

Bibliometric Analysis of Adaptive Soft Skill Curriculum Development Models for 21st-Century Challenges

Yaziz Abi Sufyan¹, Deni Kurniawan²

¹ *Zhafir Education Consulting*

² *Pengembangan Kurikulum, Fakultas Ilmu Pendidikan, Universitas Pendidikan Indonesia, Bandung, Indonesia*

Yaziz.abbi@gmail.com¹, denidoctor69@gmail.com²

ABSTRACT

This study presents a bibliometric analysis of global research patterns on Adaptive Soft-Skill Curriculum Development Models for 21st-century challenges from 2020 to 2025. The analysis was conducted using 5,329 articles retrieved from the Scopus database, employing a systematic PRISMA-based approach and utilizing VOSviewer and RStudio for visualization and synthesis. The findings reveal a significantly accelerating trend in publications, particularly post-2023, with the United States (1,705 documents), Indonesia (380), and the United Kingdom (350) identified as the top contributing countries. Three dominant thematic clusters shape the intellectual landscape: “Digital Competencies and Core Cognitive Skills,” emphasizing the foundational 4Cs (Critical Thinking, Collaboration, Communication, Creativity) and their integration with technology; “Interdisciplinary and Experiential Learning Models,” focusing on pedagogical innovations like STEAM and Project-Based Learning (PBL) to foster practical skills; and “Curriculum Policy, Standardization, and Contextualization,” which addresses governance, formal evaluation, and the need for culturally responsive curricula. Despite the robust body of literature, the analysis exposes three critical research voids: the Affective Gap (insufficient dedicated research on Emotional Intelligence and Holistic Education), the Micro-Implementation Gap (shortage of research on teacher digital competency and effective delivery in diverse settings), and the Contextual Impact Gap (lack of longitudinal studies linking new models to long-term career success and social impact). The study concludes by advocating that future educational policy and research must strategically prioritize these gaps—strengthening teacher capacity, integrating emotional adaptability, and mandating rigorous program evaluation—to ensure curricula are responsive to the volatile demands of the 21st-century workforce.

ARTICLE HISTORY

Received 28 July 2026

Revised 18 August 2026

Accepted 29 August 2026

KEYWORDS

Adaptive Soft Skill ,
Curriculum Development ,
Bibliometric Analysis ,
21st Century Skills ,
Educational Innovation,

Introduction

The rapid transformation of global education in the 21st century has underscored the essential role of soft skills in navigating complex social, technological, and economic challenges. Scholars have consistently emphasized that traditional curricula focusing solely on cognitive knowledge are insufficient for equipping learners with adaptive capacities needed for dynamic environments [1][2]. Communication, collaboration, adaptability, and emotional intelligence have emerged as the central competencies underpinning sustainable human development and employability [3][4]. The increasing demand for these competencies has driven educational institutions to adopt adaptive curriculum models integrating experiential and interdisciplinary learning [5][6]. Within this evolving landscape, soft skills are no longer

seen as supplementary attributes but as dynamic, context-dependent capabilities that require deliberate cultivation through flexible learning ecosystems [7].

In educational theory, curriculum innovation is recognized as a mechanism for systemic change bridging the gap between social expectations and institutional realities [8]. Integrating soft-skill development into curriculum frameworks signifies a paradigm shift toward competency-based and human-centered education [9] [10]. This shift aligns with UNESCO's Education for Sustainable Development and the OECD's Learning Compass 2030, which highlight adaptability and lifelong learning as critical drivers of future-ready education [11] [12]. Accordingly, adaptive curriculum design seeks to embed such competencies into teaching practices, fostering learner resilience and self-agency [13] [14]. Moreover, research indicates that soft skills contribute not only to employability but also to civic engagement, ethical reasoning, and collective well-being [15].

Over the past decade, the scholarship on 21st-century competencies and adaptive curriculum frameworks has proliferated across multiple disciplines. Empirical works demonstrate that integrating digital competence and socio-emotional learning into education enhances learner adaptability and critical reflection [16] [17]. Studies in teacher education and vocational training similarly stress the importance of project-based, technology-enhanced pedagogies in nurturing creativity and problem-solving skills [18][19]. Despite this progress, the field remains theoretically fragmented, with diverse models and definitions of "soft skills" across global contexts [20] [21]. Therefore, bibliometric mapping and conceptual synthesis are increasingly used to structure and interpret the growing knowledge base.

Recent studies have moved beyond descriptive frameworks to propose actionable pathways for integrating 21st-century skills into national curricula. For example, research on higher education reform highlights the importance of aligning curriculum with global standards such as the ISTE framework and the OECD Learning Compass [22][23]. Adaptive and backward-design models have been widely adopted to strengthen teamwork, communication, and leadership skills in management and teacher education programs [24][25]. Similarly, project-based and blended-learning approaches have been shown to foster collaboration and digital literacy, although challenges persist in infrastructure and pedagogical readiness [26] [27]. The convergence of digital innovation and soft-skill pedagogy represents a crucial foundation for future-oriented curriculum transformation [28].

Nevertheless, significant gaps remain in the global literature. Few studies provide systematic mappings of adaptive soft-skill curriculum models across regions and education levels. Comparative and data-driven analyses that reveal collaboration networks and institutional influences are still limited [29][30]. Understanding how adaptive curricula operationalize soft skills within broader sustainability and employability agendas remains a pressing challenge for researchers and policymakers alike [31]. Consequently, bibliometric synthesis is crucial to consolidating fragmented knowledge, identifying emerging clusters, and providing theoretical direction for 21st-century education research [32] [33].

