

Scaling Technology Workforce: Experiences in Coordinating and Teaching Online Cyber Security and Blockchain Programs

EduHiPC'25 Keynote

Sandeep Kumar Shukla

IIIT Hyderabad





Agenda

- India's Demographic Dividend -- Projections vs. Actualization
- Needs and Opportunities of High Tech Skilling and Education
- Need for Human Skill Centric Education and Skilling
- Role of Online Education and Skilling
- Our Experiences in online Education and Skilling in
 - Cyber Security
 - Blockchain Technology

Golden W

INDIA'S DEMOGRAPHIC WINDOW



D
ag



Th
ar

START

PEAK

END



2011

2020-2030

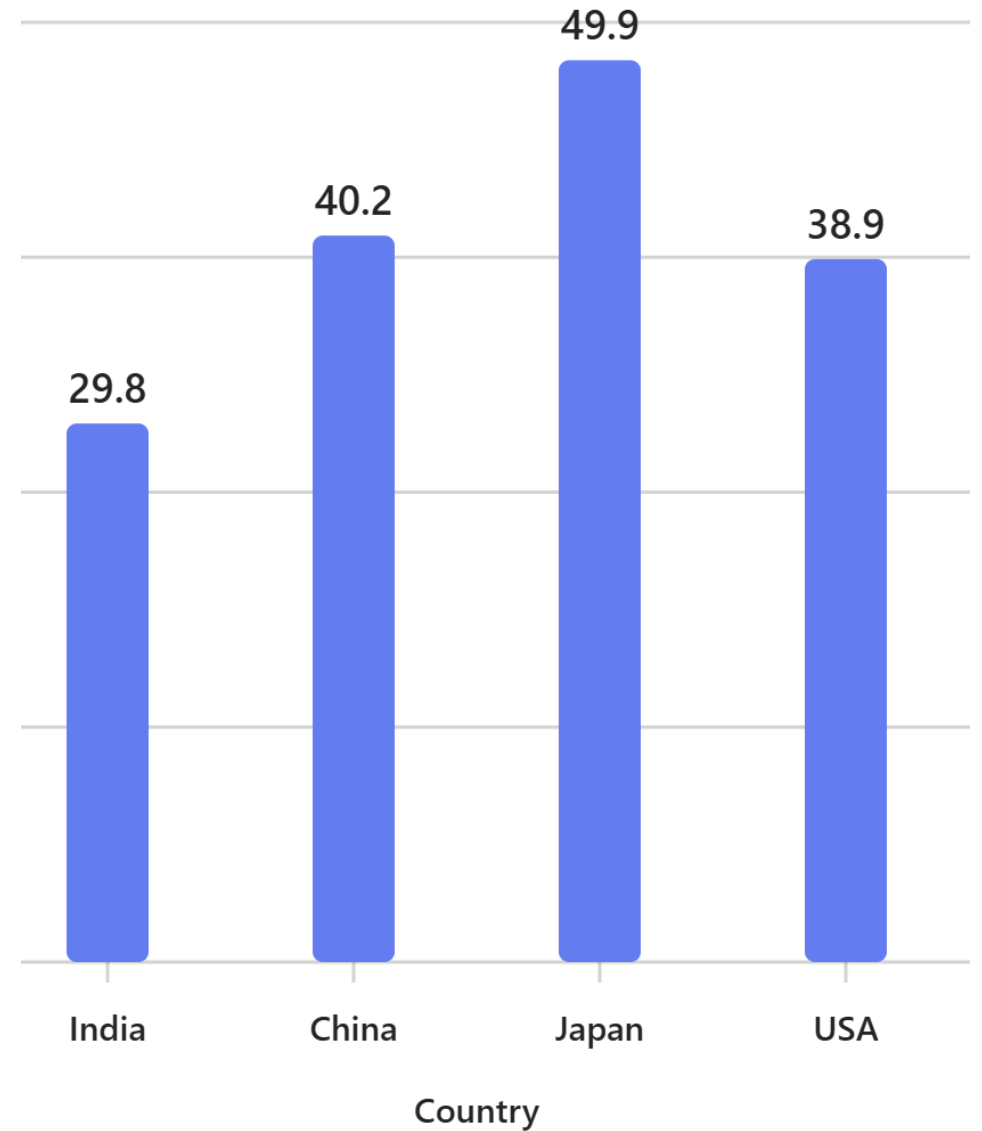
≈2041

**CRUCIAL PERIOD
2020-2030**

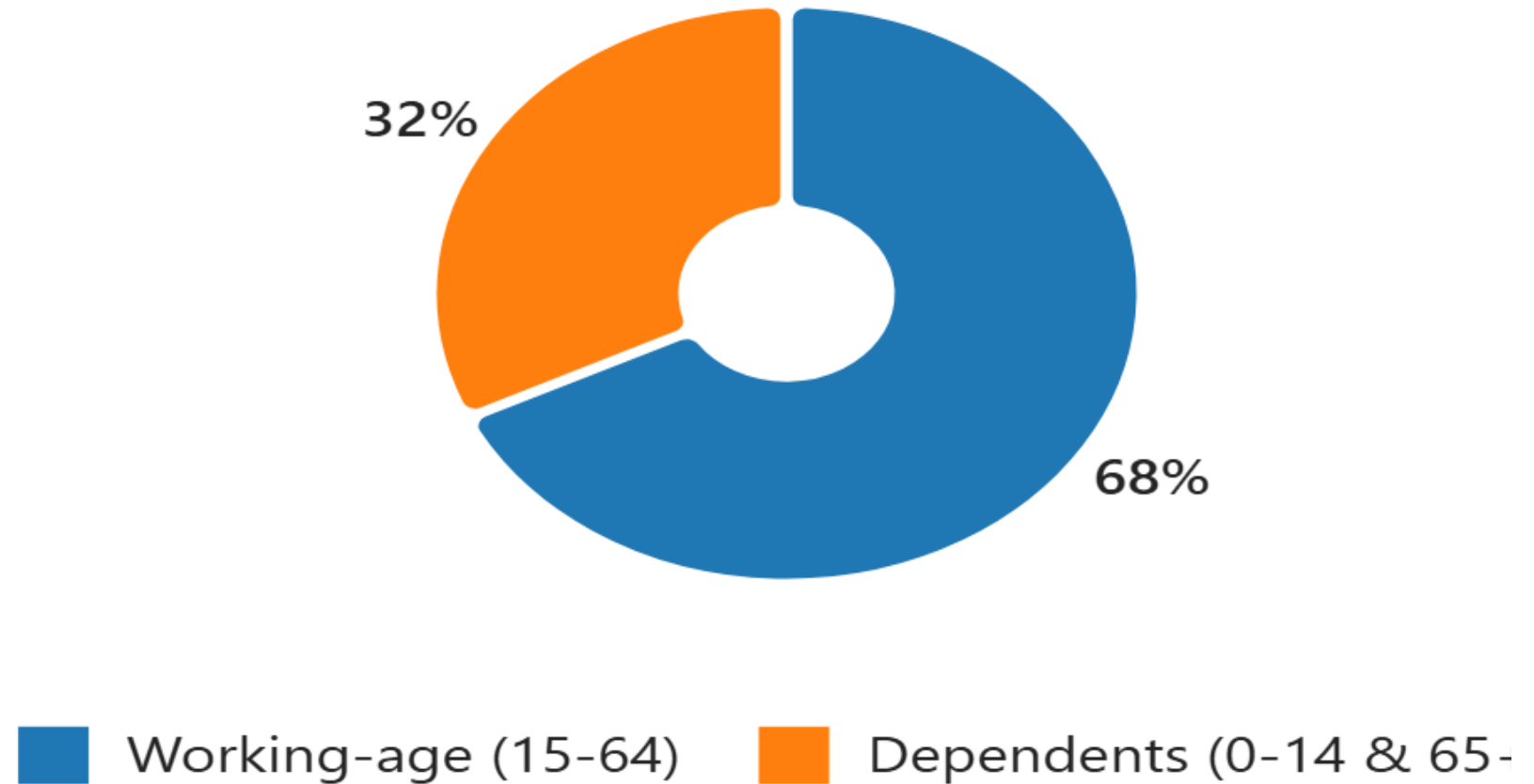
ulation's
nger than

ound 2041

MEDIAN AGE COMPARISON ACROSS COUNTRIES IN 2025



India 2025: Working Age vs. Dependent Age

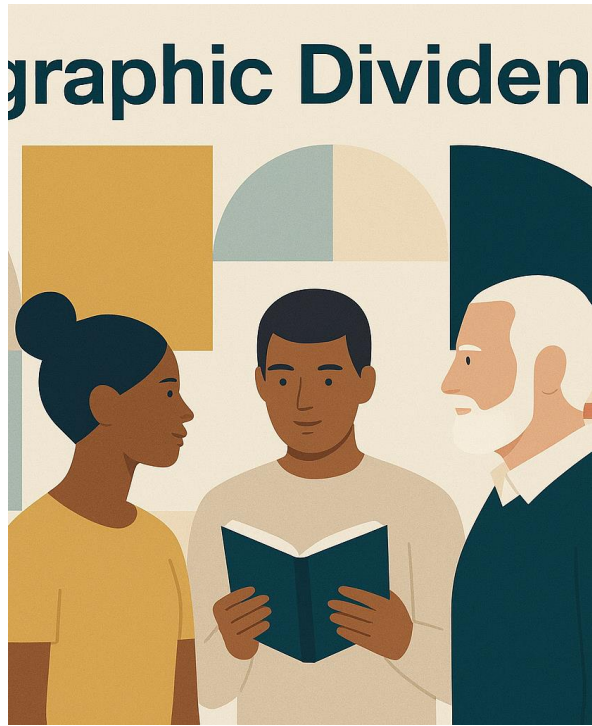




India's Expected Contribution to Global Workforce

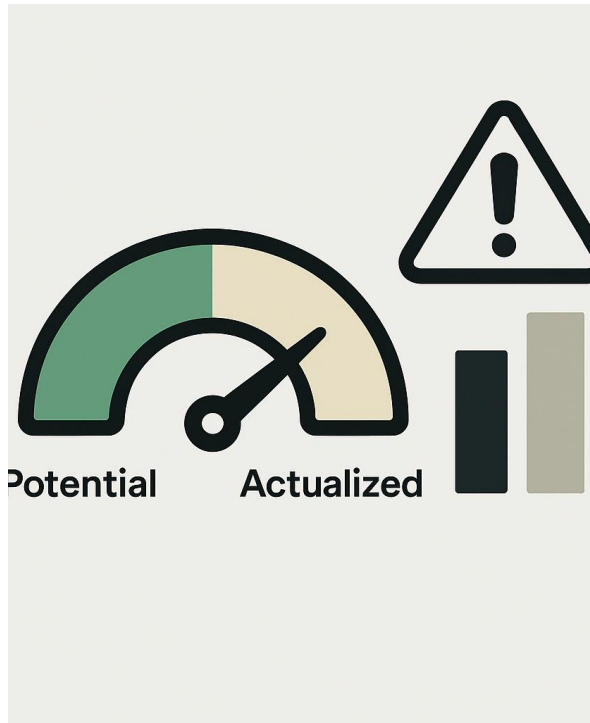
24.3% of the incremental global workforce over the next decade is projected to come from India.

