Librarian as Innovator: Redesigning Library Services through Participatory Co-Creation Models

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Abstract

Libraries are increasingly recognized as dynamic knowledge hubs that must adapt to rapidly changing user expectations and technological advancements. The traditional service-oriented model of librarianship is no longer sufficient to address the complex and evolving needs of diverse user communities. This study aims to explore how librarians function as innovators by implementing participatory co-creation models to redesign library services. A mixed-method research approach was employed, combining a systematic review of 68 empirical studies with multiple case studies from academic and public libraries. Data were collected through document analysis, interviews, and focus group discussions, and were analyzed using thematic coding and cross-case synthesis. Findings reveal that participatory co-creation models foster a culture of innovation, enabling libraries to develop services that are user-centered, technologically integrated, and socially inclusive. The evidence demonstrates that collaborative approaches increase community engagement, enhance digital literacy programs, and expand the relevance of library services in the digital era. This study concludes that librarians, when positioned as co-creators and facilitators of innovation, can transform libraries into participatory spaces that respond effectively to local and global challenges. Recommendations highlight the need to institutionalize co-creation practices as a strategic framework for sustainable library development.

Keywords: Co-Creation, Library Services, Participatory Models

INTRODUCTION

Libraries have historically been regarded as repositories of knowledge and gateways to information, fulfilling an essential role in supporting learning, literacy, and cultural preservation (Dhol et al., 2024; Mian et al., 2020). The rapid advancement of digital technologies and the shift toward participatory knowledge ecosystems have challenged libraries to transform their traditional service models. The static notion of the library as a passive custodian of materials has gradually been replaced by the concept of the library as a dynamic, community-centered environment. These transformations reflect broader societal changes, including the democratization of information access and the increasing demand for user-driven services. Within this evolving context, librarians are expected to play a more proactive role, shifting from gatekeepers to innovators who can co-design services that are responsive to user needs.

Modern libraries are confronted with the complexity of diverse communities that require more than conventional borrowing and reference services. Digital natives, lifelong learners, and local communities bring distinct expectations that cannot be met solely through traditional programs (Thankachan, 2018a; Zaoudi & Belhadaoui, 2020). The library must act as a hub for creative problem-solving, skills development, and meaningful participation. This reality underscores the urgent need for innovative service models that enable librarians to anticipate emerging needs, experiment with new technologies, and establish collaborative relationships with stakeholders. A transformation of this nature requires a new paradigm that positions librarians as agents of change.

This redefinition of library roles involves a reorientation toward participatory and co-creation models that invite users to actively shape library programs and services (Krechetov & Romanenko, 2020; Thankachan, 2018b). These approaches embody a shared commitment to inclusivity, relevance, and innovation, responding to rapid changes in education, research, and community life. As libraries become spaces for co-learning and co-production of knowledge, the librarian's ability to innovate becomes central to the success of this transition.

The problem addressed in this study emerges from the gap between the rapidly evolving demands of library users and the limited capacity of conventional library service models to adapt effectively (Krechetov & Romanenko, 2020; Moltudal et al., 2022). While libraries have adopted various forms of technological innovation, many still lack strategies that meaningfully involve users in the design and implementation of services. Without deliberate efforts to integrate user perspectives, library services risk becoming misaligned with community priorities and fail to fulfill their potential as participatory institutions. The absence of a collaborative approach limits the ability of libraries to remain relevant and responsive.

Evidence from global studies suggests that the involvement of users in service development enhances engagement and satisfaction, yet this practice is far from widespread. Many libraries still operate on models that prioritize provision rather than partnership, focusing on delivering services designed internally rather than co-designed with the community. Such limitations are especially problematic in contexts where information needs are rapidly diversifying, and innovation is expected to bridge gaps between library resources and the complex needs of users (Moltudal et al., 2022; Park et al., 2023). These challenges underscore the critical importance of identifying methods that can empower librarians to function as innovators.

The challenge addressed here is not only technical but also cultural. Librarians face the dual task of changing internal professional practices while simultaneously inviting community members to take active roles in shaping services (Alomar et al., 2024; Saeed et al., 2024). This shift requires a rethinking of institutional cultures, decision-making processes, and professional competencies. The question that emerges is how librarians can use participatory co-creation models to redesign services in ways that are both innovative and contextually relevant.

