



Harnessing AI for STEM Education in South Asia: Impact, Opportunities, and Challenges

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ABSTRACT

The integration of Artificial Intelligence (AI) into Science, Technology, Engineering, and Mathematics (STEM) education has transformative potential, particularly for South Asia, a region marked by economic and educational disparities. This paper examines the impact, opportunities, and challenges associated with adopting AI in STEM higher education in South Asia. Through AI, education systems in the region can overcome limitations in resources, geographical barriers, and outdated curricula, offering adaptive, personalized, and accessible learning experiences. The study highlights the roles of leading AI-focused institutions, particularly in India, which are pioneering AI initiatives and fostering regional leadership in AI-driven education. By evaluating current AI integration, institutional contributions, and socio-economic barriers, the paper provides insights into harnessing AI to enhance research, improve STEM education outcomes, and prepare South Asian students for a global, AI-driven economy. This research underscores the need for a balanced approach that considers AI's ethical, cultural, and infrastructural challenges, aiming to create an inclusive and sustainable model for AI-enhanced STEM education in South Asia.

DOI: <https://doi.org/10.69727/jdi.v8i2.113>

Received:

25 November 2024

Accepted:

5 December 2024

Available Online:

22 December 2024

JEL classification:

I21, O33, O36

Keywords:

Artificial Intelligence, STEM Education, Educational Accessibility, South Asia

Editor:

Santa Man Rai

1. Introduction

Artificial Intelligence (AI) is profoundly reshaping higher education worldwide (Crompton & Burke, 2023), with significant implications for Science, Technology, Engineering, and Mathematics (STEM) disciplines (Xu & Ouyang, 2022). As a groundbreaking technology, AI has the potential to modernize education, enabling adaptive, personalized learning experiences that traditional methods often fail to provide. For a diverse region like South Asia, where economic and educational inequalities pose major obstacles, AI presents an opportunity to bridge gaps, creating accessible, efficient, and inclusive learning environments (Bhattarai, 2024). This region, encompassing countries like India, Pakistan, Nepal, and Bangladesh, includes several lower-middle-income economies as classified by the World Bank. Despite these challenges, South Asia

stands to benefit immensely from AI's potential to enhance STEM education, encourage innovation, and support sustainable economic growth.

Among South Asian countries, India has made remarkable advances in AI research and education, positioning themselves as emerging leaders in the technology centric global economy. Integrating AI into STEM education across South Asia addresses limitations in traditional educational systems and accelerates a shift toward digital, skill-focused learning environments that align with the demands of modern industries.

With its large and youthful population, South Asia has a significant opportunity to drive economic and technological advancement through investments in STEM education. Countries like India, Pakistan, and Bangladesh can leverage STEM-focused education to develop skilled professionals for high-impact sectors such as information technology, biotechnology, and engineering. Equipping young people with STEM skills is essential to meet national development goals and maintain global competitiveness.

STEM education is also crucial for addressing regional challenges like unemployment and underemployment, which affect a substantial portion of South Asia's youth. Expanding STEM education prepares young individuals for in-demand fields, enabling them to contribute to a knowledge-based economy. India, for example, has seen notable growth in its tech sector, creating jobs and strengthening its economy. Similarly, Bangladesh's emerging tech industry shows how STEM-trained professionals contribute to economic resilience in fields like IT and finance.

However, the potential of STEM education is limited by outdated curricula, resource constraints, and unequal access. These challenges often lead to a "brain drain," with talented individuals leaving for better opportunities abroad, hindering local development. Overcoming these barriers is essential to retain skilled talent and build a resilient local economy.

STEM-trained professionals are vital across sectors, including healthcare and sustainable energy, where they drive innovations that address both local and global issues. Advances in medical technology and data-driven patient care improve health outcomes, while clean energy solutions mitigate climate change. Expanding and modernizing STEM education is not only an educational priority but a strategic necessity for South Asia's equitable and sustainable growth.

AI offers transformative potential for advancing STEM education in South Asia by enhancing learning experiences, broadening accessibility, and enabling personalized instruction. In areas with limited educational resources, especially in rural regions, AI provides scalable solutions that democratize access to quality STEM education. Through AI-powered tools, students in underserved areas gain access to personalized learning platforms, virtual labs, and intelligent tutoring systems that address individual learning needs, bridging gaps left by conventional resources (Yang et al., 2024).

The strength of AI lies in its ability to deliver adaptive, student-centered learning experiences. Personalized AI platforms adjust content based on each student's level of comprehension, helping reduce dropout rates in subjects like math and physics (Maghsudi et al., 2021). Virtual labs powered by AI allow students to conduct simulations and experiments, offering practical learning experiences even without physical lab facilities. By making STEM education more adaptable and accessible, AI overcomes geographic and socio-economic barriers, fostering an inclusive learning environment.

AI also supports educators by automating routine tasks, such as grading and tracking student performance, allowing teachers more time for personalized instruction. AI-driven analytics can identify where students struggle, enabling targeted interventions and optimizing teaching methods.

This dynamic approach not only improves learning outcomes but creates a more responsive classroom environment (Zawacki-Richter et al., 2019).

The role of AI in STEM education is crucial for addressing South Asia's regional challenges, such as climate change, healthcare access, and food security. AI-driven tools in agriculture support sustainable farming practices, while advancements in healthcare technology facilitated by AI enhance access in rural areas. Through AI-integrated STEM education, students not only gain career skills but also become empowered to create positive impacts in their communities, promoting equity and sustainable development across South Asia.

This paper aims to analyze the impact and potential of AI in advancing STEM education in South Asia. Specifically, the objectives are to:

- Assess the current state of AI integration in STEM education across South Asia, identifying how AI is being applied in educational settings and which challenges persist.
- Highlight the roles of leading AI-focused institutions in the region, emphasizing their contributions to research impact, global collaboration, and regional leadership in AI-driven education.
- Explore the socioeconomic factors and infrastructure limitations that affect AI adoption in lower- and middle-income countries in South Asia, with a focus on disparities between urban and rural areas.
- Identify opportunities for enhancing AI in STEM education through policy, funding, and international collaboration.
- Provide actionable recommendations for integrating AI-driven systems into higher education.

Through this multi-dimensional analysis, the paper aims to offer insights into harnessing AI to address educational gaps, improve research impact, and prepare South Asian students for the demands of the global AI-driven economy.

2. Background and Context

Section 2 provides an overview of the socio-economic landscape in South Asia, examines STEM education challenges, and explores AI's global impact.

2.1 Classification of South Asian Countries Based on GNI Per Capita

The World Bank classifies countries based on their Gross National Income (GNI) per capita. As of July 2024, for FY25, countries are categorized as Low-Income (LI), Lower-Middle-Income (LMI), Upper-Middle-Income (UMI), and High-Income (HI) based on specific income thresholds (see Appendix A). South Asia represents a diverse economic landscape, with countries classified across various income levels based on their GNI per capita. According to the World Bank, South Asia includes economies that range from LI to UMI countries. The majority of countries in South Asia, including Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka, are classified as LMI.

This economic classification directly impacts each country's ability to invest in and sustain advanced educational technologies, such as AI-driven initiatives in STEM. LMI and UMI countries often have the necessary, albeit limited, resources to adopt innovative solutions, making them suitable candidates for AI solutions that maximize educational impact within budgetary limits. However, LI countries like Afghanistan face significant financial and infrastructural constraints, which pose major challenges for large-scale implementation of AI in education. LMI countries like India and Pakistan may have the economic potential to fund AI in specific educational projects, but

their digital infrastructure and funding are often unevenly distributed, particularly when comparing urban and rural areas.

The economic classification also highlights specific barriers to AI adoption, such as digital infrastructure limitations and varying levels of internet penetration. UMI countries, such as the Maldives, are better positioned to deploy AI applications in educational settings. Conversely, low-income and lower-middle-income countries may require fundamental investments in digital infrastructure, like stable internet connectivity and affordable digital devices, before AI-driven tools can be effectively integrated. Therefore, economic context plays a pivotal role in understanding the feasibility and approach to AI in education across the South Asian region.

2.2 Current State of STEM Higher Education in South Asia

STEM education across South Asia has experienced considerable growth in enrollment, yet infrastructure quality and accessibility vary significantly between countries and regions. In nations like India and Pakistan, government policies increasingly emphasize the importance of STEM fields, recognizing their potential for driving economic growth and technological advancement. However, even with such programs, infrastructure limitations remain a pervasive challenge, particularly in rural and remote areas. In many schools and universities, resources such as laboratories, digital learning tools, and even qualified educators are limited, hindering the effective delivery of STEM education (Sharma et al., 2024).

The challenges facing STEM education in South Asia extend beyond physical infrastructure. Many educational institutions still rely on outdated curricula, which tend to focus heavily on theoretical knowledge rather than practical application (Ojha, 2024; Shabur, 2024). This limits students' opportunities to engage in hands-on learning and problem-solving activities, which are essential for preparing them for industry roles. STEM fields, especially those like engineering, data science, and biomedicine, demand experiential learning, yet the lack of modernized curricula and laboratory facilities means that students often graduate without the critical skills needed for practical application (Fairouz et al., 2023; Samman, 2024). This gap between theoretical knowledge and practical skills impacts the readiness of South Asian students to enter the STEM workforce, ultimately affecting the region's ability to innovate and compete in global markets.

Another pressing issue in South Asia is the unequal access to STEM resources between urban and rural areas. Urban schools and universities generally benefit from better resources, infrastructure, and qualified educators, whereas rural institutions often face significant shortages in these areas. This divide further widens the gap in educational quality, creating disparities in STEM competencies across the region. AI-driven solutions, if implemented strategically, could play a vital role in bridging this gap by offering standardized content, virtual labs, and accessible learning tools that students from all backgrounds can use. Such tools have the potential to reduce the digital divide and create a more equitable educational landscape, especially in remote and underserved areas (Fazil et al., 2024; Shakeeb, 2021).