This study therefore seeks to map and analyze global research patterns related to adaptive soft-skill curriculum development models from 2020 to 2025. By combining bibliometric and conceptual mapping approaches, the study aims to reveal dominant themes, collaboration networks, and intellectual foundations of this emerging field. Specifically, the analysis will identify leading authors, institutions, and countries contributing to this topic, as well as visualize the conceptual relationships that define its current structure. Moreover, the study intends to project future research directions by identifying underexplored themes and potential areas for theoretical expansion.

Method

This study adopted a bibliometric analysis to systematically examine the global research landscape related to Adaptive Soft Skill Curriculum Development Models for 21st-Century Challenges. Bibliometric analysis is a quantitative research technique grounded in information science and scientometrics, designed to evaluate the structure, growth, and intellectual evolution of a body of knowledge through measurable indicators such as publication counts, citation patterns, and co-occurrence networks. The approach enables researchers to uncover hidden relationships between authors, institutions, and concepts within a field, thereby providing both descriptive and relational insights that go beyond traditional literature reviews. In the context of this study, the bibliometric method serves as a comprehensive mapping tool to reveal how global scholarship has evolved in addressing adaptive curriculum design and the integration of soft skills for 21st-century learning.

Data were retrieved from two highly reputable databases Scopus, both recognized for their extensive coverage and rigorous indexing standards across academic disciplines. These databases were selected to ensure both reliability and representativeness of the global research output. The search strategy employed the following combination of keywords: “21st century skills” OR “curriculum development”. The search encompassed publications from January 2020 to October 2025, reflecting the most recent five-year window of accelerated discourse on adaptive and future-oriented education. The initial retrieval yielded 2,317 records which were subsequently refined through a screening process that excluded duplicates, non-English materials, editorials, book chapters, and studies irrelevant to the research focus. After a careful review of titles and abstracts, 2,041 documents were retained for further analysis.

To process and analyze the data, bibliographic records were exported in CSV and RIS formats and analyzed using VOSviewer and RStudio software environments. VOSviewer was used to visualize the structure of scientific networks through co-authorship, co-citation, and keyword co-occurrence mapping, which enabled the identification of dominant research themes and emerging clusters in the literature. A minimum occurrence threshold of 10 keywords was applied to generate interpretable network maps. Meanwhile, RStudio—using the Bibliometrix package—was employed for thematic evolution analysis, allowing the exploration of how conceptual emphases have shifted over time and how new research frontiers are emerging. This combination of tools ensured a robust quantitative foundation for identifying both the intellectual and social structure of the research domain. The bibliometric indicators examined included publication growth trends, country productivity, author influence, and thematic clusters, all of which together provided a multidimensional understanding of the field’s development.

Methodologically, bibliometric analysis in this study follows the tradition established by Price’s theory of scientific growth, which posits that knowledge production follows cumulative and exponential patterns influenced by collaboration and technological advancement. By integrating this theoretical orientation, the study interprets bibliometric patterns not only as descriptive data but also as reflections of epistemological change in educational research—particularly in the transition toward adaptive, human-centered, and skills-based learning paradigms. This approach situates the bibliometric findings within a broader theoretical understanding of how educational innovation aligns with global sustainability and employability goals.

Although the use of Scopus enhances the validity of this analysis, the study acknowledges certain limitations. Restricting the dataset to English-language publications may exclude relevant works published in other languages, particularly those reflecting localized innovations in soft skill development. Furthermore, while bibliometric analysis provides an objective and large-scale quantitative overview, it does not capture the nuanced interpretive aspects of pedagogical design. Future research could therefore complement these findings with qualitative content analysis to deepen the theoretical and contextual interpretation of adaptive curriculum models.

