidence base, rather than an impression, for a concern raised anecdotally in the field but rarely measured directly: the underrepresentation of Southeast Asian and African scholarship in the discipline's leading outlets. By mapping publication patterns, collaboration networks, and thematic concentrations across these three journals together rather than separately, this study aims to give a structural, evidence-based picture of the PER landscape — one that can inform future research directions as well as editorial and community priorities at the journal level.

Method

This study used a Systematic Mapping Review (SMR) approach, a method Petersen et al. (2008) originally defined for classifying and visualizing trends, patterns, and gaps within a research field over time. Unlike a systematic literature review, which synthesizes empirical findings, an SMR focuses on classifying and quantitatively describing research output which fits the goal here of characterizing the broad landscape of PER rather than evaluating individual studies. Following Petersen et al. (2008), the review proceeded through five stages: (1) definition of the research questions (RQ1–RQ3, stated in the Introduction); (2) conduct of the search in the Scopus database; (3) screening of records for inclusion, reported using the PRISMA 2020 flow diagram (Page et al., 2021); (4) keywording and classification of the retained records using metadata fields (year, source, authorship, country, and keywords) rather than full-text coding, consistent with the mapping rather than evaluative aim of an SMR; and (5) data extraction and bibliometric mapping, carried out in RStudio.

Search Strategy

The literature search was conducted in the Scopus database on 12 August 2026, using three separate SRCTITLE queries one per target journal rather than a single combined query, after an initial combined-SRCTITLE attempt failed to retrieve European Journal of Physics and

Physics Education records (a Scopus indexing quirk documented further below). Each query took the form:

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TITLE-ABS-KEY ( "physics education" ) AND SRCTITLE ( "<journal name>" ) AND ( LIMIT-TO ( DOCTYPE , "ar" )
OR LIMIT-TO ( DOCTYPE , "re" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) )
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with <journal name> substituted in turn for “Physical Review Physics Education Research,” “European Journal of Physics,” and “Physics Education.” The PUBYEAR filter was found to be unreliable when embedded in the query string or applied only through the on-screen year panel before export — across three successive export attempts, 11–78 records outside the intended 2015–2025 window were still included — so the year restriction was instead applied during data processing, after export, using the publication-year field of each exported record. Records published under Physical Review Physics Education Research's pre-2015 name, Physical Review Special Topics – Physics Education Research, were retained and merged with PRPER records, since Scopus treats them as the same continuous source. Combined, the three queries identified 644 records; after screening for the 2015–2025 publication window (78 records outside this range were excluded, all from 2026) and checking for duplicate DOIs across the three exports (none were found), 566 articles were retained for analysis, exported in RIS format for further processing.

These three journals were purposively selected as the leading discipline-specific outlets for physics education research; this deliberate narrowing ensures disciplinary relevance and data quality but necessarily excludes physics-education-relevant studies published in general science-education or educational-technology journals, a trade-off discussed further as a limitation of this review. Inclusion and Exclusion Criteria, Table 1 summarizes the criteria applied at each stage of record selection, together with the reason a record was excluded where applicable.

Table 1. Inclusion and Exclusion Criteria Applied at Each Screening Stage

Stage	Inclusion criteria	Exclusion criteria / reason removed
Database querying	Document type: article or review; source: one of the three target journals (queried separately per journal); language: English	Records outside these filters were not retrieved by the search (n/a — filtered at query level)
Publication-year screening	Publication year 2015–2025 (applied to the exported publication-year field)	78 records published in 2026 were excluded
Duplicate screening	One record per unique DOI, checked across all three journal exports	No duplicate DOIs were found across the three exports (0 records removed)
Final dataset	—	566 articles retained for analysis