Expected Demographic Dividends



- **Higher GDP Growth:** Projections suggested an addition of 2 percentage points per annum to per capita GDP growth over two decades
- **Increased Savings & Investment:** Fewer dependents were expected to lead to higher household savings, funding domestic investment.
- **Consumption Boom:** A large, young workforce with disposable income driving Private Final Consumption Expenditure (PFCE). (PFCE grew at a CAGR of 11.3% vs. Nominal GDP growth of 10.6% over the last decade).
- **Global Skill Hub:** India was expected to solidify its position as the largest provider of human resources globally, especially in STEM fields.

Dividend Actualization Gap



- **Lower GDP Impact:** The demographic dividend's contribution to GDP per capita growth in recent decades has been lower than peer Asian countries and is already tapering (0.7% annually).
- **Job Creation Lag (The Big Concern):** The rate of job creation is insufficient to absorb the 12-15 million people entering the labor force annually.
 - **Data Point:** In 2022, youth accounted for 83% of the country's total unemployed population.
- **Skill-Employability Mismatch:** Despite a large pool of graduates, many lack the requisite skills for modern, productive jobs.
 - **Data Point:** Surveys indicate a significant percentage of engineering graduates are "unfit" for software development roles.

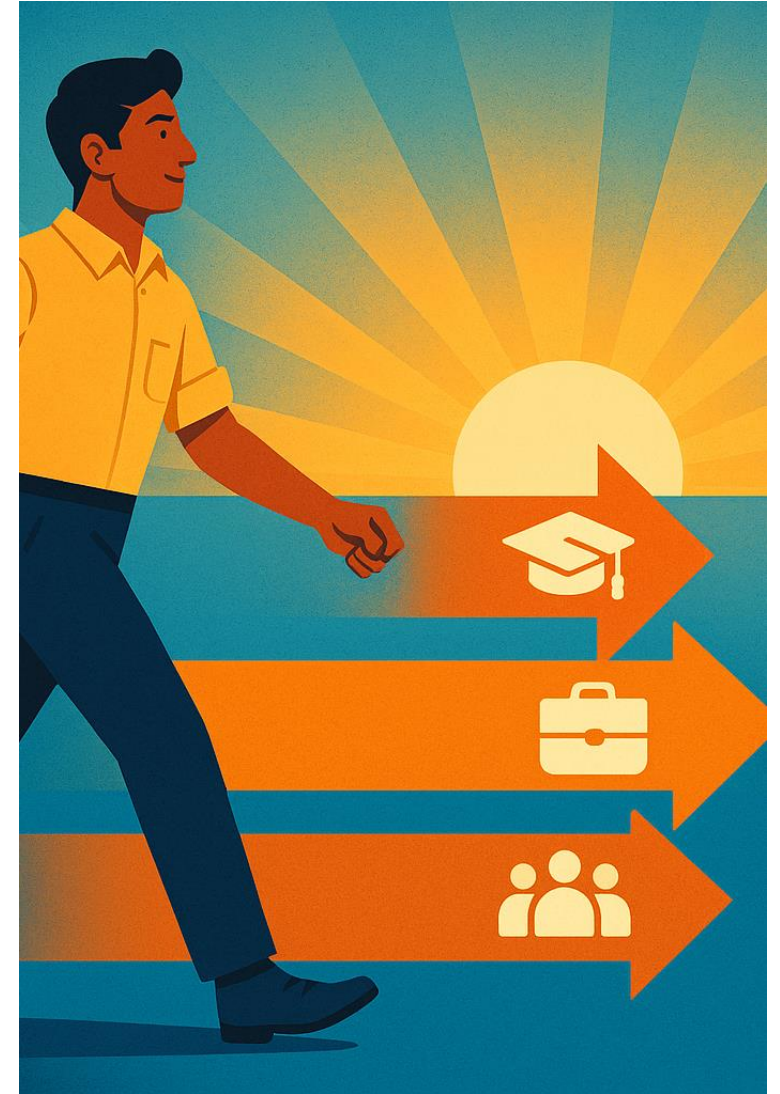


Bottleneck to full Potential

- **Skills & Education Gap:** Low overall literacy compared to peers (India 75%, China 97%).
 - Curriculum lag and poor practical training fail to meet industry demands.
- **Low Female Labor Force Participation (FLFP):** India's FLFP is low **32.8%** compared to the global average **47%**
- **Regional Disparity:** The dividend is not uniform
 - Southern and Western states are aging faster with lower fertility, while Northern and Eastern states still have a high youth bulge but often lag in social indicators (health, education).