2.3 AI's Role in Education Globally: Best Practices and Research Findings

Globally, AI has started to reshape STEM education by enabling personalized learning experiences, adaptive assessments, and virtual lab environments (Nagaraj et al., 2023). In developed countries, AI is widely adopted in educational settings, transforming traditional learning models into interactive, student-centered experiences (Duterte, 2024). Key innovations include intelligent tutoring systems (ITS), virtual simulations, and data-driven insights that help educators make informed decisions based on real-time data analysis. These AI applications provide a benchmark for how AI could be applied in South Asia to achieve similar outcomes in STEM education.

One prominent example of AI's impact in education is the development of Intelligent Tutoring Systems (ITS), which deliver personalized, one-on-one tutoring by adapting content based on each student's performance. For instance, platforms like Smart Sparrow (Hoboken, 2020) have demonstrated significant success in improving learning outcomes by enabling educators to design interactive courseware that provides real-time feedback and adapts to individual progress. Widely used in STEM subjects such as biology, engineering, and health sciences, Smart Sparrow offers tailored guidance and fosters active learning experiences. For South Asia, where teacher-student ratios are often high and individualized instruction is limited, ITS platforms like Smart Sparrow provide a scalable solution for personalized STEM education.

Similarly, AI-driven virtual labs and simulations, like those offered by Labster, provide students with a risk-free environment to explore scientific concepts, simulating real-world scenarios in biology, chemistry, and physics. These tools are particularly advantageous for schools lacking physical lab facilities, enabling hands-on digital learning experiences. Additionally, AI-powered data analysis offers valuable insights into learning patterns, performance trends, and dropout risks. By identifying areas where students face challenges, educators can tailor teaching strategies to improve outcomes. This combination of innovation and adaptability enhances the overall quality and accessibility of STEM education.

Despite these advancements, AI's global deployment in education has also brought forth ethical considerations, particularly around data privacy and potential algorithmic biases. Institutions need to establish clear guidelines and policies for AI implementation, especially in sensitive areas like student assessment and monitoring (Hwang et al., 2020). As South Asia considers implementing AI in education, understanding these global best practices and addressing ethical concerns will be essential to ensure that AI solutions are used responsibly and equitably.

3. Research Impact and Global Engagement of AI-focused Institutions in South Asia

Section 3 explores the research impact and global engagement of leading AI-focused institutions in South Asia, highlighting how these universities rank and perform in AI-related subjects. This section explores academic contributions, employer reputation, research output, and international collaboration, showcasing South Asian institutions' global AI impact.

3.1 2024 Rankings and Insights: Analysis of South Asia's Premier AI-focused Institutions

This subsection provides an in-depth analysis of the 2024 rankings for top South Asian universities in AI-related subjects. The abridged dataset provided by the QS World University offers a detailed overview of top South Asian universities with strengths in AI-related fields, including Data Science & AI (see Appendix B1) and Computer Science & Information Systems (see Appendix B2). Institutions are ranked by their QS World University scores across multiple dimensions (see Appendix C).

3.1.1 Top-Tier South Asian Institutes in Data Science & AI

South Asia hosts a range of top-tier institutions renowned for their excellence in Data Science & AI, with several Indian Institutes of Technology (IITs) standing out in global rankings. IIT Bombay, IIT Delhi, IIT Kanpur, IIT Kharagpur, and the Indian Institute of Science (IISc) consistently demonstrate superior performance, securing their positions as world-class institutions in Data Science and AI. Notably, IIT Bombay ranks highest globally in this field, securing the 30th position, followed closely by IIT Delhi at 35 and IIT Kanpur at 36. The IITs in this category excel in metrics such as Employer Reputation and Academic Reputation, with IIT Bombay and IIT Delhi particularly distinguished for their employer reputation, scoring 86.6 and 84.0, respectively. Research metrics, including citations per faculty and H-index values, further affirm the research impact and scholarly influence of these institutions.

3.1.2 Top-Tier South Asian Institutes in Computer Science & Information Systems

In the field of Computer Science & Information Systems, IIT Delhi and IIT Bombay lead among South Asian institutions, ranking 63rd and 64th globally, with IIT Kanpur and IIT Madras also displaying stable or improved positions from previous years. These institutions show strong scores in Employer and Academic Reputation and have steadily gained global interest, as indicated by favourable score in International Research network indicator. This global recognition is significant, as it enhances both academic prestige and industry partnerships, which are essential for sustaining influence and competitiveness in the tech sector.

3.1.3 Institutions in Pakistan

Pakistan's National University of Sciences and Technology (NUST) in Islamabad and COMSATS University hold notable positions, with NUST ranking in the 174 band and COMSATS between 251-300 band in the field of Computer Science & Information Systems. Both institutions exhibit strong employer and citation scores, indicating the high regard in which their graduates are held by employers and the significant impact of their research output. Lahore University of Management Sciences (LUMS) and Quaid-i-Azam University also hold strong standings, particularly in employer reputation and citation metrics. Despite challenges such as limited funding and infrastructure, these institutions attract significant attention and respect for their contributions to the region's academic and professional fields.

3.1.4 Institutions in Bangladesh

In Bangladesh, the Bangladesh University of Engineering and Technology (BUET) and the University of Dhaka represent the country in global rankings in the field of Computer Science & Information Systems. BUET, in particular, stands out in metrics like Citations and H-index, highlighting its focused research output and contributions to scientific literature. Employer Reputation for both universities remains positive, reflecting strong perceptions among employers, although international collaborations remain an area with room for growth.

3.1.5 Emerging Institutions and Regional Impact

Emerging institutions like Vellore Institute of Technology, Anna University, Chandigarh University, and the University of Delhi are also gaining recognition for their strengths in Computer Science & Information Systems. These institutions demonstrate solid domestic rankings and are making headway in global positions. Their growing success reflects South Asia's increasing focus on aligning academic programs with industry demands, especially in technology and engineering sectors, which positions them as noteworthy contributors within the region's academic landscape.

3.2 *University Performance Assessment of Top South Asian AI-focused Institutions*

This subsection delves into a detailed performance assessment of the top AI-focused institutions in South Asia, evaluating them across specific dimensions (see Appendix C). It analyzes scores in academic reputation, employer perception, citations, and networks, revealing strengths and areas for improvement.

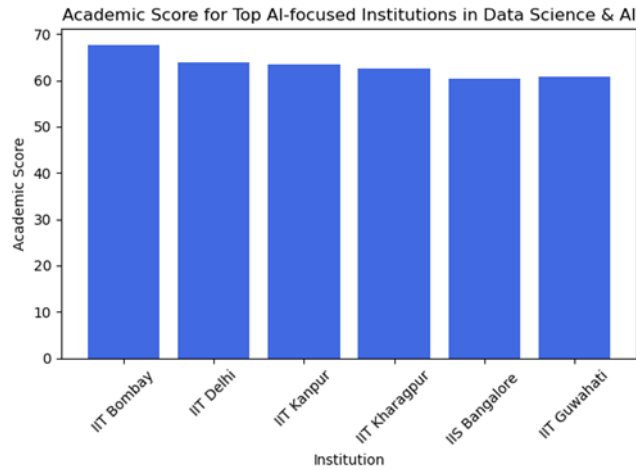
3.2.1 A Detailed Score Analysis for Top South Asian AI-focused Institutions

This sub-subsection presents a breakdown of scores across key performance indicators (see Appendix C). Using the Exploratory Data Analysis (EDA) of the datasets mentioned in Appendices B1 and B2, all graphs presented in this section were generated using Python. For the complete datasets, please refer to the web link provided in Appendix B.

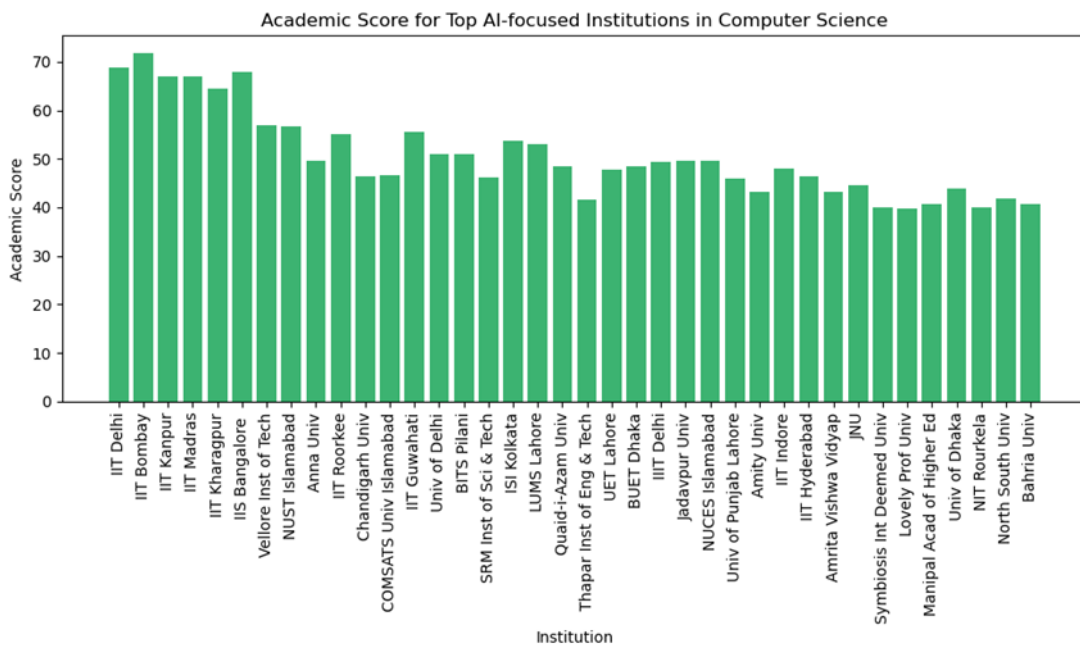
A. Academic Score for Top AI-focused Institutions

Figure 1

Academic Score for Top South Asian AI-focused Institutions in (a) Data Science & AI; and (b) Computer Science & Information Systems



(a) Data Science & AI



(b) Computer Science & Information Systems

Figure 1(a) displays Academic Scores of leading AI-focused institutions in Data Science & AI, with IIT Bombay scoring highest around 70, closely followed by IIT Delhi and IIT Kanpur. All institutions score above 60, indicating a strong academic reputation across these Indian institutions in AI education.