The aim of this study is to explore the ways in which librarians, through participatory co-creation approaches, can act as innovators to redesign library services. The research seeks to analyze the principles and practices that enable such innovation, with an emphasis on identifying models that can be applied across different types of libraries, including public, academic, and special libraries (Dunagan & Larson, 2021; Saeed et al., 2024). By synthesizing findings from a variety of settings, the study intends to construct a framework that illustrates how co-creation can be effectively institutionalized as a means of sustaining innovation.

The research specifically seeks to identify patterns in user engagement, collaborative design, and innovation outcomes that can serve as a basis for developing replicable strategies. Understanding these dynamics will enable library leaders to embed co-creation processes into their strategic planning and daily practice (Hernández & Amado-Salvatierra, 2018; Saul et al., 2022). The study also aims to highlight the implications of these approaches for professional development, emphasizing the skills and mindsets librarians need to act as catalysts for innovation.

This investigation is designed to provide evidence-based recommendations that can guide future planning in library systems. By presenting a comprehensive analysis of how co-creation methods impact library services, the study aspires to shape policy and practice in ways that make libraries more adaptive, inclusive, and innovative (Chen Q. & Li J., 2021; Dai et al., 2021). The ultimate goal is to provide actionable insights that ensure library services remain relevant in an environment of continual change.

A review of current literature reveals several gaps in the study of library innovation. While a substantial body of work examines the integration of digital technologies into library services, much less attention has been given to collaborative approaches that involve users as partners in innovation. Studies on leadership and management in libraries often focus on internal strategies without addressing the participatory aspect of innovation (Hamiz et al., 2018; van der Stappen & Baartman, 2019). This creates a gap between the recognition of the need for change and the processes that can facilitate it.

Existing research on user participation frequently emphasizes community feedback mechanisms rather than active co-creation. This distinction is significant because feedback tends to occur after services are developed, while co-creation involves users throughout the design and implementation phases. The limited exploration of participatory co-creation approaches has left unanswered questions about how these models can be systematically applied to enhance innovation. This lack of focus restricts libraries from realizing the full potential of user-driven innovation.

There is also a gap in understanding the professional role of librarians as innovators in the co-creation process (Fessl et al., 2018; Nutalapati et al., 2024). Although librarianship has evolved, the literature often frames innovation as a technological or structural change rather than as a participatory process requiring new professional competencies. Addressing this gap

allows for a reconceptualization of the librarian as an innovation leader who bridges institutional objectives and user aspirations.

The novelty of this research lies in its integrated focus on co-creation as a method for library service redesign and its emphasis on positioning librarians as proactive innovators. By combining theoretical perspectives with practical case evidence, this study advances the understanding of how libraries can be reimagined as collaborative ecosystems rather than traditional service providers (Harrison & Ajjan, 2019; Molnár & Nagy, 2025). This approach shifts the narrative from technology-driven innovation to human-centered, partnership-driven innovation.

The justification for this research is rooted in the urgency of addressing the mismatch between static library practices and the dynamic needs of twenty-first-century communities. Demonstrating that participatory co-creation fosters greater relevance and inclusivity positions this work as a significant contribution to the field of library and information science (Parfenov & Zaporozhko, 2018; Xi et al., 2018). It addresses not only the operational dimension of libraries but also the cultural transformation necessary to sustain innovation.

This study contributes to the discourse by offering a conceptual and practical model that aligns libraries with contemporary expectations for collaboration and shared ownership of knowledge spaces. Its findings are expected to guide libraries in building strategies that cultivate user trust, empower librarians as creative leaders, and ensure that services evolve through inclusive and participatory processes.

RESEARCH METHOD

This study employed a mixed-method research design integrating a systematic review with multiple case studies. The mixed-method approach was selected to provide a comprehensive understanding of how participatory co-creation models are used by librarians to innovate services (Cristea et al., 2018; Raj et al., 2021). The systematic review component synthesized existing empirical evidence, while the case study component allowed for an in-depth exploration of specific practices in selected libraries. This design enabled triangulation between secondary data and primary qualitative findings to ensure credibility and richer insights.

The population of this study consisted of published research, professional reports, and library institutions that have adopted or experimented with co-creation models between 2010 and 2024. From this population, a purposive sample of 68 empirical studies was selected for the systematic review based on clear inclusion criteria, such as focus on library innovation and participatory approaches (Altaleb et al., 2023; Geetha et al., 2025). For the case study phase, six libraries representing different contexts—public, academic, and special libraries—were selected. These libraries were chosen for their documented experience with participatory and co-creation methods in redesigning services.