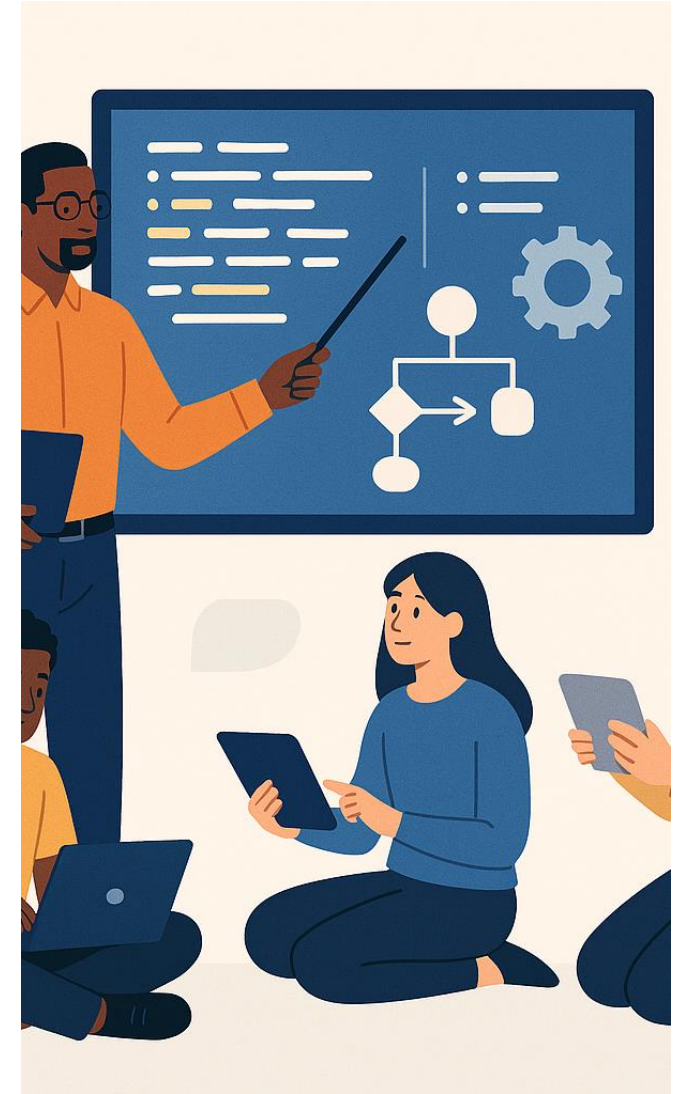
Reaping the Remaining Dividend

- Policy Imperatives (The 'To-Do' List):
 - **Massive Investment in Human Capital:** Prioritize quality Health, Education, and Skill Development (HE&S) with a **focus on job-relevant and future-ready skills (AI, Cyber Security, Green Energy, etc.)**.
 - **Accelerated Job Creation:** Focus on policies that boost labor-intensive manufacturing and high-value services to create productive employment outside of agriculture.
 - **Empowering Women:** Implement targeted policies to significantly increase the Female Labor Force Participation Rate.
 - **Targeted Regional Strategy:** Develop differentiated policies for states based on their specific demographic phase (aging vs. youth bulge).



The role of a Computer Science Educator

- Need to create the curriculum relevant to the required skills
- The world is changing; technology is rapidly evolving - skills required are changing
- Deliver skilling and education at scale with effectiveness
- Deliver innovation and entrepreneurship education
- Deliver Human Skills Centric Skilling and Education





Human Skill Centric Education

Human Skills Unmatched by AI

Creativity, empathy, and judgment remain difficult for AI to replicate, making human skills vital for innovation and leadership.

Adaptability and Agility

Human-centric skills enable individuals and organizations to adapt swiftly to technological and economic changes.

Foundation for Sustainable Progress

Investing in human skills supports economic recovery, innovation, inclusive growth, and social cohesion.

Key Human Skills in 2030

Analytical and Creative Thinking

Analytical thinking enables informed decision-making, while creative thinking drives innovation and effective problem-solving.

Resilience and Adaptability

Resilience helps individuals adapt to change and thrive in volatile environments across diverse industries.

Curiosity and Lifelong Learning

Curiosity fuels continuous growth and readiness for emerging challenges through lifelong learning.

Leadership and Social Influence

Effective leadership guides teams through transformation and uncertainty, fostering collaboration and trust.



Employer Demand vs. Workforce Readiness

Demand for Human-Centric Skills

Employers highly value collaboration, creativity, and resilience as essential skills for the workforce.

Workforce Skill Gaps

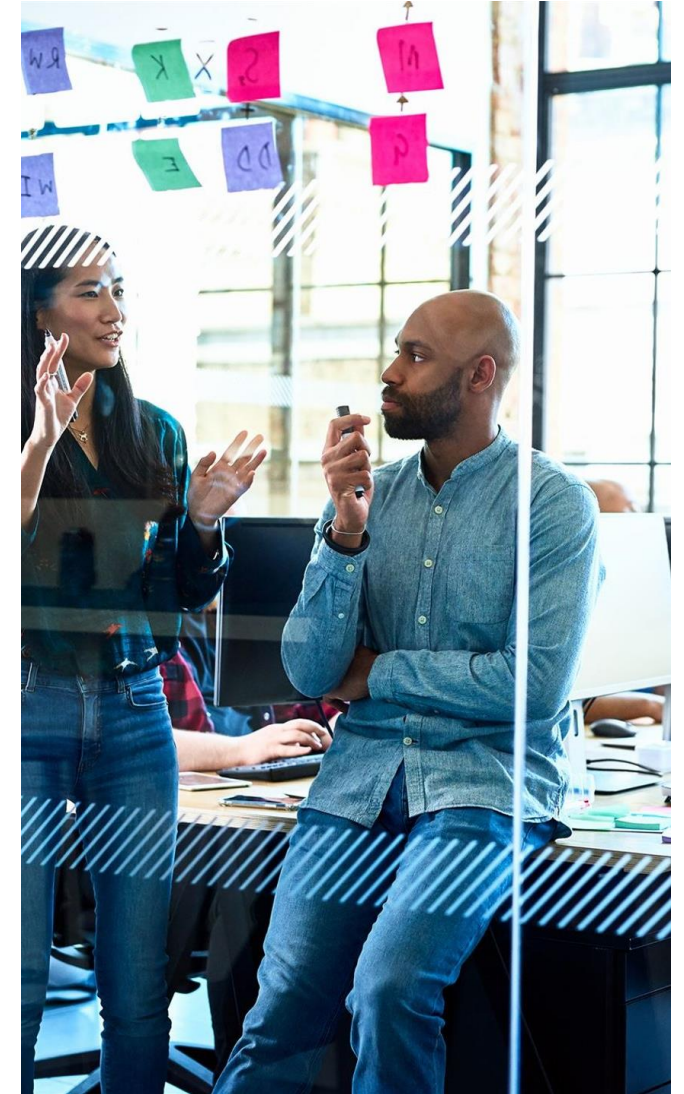
Many workers lack proficiency in key skills, with curiosity and lifelong learning notably underdeveloped.