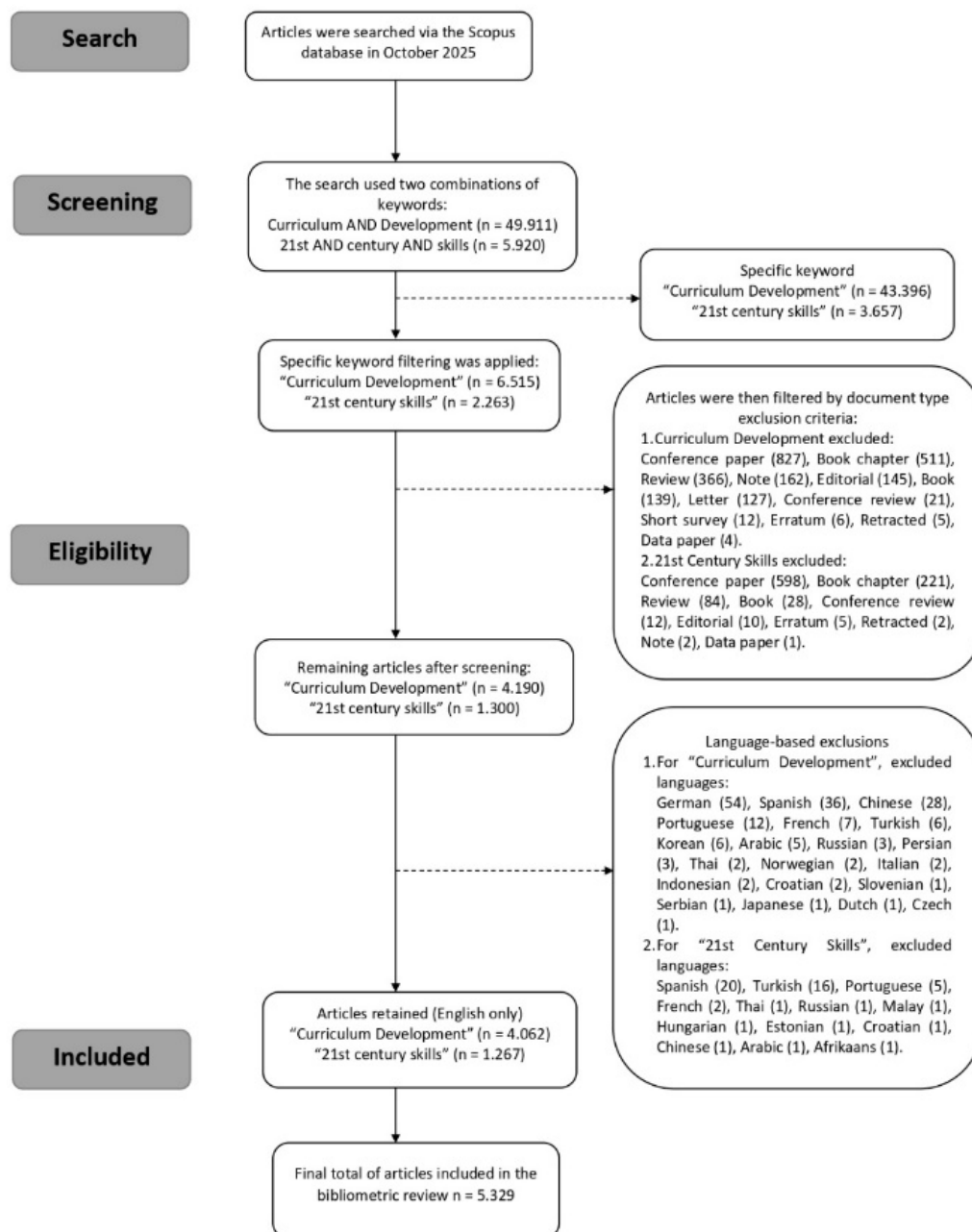


Figure 1. PRISMA Flow Diagram: Detailing Steps in The Identification and Screening of Sources Scopus

The data retrieval and screening process followed a systematic PRISMA-based approach consisting of four stages: search, screening, eligibility, and inclusion. Data were extracted from the Scopus database in October 2025 using two main keyword combinations: "Curriculum AND Development" (n = 49,911) and "21st AND century AND skills" (n = 5,920). The search was refined with the specific keywords "Curriculum Development" (n = 6,515) and "21st century skills" (n = 2,263) to ensure thematic accuracy. Non-journal documents such as conference papers, book chapters, reviews, and editorials were excluded, resulting in 4,190 eligible records for Curriculum Development and 1,300 for 21st Century Skills. A subsequent

language filter retained only English-language publications, eliminating non-English articles from more than 20 languages. The final dataset comprised 4,062 English-language articles on Curriculum Development and 1,267 on 21st Century Skills, yielding a total of 5,329 articles included in the bibliometric analysis. This rigorous, multi-stage selection process ensured the inclusion of high-quality, peer-reviewed studies relevant to adaptive curriculum development and 21st-century skill integration. The dataset was then analyzed to address three key research questions: RQ1: What are the global publication trends and patterns related to adaptive soft-skill curriculum development for 21st-century challenges? RQ2: What emerging thematic clusters and research gaps can be identified to inform future directions in curriculum innovation and educational policy?

Results and Discussion

The results of this study focus on findings derived from 5,329 articles retrieved from the Scopus database, encompassing research on Curriculum Development and 21st Century Skills. The data were obtained through a systematic bibliometric process that identified the number of publications, annual growth trends, and distribution across journals, authors, and institutions. This study highlights the evolution of scholarly interest in adaptive soft-skill curriculum design during the 2020–2025 period, reflecting the growing emphasis on employability, human-centered learning, and digital competence in education. Furthermore, the analysis identifies the most influential authors, leading institutions, and contributing countries shaping global discourse in this domain. The study also maps thematic clusters and keyword co-occurrence networks, revealing emerging patterns in research on adaptability, pedagogical innovation, and 21st-century competencies that inform both theoretical and practical directions for future curriculum development.

A. RQ1: What are the global publication trends and patterns related to adaptive soft-skill curriculum development for 21st-century challenges?

To address RQ1, a descriptive bibliometric analysis was conducted to examine how global research output on adaptive soft-skill curriculum development has evolved in response to 21st-century educational challenges. Over the past five years, the intersection of curriculum innovation, soft-skill development, and digital transformation has become one of the most intensively explored areas in education research [2] [34] [10]. Studies indicate that the publication trajectory reflects the rapid acceleration of pedagogical reforms following the COVID-19 pandemic, as educators worldwide sought adaptive, flexible learning systems to meet new socio-technological demands [13] [32] [35]. This surge coincides with global initiatives emphasizing resilience, creativity, and adaptability as pillars of lifelong learning [4] [19].