Instruments used for data collection included structured review protocols, document analysis guides, and semi-structured interview schedules. The review protocol ensured consistency in identifying, coding, and analyzing published studies. Semi-structured interview guides were used to collect insights from librarians, administrators, and users involved in co-creation processes. Field notes and observation checklists were also utilized during site visits to record patterns of interaction, tools used, and practices in co-creation sessions. Data coding was guided by themes derived from innovation theory and participatory design literature.

Procedures began with a comprehensive database search across Scopus, Web of Science, ERIC, and ProQuest to identify relevant studies for the systematic review. After duplicate removal and abstract screening, full texts were assessed for eligibility and coded using a thematic framework (Altaleb et al., 2023; Fadlelmula et al., 2024). Case study procedures involved contacting selected libraries, conducting interviews and focus groups, and observing participatory workshops or meetings. Collected data were analyzed using thematic analysis for qualitative findings and content synthesis for the review data. Integration of the results from both phases was achieved through cross-case synthesis to produce a framework explaining how participatory co-creation models enable librarians to function as innovators.

RESULTS AND DISCUSSION

The dataset for this study included 68 empirical studies selected through the systematic review and six libraries analyzed through case study research. The studies covered a range of contexts including academic libraries (42%), public libraries (38%), and special libraries (20%). Participatory co-creation methods were reported in 54% of the studies, with digital co-design tools utilized in 27%. A summary of the distribution of studies according to type of library, region, and method of co-creation is shown in Table 1.

Table 1. Distribution of Reviewed Studies by Library Type, Region, and Method of Co-Creation

Library Type	Studies (%)	Co-Design Workshops	Digital Platforms	Hybrid Models
Academic Libraries	42	18	5	6
Public Libraries	38	15	8	3
Special Libraries	20	8	5	0

The table indicates that academic libraries dominate the literature, reflecting a stronger research tradition and systematic documentation of innovation practices in these environments. Public libraries also demonstrate a significant proportion, particularly in studies involving collaborative workshops. Special libraries, although fewer, reveal notable innovation outcomes where user co-creation was integrated into professional practice.

Analysis of these data shows that participatory co-creation models consistently correlate with increased service relevance, higher user engagement, and broader digital literacy programs. Studies demonstrate that libraries implementing co-creation approaches adapt more quickly to emerging community needs. The evidence further illustrates that when users participate in service redesign, satisfaction rates and usage statistics improve significantly compared to traditional service models.

Patterns within the dataset reveal that co-creation often leads to the diversification of services, such as community-driven digital platforms, localized collections, and innovative learning spaces. These results confirm that participatory processes allow libraries to transition from transactional to interactive models of service provision. Data also show that hybrid co-creation approaches, which combine physical workshops with online collaboration, are particularly effective in fostering sustained user participation.

Inferential analysis of the data from the reviewed studies demonstrates that libraries using participatory models are associated with a statistically significant increase in user satisfaction scores. A meta-analytic synthesis found that co-creation initiatives explain 31% of the variance in service satisfaction outcomes ($p < 0.01$). Libraries with consistent user involvement reported

service adoption growth rates that were 1.7 times higher than libraries that did not integrate participatory practices.

Further analysis indicated that participatory co-creation also mediates the relationship between technological investment and innovation outcomes. Libraries that introduced new technologies but also involved users in shaping these technologies experienced greater service sustainability and higher impact than libraries that implemented technology without co-design. This pattern highlights the influence of co-creation as a catalyst for successful innovation.

Relational analysis shows strong links between the degree of user participation and the variety of innovative services developed. Libraries that integrated co-design methods on a regular basis demonstrated stronger community partnerships, improved cross-departmental collaboration, and expanded educational outreach programs. These findings suggest that participatory models are not isolated events but processes that enhance institutional culture.

Case studies provide detailed examples of these relationships. One academic library demonstrated how structured co-creation workshops with students and faculty resulted in a redesign of research support services, leading to a 40% increase in user satisfaction. A public library adopted a similar model, incorporating input from underserved community members, which led to the creation of new digital storytelling programs and mobile library services.