Need for Targeted Interventions

Education and workplace training interventions are urgent to prevent skill shortages affecting innovation.

Collaborative Solutions

Partnerships between governments, businesses, and educators are key to embedding human-centric skills.



Fragility and Recovery of Human Skills

Sensitivity of Human Skills

Human-centric skills are vulnerable to external shocks and declined significantly during the COVID-19 pandemic.

Resilience in Empathy and Listening

Empathy and active listening showed resilience, driven by increased demand for connection in crises.

Recovery through Safe Environments

Structured practice and psychologically safe environments help recover and strengthen human skills.

Importance of Continuous Development

Embedding human skills into culture and continuous development secures long-term workforce adaptability.





Global Principles for Developing and Credentialing Skills

Innovative Skill Assessment

Assessment methods should capture adaptive thinking and real-world skill application using AI simulations and digital portfolios.

Experiential Skill Development

Safe environments for experimentation and reflection support skill growth through role-play and challenge-based projects.

Trusted Credentialing Systems

Credentialing should ensure portability and trust via digital badges and blockchain-secured records for global recognition.

Global Standards and Interoperability

Shared standards prevent fragmentation and enhance credibility across education and workplace training systems worldwide.

Innovative Models for Human Skills Development

AI-Powered Simulations

AI-driven simulations create safe, scalable environments for developing technical and interpersonal skills simultaneously.

Digital Credentialing

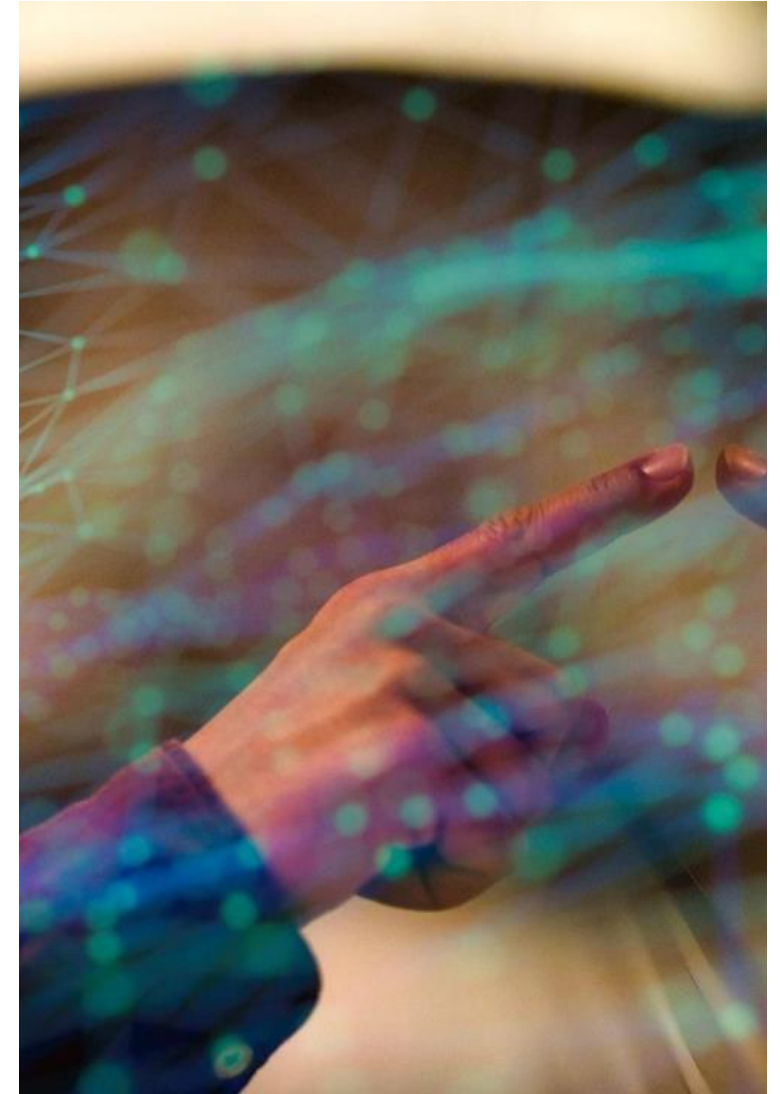
Digital badges recognize and validate inclusive behaviors and human-centric skills integrated into performance systems.