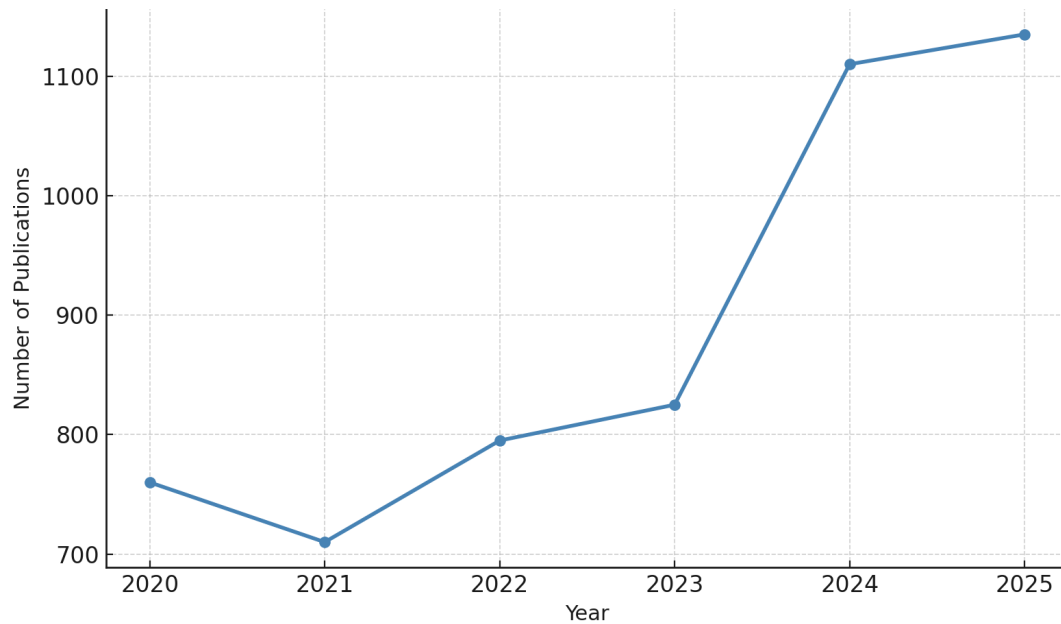


Figure 2. Global Publication Trends (2020–2025)

The bibliometric trend shows a steady increase in publications from 2020 to 2025. After a slight decline in 2021 (710 documents), the number of studies began to rise gradually from 795 in 2022 to 825 in 2023, before sharply increasing in 2024 and stabilizing at more than 1,100 documents in 2025. This pattern indicates accelerating global attention toward adaptive soft-skill curriculum development in the post-pandemic period, aligning with educational reforms and the integration of 21st-century competencies.

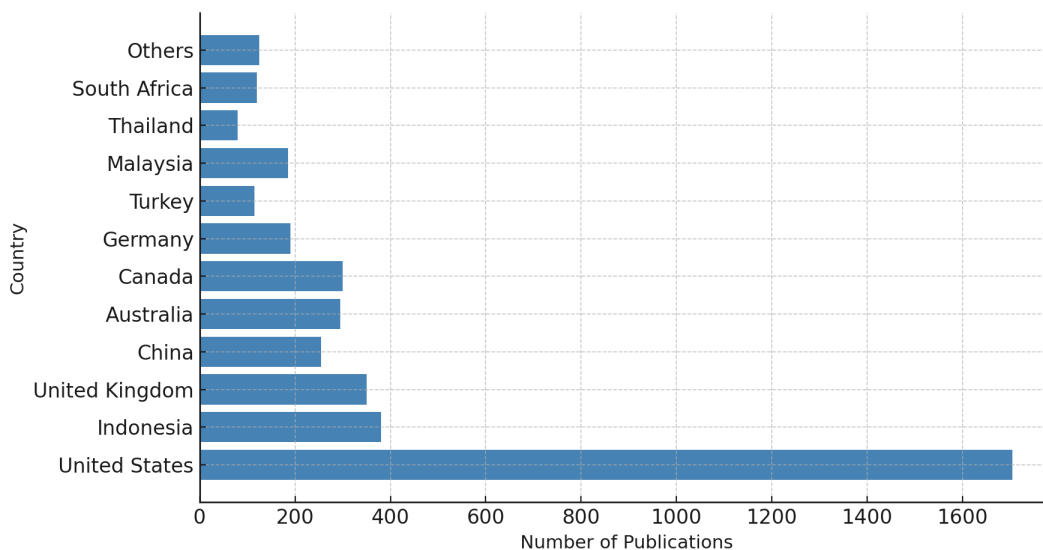


Figure 3. Top Contributing Countries in Adaptive Soft-Skill Curriculum Research

The country distribution reveals that the United States dominates research output (=1,705 documents), followed by Indonesia (=380) and the United Kingdom (=350). Other significant contributors include China, Australia, and Canada, each producing between 250 and 300 publications. Meanwhile, countries such as Malaysia, Germany, and Turkey demonstrate emerging participation in the field. The overall pattern suggests that adaptive curriculum and soft-skill research have gained prominence not only in Western academic ecosystems but also

across Asia, indicating a growing global commitment to equipping learners with future-oriented competencies.

B. RQ2: What emerging thematic clusters and research gaps can be identified to inform future directions in curriculum innovation and educational policy?