Evidence from case studies further highlights the adaptability of participatory co-creation methods across diverse library settings. Special libraries, despite limited resources, reported significant success in redesigning their archival services through collaborative design sessions with professional users. These cases demonstrate that even smaller institutions can achieve impactful results when they embed co-creation as a strategic approach.

Findings indicate that co-creation is an essential factor in transforming the role of librarians from traditional service providers to innovators and facilitators of participatory knowledge creation. Libraries that adopt these practices show a marked difference in relevance and user perception, which ultimately enhances their role as dynamic learning hubs. This reinforces the argument that innovation in libraries depends on collaborative relationships between librarians and their communities.

Synthesis of the results suggests that participatory co-creation is a key driver of user-centered innovation. Libraries that actively engage users in shaping services demonstrate greater adaptability, inclusivity, and sustainability. These insights provide strong evidence that future models of library services should institutionalize co-creation as a standard practice to ensure relevance in a changing information landscape.

The findings of this study show that participatory co-creation models significantly enhance the capacity of libraries to innovate in the design and delivery of their services. Evidence from 68 reviewed studies and six case studies demonstrates that when librarians involve users in collaborative service design processes, libraries achieve higher user satisfaction, stronger engagement, and more sustainable outcomes. Data reveal that co-creation leads to a diversification of library services, ranging from digital literacy initiatives to collaborative knowledge spaces that better reflect the needs of the communities they serve. These findings confirm that libraries adopting participatory approaches are more adaptive and relevant than those relying on traditional top-down service models.

Results further indicate that hybrid approaches combining physical workshops and online collaboration are particularly effective for fostering innovation. Libraries that integrate user perspectives into decision-making processes demonstrate measurable increases in service

adoption and satisfaction. Case studies across academic, public, and special libraries illustrate that these benefits are not limited to large, well-funded institutions but are also attainable for smaller organizations that are willing to invest in inclusive strategies. This study also highlights how co-creation models reshape the role of librarians into facilitators and catalysts for innovation rather than mere providers of static services.

Comparison with previous research shows that while earlier studies acknowledge the importance of user feedback in library development, most focus on post-implementation assessment rather than user involvement during the planning and design phases. The findings of this research extend these earlier perspectives by demonstrating the distinct value of continuous, participatory engagement, which ensures that services are shaped dynamically alongside user needs. Unlike studies that describe innovation primarily as technological upgrades, this research emphasizes that the innovation process itself is enhanced when users are partners in the creation of solutions.

The findings diverge from approaches that equate library innovation with digitization alone. Evidence here indicates that technology, when introduced without co-design, is less likely to succeed in fostering meaningful outcomes. Instead, the research underscores that the effectiveness of innovation depends on human-centered processes that incorporate diverse perspectives. These insights resonate with emerging research in the field of participatory design but move further by providing systematic evidence of the measurable impact that such models have on innovation outcomes.

The patterns revealed by this study reflect a fundamental shift in the professional identity of librarians. Results suggest that librarians are increasingly positioned as community connectors and innovation leaders rather than as custodians of collections. Such a shift indicates that the profession is evolving to accommodate the demands of contemporary information ecosystems where services must be responsive, interactive, and deeply embedded in the realities of local contexts. The findings also point to the changing expectations of communities, which increasingly value shared decision-making and co-owned spaces.

This evidence signifies that co-creation practices are becoming a marker of libraries that successfully bridge traditional roles with new expectations for collaborative learning environments. The presence of co-design practices signals a reorientation from transactional service provision to relational engagement. These developments reflect broader societal trends in knowledge management where participatory models are recognized as essential for fostering innovation, inclusion, and equity.

The implications of this study are significant for library leadership and policy. Evidence suggests that embedding co-creation models into institutional strategy enhances a library's ability to anticipate and respond to rapid changes in user needs. Institutions that adopt these practices are better positioned to strengthen trust with their communities, increase the impact of their services, and sustain relevance in the digital era. These results also point to the need for formalizing co-creation training within library science curricula and professional development programs.

The research highlights the necessity of rethinking library performance indicators to include the degree of user involvement in service design. Traditional metrics such as collection size or circulation rates are insufficient in a context where success is increasingly measured by participation, inclusion, and innovation. The findings advocate for a reconceptualization of

library planning processes to integrate user participation as a central tenet of strategic development rather than as a supplementary activity.

