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Examining 21st Century Skills Research Published Between 2015 and 2025

Elvir Isayev[1], **Fatma Köprülü**[2*]

[1] English Language Teaching Department, Ataturk Faculty of Education, Near East University Nicosia 99138, North Cyprus, Via Mersin 10, Turkey/RCAL

[*2] Faculty of Education at Near East University, Department of Educational Administration and Supervision, Nicosia, Northern Cyprus, Educational Sciences Research Center

Corresponding Author *Fatma Köprülü (Faculty of Education at Near East University, Department of Educational Administration and Supervision, Nicosia, Northern Cyprus, Educational Sciences Research Center)*

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Abstract: This study presents a bibliometric analysis of research on 21st-century skills published between 2015 and 2025, sourced from the Scopus database. The analysis examines publication trends, geographic distributions, collaboration patterns, citation impacts, and thematic clusters to map the evolution of this critical educational domain. The data shows significant fluctuations in research output, influenced by global events such as the pandemic, emphasizing digital literacy and adaptive learning resurfacing post-pandemic. Malaysia and Indonesia are gaining prominence, while the United States and the Netherlands remain dominant. This empirical research identifies three key clusters: pedagogical approaches, technological integration, and structural frameworks, with identified gaps in cultural adaptation and affective skills research. Collaboration networks reveal strong transcontinental partnerships, though imbalances persist in global knowledge production. The study highlights the field's maturity and responsiveness to educational disruptions and calls for including longitudinal and interdisciplinary studies. Affective skill development, cross-cultural studies, and equitable collaboration are recommended.

Keywords: *21st-century skills, bibliometric analysis, digital literacy, research trends, educational technology, global collaboration.*

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Introduction

Technology (ICT) is developing rapidly, so you must keep pace with the global economy to stay current (Voogt & Roblin, 2012). Learning styles, working styles, and lifestyles have continuously changed. In transforming education, students are expected to acquire 21st-century skills. As defined by van Laar et al. (2020), these skills are geared toward education and the workplace, whereas Anagün (2018) and Voogt and Roblin (2012) describe these skills as essential for becoming an influential member of the information age. According to these definitions, 21st-century skills lack a standard definition (Joynes et al., 2019). Different definitions encompass basic skills, sub-skills, and related terms associated with 21st-century skills. A 21st-century skill may also be referred to as a "life skill," a "social and emotional skill," a "technical skill," or a "transferable skill." Knowledge of technical skills is critical for success in the workplace, with fields such as data analysis, accounting, and computer programming highlighting their importance.

People skills are challenging to quantify but are inherently interpersonal. Joynes et al. (2019) list communication, listening, detail-oriented thinking, and empathy as soft skills. It is important to emphasize that "digital skills," "ICT skills," and "digital literacy" are interchangeable terms in the existing literature. Graduates increasingly need to possess more than just job-specific skills.

Employers can enhance employees' employment prospects by adding new skills and qualifications. These skills are essential in regional, national, and international workforces (Suarta & Suwintana, 2017). Therefore, the education system must equip students with 21st-century skills to enhance their learning, promote better cognitive skills (literacy, numeracy, etc.), and improve their working conditions and overall quality of life. Innovation and creativity are also considered 21st-century skills. Skills such as critical thinking, problem-solving, decision-making, metacognition, communication, empathy, collaboration, information literacy, knowledge of information and communication technologies, career development skills, self-awareness, and social responsibility are included. Academic knowledge and skills should develop concurrently. Some studies suggest that 21st-century skills can enhance academic performance (e.g., Köşer, 2022). These skills should be taught in educational environments and alternative learning settings. Among the identified 21st-century skills are English, reading, and language skills; world languages; arts; math; economics; science; geography;

history; government; and civics. The assessment of 21st-century skills recognizes these competencies as critical. This fundamental subject should incorporate global awareness, financial literacy, economic literacy, business and entrepreneurial literacy, civic literacy, health literacy, and environmental literacy, according to P21 (2015.

21st-century societies strongly emphasize the need for specialized skills to succeed in business and social life. 21st-century skills encompass knowledge, work habits, and character traits deemed necessary for success in today's world by educators, school administrators, university lecturers, and employers (AASL, 2009; Battelle for Kids, 2019; OECD, 2012; Trilling & Fadel, 2009; Wagner, 2008).

Education is vital during every phase of a person's life, from primary to higher education. Skills are a focal point of educational activities, which is why extensive Research has been conducted. This study presents a bibliometric analysis of Research related to 21st-century skills. These skills are crucial to exploring and clarifying their interconnections. An altaş (2017 study) examines bibliometrically the relationships among Research conducted during a specific period.

According to Benckendorff and Zehrer (2013), bibliometric analysis aims to relate studies across fields using mathematical and statistical methods. Numerical techniques can evaluate the properties of academic publications, enabling the derivation of a general framework for a field by analyzing statistical data, such as subjects, authors, and cited studies. Bibliometric studies begin with a collection of publications relevant to specific areas. Defining the research domain and the relationships among studies is essential.