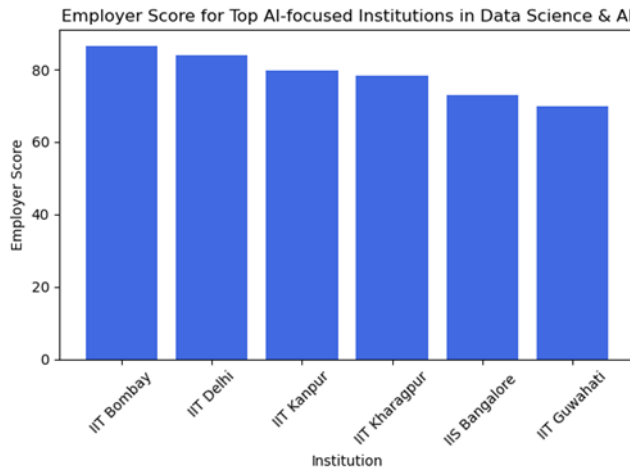
Figure 1(b) displays Academic Scores for leading South Asian institutions in Computer Science & Information Systems. IIT Delhi and IIT Bombay lead with the highest scores around 70, closely followed by IIT Kanpur, IIT Madras and IISc Bangalore. Vellore Institute of Technology, NUST Islamabad, IIT Roorkee, and IIT Guwahati also have strong scores above 55. Institutions like COMSATS University and LUMS Lahore show moderate scores, representing Pakistan’s contributions, while BUET and University of Dhaka from Bangladesh have lower scores. The

diversity in scores highlights a significant range in academic reputation across institutions in the region.

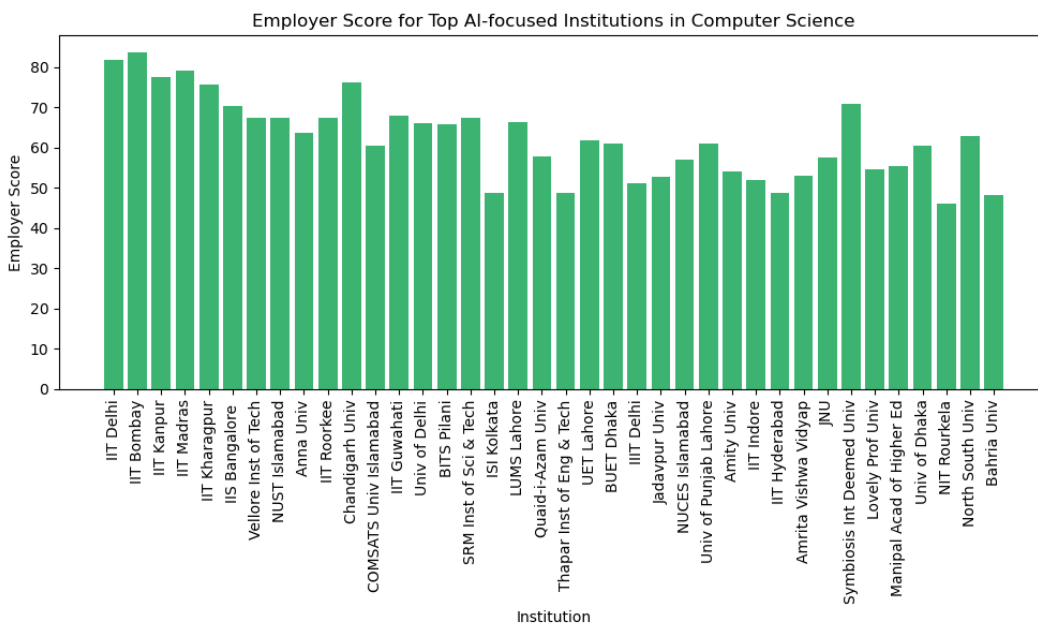
B. Employer Score For Top AI-focused Institutions

Figure 2

Employer Score for Top South Asian AI-focused Institutions in (a) Data Science & AI; and (b) Computer Science & Information Systems



(a) Data Science & AI



(b) Computer Science & Information Systems

Figure 2(a) shows Employer Scores for top AI-focused institutions in Data Science & AI. IIT Bombay leads with the highest score, closely followed by IIT Delhi and IIT Kanpur, all scoring above 80. This highlights strong employer recognition for graduates, particularly from these top Indian institutions.

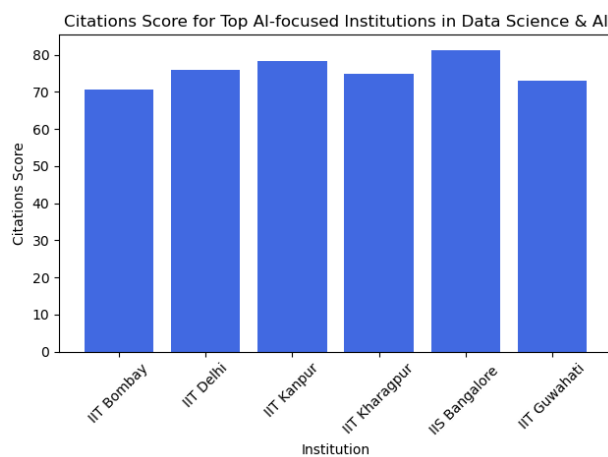
Figure 2(b) shows Employer Scores for leading South Asian institutions in Computer Science & Information System. IIT Delhi, and IIT Bombay, top the chart, with scores above 80,

reflecting strong employer demand for their graduates. Similarly, IIT Kanpur, IIT Madras, and Chandigarh University have high employer scores, above 75, whereas IISc Bangalore and Symbiosis International (Deemed University) also have good employer reputation with scores around 70. Pakistani institutions like NUST Islamabad and Lahore University of Management Sciences (LUMS) show moderate scores, while Bangladeshi universities, including BUET and North South University, rank lower. The chart illustrates the wide range of employer perceptions across the region, with Indian IITs standing out for employability.

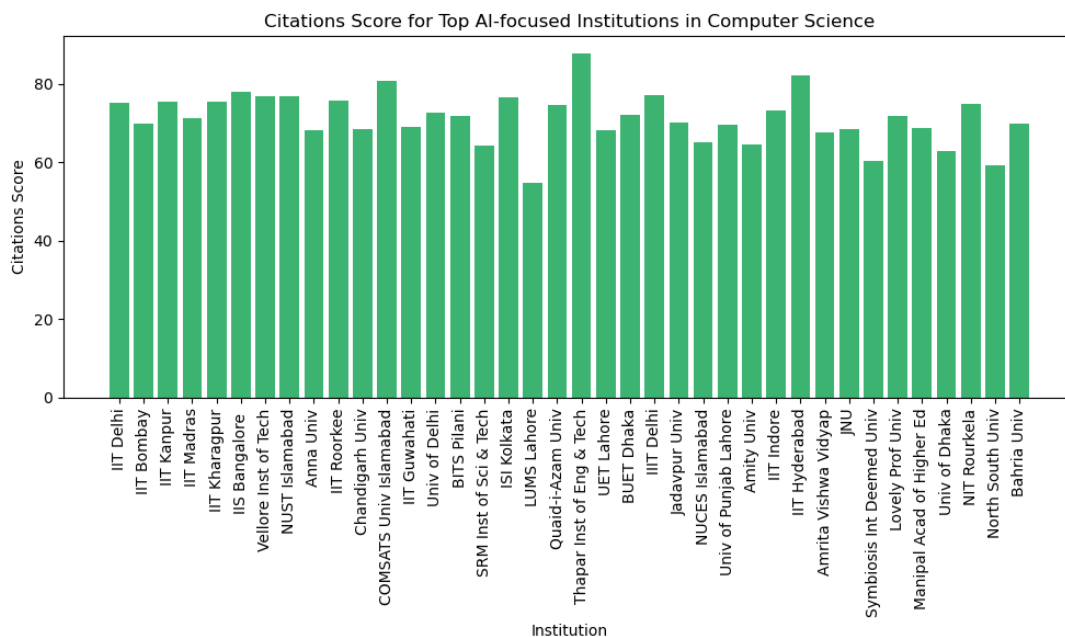
C. Citations Score For Top AI-focused Institutions

Figure 3

Citations Score for Top South Asian AI-focused Institutions in (a) Data Science & AI; and (b) Computer Science & Information Systems



(a) Data Science & AI



(b) Computer Science & Information Systems

Figure 3(a) illustrates Citations Scores for leading AI institutions in Data Science & AI, with IISc Bangalore at the top, scoring around 80, highlighting its research influence. IIT Kanpur and IIT Delhi follow closely. IIT Bombay and IIT Guwahati have slightly lower scores, indicating room for growth in citation impact.

Figure 3(b) shows Citations Scores for South Asian institutions in Computer Science & Information System. Thapar Institute of Engineering & Technology and IIT Hyderabad lead among Indian institutions, with scores of 87.7 and 82, indicating strong research impact. Other IITs and IISc Bangalore also perform well, with scores around 70-80, showcasing solid academic influence. Among Pakistani institutions, COMSATS University stands out with the highest score of 80.8, followed by NUST Islamabad and Quaid-i-Azam University with scores above 70. For Bangladeshi universities, BUET scores highly at 72. Overall, the chart highlights a range in research impact, with Indian institutions generally exhibiting stronger citation metrics than other South Asian counterparts.