1) Emerging Thematic Clusters

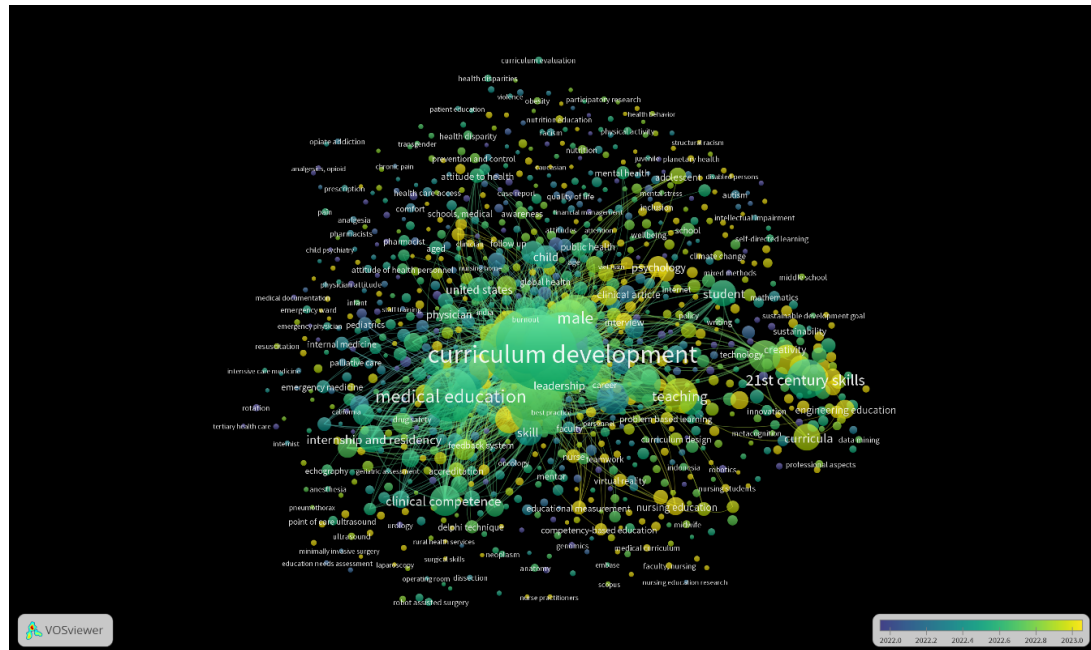


Figure 4. VOSviewer Keyword Cluster Network Map

The bibliometric cluster analysis revealed three dominant thematic areas shaping global discourse on adaptive soft-skill curriculum development: (1) digital competencies and cognitive skills, (2) interdisciplinary and experiential learning models, and (3) curriculum policy, standardization, and contextualization. These clusters collectively illustrate how the field has evolved from conceptual alignment to applied innovation [19] [33] [36].

The first cluster, Digital Competencies and Core Cognitive Skills, underscores the shift from general digital literacy toward cultivating higher-order thinking within technologically mediated learning environments [10] [35]. Studies have increasingly focused on the integration of critical thinking, problem-solving, and analytical reasoning into digital pedagogies [20] [36]. For instance, the proposed Taxonomy of Digital Curation Activities demonstrates how digital environments can systematically promote reflective and evaluative reasoning [36]. Other works affirm that artificial intelligence, simulation-based learning, and online collaboration platforms enhance cognitive adaptability and decision-making [1] [4] [26]. These findings align with global frameworks such as the OECD Learning Compass 2030, emphasizing metacognition and lifelong learning capacities [12] [34].

The second cluster, Interdisciplinary and Experiential Learning Models, reflects a surge in research exploring project-based, problem-based, and STEAM learning strategies as vehicles for adaptive soft-skill development [2] [37]. Numerous studies have validated the transformative role of hands-on inquiry and collaborative problem-solving in enhancing communication, creativity, and adaptability [16][17][38]. In particular, STEAM-based and e-task-based approaches (eTBA) have proven effective in fostering 21st-century competencies such as agility and digital fluency [7][8]. Moreover, immersive learning technologies—such as augmented reality, 3D modeling, and gamification—are increasingly used to create authentic environments that engage emotional and cognitive dimensions simultaneously [9][19][39]. By

embedding experiential learning into curriculum frameworks, educators can cultivate adaptive reasoning skills and prepare learners for unpredictable socio-technical futures [13] [14] [18].

The third cluster, Curriculum Policy, Standardization, and Contextualization, highlights the need to balance global frameworks with local relevance [15] [25] [40]. Research in this area frequently applies evaluative models, such as Harden's 10 Questions framework, to ensure curricular coherence and quality assurance [15]. National education policies, including Indonesia's Kampus Merdeka and India's NEP 2020, have been studied for their contributions to institutional autonomy and curricular innovation [6] [27]. Beyond policy alignment, emerging sub-themes such as decoloniality and critical pedagogy emphasize the importance of designing culturally responsive and ethically grounded curricula [30]. The convergence of these perspectives indicates a paradigm shift toward inclusive and context-aware educational models.

2) Research Gaps and Policy Implications

Despite this growing body of literature, several research gaps remain that constrain theoretical development and policy translation. The first is the Affective Gap, representing a persistent neglect of socio-emotional competencies in curriculum innovation [4] [20]. While cognitive and technical skills dominate current research, emotional intelligence and holistic learning outcomes are rarely operationalized in empirical studies [3] [34]. Addressing this imbalance is essential for fostering adaptability that is both intellectual and emotional.