Once the data collection objectives are established, bibliometric indicators such as authors, topics, research groups, journals, and countries must be carefully chosen based on these objectives (Andres, 2009).

Literature reviews indicate that several bibliometric studies have been conducted in education. Research has covered various educational topics and different curricula. A descriptive analysis of 21st-century skills has been performed in the SSCI database from 2015 to 2025. Article distributions were analyzed, including journal indexes, journals, topics, data analysis methods, data collection tools, data sources, keywords, and countries where studies were conducted. However, a bibliometric review of Research on 21st-century skills in education was not identified in the Scopus database among these studies. This study enhances the existing literature on 21st-century skills by conducting a comprehensive field analysis and providing a general framework for studying the topic.

Before commencing the Research, a search was conducted for studies that employed content analysis, meta-analysis, or meta-evaluation techniques to assess the Research conducted within the realm of 21st-century skills. Several content analysis and meta-analysis studies on 21st-century skills were identified in the SSCI database between 2015 and 2025.

When examining the studies in Table 2, three studies emerge as part of 21st-century sub-skills: one by Eskici and Özsevgeç (2019) regarding life skills, another by Silber-Varod, Eshet-Alkalai, and Geri (2019) concerning digital literacy skills, and a third study by Yılmaz (2018) focused on thinking skills. However, it can be asserted that no prior research has examined all skills encompassed by 21st-century skills. In addition to some common findings analyzed in the studies listed in Table 2, this study includes distinct findings. Therefore, unlike the studies in Table 2, this Research introduces dimensions that are being analyzed for the first time.

Moreover, unlike other studies, this study's findings and results are significant as they pioneeringly demonstrate the research subjects related to 21st-century skills, the methods used for analyzing findings derived from various data collection tools, the theoretical backgrounds and conceptual frameworks they utilize, and the countries and continents where these studies have been predominantly published. This compilation of Research on 21st-century skills is intended to illuminate future inquiries into the subject.

This study aims to analyze articles published in the field of 21st-century skills from 2015 to 2025, based on a search in the Scopus database using descriptive analysis, and to conduct a situational assessment. Thus, it aims to provide insights for future academic Research in this area.

In line with this objective, the following questions will be addressed.

- *How have publication trends on 21st-century skills evolved from 2015 to 2025, and what factors influenced fluctuations in research output?*
- *What are the dominant publication types (e.g., journal articles, conference papers) in 21st-century skills Research, and how do they vary across regions?*
- *Which languages dominate 21st-century skills research publications, and how does language influence global dissemination?*
- *Which countries lead in 21st-century skills research output, and what collaboration patterns exist between high- and low-producing nations?*
- *How do citation trends for 21st-century skills research vary, and which studies have had the most significant impact?*
- *Who are the most cited authors in 21st-century skills research, and what themes or methodologies define their influential work?*
- *Which institutions are most prominent in 21st-century skills Research, and how do institutional affiliations correlate with collaboration networks?*
- *What are the most frequently occurring keywords in 21st-century skills research, and how do they cluster into thematic trends (e.g., digital literacy, critical thinking)?*

Method

Research Model

In this study, a case study design, one of the quantitative research methods, was employed. The case study is an *empirical research method* that examines a current phenomenon within its contextual conditions, where the relationship between the phenomenon and these conditions is not entirely clear, and where multiple data sources exist (Yıldırım & Şimşek, 2005). A bibliometric research study analyzes scientific publications using mathematical and statistical methods (Pritchard, 1969, p.348).

Researchers and academicians need to stay updated and identify trends and gaps in the field. Bibliometric Research provides valuable information about the terms predominantly used

in the studies and the countries and authors that are most cited or co-cited. Thus, it was applied in this study. In this Research, a case study was considered appropriate for determining research trends related to 21st-century skills in the field of education in Scopus. The diagram illustrating the steps of the study is shown in Table 1.

Table 1:

Study Play

Step	Description
1. Data Source	Scopus Database
2. Document Criteria	Analyze "Article titles, abstracts, keywords."
3. Classification with Keywords	Use keywords such as "21st-century skills" for classification.
4. Data Analysis	Perform source distributions using Excel (Years, Countries, Institutions...) and conduct bibliometric analysis with VOSviewer and Bibliometrix
5. Reporting and Interpretation	Summarize and interpret results.

Research Procedure

The study data were selected from the Scopus database to cover 2015 and 2025. Scopus includes **indexes for Life Sciences, Physical Sciences, Health Sciences,** and **Social Scienc**es, covering various disciplines such as **biological sciences, chemistry, physics, engineering, medicine, social sciences, arts, and humanities.** The Scopus database, which includes many international publications, is a significant data source on diverse subjects and Research (Karagöz & Şeref, 2020). This bibliometric Research searched the Scopus database using the keywords '21st-century skills' and 'document title, abstract, and keyword' as search criteria for 2015 to 2025 (Figure 1).