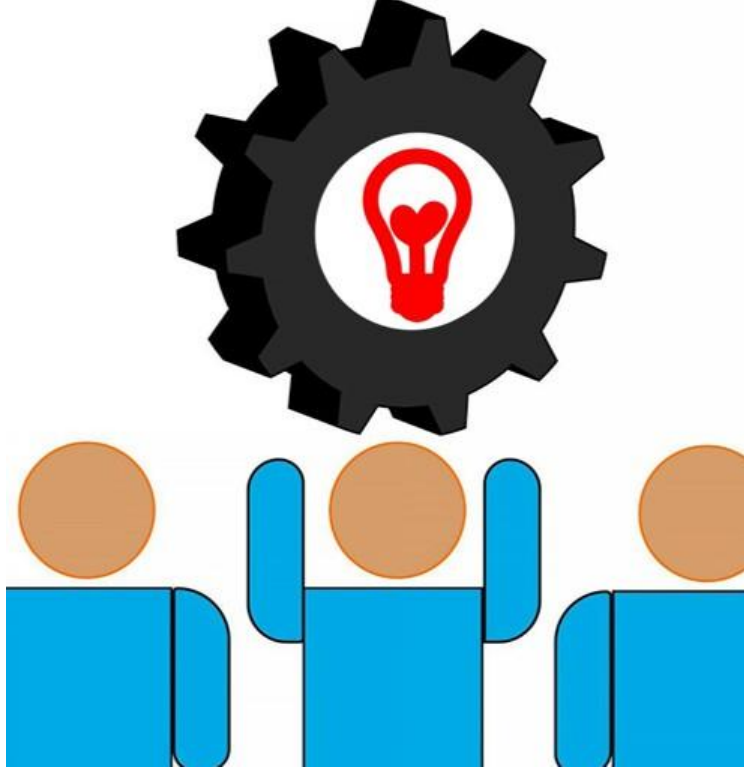
Challenge-Based Learning

Challenge-based learning prepares students for real-world problems with competency assessments and digital portfolios.

Adaptive Role Play

Adaptive AI role play offers personalized practice in communication and leadership in psychologically safe settings.





Investing in Human Skills for Future Growth

Human-Centric Competitive Edge

Human skills offer a true competitive advantage in a world of technological disruption, fostering economic resilience.

Systemic Education Reforms

Education and training systems must reform to prioritize human-centric skills and responsible technology use.

Equity and Shared Standards

Equity, shared standards, and supportive conditions are essential for embedding human skills in societies.

Sustainable Growth and Prosperity

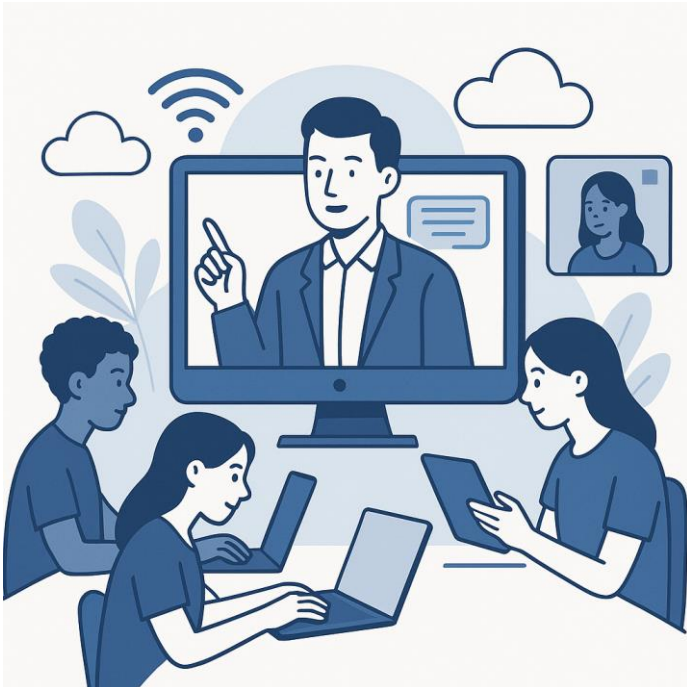
Investing in human skills ensures sustainable, inclusive growth where technology supports humanity.



How does online Skilling and Education Measure up?

- **Online Education/Skilling:** Delivery of structured learning content through digital platforms, accessible via the internet.
- **Key Features:**
 - Virtual classrooms and interactive sessions
 - Multimedia resources (videos, simulations, e-books)
 - Flexible schedules and self-paced learning
- **Purpose:** To provide academic knowledge and credentials remotely, bridging geographical and time constraints.

Introduction to Online Education and Skilling



Flexible Online Education

Digital platforms deliver structured academic programs, enabling remote learning with virtual classrooms and interactive resources.

Practical Online Skilling

Short courses and certifications focus on job-ready skills to meet evolving industry demands, including technology and AI fields.

Accessibility and Lifelong Learning

Affordable and convenient, online education promotes inclusivity by enabling learning anytime, anywhere for all ages.

Workforce Innovation

Organizations invest in online skilling to stay competitive, fostering innovation and workforce development globally.



Market Size and User Growth of Online Degree Programs

YEAR	MARKET SIZE (USD BILLION)
2015	107
2023	316
2025	203.8
2029	279.3

Corporate Training and Revenue Breakdown

SEGMENT	REVENUE (USD BILLION, 2025)
Online Learning Platforms	56.7
University Education	85.5
Professional Certificates	4.7

Trends and Projections

Market Growth Projections

E-learning market is projected to reach \$400 billion by 2026 and over \$1 trillion by 2032, showing rapid expansion.