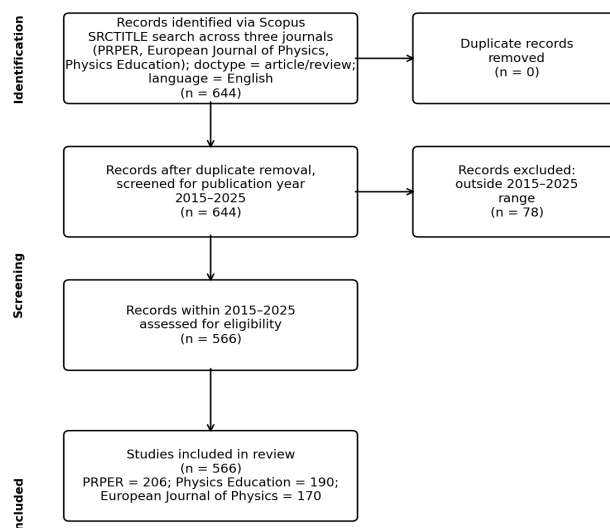


Figure 1. PRISMA Flow Diagram

Article selection followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 flow logic shown in Figure 1 (Page et al., 2021), adapted here to a metadata-based screening process rather than full-text review, since this is a mapping rather than an evaluative review. Of the 644 records identified across the three per-journal queries, 78 fell outside the intended 2015–2025 window (all dated 2026) and were removed. No duplicate DOIs were found across the three exports, leaving 566 articles in the final dataset: 206 from Physical Review Physics Education Research (including its pre-2015 predecessor title), 190 from Physics Education, and 170 from European Journal of Physics.

Data Cleaning, Validation, and Analysis

Exported records (CSV and BibTeX) were imported into RStudio using the bibliometrix package (Aria & Cuccurullo, 2017), accessed through its Biblioshiny web interface, for bibliometric mapping; tidyverse and dplyr were used for data cleaning, and ggplot2 was used to generate visualizations. Data cleaning consisted of checking author, affiliation, and keyword fields for inconsistent spellings or abbreviations (for example, variant renderings of the same author or institution name) and merging these where a duplicate was unambiguous, following bibliometrix's standard metadata-harmonization routines; records with missing DOI, affiliation, or keyword fields were retained but flagged, since the analyses in this review do not depend on complete coverage of every field for every record. The analytical focus included annual publication trends, source distribution, author productivity, institutional affiliations, keyword co-occurrence (visualized as a thematic map), thematic evolution, and international collaboration networks (visualized as a co-authorship network using VOSviewer-style force-directed layout principles; van Eck & Waltman, 2010).

Several limitations should be acknowledged. The review was confined to Scopus-indexed articles, so relevant literature indexed in other databases (e.g., Web of Science, ERIC) may have been excluded. Restricting the search to three discipline-specific journals means the 566 articles analyzed represent trends within specialized physics-education publishing rather than the entirety of global physics-education-relevant research, since related studies published in general science-education or educational-technology journals were not captured; findings should not be generalized beyond this defined journal set without further verification. As a

mapping review, this study did not evaluate the methodological rigor or empirical quality of individual articles. Two further data-completeness limitations affect specific analyses reported below. First, the Scopus RIS export format used for this review does not include an Author Keywords field, so the keyword co-occurrence thematic map (Figure 4) could not be regenerated from the current 566-article corpus and instead reflects an earlier, smaller keyword extraction; it is reported here as an illustrative rather than a definitive picture of the field's thematic structure, and re-running it on the current corpus is a priority for future revisions of this work. Second, author-affiliation data (used for the country-level analysis in Figure 5) could be recovered for only 312 of the 566 articles (55%), because affiliation fields were likewise inconsistently included across the three per-journal Scopus exports; the country distribution reported should therefore be read as provisional, particularly for the lower-ranked countries, pending a complete affiliation-inclusive re-export.

Because this study analyzed secondary data from publicly available scientific publications, no direct involvement of human subjects occurred and institutional ethical approval was not required. All sources used were properly cited to uphold academic integrity.

Results and Discussion

In total, 566 peer-reviewed articles published between 2015 and 2025 in the three journals were analyzed. The bibliometric analysis pointed to several notable patterns in publication trends, citation impact, and collaboration, which are presented below together with their interpretation.