D. H-Index Score For Top AI-focused Institutions

Figure 4

H-Index Score for Top South Asian AI-focused Institutions in (a) Data Science & AI (upper) and (b) Computer Science & Information Systems(lower)

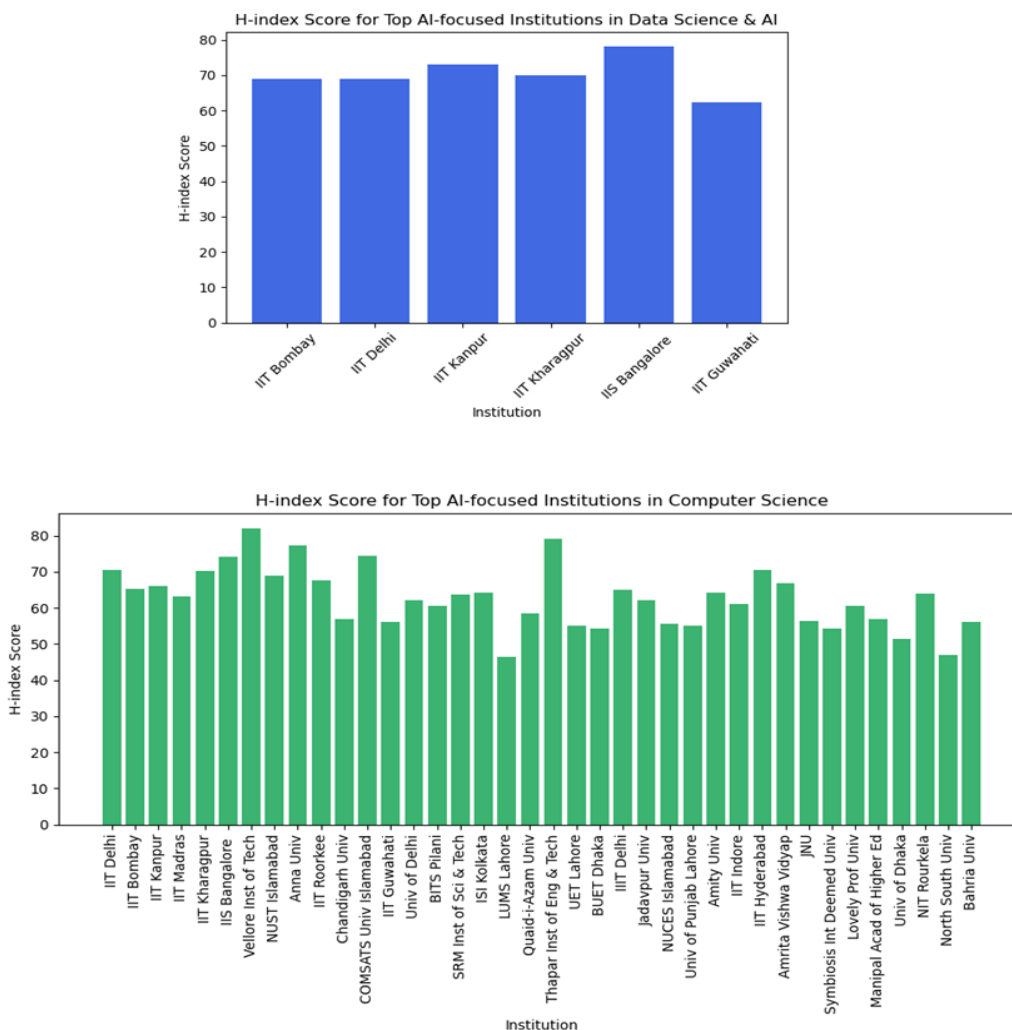


Figure 4(a) shows H-index Scores for top AI-focused institutions in Data Science & AI. IISc Bangalore leads with the highest H-index, indicating high research productivity and consistent impact. IIT Kanpur follows closely, with IIT Bombay and IIT Delhi slightly lower. IIT Guwahati has the lowest score, suggesting room to enhance research impact.

Figure 4(b) illustrates H-index Scores for South Asian institutions in Computer Science & Information Systems, reflecting research productivity and impact. Vellore Institute of Technology and Thapar Institute of Engineering & Technology lead with scores over 80, indicating high research influence. Anna University and IISc Bangalore have strong H-index scores, demonstrating consistent impact. Among Pakistani institutions, COMSATS also shows robust score. Some institutions like LUMS Lahore and North South University, have lower scores, highlighting regional disparities in research impact.

E. International Research Network Score For Top AI-focused Institutions

Figure 5

International Research Network Score for Top South Asian AI-focused Institutions in Computer Science & Information Systems

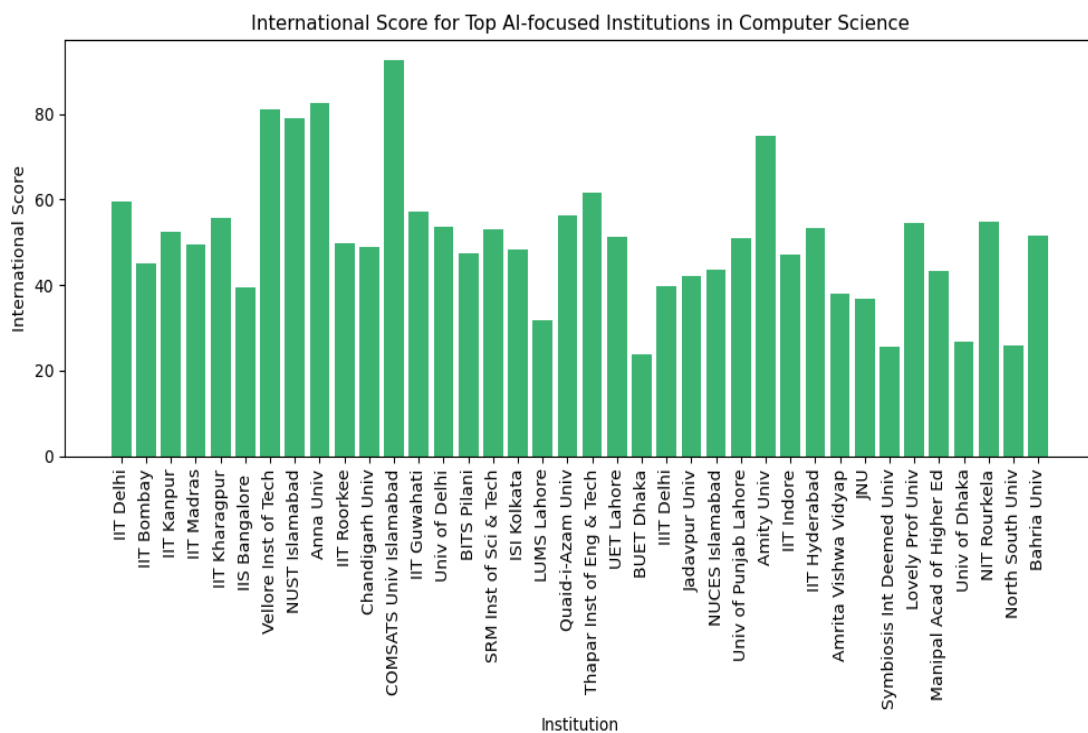
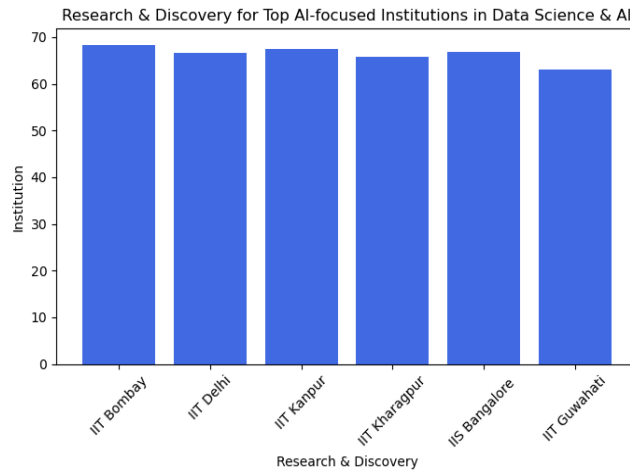


Figure 5 presents International Research Network Scores for South Asian institutions in Computer Science & Information System, highlighting global engagement levels. COMSATS University, Islamabad leads with a score above 90, indicating extensive international connections. Anna University and VIT Vellore follow closely, each scoring above 80, which reflects strong global collaboration. NUST Islamabad and Amity University also have high scores above 75, showing active international partnerships. Among Indian IITs, IIT Delhi and IIT Kharagpur have moderate scores around 60, suggesting potential for expanding global collaborations. In contrast, Bangladeshi institutions like BUET Dhaka and North South University score lower, indicating regional variations in global engagement.

F. Research & Discovery Score For Top AI-focused Institutions

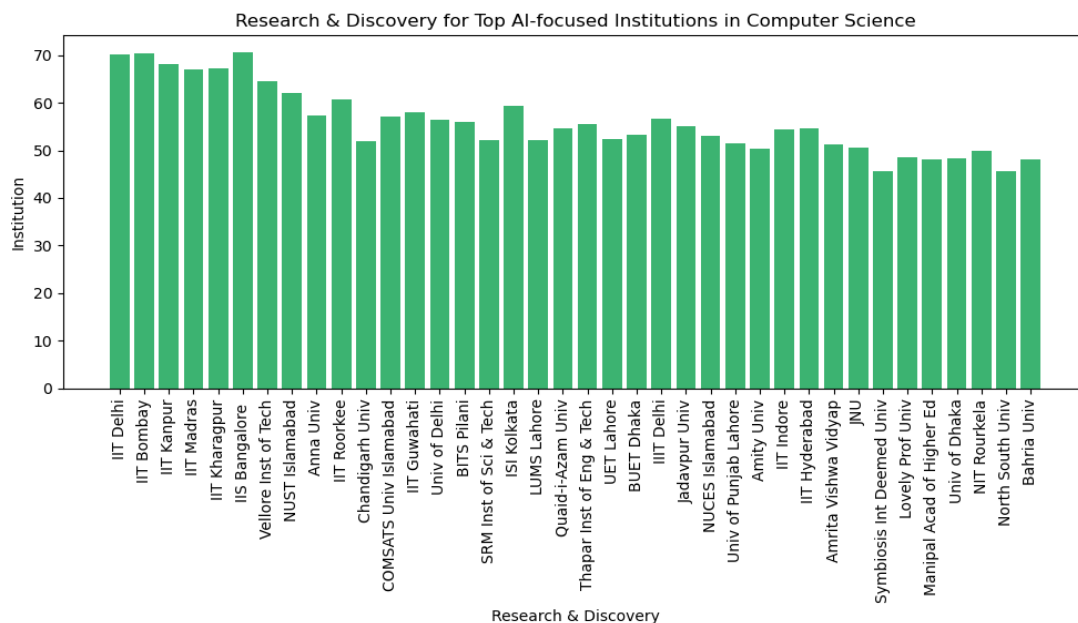
Figure 6

Research & Discovery Score for Top South Asian AI-focused Institutions in (a) Data Science & AI;



and (b) Computer Science & Information Systems

(a) Data Science & AI



(b) Computer Science & Information Systems

Figure 6(a) presents Research & Discovery Scores for leading AI-focused institutions in Data Science & AI. IIT Bombay leads with the highest score, closely followed by IIT Kanpur, both scoring around 70, underscoring their strong research capabilities. IIT Delhi, IISc Bangalore, and IIT Kharagpur also demonstrate high scores, reflecting significant research contributions. IIT Guwahati scores slightly lower, indicating room for growth in research impact. Overall, the chart highlights the prominent role of Indian IITs and IISc in advancing research in AI.