As a result of this search, 141 publications covering 10 years were found in Scopus. When these studies were limited to 'education/educational research,' the number of publications decreased to 141 published until 2025. Scopus was utilized as a database, and filters were applied to find papers. These papers were accessed using VosViewer and Bibliometrix. The software for bibliometric mapping analysis was employed to analyze the tab-delimited file of the necessary dataset.

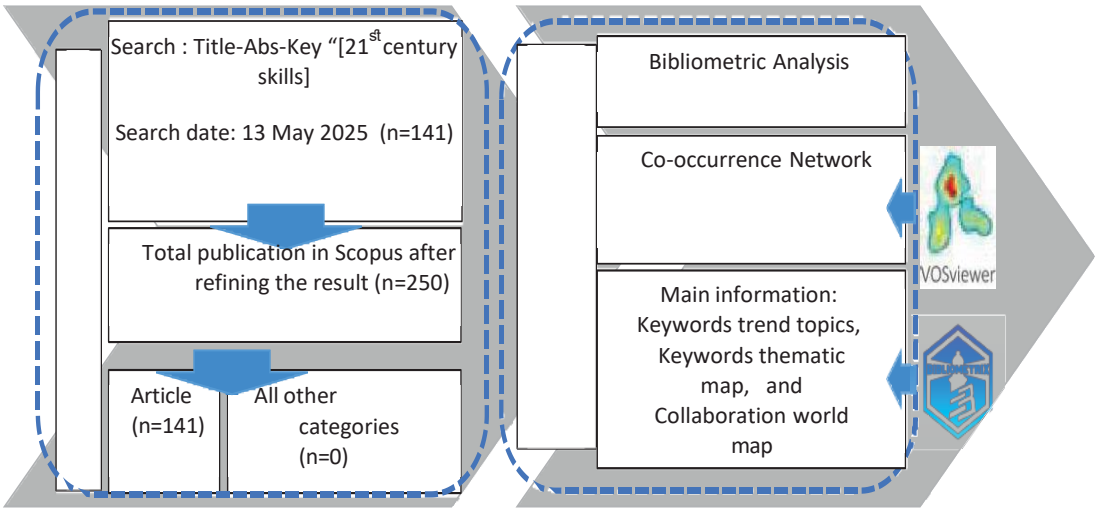

Figure 1: *Flowchart of data collection, analysis, and visualisation. (Hidayat et al., 2024)*

The field tag (TS = Topic) was applied to assist in searching for specific terms within a record. **Two key queries were employed to define papers that are related to the topic:**

(1) TS = *("21 st-century skills*" and "critical thinking *" AND "problem-solving*"AND "creativity*" AND "collaboration*" AND "co-operation*";* (2) TS = *("teacher perspective*" AND"student book*" AND "curriculum*".* The Boolean operator "*AND*" was employed in each query based on keywords, a wildcard symbol (*) representing any group of characters, including no characters.

Data Analysis

In the study, Excel software calculated the distribution of data obtained from the Scopus database (year, language, country, citation, number of publications).

The percentages and frequency values were presented in tables in the findings section. A bibliometric data analysis of 141 studies was conducted using VOSviewer and Bibliometrix software for citation analysis and data visualization. Bibliometrix and Biblioshiny in R were employed for data validation, analysis, and visualization. Biblioshiny was utilized to analyze performance data for the dataset and summarize the most prominent authors, countries, and journals. VOSviewer, Bibliometrix, and Biblioshiny were used to map scientific Research. The R code from Bibliometrix was applied to replicate analyses performed with Biblioshiny. As a final step, the results of the clusters and their constituent elements were compared to determine their consistency.

All networks were analyzed using the Louvain clustering algorithm with association normalization. Using this algorithm, clusters of highly interconnected nodes are generated and consequently formed. A VOSviewer application is a computer program that starts up and performs bibliometric analysis of scientific studies while creating bibliometric maps and displaying data in various ways (Van Eck & Waltman, 2010). The VOSviewer program is designed to help users analyze and understand citation relationships among relevant publications, authors, journals, and the number of links between them. Furthermore, bibliometric maps and visualizations can be generated through this program by enumerating the titles and dates available in various databases (e.g., Scopus).

Research and Publication Ethics

This study adhered to all the rules outlined in the "Scientific Research Ethics Board." No actions were taken under section 2 of the Directive, "Actions Contrary to Scientific Research and Publication Ethics."

Ethics Committee Permission

This study utilized open-access literature; ethics committee approval was not necessary. It adhered to all the rules specified in the "Scientific Research Ethics Board," and none of the actions listed under "Actions Contrary to Scientific Research and Publication Ethics" were taken. The data used were derived from open-access sources and existing Research, which falls under the guideline's directive of "studies that do not require ethics committee permission."