Technology Integration

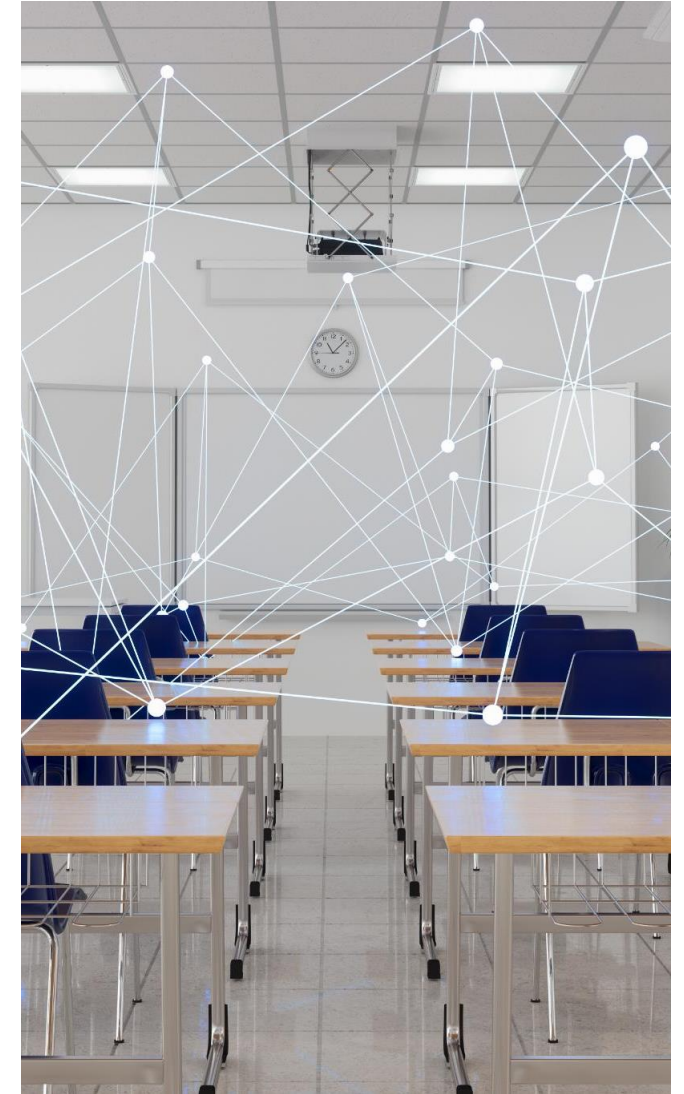
Advanced technologies like AI, AR, and VR are increasingly integrated into e-learning platforms enhancing user engagement.

Regional Market Variations

North America leads with 41% revenue share, while Asia-Pacific and Latin America show rapid adoption due to accessibility.

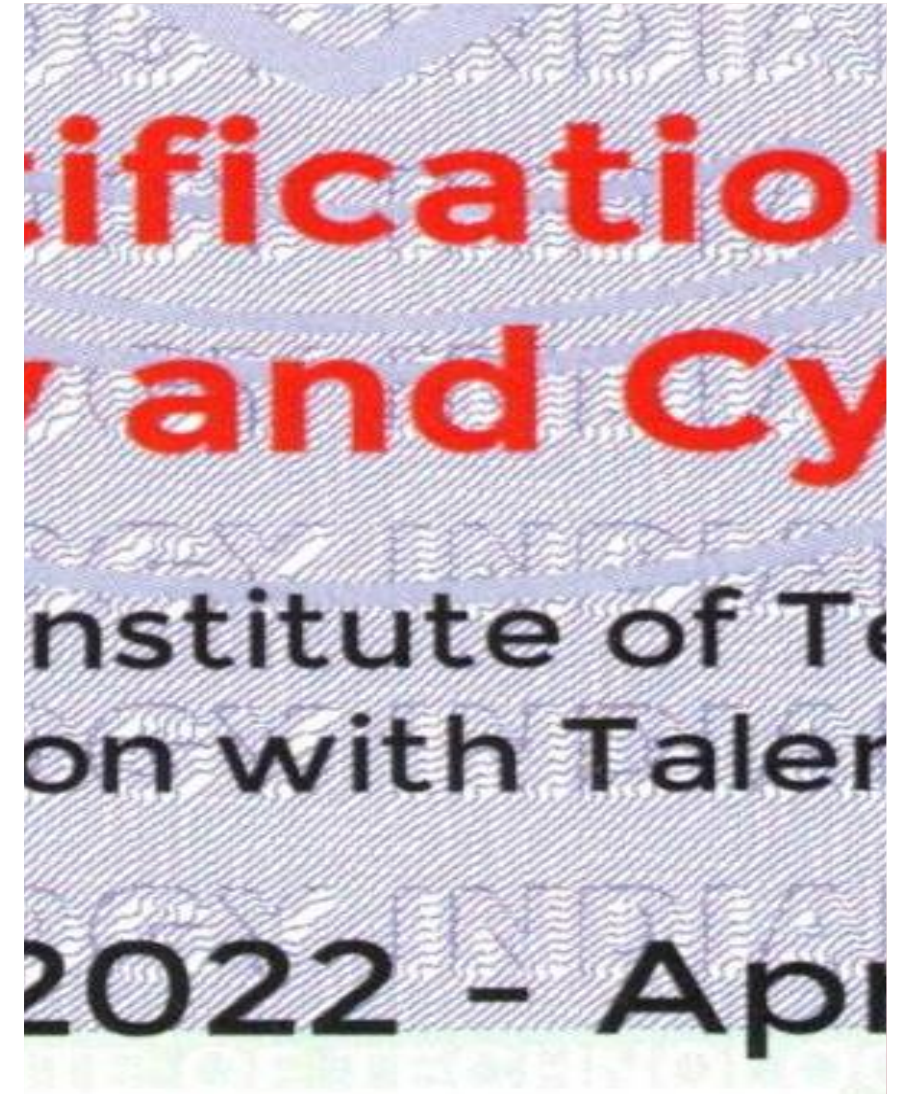
Future Learning Trends

Personalized learning, micro-credentials, and immersive technologies will shape online education's future and engagement.



