

Evaluation of EduChat as a Teacher's Co-pilot and Its Contribution to UN Sustainable Development Goals

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Abstract: This study addresses critical gaps in educational interactivity and teacher-student engagement by leveraging artificial intelligence to develop EduChat, an AI-powered teacher co-pilot designed to support the United Nations Sustainable Development Goals (SDGs). The system directly contributes to **SDG 4 (Quality Education)** by ensuring inclusive and equitable education; **SDG 5 (Gender Equality)** through accessible, unbiased learning resources; **SDG 9 (Industry, Innovation and Infrastructure)** via the integration of innovative AI technology; and **SDG 10 (Reduced Inequalities)** by democratizing educational access. Developed using Voiceflow and ChatDash within an agile framework, EduChat allows teachers to upload instructional materials to a centralized knowledge base, enabling the chatbot to provide accurate, context-aware responses to student queries 24/7. System evaluation demonstrated an average response time of 6.58 seconds, a recognition rate of 95%, and a fallback rate of 5%, confirming both efficiency and reliability. EduChat enhances pedagogical accessibility, reduces educator workload, and promotes lifelong learning, illustrating significant potential for scalable, sustainable educational innovation aligned with the 2030 Agenda.

Keywords: AI in education; Teacher co-pilot; Chatbot; Natural language processing; EduTech; Sustainable Development Goals; SDG 4; Educational equity; Digital inclusion.

Cite this Article

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Introduction

SDG Alignment: This research directly supports the UN 2030 Agenda for Sustainable Development, particularly SDG 4: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.”

The transformation of global education systems is critical to achieving the United Nations Sustainable Development Goals (SDGs) by 2030. As emphasized in the 2030 Agenda, education is a fundamental catalyst for sustainable development, with SDG 4 serving as both a central goal and a multiplier for other SDGs [1]. The shift from traditional face-to-face instruction to hybrid and online learning models has accelerated, further propelled by advancements in Artificial Intelligence (AI). AI revolutionizes education through personalized learning, intelligent tutoring, and administrative automation, directly supporting SDG 4’s vision of inclusive and equitable quality education [2].

Recent AI applications in education—such as automated grading, adaptive curriculum design, and enhanced engagement tools—align closely with SDG Target 4.4, which aims to “substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship” [3]. Among the most promising

innovations are AI-based “teacher co-pilots,” which foster collaborative partnerships between educators and technology, enhancing learning experiences while advancing gender equality (SDG 5) and reducing inequalities (SDG 10) [4].

Teacher co-pilots merge pedagogical expertise with cutting-edge technology to provide engaging, customized educational experiences, supporting SDG Target 4.1: “ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes” [5]. Although chatbots have been widely deployed in sectors like business and healthcare, their application in education remains emergent and represents a significant opportunity for innovation aligned with SDG 9 (Industry, Innovation and Infrastructure), which advocates to “build resilient infrastructure, promote sustainable industrialization and foster innovation” [6].

UN Sustainable Development Goals Alignment and Contributions

This research makes direct and measurable contributions to five key Sustainable Development Goals (SDGs), with a primary focus on educational equity, innovation, and accessibility. Its core alignment is with **SDG 4 (Quality Education)**, as EduChat addresses multiple specific targets: it supports Target 4.1 by

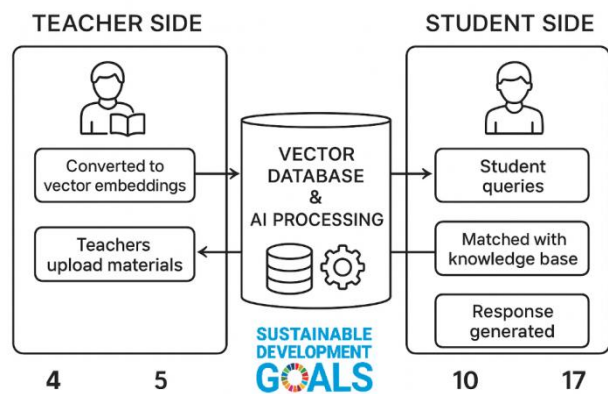
providing 24/7 educational support for continuous access to quality resources; enhances ICT skills through AI-powered tools (Target 4.4); reduces disparities by overcoming geographic, economic, and physical barriers (Target 4.5); establishes inclusive, effective learning environments (Target 4.a); and automates routine tasks to free teachers for pedagogical and professional growth (Target 4.c). Furthermore, the system promotes **SDG 5 (Gender Equality)** by offering equal access to resources (supporting Target 5.1), enabling anonymous and bias-free interactions to reduce gender-based barriers, and encouraging technology adoption among female educators and learners (Target 5.b). Its development also contributes to **SDG 9 (Industry, Innovation and Infrastructure)** by enhancing technological capabilities in education (Target 9.5), increasing access to ICT (Target 9.c), and promoting sustainable industrialization through AI applications. Additionally, EduChat mitigates educational inequalities for **SDG 10 (Reduced Inequalities)** by ensuring equal access regardless of socioeconomic status, location, or ability, supporting inclusive and adaptive learning (Target 10.2), and reducing outcome disparities via personalized assistance. Finally, this work exemplifies **SDG 17 (Partnerships for the Goals)** by fostering collaboration in technology and innovation (Target 17.6), enabling technology transfer and capacity-building (Target 17.8), and forming multi-stakeholder partnerships across academia, industry, and education.