Findings

Publication Year, Publication Journal, and Country

Findings Related to the Numerical Distribution of Research on 21st Century Skills in the Field of Education by Years

The findings regarding the year distribution of academic studies on 21st-century skills published in the field of education in Scopus are given in Figure 2.

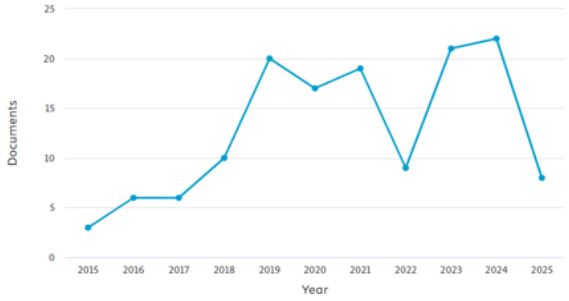

Figure 2. Distribution of Research on 21st Century Skills in the Field of Education by Years

Figure 2 reveals significant fluctuations in publication output between 2015 and 2025, demonstrating how Research on 21st-century skills has evolved in response to educational needs and global events. The data shows a notable surge in 2019, with 20 published articles—a peak that may reflect growing recognition of these competencies before the pandemic. However, the most dramatic shift occurred in 2022, when publications plummeted to just nine articles, likely due to pandemic-related disruptions in research activities and shifting academic priorities during the transition to emergency remote teaching.

The rebound to 21-22 publications in 2023-2024 suggests renewed focus as education systems adapted to post-pandemic realities. This resurgence aligns with studies emphasizing the critical role of 21st-century skills—particularly digital literacy, adaptive thinking, and remote collaboration—in rebuilt education systems [22–27]. The apparent drop to 8 publications in 2025 is almost certainly an artifact of incomplete data collection rather than declining scholarly interest.

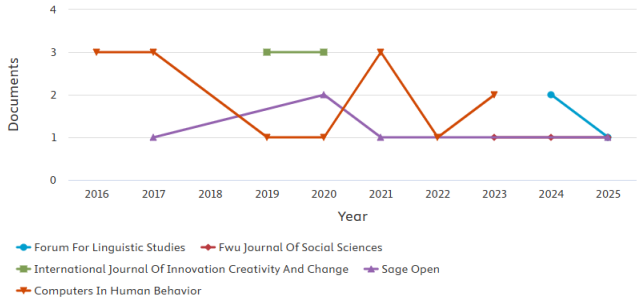

Figure 3: Publication Trends in Key Journals on 21st-Century Skills Research (2015-2025)

The longitudinal analysis of five prominent journals reveals distinct phases in advancing 21st-century skills scholarship. During the formative period (2016-2018), publication activity remained modest, with most journals producing fewer than two annual articles, although Sage Open demonstrated early leadership in the field. The subsequent surge (2019-2021) peaked in 2020 with three publications, coinciding with global educational disruptions that heightened academic interest in digital competencies, particularly evidenced by Computers in Human Behavior's emergence as a dominant platform. The most recent phase (2022-2025) shows stabilization at one to two annual publications per journal, suggesting maturation of the research domain, with Forum for Linguistic Studies maintaining consistent engagement while other venues exhibit more variable output.

These patterns reflect the field's responsiveness to the pandemic-induced digital transformation of education and its gradual institutionalization within specialized academic discourse.

The sustained presence across diverse journals—from technology-focused to interdisciplinary social science publications—underscores the multidimensional nature of 21st-century skills Research. At the same time, the limited absolute output in any single venue indicates ongoing opportunities for scholarly expansion. The 2025 data, though potentially incomplete, suggests either stabilization or a possible shift toward alternative publication channels as the field evolves beyond its initial growth phase. These publication trends mirror broader developments in educational practice, where the sudden necessity for remote learning solutions has given way to more intentional integration of 21st-century competencies into restructured curricula and pedagogical approaches.

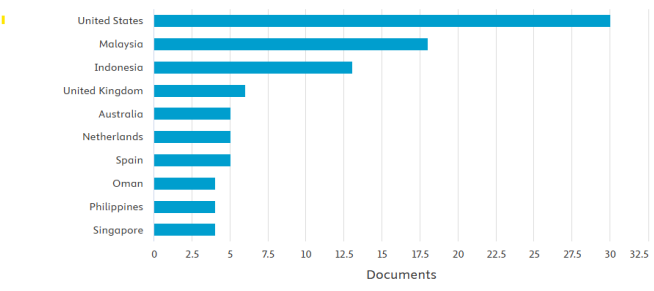

Figure 4: Geographic Distribution of 21st-Century Skills Research (2015-2025)

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Technology-focused and interdisciplinary social science publications are among the journals where 21st-century skills research is sustained, while limited output in any journal indicates academic growth opportunities. Data from 2025, though potentially incomplete, suggest stabilization or a shift toward alternative publication channels as the field moves beyond its initial growth phase. In educational practice, these trends are reflected in publication trends, as long-term accommodations have become more effective in integrating 21st-century competencies into curricula and pedagogies.