Our Experience

- Online Degree Programs
 - E-Masters in Cyber Security
- Online Certification Programs
 - Fully Engaged Mode
 - CSCD Program
 - Partially Engaged Mode
 - Red-Teaming Certification
 - Blockchain Technology and Application Certification
 - Online Mass Education through Swayam/NPTEL
 - Blockchain
 - Cyber Security



E-Masters Program



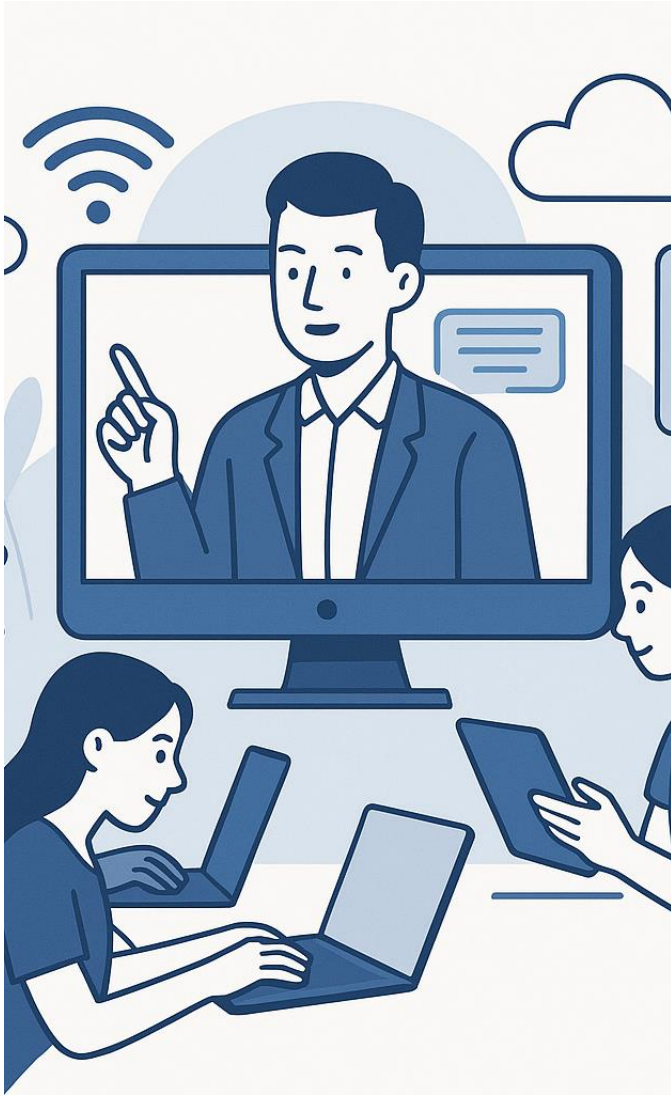
4 Cohorts – about 50 students each

The students were all experienced IT professionals (between 2 years to 30+ years but on average 6-10 years experience)

12 modules each consisting of 20 hours of pre-recorded lectures and 8 hours of live Q & A sessions during weekends for 8 weeks

A module duration was 3 months – each week a 2.5 hours of pre-recorded lecture was released, followed by 1 hour interaction during weekend. The last month was for exams

Each week, a quiz or a homework was released for online submission



CSCD program

A certificate program starting in 2020 February, and until September 2025, 10 Cohorts

Each Cohort had about 60 students

Students were between 1 to 10 years experienced in the IT field with rare exceptions

6 hours of live lectures every weekend (4 hours Saturday, 2 hours Sunday)

A Quiz online every Sunday

Homework projects at least 2 to 3

A CTF challenge ran throughout the semester as they learn newer skills

A virtual lab on the cloud with more than 40 challenges were available to exercise their skills and gain additional points

A Capstone group project culminating in a final demo and presentation

Final score took attendance in live lectures, quizzes, capstone projects with highest weights followed by scores in CTF, Virtual Labs, and Homework Projects

Simplilearn Red Teaming Certification



7 months duration – Master Class model



I designed the curriculum but classes, hands on, virtual lab and projects were administered by the Simplilearn Trainers



Every month, I did a master class for 2 hours over weekends



Also had overlapping cohorts – admitting a new cohort every month or two months



Low visibility on student progress

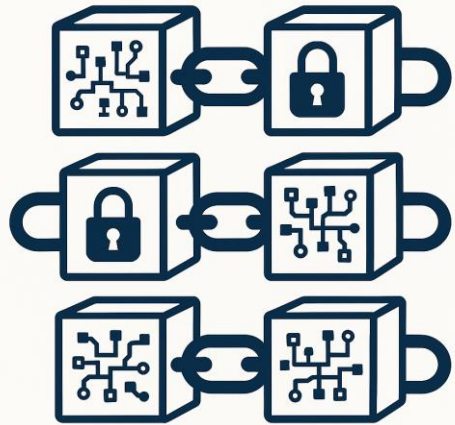


Low visibility of the level of the students present during the master class (mixture of lagging and leading cohorts)



Certification was a participation certificate and not a qualification certificate

Simplilearn Professional Certificate on Blockchain Technology and Applications



- 20+ cohorts – with some cohorts having 100+ students in 2021 whereas by 2024 dropped significantly
- 20 hours of recorded lecture was made available to the students recorded at IIT Kanpur for our NPTEL course
- The curriculum was designed but delivery was through industry based trainers
- Capstone project was also delivered through the trainers
- Only monthly Master classes of 2 hours duration was from IIT Kanpur
- It worked well in the beginning – but towards the end around 2025 – the interests tapered off even though in 2024 I forced a curriculum revision

Flipped Classroom Teaching



In 2018, the Computer Systems Security course was taught in a flipped classroom model



The lectures were pre-recorded and released on every Monday and Wednesday\



Friday was the 1 hour live in person interactive session



The homework projects were released in equal intervals



Students hardly came for live sessions



Faculty at the end had very little familiarity with the students - even though almost 100 students enrolled



Decided to not repeat the experiment again

Conclusions

- Live online lectures with interactions is the best way to provide online education
- Own the curriculum, delivery fully – do not use third party to deliver the curriculum
- Know your students (for very large courses hard but not impossible)
- Encourage more students to interact during interaction sessions
- Find ways to reduce dishonesty – personalized homework (GenAI may help)
- Campus immersion would be good idea but may not scale well
- Other kind of interactions online beyond classroom teaching may be helpful
- EdTech companies are there to make money – not impart education or skills – so try to own your online programming