Figure 6(b) displays Research & Discovery Scores for leading South Asian institutions in Computer Science & Information System. IISc Bangalore, IIT Bombay, and IIT Delhi lead with scores around 70, reflecting strong research capabilities. Other IITs, including IIT Kanpur, IIT

Madras, and IIT Kharagpur, also perform well with scores above 65. VIT Vellore and NUST Islamabad score above 60, indicating competitive research output. Pakistani institutions like LUMS Lahore and COMSATS University, along with Bangladeshi institutions like BUET Dhaka, have moderate scores above 50, demonstrating a solid research presence across South Asia.

G. Rank Changes 2023 vs 2024

Figure 7

Rank Changes 2023 vs 2024 for Top South Asian AI-focused Institutions in Computer Science & Information Systems

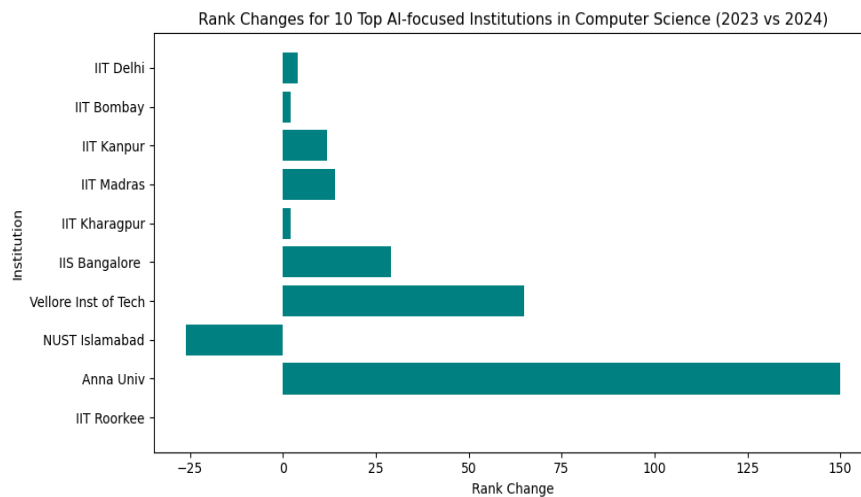


Figure 7 displays Rank Changes from 2023 to 2024 for leading South Asian institutions in Computer Science & Information Systems. Anna University demonstrates the most significant improvement, followed by IISc Bangalore and VIT Vellore with substantial gains. Among the IITs, IIT Madras and IIT Kanpur show notable rank increases, while others recorded moderate gains, indicating stable performance. IIT Roorkee remains unchanged, whereas NUST Islamabad experienced a slight decline.

4. Shaping STEM Education: Impacts and Contributions of Premier AI-Focused Institutions

Section 4 explores the pivotal role of top AI-focused institutions in shaping STEM education across South Asia. It covers advancements in research and development (R&D), regional leadership, industry partnerships, curriculum innovation, and ethical AI practices, highlighting their contributions to global visibility and collaboration in STEM fields (Sharma et al., 2024).

4.1 Strengthening Research and Development Capabilities

Top-tier universities in South Asia are increasingly strengthening their research and development (R&D) capabilities in AI, focusing on applied research that addresses regional needs. Significant investments have been directed toward establishing specialized AI and data science labs, which serve as hubs for pioneering research and collaboration. For example, the Robert Bosch Centre for Data Science and Artificial Intelligence (RBC-DSAI) (IndianWeb2, 2024) at IIT Madras partners with leading global industries to create AI solutions for critical sectors such as healthcare, agriculture, and transportation - fields that hold particular relevance for South Asia's economic and social development.

The Government of India recently announced plans to establish three AI Centers of Excellence (CoEs) by 2028, focusing on healthcare, agriculture, and sustainable cities. The healthcare CoE will be spearheaded by IIT Delhi and All India Institute of Medical Sciences (AIIMS), IIT Kanpur will drive the sustainable cities initiative, and IIT Ropar will lead the agriculture-focused efforts (Hindustan Times, 2024).

By fostering these R&D initiatives, universities not only contribute to technological advancement but also drive innovation within STEM education. Students engaged in these research environments gain hands-on experience with advanced AI applications, enabling them to build essential skills in data analysis, machine learning, and computational modeling. This practical exposure equips students with industry-ready competencies, bridging the gap between academic learning and real-world application and ensuring that graduates are well-prepared to meet the demands of the evolving job market.

4.2 Regional Leadership in AI-Related Education

The Indian Institutes of Technology (IITs) and other prestigious institutions are leading AI-related education in South Asia, significantly impacting both national and regional educational landscapes. These institutions shape educational policies, set standards for AI curriculum development, and foster public engagement in STEM fields. By promoting awareness and interest in AI careers through community outreach, public lectures, and STEM-focused events, they cultivate a stronger base of future AI professionals.

South Asia's leading universities, including IITs and NUST Islamabad play an essential role in guiding national AI strategies by advising government bodies on AI policies and educational frameworks. Their leadership helps set benchmarks in AI education, influencing policy-making and driving educational reform throughout South Asia. Through their contributions to research and policy, these institutions create a dynamic AI ecosystem that equips students with the skills needed to address real-world challenges, thus positioning South Asia as a rising leader in the global AI landscape.

4.3 Employer Engagement and Industry Collaboration

South Asian universities are strengthening employer engagement and industry collaboration by partnering with global and local tech companies. These collaborations create a bridge between academia and the workforce, ensuring that graduates are equipped with skills relevant to current industry demands. Through partnerships with companies like Google, Microsoft, NVIDIA, and local startups, universities can offer industry-relevant AI programs and hands-on research opportunities. For example, Thapar Institute of Engineering & Technology (TIET) partnered with NVIDIA to establish the Thapar School of Advanced AI & Data Science (BW Education, 2024). Supported by NVIDIA's AI University program, it offers students interactive learning and access to advanced AI tools, enhancing STEM education. Similarly, Kathmandu University and Fusemachines Nepal have signed a Memorandum of Understanding (MoU) to collaboratively foster the development of a high-quality AI workforce (School of Engineering Department of Computer Science and Engineering, Kathmandu University, 2022).

These university-industry partnerships significantly impact graduate employability by integrating real-world applications into the academic experience. Students gain valuable practical exposure through internships, mentorship programs, and industry-sponsored projects. IIT Bombay, for instance, collaborates with industry partners to offer students firsthand experience with AI applications across diverse sectors such as finance, healthcare, and manufacturing. These initiatives prepare students for competitive job markets by equipping them with the practical skills and knowledge needed to thrive in AI and technology-driven careers.

Additionally, universities like IIT Madras (Amgen, 2024), and IIT Kharagpur (AI & ML Technology Innovation Hub for Interdisciplinary Cyber Physical systems (ICPS), 2024) are fostering innovation through AI-focused hubs and startup incubators. These centers support students and faculty entrepreneurial ventures by providing resources, mentorship, and funding opportunities. By nurturing innovation and entrepreneurship, these institutions enable students to develop AI-driven solutions for real-world challenges, contributing to the growth of the AI ecosystem in South Asia. These incubators encourage a culture of innovation within universities,

empowering students to translate their academic knowledge into impactful, industry-ready applications.

4.4 Driving AI Curriculum Development and Innovation

Leading universities in South Asia are at the forefront of developing AI-centric courses that are becoming essential components of STEM education. Institutions like IIT Kanpur, and IIT Delhi have pioneered specialized courses in machine learning, robotics, and deep learning, providing students with comprehensive foundations in AI. Furthermore, IIT Bombay's Executive Post-Graduate Diploma in AI and Data Science has set a benchmark for accessible, high-quality AI education and serves as a model for other universities across the region (IndiaAI, 2024). These programs ensure that students are well-versed in current AI applications, preparing them for the demands of an AI-integrated workforce.

Beyond course offerings, the AI-focused curricula developed by these universities influence educational standards at both national and regional levels. As these institutions incorporate the latest advancements in AI, data science, and the applications of AI in STEM, they help shape the knowledge and competencies expected of future STEM professionals. Curricula from leading universities often serve as blueprints for other institutions, ensuring a consistent level of training across South Asia and contributing to the establishment of cohesive standards in AI education. This leadership in curriculum development not only drives innovation within the universities themselves but also elevates the overall quality of AI education across the region.

4.5 Collaboration Among Regional Universities

Collaboration among South Asian universities significantly enhances knowledge sharing and resource optimization, allowing institutions to leverage each other's strengths and expertise. Joint research initiatives, faculty exchanges, and shared projects create a collaborative network that elevates STEM education across the region. For instance, institutions like IIT Kanpur (Indian Institute of Technology Kanpur, 2024), IIT Bombay, and IIT Delhi have signed Memorandums of Understanding (MoUs) with the Institute of Engineering at Tribhuvan University in Nepal, aimed at advancing collaborative efforts in engineering fields. Such partnerships enable a pooling of resources, fostering an enriched academic environment that benefits students and researchers alike.