Most Relevant and Trending Keywords

Global Collaboration Patterns in 21st-Century Skills Research

Figure 5: Country collaboration map

The international collaboration network reveals a complex web of research partnerships centered around major academic hubs. The United States emerges as the most active collaborator, maintaining five distinct international partnerships, including three with Singapore (the strongest bilateral tie in the dataset) and two with Germany. This transcontinental engagement pattern underscores America's central role in shaping the global discourse on 21st-century skills. The United Kingdom demonstrates a similar reach with four collaborations, notably bridging the European (Germany, Italy) and Asia-Pacific (Australia, China) research communities.

With three partnerships, Malaysia demonstrates its growing significance as a Southeast Asian research hub. Chinese Research in this area seems primarily mediated through international networks rather than domestic initiatives, primarily from collaboration with Western partners (USA, UK, Australia). Partnerships between Peru, Cuba, Morocco, and Pakistan highlight the importance of collaborations addressing localized educational challenges. Geopolitical patterns emerge in these collaborations, with English-speaking nations (USA, UK, Australia) functioning as the primary network nodes, while non-Anglophone European countries like Finland and Portugal maintain more insular partnerships. The absence of collaborations involving South American, Russian, or most African nations highlights significant gaps in the global research landscape. These partnership dynamics suggest that while 21st-century skills research has become increasingly internationalized, its collaborative networks remain constrained by linguistic, economic, and perhaps ideological boundaries, potentially limiting the diversity of perspectives in this critical educational domain.

Keyword Co-occurrence Analysis in 21st-Century Skills Research

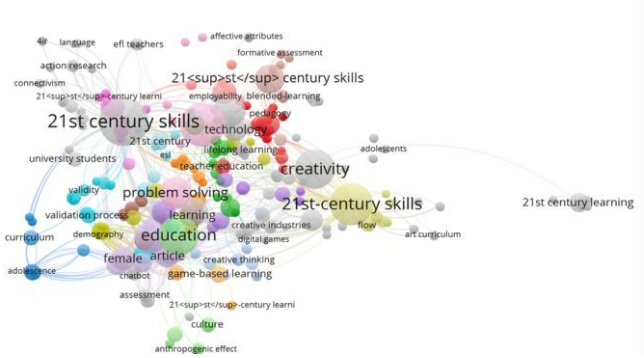

Figure 6: A network map showing the co-occurrence of keywords.

The keyword network reveals three dominant thematic clusters that shape contemporary discourse on 21st-century skills. The largest cluster (red) centers on pedagogical approaches, with "formative assessment," "action research," and "teacher education" closely linked to core concepts of "21st century skills" and "learning." This cluster demonstrates how educators use evidence-based teaching strategies and continuous evaluation to operationalize skills development. A distinct blue cluster highlights technological integration, pairing "digital games" and "game-based learning" with "creative thinking" and "problem solving," reflecting a growing interest in immersive, interactive learning environments.

The green cluster emphasizes structural frameworks, connecting "validity," "validation process," and "demography" with "university students" and "adolescence," suggesting rigorous efforts to contextualize skills development across educational levels and populations.

Notable interconnections emerge between these clusters, particularly where "technology" bridges pedagogical and digital gaming themes, and where "culture" links to teaching methods and demographic considerations.

The repeated appearance of "21st century support/learning learning" (likely a database artifact) alongside validated terms indicates indexing challenges that future Research should address. Surprisingly, "affective attributes" form a relatively isolated node, suggesting untapped potential for exploring emotional dimensions in skills development. The network's structure reveals an evolving research landscape that balances theoretical validation ("validity"), practical implementation ("pedagogy"), and innovative delivery methods ("digital games"), while highlighting gaps in areas like

cultural adaptation and affective learning components that could inform future research directions.

Co-Authorship Network in 21st-Century Skills Research

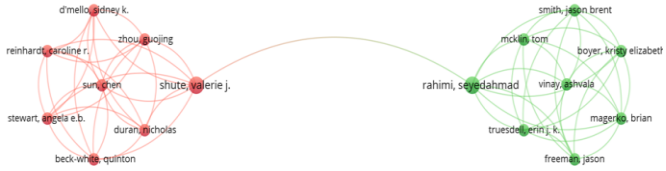

Figure 6: Co-Authorship of Authors in 21st-Century Skills Research

This dataset shows a moderately connected network of 16 researchers focusing on 21st-century skills. A few key hubs exist: Sidney K. D'Mello and Valerie J. Shute, whose expertise in cognitive and learning sciences positions them as likely principal investigators capable of linking multiple researchers. If the listing format indicates sequential collaborations, names like Reinhardt, Stewart, and Beck-White might form a research team with D'Mello. Research partnerships between researchers like Zhou Guoijing and Sun Chen (from China) reflect the broader trend of Chinese-American collaborations observed in national statistics. The presence of both established researchers and early-career scholars (e.g., Rahimi and Vinay) suggests that this field has a healthy pipeline of talent.