The second is the Micro-Implementation Gap, referring to the discrepancy between macro-level policy frameworks and ground-level classroom practices [12] [18]. Many national reforms emphasize digital transformation and curriculum flexibility but overlook teacher readiness, resource allocation, and pedagogical support [6] [16]. Studies show that limited teacher digital competence and inadequate professional development hinder the realization of adaptive models [7] [14]. Bridging this gap requires systemic investment in teacher capacity-building, infrastructure, and data-informed evaluation mechanisms.

Finally, the Contextual Impact Gap reflects the scarcity of longitudinal studies assessing the long-term effectiveness of adaptive soft-skill curricula [19] [27] [40]. Most empirical evidence remains project-based or short-term, providing limited insights into how these curricular reforms affect employability, civic engagement, and societal resilience [17] [37]. To advance this field, future policy and research must prioritize comprehensive program evaluation frameworks that link curricular innovation to measurable developmental outcomes [15] [24]. Moreover, governments and institutions should establish funding mechanisms that promote sustained teacher professional learning and iterative curriculum redesign.

Conclusion

In conclusion, the intellectual landscape for adaptive soft skill development is characterized by a strong, established focus on Digital Competencies and Core Cognitive Skills alongside significant innovation in Interdisciplinary and Experiential Learning Models. However, this analysis reveals critical voids, primarily the Affective Gap concerning Emotional Intelligence, a Micro-Implementation Gap regarding teacher preparedness and effective curriculum delivery, and a Contextual Impact Gap in assessing the long-term career and societal benefits of new models. To inform future educational policy effectively, the research agenda must shift to prioritize these understudied areas—namely, integrating emotional adaptability, strengthening teacher capacity at the local level, and commissioning rigorous, long-term program evaluations that connect curriculum reform directly to demonstrable student success and readiness for the volatile 21st-century workforce.

Acknowledgement

The authors express their gratitude to the Curriculum Development Study Program, Faculty of Educational Sciences, Universitas Pendidikan Indonesia, for its support in this research.

Declaration statement

The authors collectively confirm that there is no conflict of interest pertaining to the publication of this article, ensuring that the research and its findings are free from any undue influence or bias. Furthermore, all authors assert and guarantee that the paper is free of plagiarism and reflects original scholarly work.

References

- [1] Chen, M. (2024). Synergizing computer-aided design, commercial software, and cutting-edge technologies in an innovative nozzle test apparatus for an engineering laboratory course. *Computer Applications in Engineering Education*, 32(5). Scopus. <https://doi.org/10.1002/cae.22773>
- [2] Ghafara, S. T., Ambiyar, A., Giatman, M., Jalinus, N., Rizal, F., & Fadhillah, F. (2025). Development of an Android-assisted STEAM-based Project Based Learning Model in Informatics Subjects at Vocational High Schools. *Salud, Ciencia y Tecnologia*, 5. Scopus. <https://doi.org/10.56294/saludcyt20251826>
- [3] Hammad, M., Al-Sharqawi, S., & Al-Dajeh, H. (2024). Curriculum of music education for the basic educational stage in Jordan and Singapore: A comparative analytical study in light of the twenty-first century skills. *Humanities and Social Sciences Letters*, 12(2), 394–410. Scopus. <https://doi.org/10.18488/73.v12i2.3785>
- [4] Karacaoğlu, Ö. C. (2025). Basic Skills of 21st Century Teachers. *Australian Journal of Teacher Education*, 50(1), 75–91. Scopus. <https://doi.org/10.14221/1835-517X.6455>
- [5] González, M. Á. C., Rodríguez-Sedano, F. J., Llamas, C. F., Gonçalves, J., Lima, J., & García-Peñalvo, F. (2020). Fostering STEAM through challenge-based learning, robotics, and physical devices: A systematic mapping literature review. *Computer Applications in Engineering Education*, 29, 46–65. <https://doi.org/10.1002/cae.22354>
- [6] Ramasamy, R., & Hooi, H. C. (2025). Needs Analysis of Professional Writing in the 21st Century Among Malaysian Tertiary Students. *Malaysian Journal of Qualitative Research*, 11(1), 43–52. Scopus. <https://doi.org/10.61211/mjqr110104>
- [7] Efendi, R., Ambiyar, A., & Wulandari, R. A. (2025). Bridging the Industry 4.0 Skills Gap: An Immersive Augmented Reality Mobile Learning Approach for Vocational Education. *International Journal of Interactive Mobile Technologies*, 19(6), 60–74. Scopus. <https://doi.org/10.3991/ijim.v19i06.53825>
- [8] Salleh, M. F. M., Basri, A. S. M., Ismail, M. H., Zulkipli, Z. A., Abdullah, N., Maaruf, S. Z., Nurhadiyanti, L., Alimah, S., & Nugrahaningsih, W. H. (2025). ASSESSING PRE-SERVICE SCIENCE TEACHERS' TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) IN THE HYBRID LEARNING ENVIRONMENT. *Jurnal Pendidikan IPA Indonesia*, 14(1), 130–144. Scopus. <https://doi.org/10.15294/jpii.v14i1.16819>
- [9] Osiesi, M. P., & Blignaut, S. (2025). Impact of the teacher education curriculum on the development of 21st-Century skills: Pre-service teachers' perceptions. *Social Sciences and Humanities Open*, 11. Scopus. <https://doi.org/10.1016/j.ssaho.2025.101317>
- [10] Turner, K., Gunasekara, A. N., Fung, F. C., & Stough, C. (2025). Exploring the alignment between Australian university graduate attributes and emotional intelligence competencies. *Curriculum Journal*, 36(2), 236–254. Scopus. <https://doi.org/10.1002/curj.293>