Beyond regional collaborations, leading universities are expanding cross-border knowledge sharing by setting up offshore campuses, thereby widening access to quality AI and STEM education across South Asia. These cross-border initiatives not only raise the standard of education but also ensure students across various countries have equitable learning opportunities. For example, IIT Madras is currently working to establish an international campus in Sri Lanka, a move that underscores the commitment of top institutions to foster educational inclusivity (The Economics Times, 2024). Such initiatives pave the way for a more interconnected academic landscape in South Asia, where students benefit from diverse educational resources and a collaborative learning ecosystem.

4.6 Elevating Global Visibility and Attracting Talent

The leading South Asian universities are gaining global recognition through international rankings and high-impact research, which has significantly boosted their visibility and appeal to students and researchers worldwide. This enhanced global reputation not only raises the profile of institutions like the IITs but also attracts research funding and fosters collaborations with top global universities. The growing international standing of these universities positions them as sought-after destinations for global talent, drawing in top students and researchers who contribute to the academic and cultural diversity on campus.

Academic exchange programs and partnerships with leading global universities further strengthen these institutions' international ties. By enabling students to study AI applications across

various domains, including STEM, these exchanges foster a global outlook and provide unique opportunities to learn from diverse academic environments. This exposure enhances the quality of scientific research, and the skill sets of South Asian students, making them more competitive on the global stage. As a result, these exchange initiatives not only contribute to personal and academic growth but also help create a globally connected academic community that benefits both the students and their home institutions.

4.7 Promoting AI Ethics and Governance in Education

The leading South Asian universities are prioritizing ethical AI use and governance within their educational frameworks, recognizing the importance of responsible innovation. By integrating courses on AI ethics, bias mitigation, and responsible AI practices, these institutions are preparing students to understand the broader societal impact of AI technology (Slimi & Carballido, 2023). For example, IIT Bombay includes modules on AI ethics within its curriculum, offering students insights into the ethical dimensions of AI and encouraging them to adopt a conscientious approach to AI development. Such initiatives ensure that future AI professionals are not only technically skilled but also socially responsible.

Furthermore, these universities are playing a critical role in establishing ethical standards for AI applications in education and research. By promoting transparency, fairness, and accountability, they help define guidelines that encourage responsible AI practices across the academic landscape. Leading institutions are setting an example for AI governance, contributing to a balanced approach that considers both technological advancement and ethical concerns. This focus on responsible AI not only benefits STEM education in South Asia but also fosters a framework that can be adopted region-wide, ensuring that AI's integration into education upholds the highest ethical standards.

5. Opportunities of AI in STEM Higher Education

AI technologies present an array of opportunities to transform STEM education in South Asia, addressing educational gaps and enhancing learning experiences in ways previously unattainable. These innovations range from personalized learning and intelligent tutoring systems to automation of administrative tasks, each contributing uniquely to making STEM education more accessible, engaging, and impactful (Telfort, 2024). Through these advancements, AI can serve as a powerful tool for overcoming regional disparities and preparing students to meet the demands of the modern workforce (Wangdi, 2023).

5.1 Personalized Learning

AI's ability to personalize educational content makes it highly effective in improving learning outcomes by adapting to each student's pace, strengths, and weaknesses (Iqbal, 2023; Katiyar et al., 2024). In South Asia, where classroom resources and student academic backgrounds vary significantly, AI-driven platforms like Knewton Alta (Knewton Alta, 2024) help bridge educational gaps through individualized learning paths. By leveraging real-time assessments and adaptive learning technologies, Knewton Alta provides personalized support, just-in-time remediation, and detailed explanations to address prerequisite skill gaps in subjects like mathematics, physics, and chemistry. This tailored approach enhances engagement, improves retention, and reduces dropout rates in challenging STEM fields. In resource-constrained settings, particularly rural areas with high teacher-student ratios, AI's adaptability maximizes limited resources by supplementing teacher-led instruction and providing targeted support. Platforms like Knewton Alta empower students to stay aligned with their curriculum while receiving the individualized attention necessary to succeed, ensuring equitable access to quality education.

5.2 Intelligent Tutoring Systems (ITS)

Intelligent Tutoring Systems (ITS) leverage AI to replicate one-on-one tutoring experiences, adapting instruction to each student's progress (Telfort, 2024). In STEM subjects like chemistry or

physics, ITS provides step-by-step guidance, offering tailored hints and feedback to enhance problem-solving skills. These systems are particularly valuable in mastering foundational concepts crucial for academic success. Research highlights platforms like Smart Sparrow, which empower educators to design interactive courseware with real-time feedback, significantly improving student outcomes in fields such as engineering, and health sciences. For South Asia, where teacher shortages and overcrowded classrooms challenge education quality, ITS offers scalable solutions to support personalized learning. By guiding students through complex material and fostering independent problem-solving, ITS reduces the instructional burden on teachers while enhancing STEM education, even in resource-limited settings. Smart Sparrow's adaptive capabilities make it a key tool in transforming traditional learning environments.

5.3 Automation of Administrative Tasks

AI's role in automating administrative tasks can significantly streamline processes within educational institutions, allowing educators to allocate more time to teaching and student engagement. Routine tasks like grading, attendance tracking, and scheduling can be managed efficiently by AI, freeing up valuable time for teachers to focus on instruction. In STEM fields, where consistent feedback is critical, AI-powered assessment tools can evaluate assignments and quizzes more accurately and swiftly than manual grading, enabling students to receive immediate feedback on their work. This immediate feedback loop is particularly beneficial in STEM, where understanding and correcting mistakes in real-time can deepen conceptual understanding. Additionally, AI analytics can assist educational institutions in identifying trends such as student drop-off rates in challenging courses, providing data that can guide decisions around instructional methods, course offerings, and support services, ultimately creating a more responsive educational environment.

5.4 Enhanced Research Capabilities

AI has revolutionized research in STEM by enabling researchers to handle vast data sets, simulate complex models, and uncover insights that would otherwise be challenging to detect. For students and researchers in South Asia, AI-driven tools make it possible to conduct high-level analysis in fields like bioinformatics and physics, advancing both knowledge and innovation. Incorporating AI into STEM education equips students with critical research skills, preparing them for industry demands that increasingly require competencies in data science, machine learning, and data visualization. For instance, students can use natural language processing for efficient literature reviews, apply machine learning algorithms to data analysis, and employ visualization tools to present findings—skills that are essential in research-intensive careers. Additionally, AI facilitates collaborative research through platforms that enable data sharing, simulation, and real-time collaboration across institutions. By enabling students and researchers from different universities or even countries to work together, AI fosters a more interconnected and innovative research ecosystem.

5.5 Skill Development for Industry Readiness

AI-driven STEM education can bridge skill gaps by providing students with the practical, industry-relevant skills they need to thrive in high-demand fields. South Asia's industries increasingly require expertise in data science, AI, and machine learning, and integrating these technologies into STEM education aligns student competencies with market needs. Virtual labs and simulations powered by AI allow students to gain hands-on experience in environments that replicate real-world applications, an invaluable resource for institutions that lack physical lab facilities. For example, AI-powered chemistry labs can enable students to perform simulated experiments, developing practical skills in a cost-effective and scalable manner. This exposure to AI in educational settings familiarizes students with technologies they will encounter in the

workforce, making AI proficiency in tasks like programming machine learning algorithms or analyzing big data increasingly essential in sectors such as healthcare, finance, and engineering.

5.6 Addressing Accessibility and Inclusivity

AI technologies hold transformative potential for making STEM education more accessible, especially for students with disabilities or those in remote areas. Tools such as text-to-speech and speech-to-text applications assist visually and hearing-impaired students, ensuring that they can participate fully in STEM education. For South Asia, where urban-rural educational disparities are substantial, AI tools that work on mobile devices are especially valuable, as they help bridge the resource divide. AI-based translation tools also support non-native speakers, making it possible to deliver quality STEM education in multiple languages. Additionally, AI-powered platforms that provide career counseling and personalized learning paths promote inclusivity, encouraging diverse participation in STEM fields. By helping underrepresented students discover STEM pathways aligned with their interests and strengths, AI fosters a more inclusive and supportive educational environment.

5.7 Improving Engagement through AI-Powered Content

AI can create immersive, engaging learning experiences through interactive and gamified content, which is particularly effective in making complex STEM topics accessible and enjoyable. Gamification, for instance, is widely applied in math and science learning platforms, where AI tools generate interactive simulations and quizzes that motivate students to engage with theoretical knowledge. Enhanced visualization tools powered by AI further help students grasp abstract STEM concepts. For example, augmented reality (AR) and virtual reality (VR) applications supported by AI can visualize molecular structures in chemistry or complex systems in physics, providing students with a deeper understanding of challenging subjects. AI also enables collaborative learning by creating virtual environments where students can work together on projects, fostering teamwork and collaborative problem-solving skills essential in STEM fields.

6. Challenges of AI in STEM Higher Education

The integration of AI into STEM education in South Asia brings numerous promising opportunities; however, several critical challenges complicate its implementation and scalability. These barriers span technical and infrastructural issues, cost and funding constraints, curriculum adaptability, ethical and privacy concerns, teacher readiness, cultural barriers, and regulatory limitations (Eden et al., 2024). Each of these factors, if left unaddressed, risks diminishing the effectiveness and accessibility of AI-driven solutions in educational contexts.