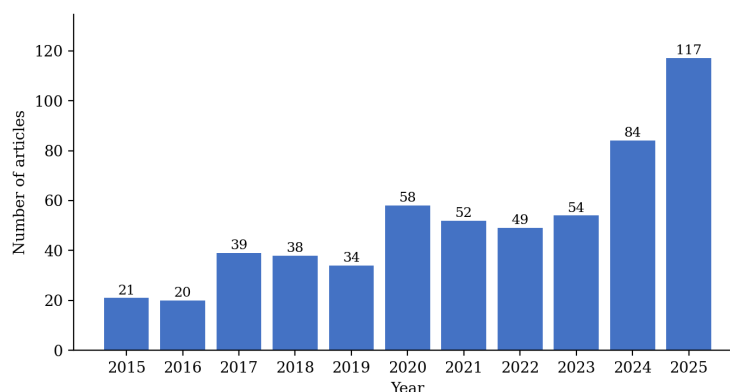


Figure 2. Annual Scientific Production

Annual output rose unevenly but substantially over the period (Figure 2): from 21 articles in 2015, output climbed to 39 in 2017, dipped slightly to 34 in 2019, then jumped to a first local peak of 58 in 2020. After holding roughly steady through 2021–2023 (52, 49, and 54 articles respectively), output rose sharply again to 84 in 2024 and 117 in 2025, the highest single year in the dataset and more than double the 2020 figure. The 2020 jump is plausibly tied to the pandemic, consistent with a dedicated bibliometric analysis of online physics education that found a comparable surge in publication activity coinciding with the pandemic period (Le et al., 2025). The larger and more sustained rise from 2023 to 2025, however, looks like a distinct and still-accelerating second wave rather than a pandemic echo; it merely coincides with, and does not establish any causal link to, the emergence of generative AI as a subject of PER interest a theme for which Figure 4b (below) reports title-count evidence directly from this corpus, and which is discussed further in connection with the field's most-cited recent articles. The wider

push toward active, student-centered instruction that predates but was accelerated by the pandemic is itself grounded in strong causal evidence: a large meta-analysis across STEM disciplines found that active-learning formats measurably outperform traditional lecturing on both examination performance and failure rates (Freeman et al., 2014), which is one plausible thread running underneath the whole 2020–2025 period rather than a specific explanation for the more recent acceleration.

Table 2 shows how these articles were distributed across the three journals: output was fairly evenly split, with Physical Review Physics Education Research contributing the largest but not dominant share ($n = 206$; 36.4%), followed by Physics Education ($n = 190$; 33.6%) and European Journal of Physics ($n = 170$; 30.0%). This more even distribution in contrast to what a single-journal-dominant pattern might have suggested indicates that all three journals are active, comparably sized venues for PER within this decade, even though they differ substantially in impact metrics (PRPER: Journal Impact Factor 3.5, CiteScore 6.8, Q1; European Journal of Physics: CiteScore 1.6, Q3; Physics Education: Q2). This is a useful reminder that publication volume and citation impact are related but distinct properties of a journal: PRPER's higher standing on impact indicators does not translate into an equivalently lopsided share of this corpus's raw output, plausibly because European Journal of Physics and Physics Education serve a partly different, more pedagogically applied audience (both are IOP titles historically oriented toward classroom-facing physics teaching) rather than competing head-to-head with PRPER for the same submissions. This more balanced distribution also means the thematic and collaboration findings that follow are less likely to simply reflect one journal's editorial preferences than they would be under a single-journal-dominant corpus — though, as discussed in the Methods section, these three journals still represent discipline-specific PER publishing rather than the full space of physics-education-relevant research.

Sources	Articles
Physical Review Physics Education Research	206 (36.4%)
Physics Education	190 (33.6%)
European Journal of Physics	170 (30.0%)
Total	566 (100%)

Table 2. Most Relevant Sources

Co-authorship Network Among Top 25 Most Prolific Authors (2015–2025)