- [11] Gómez Niño, J. R., Árias Delgado, L. P., Laverde, A., & Ortega González, E. (2025). Gamifying Learning with AI: A Pathway to 21st-Century Skills. *Journal of Research in Childhood Education*, 39(4), 735–750. Scopus. <https://doi.org/10.1080/02568543.2024.2421974>
- [12] Mutohhari, F., Sutiman, S., Nurtanto, M., Kholifah, N., & Samsudin, A. (2021). Difficulties in implementing 21st century skills competence in vocational education learning. *International Journal of Evaluation and Research in Education*, 10(4), 1229–1236. Scopus. <https://doi.org/10.11591/ijere.v10i4.22028>
- [13] Dermawan, A., Huda, Y., Hendriyani, Y., Giatman, M., Ifdil, I., & Lofandri, W. (2025). Experimental Evaluation Of Cloud-Integrated Iot Training Modules For Advancing 21st-Century Skills In Higher Education. *Seminars in Medical Writing and Education*, 4. Scopus. <https://doi.org/10.56294/mw2025802>
- [14] Rebelo, H., Christodoulou, P., Payan-Carreira, R., Dumitru, D., Makio-Marusik, E., Mäkiö, J., & Pnevmatikos, D. (2023). University–Business Collaboration for the Design, Development, and Delivery of Critical Thinking Blended Apprenticeships Curricula: Lessons Learned from a Three-Year Project. *Education Sciences*, 13(10). Scopus. <https://doi.org/10.3390/educsci13101041>
- [15] Hutahaeen, B., Telaumbanua, S., Tamba, L., & Hutabarat, R. G. N. (2024). Analysis of Innovative and Adaptive Higher Education Curriculum Development to Education 5.0 Based Challenges in Indonesia. *International Journal of Learning, Teaching and Educational Research*, 23(4), 76–98. Scopus. <https://doi.org/10.26803/ijlter.23.4.5>
- [16] Helda, T., Atmazaki, A., & Gani, E. (2024). The Validity and Practicality of Discovery-Group Learning Models to Improve 21st Century Skills of High School Students. *rEFlections*, 31(3), 1408–1433. Scopus. <https://doi.org/10.61508/refl.v31i3.277735>
- [17] Rosanawati, I. M. R., Wardo, W., Djono, D., & Purwanta, H. (2025). Pedagogical Model Innovation Based on Ki Hajar Dewantara's Among System for History Learning in the Merdeka Curriculum. *Educational Process: International Journal*, 14. Scopus. <https://doi.org/10.22521/edupij.2025.14.39>
- [18] Herlinawati, H., Marwa, M., Ismail, N., Liza, L. O., & Situmorang, D. D. B. (2024). The integration of 21st century skills in the curriculum of education. *Heliyon*, 10(15). Scopus. <https://doi.org/10.1016/j.heliyon.2024.e35148>
- [19] Yeh, L. H., Wong, W. Y., Khoo, K. Y., Mohd Nor, N., Juan, W. M., Ling, L. H., & Zhiqiang, S. (2024). Defining the Collaborative-Constructivism Based Learning and Teaching Approach in Malaysian Primary Schools in Supporting the Hybrid Learning of Visual Arts Education: A Fuzzy Delphi Method Study. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 41(2), 62–81. Scopus. <https://doi.org/10.37934/araset.41.2.6281>
- [20] Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023). Artificial intelligence and human behavioral development: A perspective on new skills and competences acquisition for the educational context. *Computers in Human Behavior*, 148. Scopus. <https://doi.org/10.1016/j.chb.2023.107903>
- [21] Bursac, I., Mtaweh, H., Lee, D., & Mema, B. (2022). The Gift of Life: Interprofessional Organ Donation Curriculum in Pediatric Critical Care. *ATS Scholar*, 3(1), 144–155. Scopus. <https://doi.org/10.34197/ats-scholar.2021-0089IN>
- [22] Latorre-Coscolluela, C., Suarez, C., Quiroga, S., Sobradie, N., Lozano-Blasco, R., & Rodríguez-Martínez, A. (2021). Flipped Classroom model before and during COVID-19: Using technology to develop 21st century skills. *Interactive Technology and Smart Education*, 18(2), 189–204. Scopus. <https://doi.org/10.1108/ITSE-08-2020-0137>