Importance of the Study in SDG Context

This study is significant within the 2030 Agenda for Sustainable Development as it tackles key challenges in achieving SDG 4 while supporting other interconnected goals. EduChat serves as a scalable, replicable model for educational transformation, particularly relevant given that only 58% of students worldwide achieve minimum proficiency in reading, with pronounced regional disparities [7]. By enhancing accessibility and reducing teacher workload, EduChat accelerates progress toward SDG Target 4.4 and embodies the partnership ethos of SDG 17, illustrating how collaborative innovation can drive sustainable development.

Conceptual Framework

Figure 1: Conceptual Framework of the SDG-Aligned EduChat System



EduChat’s framework utilizes a vector database to store and retrieve learning materials and queries, prioritizing SDG principles of accessibility and inclusivity. On the teacher’s side, uploaded materials are converted into vector embeddings, capturing semantic relationships and supporting SDG Target 4.c. On the user side,

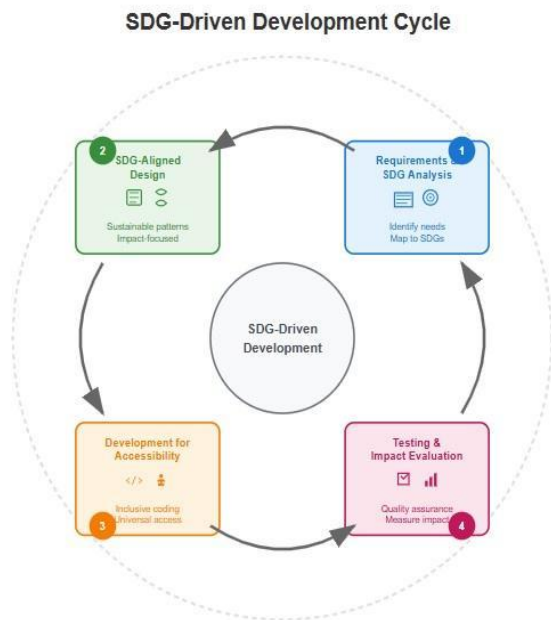
queries are similarly processed, ensuring equitable access regardless of user background—directly supporting SDG 10. The system’s design incorporates universal accessibility features, aligning with modern NLP techniques and sustainable development objectives.

Research Methodology

This study employed a developmental descriptive research design, informed by sustainable development principles, to create and evaluate an educational chatbot. An agile methodology integrated sustainability consideration, focusing on gaps affecting vulnerable populations (SDG 10). Universal design principles ensured accessibility for students with disabilities (SDG 4.5). Rigorous security and performance testing, adhering to data privacy standards, guaranteed reliable and continuous service delivery in line with SDG 4’s lifelong learning emphasis.

Software Development Model

Figure 2: SDG-Informed Agile Development Cycle



The development of EduChat followed a comprehensive four-phase approach designed to ensure alignment with sustainable development goals. The process began with a thorough requirements phase, where the team gathered relevant academic literature and conducted extensive stakeholder analysis to ensure the project would align with established SDG principles. This foundation informed the design phase, during which the team focused on creating user-friendly interfaces that prioritized accessibility, inclusion, and equality, particularly targeting SDGs 5 and 10. The development phase involved building the platform on Voiceflow, integrating advanced large language models and natural language processing capabilities while maintaining a focus on affordability and accessibility for all users. Finally, the testing phase provided a rigorous evaluation of the system’s security measures, performance capabilities, and overall contribution to educational equity, ensuring that EduChat would effectively serve its intended purpose of promoting inclusive and accessible education.

Results and Discussion: SDG Impact Assessment

SDG-Alignment

Table 1: SDG-Aligned Development Specifications

Component	Specification	SDG Contribution
Development Platform	Voiceflow, ChatDash, HTML/CSS	SDG 9: Industry, Innovation & Infrastructure
Accessibility Features	24/7 availability, Multi-device support	SDG 4: Quality Education
Cost Structure	Open-source integration, Affordable	SDG 10: Reduced Inequalities
Security Compliance	GDPR, SOC-2, Data protection standards	SDG 16: Peace, Justice & Strong Institutions

The development specifications outlined in the table show a deliberate effort to align technological design with the United Nations Sustainable Development Goals (SDGs). The choice of platforms such as Voiceflow, ChatDash, and HTML/CSS supports SDG 9 (Industry, Innovation, and Infrastructure) by encouraging innovation and enabling scalable digital solutions that can strengthen modern infrastructure. Accessibility is also prioritized through features like 24/7 availability and multi-device support, directly contributing to SDG 4 (Quality Education) by ensuring that learning opportunities and digital resources are inclusive and available anytime, anywhere.