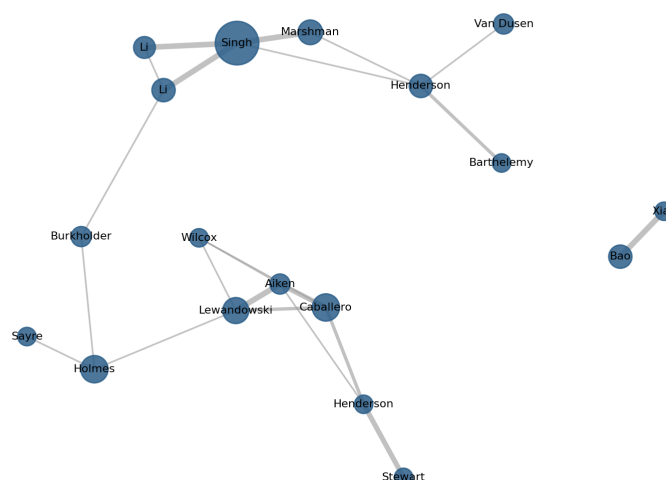


Figure 3. Co-authorship Network Among Top 25 Most Prolific Authors

The co-authorship network (Figure 3, recomputed from the full 566-article corpus) is not one densely connected web but several distinct clusters. The largest centers on Singh, C., connected to Marshman, E. and Li, Y., which itself links via Henderson, C. to a second cluster involving Barthelemy, R. S. and Van Dusen, B.; a separate cluster centers on Lewandowski, H. J., densely interconnected with Caballero, M. D., Sayre, E. C., Aiken, J. M., and Wilcox, B. R., with a further tie out to Holmes, N. G. and Burkholder, E. W. A smaller, disconnected pair links Xiao and Bao. Collaboration in this field, in other words, tends to happen within a fairly small number of established groups rather than across the community more broadly. This pattern is consistent with a well-documented general finding in the science of science: international and interpersonal research collaboration tends to grow through a self-organizing, preferential-attachment-like process, in which established groups accumulate further collaborators disproportionately because visibility and prior success attract new co-authors more than a random or evenly distributed process would predict (Wagner & Leydesdorff, 2005). Applied here, this implies that the clustering visible in Figure 3 is not simply an artifact of a small dataset but a structural feature likely to persist and even deepen over time unless deliberately counteracted for instance through cross-cluster collaborative grants, joint special issues, or conference structures that explicitly broker connections between researchers outside these established groups. The practical implication for the discipline is that knowledge production in PER's leading journals is currently concentrated in the hands of a small number of groups, which has consequences for whose research questions and methodological preferences come to define the field's mainstream.

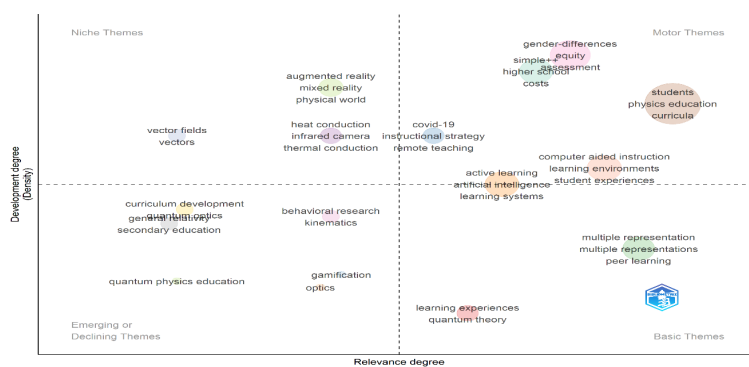


Figure 4. Keyword Co-occurrence Map from an Earlier, Smaller Extraction (illustrative only — see Figure 4b for thematic evidence drawn from the current 566-article corpus)

The keyword co-occurrence map in Figure 4 was generated from an earlier, smaller keyword extraction and could not be recomputed from the 566-article corpus analyzed elsewhere in this review, because Scopus's RIS export format does not include an Author Keywords field. It is retained here only as an illustrative snapshot of one earlier reading of the field's thematic structure, and none of the claims below about dominant or emerging themes rely on it; the corpus-derived evidence for RQ3 is instead the title-keyword trend analysis reported in Figure 4b. With that caveat, the earlier map placed two clusters in the motor-theme quadrant — one built around gender differences, equity, and assessment, the other around students, physics education, and curricula more broadly which is broadly consistent with, though not proof of, the equity/gender and assessment trends confirmed independently below (Malespina & Singh, 2022, 2024; Hazari et al., 2010; Kalender et al., 2019; Nissen & Shemwell, 2016).