- [23] Ogden, K., Kilpatrick, S., Elmer, S., & Rooney, K. (2021). Attributes and generic competencies required of doctors: Findings from a participatory concept mapping study. *BMC Health Services Research*, 21(1). Scopus. <https://doi.org/10.1186/s12913-021-06519-9>
- [24] Ángel-Urbe, I., Cano-Vásquez, L., & López-Molina, G. (2024). CHARACTERISTICS OF EDUCATIONAL EXPERIENCES IN STEM EDUCATION IN MEDELLIN. *Journal of Technology and Science Education*, 14(4), 1073–1098. Scopus. <https://doi.org/10.3926/JOTSE.2199>
- [25] Wardani, W., Rosidin, U., & Yulianti, D. (2025). The 7C Skills Framework: A Measurement Tool to Enhance Global Competence in Multicultural Learning Based on Engagement Theory. *International Journal of Learning, Teaching and Educational Research*, 24(2), 1–20. Scopus. <https://doi.org/10.26803/ijlter.24.2.1>
- [26] Fior, G., Fonda, C., & Canessa, E. (2025). Hands-on STEM learning experiences using digital technologies. *STEM Education*, 5(2), 171–186. Scopus. <https://doi.org/10.3934/steme.2025009>
- [27] Tian, X., Ji, Y., & Zhou, Y. (2023). Reconstruction of Teachers' Competencies: A Key Support for the Digital Transformation in Education. *Frontiers of Education in China*, 18(2), 126–144. Scopus. <https://doi.org/10.3868/s110-008-023-0009-0>
- [28] Lertdechapat, K., & Pimthong, P. (2021). A comparison of students' competencies of thai and international documents. *Kasetsart Journal of Social Sciences*, 42(4), 904–913. Scopus. <https://doi.org/10.34044/j.kjss.2021.42.4.26>
- [29] Ihsen, I., Ben Dhiab, M. B., Mzoughi, K., Ben Mrad, I. B., Abdessalem, I. B., & Kraïem, S. (2021). Serious Game Design with medical students as a Learning Activity for Developing the 4Cs Skills: Communication, Collaboration, Creativity and Critical Thinking: A qualitative research. *Tunisie Medicale*, 99(7), 714–720. Scopus.
- [30] Taar, J., & Palojoki, P. (2022). Applying interthinking for learning 21st-century skills in home economics education. *Learning, Culture and Social Interaction*, 33. Scopus. <https://doi.org/10.1016/j.lcsi.2022.100615>
- [31] Gonzales, R. A., & Ilagan, R. B. (2020). Millennializing' teachers towards 21st century pedagogy. *Journal of Critical Reviews*, 7(11), 279–285. Scopus. <https://doi.org/10.31838/jcr.07.11.45>
- [32] Chen, H.-L. S., Jou, H., Lin, S.-P., & Sianturi, I. A. J. (2024). Developing Teacher Performance Indicators for 21st Century Competency-Oriented Teaching and Learning: Implications From IB Philosophy and Practices. *Bulletin of Educational Research*, 70(4), 87–127. Scopus. [https://doi.org/10.6910/BER.202412_70\(4\).0003](https://doi.org/10.6910/BER.202412_70(4).0003)
- [33] Gulnara, G., Ramankulov, S., Madina, M., Nurizinova, M., Tuyakov, Y., & Abdrakhmanov, R. (2025). STEM-based approaches to soft skills development: A synthesis of meta-analytic findings and empirical evidence. *Frontiers in Education*, 10. Scopus. <https://doi.org/10.3389/educ.2025.1663155>
- [34] González-Salamanca, J. C., Agudelo, O. L., & Salinas, J. (2020). Key competences, education for sustainable development and strategies for the development of 21st century skills. A systematic literature review. *Sustainability (Switzerland)*, 12(24), 1–17. Scopus. <https://doi.org/10.3390/su122410366>
- [35] Wu, D., & Zhang, J. (2025). Generative artificial intelligence in secondary education: Applications and effects on students' innovation skills and digital literacy. *PLOS ONE*, 20(5 May). Scopus. <https://doi.org/10.1371/journal.pone.0323349>
- [36] Gadot, R., & Tsybulsky, D. (2025). Taxonomy of digital curation activities that promote critical thinking. *Smart Learning Environments*, 12(1). Scopus. <https://doi.org/10.1186/s40561-025->

00365-6

- [37] Nair, K. R., & Kareem, J. (2025). THE INFLUENCE OF STEM ATTITUDE, 21ST CENTURY SKILLS, AND TECHNOLOGY USE ON STUDENT OUTCOMES: A MEDIATION MODEL ANALYSIS. *Journal of Information Technology Education: Research*, 24. Scopus. <https://doi.org/10.28945/5621>
- [38] Huda, M. (2020). Perkembangan pendidikan Islam di Indonesia dan upaya penguatannya dalam sistem pendidikan nasional. *Journal of Islamic Education Research*, 1(02), 39–53.
- [39] Luelmo del Castillo, M. J. L. D., Izquierdo Sánchez-Migallón, E., Vinuesa Benítez, V., & García-Manzanares, N. (2025). DESIGN AND VALIDATION OF A SELF-ASSESSMENT TOOL FOR STE(A)M TEACHERS IN CLIL CONTEXTS. *Journal of Technology and Science Education*, 15(1), 186–203. Scopus. <https://doi.org/10.3926/JOTSE.2933>
- [40] Doumi, E. B. A., Ahmed, R. B., & Mugabil, A. A. E. (2024). Analysis of the Curriculum of the Faculty of Medicine, University of Kordofan, Sudan: Using Harden's 10 Questions Framework 2022. *Sudan Journal of Medical Sciences*, 19(4), 492–508. Scopus. <https://doi.org/10.18502/sjms.v19i4.14947>