6.1 Technical and Infrastructure Barriers

One of the most significant obstacles to AI integration in South Asian STEM education is the digital divide, with limited internet access and insufficient digital devices creating disparities, particularly in rural areas. Reliable infrastructure is a prerequisite for running AI applications effectively, yet many rural schools lack access to the high-speed internet necessary for AI tools, leaving these institutions unable to benefit from advancements in digital learning. Additionally, implementing AI requires substantial computational resources, from server maintenance to cloud services, and these can be prohibitively expensive for many educational institutions. In LI and LMI countries across South Asia, budget limitations often make it difficult to invest in the hardware and connectivity infrastructure needed to sustain AI technologies. Further complicating this are energy and connectivity issues; in many regions, frequent electricity disruptions and unstable internet connectivity hinder the consistent use of AI-driven educational tools, posing significant challenges for rural schools and low-resource institutions.

6.2 Cost and Funding Issues

The cost of establishing AI-driven platforms and digital infrastructure presents another formidable barrier. Setting up AI systems requires substantial upfront investment, often beyond the reach of most educational institutions across South Asia, which already struggle with limited budgets for essential educational resources. This high cost of implementation often deters schools and universities from adopting AI, as they prioritize basic needs over digital transformation initiatives. Government funding, which could alleviate these financial constraints, is generally allocated to traditional educational expenditure rather than to digital advancements, slowing the adoption of AI technologies in public institutions. Consequently, many institutions become reliant on private sector partnerships or international aid to fund AI initiatives. While these partnerships can provide critical support in the short term, long-term dependency on external funding sources raises sustainability concerns, as institutions may struggle to maintain AI initiatives once initial funding ends.

6.3 Curriculum Adaptation

Integrating AI into STEM curricula poses another set of challenges, particularly because existing curricula in South Asia are largely focused on traditional teaching methods, with limited capacity for personalization or adaptive learning. Adapting these curricula to accommodate AI-driven education requires careful planning, resources, and sometimes even restructuring of entire programs. The rigidity of standardized exams and prescribed syllabi further limits flexibility, making it difficult to incorporate interactive, AI-based learning approaches that encourage critical thinking and problem-solving. Additionally, the development of new curricula with integrated AI elements demands extensive resources, from new instructional materials to teacher training, and institutions operating on limited budgets often struggle to allocate these additional resources. As a result, the process of embedding AI into STEM curricula is complex and resource-intensive, posing significant challenges for widespread adoption.

6.4 Ethical and Privacy Concerns

Ethical considerations, particularly around data privacy and algorithmic fairness, are also pressing issues in the AI integration process (Dabis & Csaki, 2024). AI-powered educational tools often collect vast amounts of personal data to deliver tailored learning experiences, raising concerns about data protection and privacy (Ma & Jiang, 2023). In South Asia, where regulatory frameworks for data privacy are either limited or inconsistently enforced, there is a risk that sensitive student data could be mishandled or compromised. Furthermore, the algorithms used in educational AI tools can unintentionally reinforce biases, particularly if these tools are developed with data that does not represent the diversity of South Asian students. Language-processing algorithms, for instance, may favor more commonly spoken dialects or languages, potentially disadvantaging students from linguistic minorities. Transparency and accountability in AI decision-making processes are also critical; however, the opacity of many AI systems makes it challenging for educators to understand the basis of algorithmic recommendations. This lack of transparency can erode trust among educators and students, especially if AI-driven decisions impact assessments or academic progress.

6.5 Teacher Readiness and Training

The successful integration of AI in education depends heavily on teacher readiness, yet a significant skills gap exists among educators in South Asia, many of whom lack experience with AI and digital teaching tools. AI technologies require a fundamental understanding of how to operate and interpret AI-driven systems, yet without proper training, educators are often unable to fully utilize these tools. Training programs for educators to effectively implement AI in classrooms demand both time and financial investment. Given the already high workloads of teachers, finding time for additional training can be challenging, especially in rural areas where there are fewer

educators available to share responsibilities. Additionally, resistance to technological change among some educators further hinders AI adoption, as there may be concerns that AI could replace traditional teaching roles. Addressing these concerns through targeted training and fostering an openness to AI integration are essential to ensure that AI enhances, rather than disrupts, the educational process.

6.6 Language and Cultural Barriers

In a region as linguistically and culturally diverse as South Asia, language and cultural sensitivity are crucial in AI-driven educational tools. Many AI educational platforms are designed primarily in English, which can create barriers for students who speak regional languages. The lack of multilingual support means that non-English-speaking students may have limited access to AI-driven educational content, impacting their ability to fully participate in AI-supported STEM education. Additionally, for AI tools to be effective in South Asia, they must be culturally relevant and sensitive to regional contexts, respecting local traditions, beliefs, and societal norms. The individualized learning approaches that AI often emphasizes may also conflict with the more traditional, teacher-centered teaching practices valued in South Asian culture. Striking a balance that respects traditional teaching methods while incorporating AI's individualized learning benefits is essential to ensure AI's cultural harmony and acceptance in education.

6.7 Sustainability and Scalability Issues

The sustainability and scalability of AI in STEM education are further challenges, as AI tools require continuous technological upgrades to remain effective, both in terms of software and hardware. Educational institutions often lack the necessary funding to sustain these ongoing costs, making the long-term adoption of AI difficult. While pilot AI projects may initially show promise, scaling these solutions across entire educational systems involves extensive planning, resource allocation, and infrastructure development that are not readily available in many South Asian settings. Furthermore, the environmental impact of AI technologies, particularly those requiring high computational power, adds another layer of complexity. AI's substantial energy footprint is a significant consideration in regions where energy resources are limited, as the energy demands of large-scale AI deployments could strain local resources and raise questions about the environmental feasibility of widespread AI integration.

6.8 Regulatory and Policy Gaps

Finally, the absence of comprehensive policies and regulations addressing AI in education presents a substantial challenge in South Asia. The lack of a unified regulatory framework can lead to fragmented practices, where each institution or state independently determines its approach to AI integration, potentially resulting in inconsistent standards. Clear policies on data privacy, algorithmic transparency, and accountability are essential to ensure students well-being and ethical AI use, yet few South Asian countries have established frameworks specific to AI in education. As governments strive to promote AI innovation, they also face the challenge of balancing this with the need for responsible AI usage. Policymakers often struggle to keep pace with the rapid technological advancements in AI, which complicates effective regulation and oversight. Without robust policies to guide AI adoption in educational settings, institutions may encounter difficulties in implementing AI in a way that is both secure and equitable.

7. Recommendations for Adopting AI-Driven Higher Education System

South Asia faces a pivotal moment where adopting AI in STEM higher education can drive economic growth and societal progress. Amid diverse challenges, an AI-driven system demands strategic planning, innovative policies, and inclusivity. This section presents actionable recommendations to integrate AI effectively, focusing on infrastructure, accessibility, curriculum updates, and ethical implementation to transform education across the region.

7.1 Enhancing Digital Infrastructure

To enable the effective integration of AI-driven education systems, expanding affordable broadband access in rural and underserved areas is imperative. Public-private partnerships can play a vital role in achieving this goal, ensuring that even remote regions have reliable internet connectivity. High-speed internet is a cornerstone for deploying AI tools such as virtual labs, intelligent tutoring systems (ITS), and online learning platforms, all of which enhance educational accessibility and quality. Initiatives like India's BharatNet project (Telecome, 2024) serve as excellent models that can be adapted and extended across South Asia, fostering equitable access to digital infrastructure and bridging the urban-rural digital divide.

Creating regional AI resource hubs with advanced computational tools, cloud services, and secure storage is essential for supporting resource-constrained institutions. These centralized hubs enable shared access to AI-driven applications, reducing costs and fostering collaboration. By pooling resources, they lower financial barriers and promote innovation, ensuring that even institutions with limited means can actively participate in the digital transformation of higher education through AI integration.

7.2 Policy Frameworks and Governance

Developing comprehensive national and regional AI policies is essential to guide the ethical and effective adoption of AI in education. These policies should encompass clear guidelines for ethical AI use, robust data privacy measures, and strategies to promote inclusive education. Establishing such regulatory frameworks will standardize AI integration across institutions, ensuring consistency and fairness while addressing ethical concerns. By fostering an equitable and secure environment, these policies will enable institutions to confidently adopt AI technologies, benefiting diverse student populations and upholding the principles of responsible innovation.

Dedicated funding for AI in education, through government budgets, international grants, and private investments, is vital for integration. It supports infrastructure, teacher training, and AI-driven curricula, bridging gaps and enabling effective implementation. Such targeted financial support ensures institutions are equipped to enhance learning outcomes and capabilities, fostering innovation and advancing higher education across diverse contexts.

7.3 Curriculum Modernization

Integrating AI-related subjects, including machine learning, robotics, and data analytics, into STEM curricula is essential for preparing a future-ready workforce. By incorporating these cutting-edge topics, educational programs can align with the evolving demands of industries and equip students with the skills required to thrive in technology-driven fields. This proactive approach ensures that graduates are not only academically prepared but also capable of contributing to innovation and meeting the needs of a rapidly transforming job market.

Designing courses that integrate AI with other disciplines, such as healthcare or environmental sciences, is a vital step in fostering interdisciplinary learning. This approach equips students with versatile skills, enabling them to address complex global challenges that require both technical expertise and domain-specific knowledge. By bridging AI with diverse fields, such programs prepare students to innovate and solve real-world problems effectively, enhancing their adaptability and relevance in a rapidly evolving professional landscape.

7.4 Capacity Building for Educators

Implementing AI-specific teacher training modules is essential to prepare educators for effectively integrating AI tools and methodologies into their teaching practices. These programs should focus on familiarizing teachers with the functionalities and applications of AI in education. Collaborations with leading institutions, such as the IITs, can ensure the delivery of high-quality training, equipping educators with the necessary skills to enhance learning outcomes. Teacher

readiness is a pivotal factor in the successful adoption of AI, as it directly impacts the quality and effectiveness of its implementation in classrooms.

Facilitating faculty exchange programs within South Asia is a valuable strategy for promoting the sharing of best practices and expertise in AI-driven education. These exchanges encourage collaborative learning among educators, fostering the transfer of knowledge and innovative teaching methodologies. By building regional capacity through such partnerships, institutions can collectively advance the integration of AI into education, ensuring a broader impact on educational quality and innovation across the region.