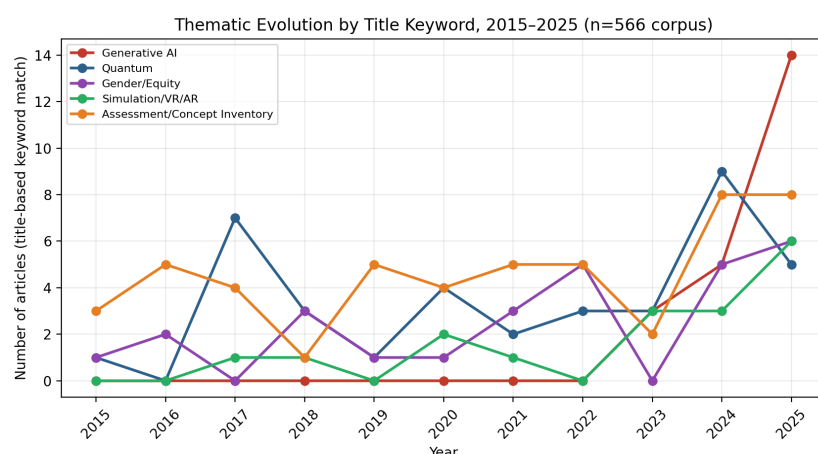


Figure 4b. Thematic Evolution by Title Keyword, 2015–2025 (n = 566, the full analyzed corpus)

Because a full keyword co-occurrence re-analysis was not possible (see above), Figure 4b instead tracks five theme categories by searching each article's title for a defined set of keywords (e.g., "quantum"; "gender", "equity", "identity"; "ChatGPT", "artificial intelligence", "large language model"), counted per year across the full 566-article corpus. This is a coarser method than formal keyword co-occurrence—it will miss articles that address a theme without naming it in the title—but unlike Figure 4, every count in Figure 4b comes directly from the corpus this review actually analyzes, which makes it the more defensible basis for answering RQ3. The clearest signal by far is generative AI: zero titles matched in every year from 2015 through 2022 except a single 2020 outlier and a single 2022 outlier, before rising to 3 articles in 2023, 5 in 2024, and 14 in 2025—a sharp, monotonic rise concentrated entirely in the corpus's final three years. Quantum-themed titles are the most frequent theme overall (38 articles across the period) but follow a noisier, non-monotonic pattern—an early peak of 7 in 2017, a trough near zero in several years, then a rise to 9 in 2024—consistent with an established but unevenly active theme, spanning early conceptual work on secondary and lower-undergraduate quantum instruction (Krijtenburg-Lewerissa et al., 2017) through to more recent empirical tests of research-based quantum teaching strategies (Donhauser et al., 2024), rather than a steadily growing one. Assessment and concept-inventory titles form a comparatively stable through-line across the whole period (50 articles total, present in every year), while gender/equity and simulation/VR/AR titles both show a gradual rise concentrated in the second half of the period (2021 onward) without generative AI's late, sharp inflection—a trajectory that runs from earlier, now well-established interactive-simulation tools (Wieman et al., 2008) through to more recent affective and systematic-review work on virtual and augmented reality specifically (Canright & White Brahmia, 2024; Vidak et al., 2024). Read together with the citation-impact analysis below, in which four of the fifteen most-cited articles in the entire corpus concern generative AI despite the theme being entirely absent from titles before 2020, this constitutes converging corpus-level evidence—from both publication counts and citation impact—that generative AI in physics instruction and assessment is the field's clearest emerging theme within this three-journal corpus, rather than a claim resting on the earlier, non-corpus thematic map alone.

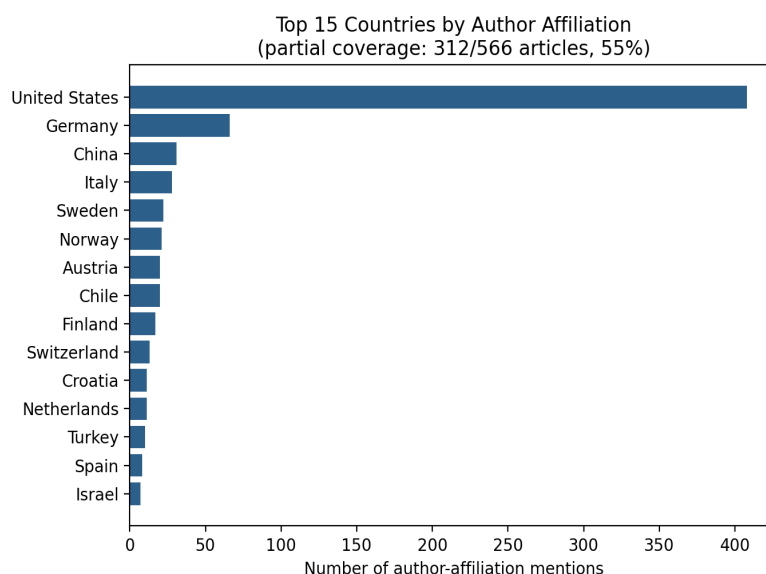


Figure 5. Top 15 Countries by Author Affiliation (partial coverage: 312/566 articles, 55%)