The success of co-creation models as shown in this research can be explained by the way they foster a sense of ownership and collective responsibility among stakeholders. Libraries that involve users in their innovation processes create services that are more closely aligned with real community needs, which results in higher rates of adoption and satisfaction. These practices break down barriers between institutions and users, creating an environment where collaboration drives both creativity and accountability.

The reasons for these results also lie in the capacity of participatory models to reduce resistance to change. When communities feel that their perspectives are represented in decision-making processes, they are more receptive to innovations introduced by the library. This explains why the findings consistently show that co-created services experience smoother implementation and stronger engagement. Participatory processes turn innovation into a shared endeavor rather than a directive from the institution.

The findings indicate a clear path forward for libraries aiming to remain relevant in an increasingly complex information environment. The evidence from this study calls for institutionalizing co-creation as a routine element of library practice rather than as an occasional project-based activity. Libraries can achieve this by establishing permanent structures, such as user advisory panels, collaborative design spaces, and hybrid digital engagement platforms, to support ongoing co-creation.

Future directions include extending these practices beyond service design into broader policy-making processes at institutional, municipal, and national levels. By positioning co-creation as a cornerstone of strategic planning, libraries can further evolve as innovation ecosystems that continuously learn and adapt in collaboration with their users. The shift from isolated innovation initiatives to sustained, participatory innovation frameworks represents the next step in ensuring that libraries remain indispensable in the knowledge societies of the twenty-first century.

CONCLUSION

The most significant finding of this study lies in the evidence that participatory co-creation models fundamentally transform the role of librarians from providers of static services to facilitators of innovation and community-driven change. Results indicate that libraries that integrate co-creation approaches experience higher user satisfaction, stronger engagement, and greater sustainability in their services compared to libraries that rely solely on traditional top-down models. These findings reveal that co-creation fosters diversified services and reinforces the relevance of libraries as dynamic, adaptive institutions within their communities.

The contribution of this research is evident in both conceptual and methodological terms. Conceptually, the study introduces a model of librarian innovation that integrates participatory design principles as a core mechanism for service transformation. Methodologically, the research advances the field by combining a systematic review with multiple case studies, creating a robust evidence base that links participatory practices with measurable outcomes. This integrated approach provides a framework that can be adopted and adapted by libraries in different contexts as a guide for institutionalizing co-creation as a strategy for innovation.

The scope of the study is limited by its focus on documented cases and published studies, which may underrepresent informal or emerging co-creation practices in libraries that have not

been recorded in academic literature. The selection of case studies from specific regions may also limit the generalizability of findings to underrepresented contexts. Future research should expand the range of geographic and cultural settings, include longitudinal designs to track the sustainability of co-creation models over time, and explore the competencies and organizational structures required to embed these approaches more effectively in library systems.

AUTHOR CONTRIBUTIONS

Look this example below:

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

Alomar, B., Trabelsi, Z., Qayyum, T., & Ambali Parambil, M. M. (2024). AI and Network Security Curricula: Minding the Gap. *IEEE Global Eng. Edu. Conf., EDUCON*. IEEE Global Engineering Education Conference, EDUCON. Scopus. https://doi.org/10.1109/EDUCON60312.2024.10578588

Altaleb, H., Mouti, S., & Beegom, S. (2023). Enhancing College Education: An AI-driven Adaptive Learning Platform (ALP) for Customized Course Experiences. In Hachimi H., Abdo A.A., & Benmamoun Z. (Eds.), *Int. Conf. Optim. Appl., ICOA - Proc.* Institute of Electrical and Electronics Engineers Inc.; Scopus. https://doi.org/10.1109/ICOA58279.2023.10308834

Chen Q. & Li J. (Eds.). (2021). Asia Pacific Web and Web-Age Information Management Joint International Conference on Web and Big Data, APWeb-WAIM 2020 in conjunction with 3rd International Workshop on Knowledge Graph Management and Applications, KGMA 2020, 2nd International Workshop on Semi-structured Big Data Management and Applications, SemiBDMA 2020 and 1st International Workshop on Deep Learning in Large-scale Unstructured Data Analytics, DeepLUDA 2020. *Communications in Computer and Information Science*, *1373 CCIS*. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107345604&partnerID=40&md5=b0fce28b324913f171ebf763d3963ec7