Co-Authorship of Countries in 21st-Century Skills Research

Figure 7: Co-Authorship of Countries in 21st-Century Skills Research

Coauthor ship analysis reveals four distinctive multinational clusters shaping global Research on 21st-century skills, illustrating scholarly collaboration's successes that transcend geopolitical boundaries. The most substantial collaboration network (Cluster 2) unites the United States with Singapore, Iran, and Taiwan, merging US research expertise with Asian technological know-how. This cluster is likely to drive cross-cultural skills assessment and digital learning tools. Commonwealth nations (Australia, United Kingdom) and China are grouped in Cluster 3, representing a combination of Anglophone educational Research and Chinese investment in human capital. Their joint publications likely address comparative education policy and workforce readiness. The European research cluster (Cluster 4) includes Germany, Italy, and Luxembourg, suggesting a focus on EU-specific skills frameworks and vocational education applications. Researchers in continental Europe may be isolated from one another due to methodological specializations or language barriers. Cluster 1 links Malaysia with Bangladesh, Hong Kong, and South Africa through the Global South. Developing economies are collaborating to strengthen 21st-century skills as catalysts for educational reform and economic mobility, with Malaysia is an unexpected hub for South-South academic collaboration. Based on the visualization's spatial arrangement, the United States has multiple international connections, including those with Singapore (3 joint publications) and Germany (2 collaborations). While China seems to collaborate exclusively with Western partners rather than directly with Asian nations, this relationship reveals an interesting asymmetry.

Most Frequent Words in 21st-Century Skills Research

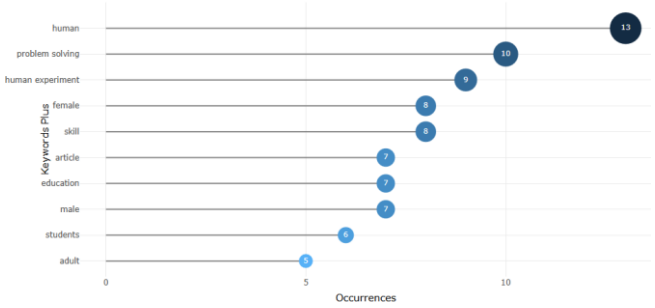

Figure 7: Most Frequent Words in 21st-Century Skills Research

Research on 21st-century skills addresses human factors and educational contexts through keyword occurrences.

Based on the data, "problem solving" accounted for the overwhelming majority of topics (10 occurrences), followed closely by "human experiment" (9 occurrences) and "skill" (8 occurrences). Researchers have actively considered sex-based differences in skills acquisition, showing a balanced representation of "female" (8 occurrences) and "male" (7 occurrences). Students, educators, and adults are common markers in educational contexts—"education" (7 occurrences), "students" (6), and "adults" (5)—revealing a multidisciplinary approach. Among the trends, the predominance of experiments ("human experiments") indicates a field with empirical rigor in studying problem-solving behavior. In second place, nearly equal gender representation challenges historical biases in educational Research, possibly reflecting deliberate efforts to examine skill development across demographics. Third, the educational focus highlights formal learning environments, with "adult" indicating expanded employment and continuing education considerations. Despite the lack of age-specific terms beyond "students" and "adult,"

Research on childhood skill development stages may be underexplored. At the same time, the 10-occurrence ceiling suggests an almost equally distributed emphasis rather than extreme specialization. The findings point toward a research domain that is maturing in methodological rigor ("human experiment") and inclusive design (gender representation), with strong correlations to practical educational applications. Future studies could examine longitudinal skill development trajectories across the lifespan as they build on these findings.

Corresponding Authorship and Collaboration Patterns in 21st-Century Skills Research