Among the 312 articles (55% of the 566-article corpus) for which affiliation data could be recovered, the United States accounted for the largest share of identifiable author-affiliation records by a wide margin (408 mentions), consistent with the country's outsized share of PRPER authorship in particular; this describes the composition of the analyzed corpus and should not be read as a claim about the global distribution of physics education research activity, which this review cannot observe directly. Germany (66) and China (31) follow as the next most active countries in the recovered sample. China's presence is notable, since it did not appear at all in earlier PRPER-only analyses of this dataset. Italy (28), Sweden (22), Norway (21), Austria (20), and Chile (20) round out the next tier, with a visibly more European- and Latin-American-inflected profile than the country distribution seen in the PRPER-only subset explored earlier in this revision. Southeast Asia and Africa remain minimal in this partial sample: no Southeast Asian country appears among the top 15, and African affiliations were negligible. This should be read as a preliminary picture rather than a definitive one, since the 45% of articles without recovered affiliation data could shift these rankings, particularly for countries near the bottom of the list; the concentration at the top is unlikely to be overturned by the missing 45%, but the ordering among the second-tier countries (ranks 2–10) should be treated as provisional until full affiliation coverage is available. Structurally, this concentration plausibly reflects factors that operate well beyond individual researchers' choices: differential access to research funding, institutional journal subscriptions and article-processing charges, and graduate training pipelines rather than a shortfall of PER activity in underrepresented regions as such.

Most Cited Documents and Authors

Within the full 566-article corpus, the single most-cited article is not from the flagship PRPER but from Physics Education: Staacks et al.'s (2018) tool paper on phyphox, a smartphone-based physics-experiment platform, with 263 citations. This is a notable finding in its own right — the corpus's most influential contribution by citation count is a practical instrumentation tool rather than a theoretical synthesis or an empirical intervention study, suggesting that infrastructure and tool-building papers can accumulate outsized influence in a field like PER. The next several most-cited articles span multiple themes: vector calculus and kinematics instruction (Eager et al., 2016, 188 citations, on jerk, snap, and higher motion

derivatives — consistent with the vectors/vector-fields niche theme identified in Figure 4), gender and equity (Barthelemy et al., 2016, 182 citations; Traxler et al., 2016, 144 citations), and generative AI in physics instruction and assessment, which appears repeatedly among the most-cited recent articles: Kortemeyer (2023, 160 citations, on whether an AI agent could pass an introductory physics course), Polverini and Gregorcic (2024, 101 citations, on using large language models to inform ChatGPT-assisted physics teaching), Kieser et al. (2023, 98 citations), and Dahlkemper et al. (2023, 92 citations, on how physics students evaluate AI-generated responses). Four of the fifteen most-cited articles in the corpus concern generative AI, all published 2023–2024 — a striking concentration that is not represented as its own cluster in the thematic map in Figure 4 as currently drawn, and which plausibly connects to the sharp rise in overall output in 2024–2025 documented in Figure 2. This is worth flagging as a concrete revision once the thematic map is regenerated from the full three-journal corpus.

By total citations accumulated across their papers in this corpus, the most influential author by a wide margin is Singh, C. (883 citations across 28 papers), followed by Marshman, E. (391 across 9 papers), Henderson, C. (378 across 8 papers), Lewandowski, H. J. (346 across 10 papers), and Caballero, M. D. (320 across 11 papers). Singh, C. is also the most prolific author in the corpus by a substantial margin (28 papers, roughly 5% of the entire 566-article dataset), ahead of Holmes, N. G. and Caballero, M. D. (11 papers each), Lewandowski, H. J. (10 papers), and Gregorcic, B. and Marshman, E. (9 papers each). Singh's combined position as both the most prolific and most-cited author — with total citations more than double the next-highest author — indicates a level of sustained, high-impact productivity that is unusual even relative to the other established groups visible in the collaboration network in Figure 3, and would be a natural focus for a closer case-study look at what sustains this kind of output across nearly three decades of PER scholarship.