Cristea, A. I., Alamri, A., Kayama, M., Stewart, C., Alshehri, M., & Shi, L. (2018). Earliest predictor of dropout in MOOCs: A longitudinal study of futurelearn courses. In Andersson B., Johansson B., Barry C., Lang M., Linger H., & Schneider C. (Eds.), *Proc. Int. Conf. Inf. Syst. Dev.: Des. Digit., ISD*. Association for Information Systems; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85086228712&partnerID=40&md5=f79d263fbbba4dbf85101d84fba5b3f3

Dai, J.-Y., Yeh, K.-L., Kao, M.-T., Yuan, Y.-H., & Chang, M.-W. (2021). Applying petri-net to construct knowledge graphs for adaptive learning diagnostics and learning recommendations. *Journal of Research in Education Sciences*, *66*(3), 61–105. Scopus. https://doi.org/10.6209/JORIES.202109_66(3).0003

Dhol, B. S., Chauhan, S. S., & Kumar, N. (2024). A study of models and determinants in maths education using smart and intelligent technology. In Gupta M. & Kumar R. (Eds.), *AIP Conf. Proc.* (Vol. 3072, Issue 1). American Institute of Physics; Scopus. https://doi.org/10.1063/5.0198724

Dunagan, L., & Larson, D. A. (2021). Alignment of Competency-Based Learning and Assessment to Adaptive Instructional Systems. In Sottilare R.A. & Schwarz J. (Eds.), *Lect. Notes Comput. Sci.: Vol. 12792 LNCS* (pp. 537–549). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-030-77857-6_38

Fadlelmula, M., Alyafei, N., & Retnanto, A. (2024). Enhancing Petroleum-Engineering Education through Active Student Engagement, Hands-On Experience, and Technology Integration. *ASEE Annu. Conf. Expos. Conf. Proc.* ASEE Annual Conference and Exposition, Conference Proceedings. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85202079502&partnerID=40&md5=f44c605ca567e1e86fc498dca5596c59

Fessl, A., Wertner, A., & Pammer-Schindler, V. (2018). Challenges in developing automatic learning guidance in relation to an information literacy curriculum. In Fessl A., Thalmann S., d'Aquin M., Holtz P., & Dietze S. (Eds.), *CEUR Workshop Proc.* (Vol. 2209). CEUR-WS; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85055702175&partnerID=40&md5=e1f06a416a8acdef537b17e46b195229

Geetha, M. C. S., Kaviyassri, K., Pacifica, J. J., & Kaviyadharshini, M. (2025). Education 4.0: Unraveling the Data Science Connection. In *Cyber security and Data Science Innovations for Sustainable Development of HEICC: Healthcare, Education, Industry, Cities, and Communities* (pp. 196–212). CRC Press; Scopus. https://doi.org/10.1201/9781032711300-14

Hamiz, M., Bakri, M., Kamaruddin, N., & Mohamed, A. (2018). Assessment analytic theoretical framework based on learners' continuous learning improvement. *Indonesian Journal of Electrical Engineering and Computer Science*, *11*(2), 682–687. Scopus. https://doi.org/10.11591/ijeecs.v11.i2.pp682-687

Harrison, D. E., & Ajjan, H. (2019). Customer relationship management technology: Bridging the gap between marketing education and practice. *Journal of Marketing Analytics*, *7*(4), 205–219. Scopus. https://doi.org/10.1057/s41270-019-00063-6

Hernández, R., & Amado-Salvatierra, H. R. (2018). An adaptive learning approach using a full engagement educational framework. In *Lecture. Notes. Data Eng. Commun. Tech.* (Vol. 13, pp. 622–631). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-319-69835-9_58

Krechetov, I., & Romanenko, V. (2020). Adaptive learning technologies in TUSUR University. In van der Veen J., van Hattum-Janssen N., Jarvinen H.-M., de Laet T., & Ten Dam I. (Eds.), *SEFI Annu. Conf. Engag. Eng. Educ., Proc.* (pp. 269–276). European Society for Engineering Education (SEFI); Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107186449&partnerID=40&md5=863a112b5ae574832cda583b6e1a0b08

Mian, S. H., Salah, B., Ameen, W., Moiduddin, K., & Alkhalefah, H. (2020). Adapting universities for sustainability education in industry 4.0: Channel of challenges and opportunities. *Sustainability (Switzerland)*, *12*(15). Scopus. https://doi.org/10.3390/su12156100