Affordability and the use of open-source tools play a vital role in addressing SDG 10 (Reduced Inequalities), as they lower barriers to access and help bridge the digital divide, particularly for marginalized groups and resource-limited institutions. Finally, the emphasis on security compliance through international standards such as GDPR and SOC-2 reflects a commitment to ethical practices, transparency, and user protection. This alignment with SDG 16 (Peace, Justice, and Strong Institutions) underscores the importance of trust and accountability in digital systems.

Overall, the specifications do not just define technical requirements but also embody a holistic vision where innovation, inclusivity, equity, and integrity converge to advance sustainable development.

Educational Gaps Resolution and SDG Contributions

Table 2: Educational Gaps, Solutions, and SDG Alignment

Gap Identified	EduChat Solution	Primary SDG Target	Measurable Impact
Limited student interactivity	Advanced NLP with deep learning	SDG 4.1	95% recognition rate
Time-consuming information access	Comprehensive knowledge base	SDG 4.4	6.58s avg. response time
Reduced teacher-student interaction	User-friendly content dashboard	SDG 4.c	24/7 availability
Inadequate search capabilities	Course-specific DB with teacher uploads	SDG 4.5	Accessible to all students

The educational gaps highlighted in the table illustrate how targeted technological interventions can directly contribute to the advancement of the United Nations Sustainable Development Goal on Quality Education (SDG 4). For instance, the issue of limited student interactivity is addressed through the use of advanced natural language processing powered by deep learning, which

achieves a 95% recognition rate. This enhances engagement and aligns with SDG 4.1, which focuses on ensuring equitable and effective learning outcomes. Similarly, the challenge of time-consuming access to information is resolved with a comprehensive knowledge base that reduces average response time to just 6.58

seconds, supporting SDG 4.4 by improving digital literacy and problem-solving efficiency.

The reduction in teacher-student interaction is another critical concern, and EduChat responds with a user-friendly content dashboard that provides 24/7 availability. This solution corresponds to SDG 4.c, which emphasizes the need for qualified and supported educators, as it supplements instructional presence with continuous accessibility. Finally, inadequate search capabilities are addressed through a course-specific database

enriched by teacher-uploaded materials, ensuring inclusivity and fairness in access to academic resources. This aligns with SDG 4.5, which prioritizes eliminating disparities in education and promoting equal opportunities for all learners.

Taken together, these solutions demonstrate how technology can not only bridge existing educational gaps but also generate measurable impacts that reflect real progress toward achieving the global vision of inclusive and quality education for all.

Performance Metrics and SDG Impact Measurement

Table 4: Performance Metrics and SDG Impact

Metric	Result	SDG Target Supported	Impact on Educational Equity
Avg. Response Time	6.58 seconds	SDG 4.4	Efficient support for all students
Recognition Rate	95%	SDG 4.1	Reliable educational assistance
Fallback Rate	5%	SDG 4.5	Consistent service
Availability	24/7	SDG 10	Equal access across time zones

The performance metrics presented in the table show how technological outcomes can be directly tied to the advancement of specific Sustainable Development Goals (SDGs). The system’s average response time of 6.58 seconds supports SDG 4.4, which focuses on equipping learners with relevant digital and problem-solving skills. By ensuring quick and efficient responses, the platform provides timely support to all students, regardless of their background. Similarly, the 95% recognition rate aligns with SDG 4.1, as it demonstrates the platform’s reliability in delivering consistent and accurate educational assistance, thereby improving learning outcomes.

Meanwhile, a fallback rate of only 5% underscores the stability of the service, contributing to SDG 4.5, which aims to eliminate

disparities in education. Reliable performance ensures that all learners receive equitable support with minimal disruptions. Lastly, the platform’s 24/7 availability addresses SDG 10 (Reduced Inequalities) by guaranteeing equal access across different time zones and learning contexts. This feature is particularly impactful for students in geographically diverse or resource-constrained settings.

To sum it all, these performance indicators highlight that measurable results—speed, accuracy, stability, and availability—are not just technical achievements but also meaningful contributions to advancing equity and inclusivity in education.