7.5 Promoting Accessibility and Inclusion

Developing AI tools and platforms that support multiple regional languages is crucial to ensuring inclusivity and accessibility in South Asia's diverse linguistic landscape. Language barriers pose a significant challenge in this region. Localized content can bridge this gap, enabling a wider range of learners to benefit from AI-driven educational resources and fostering equitable access to quality education.

Integrating AI-driven assistive technologies into education systems is essential for supporting students with disabilities. Tools such as text-to-speech and voice recognition can significantly enhance accessibility, enabling these students to participate equitably in STEM education. By leveraging such technologies, institutions can create inclusive learning environments that empower all learners to achieve their full potential.

7.6 Strengthening Research and Collaboration

Establishing South Asian AI research consortia is a vital step toward pooling resources and expertise across the region. These collaborative networks can drive innovation and provide solutions tailored to region-specific challenges in education and technology. By uniting institutions, such consortia enhance the collective capacity for impactful research and ensure that advancements in AI address the unique needs of South Asia.

Forging partnerships with global institutions is essential for introducing best practices, securing funding, and accessing cutting-edge technologies in South Asia. International collaboration accelerates the transfer of knowledge, enhances research capabilities, and strengthens the region's ability to innovate and contribute meaningfully to the global academic and technological landscape.

7.7 Ethical AI Practices

Implementing robust data privacy measures safeguards sensitive student information, ensuring trust and security. Strong protections foster confidence in AI technologies while upholding ethical standards and supporting responsible integration into educational systems.

Regular audits of AI algorithms are essential to identify and address biases, ensuring that AI systems operate ethically and impartially. By promoting fairness and equity in learning outcomes, these audits help create a more inclusive educational environment, reinforcing trust in AI-driven solutions.

7.8 Scaling AI Integration

Pilot projects in AI-enhanced education allow for testing feasibility, identifying challenges, and minimizing risks. They provide insights that guide the development of scalable, sustainable strategies, ensuring effective implementation before expanding to larger-scale applications.

Establishing clear metrics to evaluate the impact of AI tools on learning outcomes and accessibility is essential for ensuring their effectiveness. Continuous monitoring fosters

accountability identifies areas for improvement, and provides actionable insights to refine AI implementations, ultimately enhancing the quality and inclusivity of education.

8. Conclusion

This paper demonstrates that AI's integration into STEM education presents a unique opportunity to transform learning environments in South Asia, bridging gaps in accessibility, curriculum quality, and educational outcomes. AI-powered tools can provide adaptive and personalized learning experiences, enhancing student engagement and comprehension, particularly in complex STEM subjects. As South Asia works to strengthen its technological and economic position, AI-driven STEM education can play a pivotal role in preparing a skilled workforce ready to tackle regional and global challenges.

The findings emphasize the significant progress made by leading South Asian institutions, notably in India, in advancing AI research and education. These institutions have not only made strides in AI integration within STEM but also serve as regional leaders, influencing policies and setting standards that shape the future of AI in education. However, several barriers, such as limited infrastructure, funding challenges, and teacher readiness, continue to impede the full-scale adoption of AI across South Asia. Addressing these challenges requires a coordinated approach that includes investment in digital infrastructure, targeted training for educators, and policies that support responsible AI use in education. Policymakers and educators must also address ethical considerations, ensuring data privacy and equitable access to AI tools. By creating a robust framework for AI-enhanced STEM education, South Asia can leverage AI's potential to foster economic growth, innovation, and inclusivity in education, preparing future generations for success in an increasingly AI-centric world. This balanced, ethical, and inclusive approach will be crucial in maximizing AI's benefits for all students, irrespective of socio-economic or geographical limitations.

Acknowledgements

The author is thankful to two anonymous reviewers and editors for their sincere advice and comments which helped to improve the quality of this manuscript.

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Appendices

A. Income Groups and GNI Per Capita of South Asian Countries

Income Group	GNI Per Capita	Country
Low-Income (LI)	Less than \$1,146	Afghanistan
Lower-Middle-Income (LMI)	Between \$1,146 and \$4,515	Bangladesh; Bhutan; India; Pakistan; Nepal; Sri Lanka
Upper-Middle-Income (UMI)	Between \$4,516 and \$14,005	Maldives

Source : <https://ourworldindata.org/grapher/world-bank-income-groups?tab=table>

B1. QS World University Rankings by Subject 2024: Data Science and Artificial Intelligence

2024	2023	Institution	Location
30		Indian Institute of Technology Bombay (IITB)	India
35		Indian Institute of Technology Delhi (IITD)	India
36		Indian Institute of Technology Kanpur (IITK)	India
44		Indian Institute of Technology Kharagpur (IIT-KGP)	India
45		Indian Institute of Science	India
51-70		Indian Institute of Technology Guwahati (IITG)	India

Source : <https://www.topuniversities.com/university-subject-rankings/data-science-artificial-intelligence>

B2. QS World University Rankings by Subject 2024: Computer Science and Information Systems

2024	2023	Institution	Location
63	67	Indian Institute of Technology Delhi (IITD)	India
64	66	Indian Institute of Technology Bombay (IITB)	India
84	96	Indian Institute of Technology Kanpur (IITK)	India
87	101	Indian Institute of Technology Madras (IITM)	India

92	94	Indian Institute of Technology Kharagpur (IIT-KGP)	India
95	124	Indian Institute of Science	India
136	201-250	Vellore Institute of Technology (VIT)	India
174	148	National University of Sciences And Technology (NUST) Islamabad	Pakistan
201-250	351-400	Anna University	India
201-250	201-250	Indian Institute of Technology Roorkee (IITR)	India
251-300	301-350	Chandigarh University	India
251-300	251-300	COMSATS University Islamabad	Pakistan
251-300	251-300	Indian Institute of Technology Guwahati (IITG)	India
251-300	301-350	University of Delhi	India
301-350	301-350	Birla Institute of Technology and Science (BITS), Pilani	India
351-400	451-500	SRM Institute of Science And Technology	India
401-450	351-400	Indian Statistical Institute	India
401-450	351-400	Lahore University of Management Sciences (LUMS)	Pakistan
401-450	351-400	Quaid-i-Azam University	Pakistan
401-450	451-500	Thapar Institute of Engineering & Technology	India
401-450	401-450	University of Engineering & Technology (UET) Lahore	Pakistan
451-500	401-450	Bangladesh University of Engineering and Technology (BUET)	Bangladesh
451-500	451-500	Indraprastha Institute of Information Technology (IIIT) Delhi	India
451-500	601-650	Jadavpur University	India
451-500	351-400	National University of Computer and Emerging Sciences, Islamabad	Pakistan
451-500	451-500	University of the Punjab	Pakistan
501-550	451-500	Amity University	India

501-550	451-500	Indian Institute of Technology Indore (IIT Indore)	India
501-550	451-500	International Institute of Information Technology - Hyderabad (IIIT-H)	India
551-600	651-680	Amrita Vishwa Vidyapeetha	India
551-600	501-550	Jawaharlal Nehru University (JNU)	India
551-600		Symbiosis International (Deemed University)	India
601-650		Lovely Professional University (LPU)	India
601-650	651-680	Manipal Academy of Higher Education, Manipal	India
601-650	551-600	University of Dhaka	Bangladesh
651-700		Indian Institute of Technology Hyderabad (IIT-H)	India
651-700	601-650	National Institute of Technology (NIT) Rourkela	India
651-700	651-680	North South University	Bangladesh
701-720		Bahria University	Pakistan

Source : <https://www.topuniversities.com/university-subject-rankings/computer-science-information-systems>

C. QS World University Ranking Methodology

QS World University Ranking methodology uses a structured framework to assess institutional performance across key dimensions, organized into three lenses—Employability, Research & Discovery, and Global Engagement—each with specific indicators showcasing institutional strengths.

Employability Lens evaluates an institution's reputation among employers, focusing on how well programs align with job market demands and measure the ability to produce industry-ready graduates, while Research & Discovery Lens assesses an institution's research output and impact, focusing on quality, reach, and innovation, highlighting its role in advancing knowledge and academic influence. And Global Engagement Lens evaluates an institution's ability to build and maintain international research collaborations, reflecting its global engagement and impact.

QS World University Rankings by Subject evaluate over 1,500 institutions across 55 subjects in five faculty areas, using following five key indicators for academic reputation, employer reputation, and research strength to provide a full picture of program performance.

- **Academic Reputation:** This indicator assesses institutional standing within the academic community, capturing the quality of research, educational innovation, and societal impact. It is a core component of the Research & Discovery Lens and plays a pivotal role in the overall rankings.
- **Employer Reputation:** Central to the Employability Lens, this indicator evaluates the perception of an institution and its programs among employers. It is particularly valuable for

undergraduate students who seek employment soon after graduation, highlighting the employability of graduates in the job market.

- **Research Citations per Paper:** This indicator measures the impact and visibility of research, drawing data from Elsevier Scopus. A minimum publication threshold is set per subject, with both the threshold and weighting adjusted to reflect standard publication patterns in each discipline. It plays a vital role in the Research & Discovery Lens, showcasing the reach of institutional research.
- **H-Index:** This metric assesses both the productivity and impact of faculty by measuring the number of highly cited publications. As part of the Research & Discovery Lens, it captures the influence and consistency of an institution's research output, contributing significantly to overall rankings.
- **International Research Network (IRN):** This indicator reflects an institution's ability to build a geographically diverse research network through sustainable international partnerships. As a primary measure within the Global Engagement Lens, the IRN score provides insights into the institution's global research footprint.

The Engineering & Technology faculty area, for example, applies the following indicator weights to ensure a balanced and relevant ranking:

Faculty Area	Indicator/Weight				
	Academic	Employer	Citations	H-Index	IRN
Engineering & Technology	40%	30%	10%	10%	10%

These weights reflect the importance of both academic and employer perceptions, balanced with research productivity and international engagement, ensuring that the rankings are aligned with the demands and expectations of the Engineering & Technology field.

Source : <https://www.topuniversities.com/subject-rankings/methodology>