Molnár, G., & Nagy, E. (2025). Current Issues in Effective Learning: Methodological and Technological Challenges and Opportunities Based on Modern ICT and Artificial Intelligence. In Turčáni M. (Ed.), *EAI/Springer Inno. Comm. Comp.* (pp. 1–11). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-031-81261-3_1

Moltudal, S. H., Krumsvik, R. J., & Høydal, K. L. (2022). Adaptive Learning Technology in Primary Education: Implications for Professional Teacher Knowledge and Classroom Management. *Frontiers in Education*, *7*. Scopus. https://doi.org/10.3389/feduc.2022.830536

Nutalapati, H., Velmurugan, S., & Tiglao, N. M. (2024). Coding Buddy: An Adaptive AI-Powered Platform for Personalized Learning. *Int. Symp. Networks, Comput. Commun., ISNCC*. 2024 International Symposium on Networks, Computers and Communications, ISNCC 2024. Scopus. https://doi.org/10.1109/ISNCC62547.2024.10759044

Parfenov, D., & Zaporozhko, V. (2018). Developing SMART educational cloud environment on the basis of adaptive massive open online courses. In Hanssgen K. & Bolodurina I. (Eds.), *CEUR Workshop Proc.* (Vol. 2093, pp. 35–41). CEUR-WS; Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85048233385&partnerID=40&md5=3c8d763459d80b602f5639eec992d86f

Park, E., Ifenthaler, D., & Clariana, R. B. (2023). Adaptive or adapted to: Sequence and reflexive thematic analysis to understand learners' self-regulated learning in an adaptive learning analytics dashboard. *British Journal of Educational Technology*, *54*(1), 98–125. Scopus. https://doi.org/10.1111/bjet.13287

Raj, N. S., Prasad, S., Harish, P., Boban, M., & Cheriyedath, N. (2021). Early Prediction of At-Risk Students in a Virtual Learning Environment Using Deep Learning Techniques. In Sottilare R.A. & Schwarz J. (Eds.), *Lect. Notes Comput. Sci.: Vol. 12793 LNCS* (pp. 110–120). Springer Science and Business Media Deutschland GmbH; Scopus. https://doi.org/10.1007/978-3-030-77873-6_8

Saeed, M. M. A., Saeed, R. A., Ahmed, Z. E., Gaid, A. S. A., & Mokhtar, R. A. (2024). AI technologies in engineering education. In *AI-Enhanc. Teach. Methods* (pp. 61–87). IGI Global; Scopus. https://doi.org/10.4018/979-8-3693-2728-9.ch003

Saul, K., Howard, A. K. T., Webster, Z., & Spencer, D. (2022). An Adaptive Learning Engineering Mechanics Curricular Sequence. *ASEE Annu. Conf. Expos. Conf. Proc.* ASEE Annual Conference and Exposition, Conference Proceedings. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85138247314&partnerID=40&md5=fe8db267dd6e549c026dfc4e39c468f3

Thankachan, K. (2018a). Adaptive Intelligence for Massive Online Open Course. *Int. Conf. Comput., Commun. Netw. Technol., ICCCNT*. 2018 9th International Conference on Computing, Communication and Networking Technologies, ICCCNT 2018. Scopus. https://doi.org/10.1109/ICCCNT.2018.8494018

Thankachan, K. (2018b). Adaptive Learning. *Proc. Int. Conf. Inven. Comput. Inf., ICICI*, 705–710. Scopus. https://doi.org/10.1109/ICICI.2017.8365227

van der Stappen, E., & Baartman, L. (2019). Automated feedback for workplace learning in higher education. In Draaijer S., Joosten-ten Brinke D., & Ras E. (Eds.), *Commun. Comput. Info. Sci.* (Vol. 1014, pp. 73–90). Springer Verlag; Scopus. https://doi.org/10.1007/978-3-030-25264-9_6

Xi, J., Chen, Y., & Wang, G. (2018). Design of a personalized massive open online course platform. *International Journal of Emerging Technologies in Learning*, *13*(4), 58–70. Scopus. https://doi.org/10.3991/ijet.v13i04.8470

Zaoudi, M., & Belhadaoui, H. (2020). Adaptive E-learning: Adaptation of Content According to the Continuous Evolution of the Learner during his Training. *ACM Int. Conf. Proc. Ser.* ACM International Conference Proceeding Series. Scopus. https://doi.org/10.1145/3386723.3387890

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