Summary of Findings

Returning to the three research questions: production grew substantially over 2015–2025 across all three journals combined, with a first surge in 2020 and a much larger, still-accelerating rise in 2024–2025 that coincides with the emergence of generative AI as a PER research subject (RQ1). The United States led by a wide margin in the 55% of the corpus with recoverable affiliation data, followed by Germany and China, and co-authorship clustered within a small number of established groups centered respectively on Singh/Henderson and Lewandowski/Caballero rather than spreading broadly across the community, consistent with self-organizing collaboration dynamics documented elsewhere in the science of science (RQ2). And the most-cited work spans equity and gender (Barthelemy et al., 2016; Traxler et al., 2016), instrumentation and tools (Staacks et al., 2018), and a fast-growing cluster on generative AI in physics instruction and assessment that accounts for four of the fifteen most-cited articles in the corpus despite only emerging as a topic since 2023 (RQ3).

Conclusion

This review makes two contributions beyond its empirical findings. Theoretically, it demonstrates that a Systematic Mapping Review conducted jointly across a discipline's flagship, discipline-specific journals rather than across conference proceedings or a single national literature, as prior computational studies of PER have done (Odden et al., 2020; Santoso et al., 2022) surfaces structural patterns, such as the collaboration clustering documented in Figure 3, that a narrower or more fragmented corpus would not reveal; this suggests science-mapping reviews of other applied education-research subfields would benefit from the same discipline-

specific, cross-journal design rather than defaulting to single-journal or single-database studies. Practically, the findings carry distinct implications for three audiences. For PER researchers, the collaboration-network results suggest that deliberately building ties outside one's existing cluster for instance through joint proposals, exchange visits, or multi-site replication studies would counteract the self-reinforcing concentration this review documents. For the editorial teams of the three journals studied, the geographic concentration findings suggest concrete, actionable steps: targeted invitations to submit from underrepresented regions, article-processing-charge waivers of the kind APS already offers PRPER authors from lower-income countries (American Physical Society, 2026), and Focused Collections or special issues explicitly soliciting Southeast Asian and African scholarship. For researchers based in underrepresented regions specifically, the thematic mapping results particularly the still-niche status of technology-integrated and quantum-education themes point to areas where a smaller, resource-constrained research program could plausibly make a distinctive contribution rather than competing directly in the already-crowded equity-and-assessment motor theme.

Taken as a whole, this review gives a structural picture of physics education research in three leading discipline-specific journals over the past decade: substantial growth in output that accelerated around the COVID-19 period, a thematic landscape centered on equity, assessment, and curriculum, and a collaboration structure built around a handful of established groups rather than broad, community-wide co-authorship.

Research attention within these three journals is heavily concentrated in the United States and a small set of European countries, and Southeast Asia and Africa are clearly underrepresented. Whether this reflects the narrow journal scope of this review or a deeper structural pattern in the field is still an open question. Future research should pursue this question along four specific, operational lines: (1) extending the search to general science-education and educational-technology journals and to databases beyond Scopus (e.g., Web of Science, ERIC), to test whether the geographic and thematic patterns found here hold outside the three discipline-specific journals studied; (2) applying formal citation-burst detection (Kleinberg, 2002) to the now-completed most-cited-document and most-cited-author analysis reported above, to characterize not just which themes and contributors are currently dominant but how attention to them has shifted year over year particularly around the 2023–2025 rise of generative-AI-related articles; (3) combining this bibliometric mapping with a small set of qualitative case studies or interviews with PER researchers based in Southeast Asia and Africa, to test directly whether structural barriers such as funding access and publication costs, rather than a lack of research activity, explain the observed underrepresentation; and (4) tracking the quantum-education and technology-integration clusters identified here as niche themes in a follow-up mapping review in three to five years, to test the prediction offered tentatively in the Discussion above that these are clusters on the verge of moving toward motor-theme status.

Author Contributions

Masita Husen: conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing original draft. Sukardiyono: supervision, validation, writing review & editing.

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