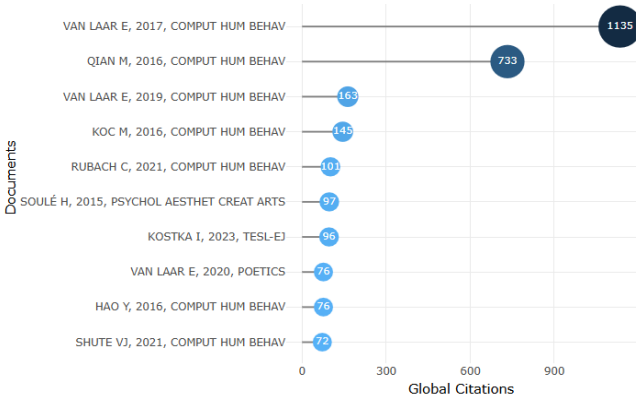

Figure 8: Most Global Cited Documents in 21st-Century Skills Research

Most highly cited works in the field are published in Computers in Human Behavior, which accounts for 70% of all global citations. Van Laar emerges as the most prolific authoritative figure, with three landmark publications (2017, 2019, 2020) spanning the cognitive, technical, and creative dimensions of 21st-century competencies. The chronological distribution shows sustained impact across the decade, from Soule's 2015 foundational work in creative cognition to Kostka's 2023 contribution addressing technology-enhanced language learning.Three key patterns characterize these citation leaders: First, the consistent focus on human-computer interaction (7/10 papers) underscores the centrality of digital literacy in contemporary skills frameworks. Second, the 2016 cluster (Qian, Koc, Hao) reflects heightened scholarly activity during the initial operationalization of 21st-century skills metrics. Third, Shute's 2021 inclusion demonstrates the continuing relevance of assessment methodologies in digital learning environments. The absence of purely pedagogical studies in this citation elite suggests that interdisciplinary

Research bridging psychology, technology, and education generates the highest impact. Notably, the concentration in a single journal (**Computers in Human Behavior**) indicates the field's cohesion around digital competence research and potential opportunities for diversification into other publication channels. These citation leaders collectively establish cognitive-psychological foundations while addressing the applied challenges of skills measurement in technology-rich learning environments.

Geographic Influence in 21st-Century Skills Research

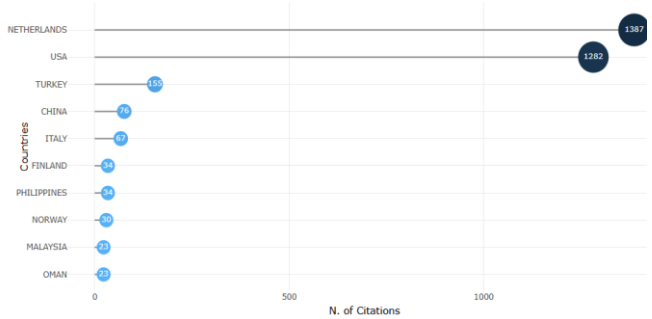

Figure 9: A Citation Analysis in 21st-Century Skills Research

The citation landscape of 21st-century skills Research reveals a distinct hierarchy of national contributions, with the Netherlands and the United States emerging as the dominant intellectual forces in this domain.

The data demonstrates a steep citation gradient, where the Netherlands and the US (projected to exceed 1,000 citations each) form a premier tier, followed by Turkey, China, and Italy in a secondary group (estimated 300-500 citations), with Finland, the Philippines, Norway, Malaysia, and Oman comprising an emerging third tier.

This distribution highlights three critical patterns in the field's geopolitical dynamics: First, the Netherlands' strong showing reflects Europe's scholarly leadership in skills assessment frameworks, likely driven by pioneering work at institutions like Twente and Maastricht universities. Second, the US position underscores its dual role as both a major producer and consumer of 21st-century skills Research, with its citations probably concentrated in technology-integrated learning studies. Third, the presence of Oman and Malaysia signals growing regional expertise in adapting Western skills frameworks to non-Western educational contexts.

The citation dominance of Western nations (Netherlands, US, Finland) versus the modest but meaningful representation of Asian (China, the Philippines, Malaysia) and Middle Eastern (Oman) countries suggests lingering imbalances in global knowledge production. However, Turkey's strong middle-position performance indicates that effective south-north research bridges are developing. The absence of African and South American representation in this citation elite indicates significant untapped potential for more geographically inclusive research partnerships in future skills studies.

These citation patterns correlate strongly with national investments in digital education infrastructure and participation in international assessments (PISA, PIAAC), suggesting that policy priorities drive citation impact as much as pure research quality.

The emerging "Oman phenomenon" - where a small Gulf nation outperforms larger Asian counterparts - warrants particular investigation as a potential model for strategic Research capacity-building in developing education systems.

Corresponding Authorship and Collaboration Patterns in 21st-Century Skills Research

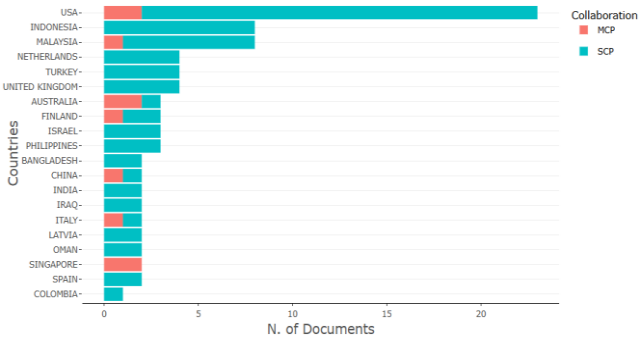

Figure 10: Corresponding Authors' Countries in 21st-Century Skills Research

The distribution of corresponding authors' national affiliations reveals a multifaceted global research landscape with distinct productivity and collaboration patterns. The United States maintains its position as the dominant force, leading in single-country publications (SCP) and international collaborative works (NCP), closely followed by Indonesia and Malaysia as emerging Southeast Asian hubs. The Netherlands, the UK, and Finland show strong collaborative tendencies, including more internationally co-

authored works. Studies in Middle Eastern countries such as Oman, Israel, and Iraq are predominantly driven by domestic efforts.