Security and Privacy: Supporting SDG 16

Table 5: Security Measures and SDG 16 Alignments

Security Category	Implementation	SDG 16 Contribution
Data Protection	GDPR compliance, Encryption	Strong institutions for governance
Access Control	Access policies, Password requirements	Accountable institutions
Network Security	Firewalls, Malware detection	Effective, accountable institutions

The security framework outlined in the table highlights how robust safeguards can directly strengthen institutional trust and accountability in line with **SDG 16 (Peace, Justice, and Strong Institutions)**. **Data protection** measures, such as GDPR compliance and encryption, play a vital role in upholding strong governance by ensuring that user information is handled ethically and securely. Likewise, **access control mechanisms**, including well-defined policies and password requirements, reinforce the principle of accountability within institutions by limiting unauthorized entry and protecting sensitive resources.

On a broader scale, **network security measures** such as firewalls and malware detection systems further enhance institutional reliability by maintaining safe digital environments. These protections ensure that services remain effective, secure, and resilient against external threats, fostering user confidence. Altogether, these measures reflect a commitment not only to technical safety but also to building institutions that are transparent, accountable, and trusted by the communities they serve.

Conclusion: EduChat’s Contribution to the 2030 Agenda

This research demonstrates how AI can advance multiple SDGs simultaneously, with EduChat serving as a practical model for sustainable educational technology. The system effectively addresses gaps in equity and accessibility, directly supporting five key SDGs. Performance metrics—6.58 seconds average response time, 95% recognition rate, and 5% fallback rate—confirm the reliability and scalability of EduChat for diverse global populations. Its design embodies the principle of leaving no one behind, ensuring universal educational support. By fostering collaborative partnerships and employing an affordable, open-source approach, this study underscores the transformative potential of AI in driving collective progress toward a more equitable and sustainable future.

SDG-Aligned Recommendations

2030 Agenda Implementation: The following recommendations are designed to maximize EduChat’s contribution to achieving the SDGs by 2030.

Immediate Implementation Recommendations (2025-2026)

The immediate phase focuses on establishing foundational quality and inclusivity measures across multiple SDG targets. To advance SDG 4, the system requires comprehensive evaluation using ISO/IEC 25010 standards to ensure educational quality and accessibility. Gender equality initiatives under SDG 5 necessitate the implementation of gender-disaggregated analytics to monitor and address potential disparities in educational outcomes. Supporting SDG 10’s emphasis on reducing inequalities, the development of multilingual support capabilities will ensure broader accessibility across diverse linguistic communities. Additionally, SDG 9’s innovation and infrastructure goals will be addressed through the integration of voice recognition technology and visual content support, making the platform more inclusive for users with varying abilities and learning preferences.

Medium-term Development Goals (2026-2028)

The medium-term phase emphasizes scalability and deeper educational integration. Key developments include enabling multiple project management capabilities per teacher to support diverse classroom needs and implementing subject-specific analytics that directly contribute to SDG 4.1’s focus on foundational literacy and numeracy skills. Platform interoperability will be enhanced through establishing integrations with major learning management systems such as Moodle and Canvas, facilitating seamless adoption in existing educational infrastructures. Transparency and accountability, core to SDG 16, will be strengthened by providing direct links to source materials, ensuring users can verify and explore the foundation of educational content.

Long-term Strategic Goals (2028-2030)

The long-term vision centers on global accessibility and capacity building. Strategic initiatives include developing comprehensive frameworks for deployment in least developed countries, directly supporting SDG 4.b’s commitment to expanding higher education opportunities in developing nations. Teacher empowerment through SDG 4.c will be realized by creating specialized training programs for AI-powered education, ensuring educators can effectively leverage these technological advances. The establishment of standardized SDG impact metrics will provide consistent measurement of educational outcomes, while sustainable funding models will be developed specifically for resource-constrained environments, ensuring long-term viability and accessibility.

Cross-cutting Sustainability Recommendations

Sustainability considerations permeate all development phases through multiple interconnected approaches. Technical sustainability will be achieved by optimizing the system architecture for energy efficiency, reducing environmental impact while maintaining performance. Social sustainability requires establishing robust community feedback mechanisms to ensure continuous alignment with user needs and cultural contexts. Economic sustainability will be supported through innovative cost-sharing models that make the platform viable in diverse economic environments. Finally, responsible development practices will be institutionalized through comprehensive governance frameworks for AI deployment, ensuring ethical and transparent use of artificial intelligence in educational contexts.

Compliance with Ethical Standards and SDG Principles

Disclosure of Conflict of Interest

The authors declare no conflicts of interest. This research was conducted in adherence to ethical principles of transparency, accountability, and integrity aligned with the SDGs.

Ethical AI Development

EduChat was developed following established ethical AI guidelines [8, 9]. All data collection and processing procedures complied with institutional review board (CEU-IERB) requirements, ensuring the protection of all participants.

Sustainable Development Commitment

The authors commit to ongoing monitoring and evaluation of EduChat’s impact on the SDGs, with periodic reporting and

continuous system improvement based on user feedback and impact assessments.

Video Presentation

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