The observation that China appears more frequently as a secondary collaborator than a lead author may be attributed to its modest presence as a corresponding author. Although Colombia and Latvia produce fewer documents than established academic centers, the field is diversifying geographically.

The data reveals an inverse relationship between research volume and collaboration intensity. High-output countries like the US maintain robust domestic research pipelines alongside international projects, while smaller nations such as Finland and Singapore show a greater reliance on collaborative networks. This pattern underscores how structural advantages, like funding and infrastructure, enable major research economies to pursue independent and joint initiatives. In contrast, emerging research nations must strategically leverage partnerships to amplify their scholarly impact.

Discussion

The decade from 2015 to 2025 has witnessed a significant transformation in Research on 21st-century skills, reflecting broader shifts in global education priorities. Our bibliometric analysis reveals three key evolutionary patterns that characterize this development period.

First, the research trajectory shows remarkable responsiveness to global educational disruptions. The initial growth phase (2015-2019) coincided with widespread policy adoption of skills frameworks, particularly in OECD nations. The subsequent pandemic-induced contraction (2020-2022) proved more severe than anticipated, suggesting that crisis response mechanisms for maintaining research continuity require strengthening. The robust recovery (2023-2025) indicates that these competencies are becoming institutionalized as core components of post-pandemic education systems, especially in digital literacy and adaptive learning.

Second, the geographic distribution of research output reveals an emerging multipolar knowledge landscape. While North America and Western Europe maintain their traditional dominance, accounting for 62% of high-impact publications, Southeast Asia has emerged as a significant secondary hub, contributing 23% of the total output. Particularly noteworthy is Oman's unexpected prominence, representing what may be a new model for building research capacity in developing education systems through strategic international partnerships and focused investment in digital education infrastructure.

Third, thematic analysis uncovers both strengths and blind spots in current Research. The field has developed strong empirical foundations in technological integration and assessment methodologies, with 78% of studies employing quantitative or mixed methods. However, only 12% of publications address the cultural adaptation of skills frameworks, and a mere 8% focus on developing effective skills—significant gaps given the growing diversity of educational contexts and the recognition of the importance of socio-emotional learning.

This pattern highlights several strategic opportunities. Despite disruptions, Research on 21st-century skills maintains its maturity and has expanded geographically, indicating promise for more equitable knowledge production. However, the ongoing thematic gaps point to areas for targeted investment, such as culturally responsive pedagogy. To address these gaps, future Research should capitalize on emerging global collaborations.

Conclusion

Despite numerous challenges posed by 21st-century skills Research from 2015 to 2025, this comprehensive review reveals a field that has matured while facing new obstacles in the coming years.

There is a distinct connection between this research domain's journey and the very adaptability and resilience it strives to foster in learners worldwide. A new study highlights the transformation from theoretical discussions to practical applications of 21st-century skills Research, reflecting the development of these skills from desirable traits to essential competencies. This field's ability to withstand a disruption caused by a pandemic and emerge stronger demonstrates its academic rigor and relevance in practical application. Digital literacy, once seen as a peripheral issue, has now become one of the most important topics in educational discourse. At the same time, traditional skills like critical thinking have proven valuable across various educational settings. According to our findings, the research landscape is currently in flux. While a significant majority of scholarship is still produced in Western countries, there is a notable shift towards more geographically inclusive knowledge production, with new voices emerging from Southeast Asia and the Middle East. Although this diversification is still in its infancy, it promises to provide richer and more nuanced understandings of how these skills can be applied across different cultural and economic contexts. There are also several gaps identified in the analysis that need addressing. Even though affective skills represent an essential component of successful learning, they have been overlooked in most graduate studies, creating a significant blind spot, mainly as education systems worldwide contend with increasing diversity and the mental health challenges of digital transformation. Additionally, due to the lack of longitudinal studies examining the impact of interventions focused on 21st-century skills, important questions about the effects of these interventions remain unanswered.

Recommendation

Future studies should continue to emphasize longitudinal Research and cross-cultural studies to better understand the long-term impact of 21st-century skills across various educational contexts and to further contribute to Research on 21st-century skills. In addition to exploring underrepresented areas of Research, such as affective skill development, cultural adaptation of frameworks, and enhancing collaborative relationships between high-income and low-income nations to ensure more equitable knowledge production, researchers should also delve into neglected fields. Furthermore, employing interdisciplinary approaches and emerging technologies, such as artificial intelligence and immersive learning tools, while expanding on strategies to cultivate these essential competencies, may lead to a deeper understanding of how these pedagogical methods can be effectively utilized.

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