

# TECHNOLOGY-BASED EDUCATION

AND **21ST CENTURY SKILLS**

**REALIZING FLEXIBILITY IN GLOBAL LEARNING**



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## **TECHNOLOGY-BASED EDUCATION AND 21ST CENTURY SKILLS: REALIZING FLEXIBILITY IN GLOBAL LEARNING**

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### **1. Introduction: The Changing Landscape of Global Education**

The 21st century has ushered in a transformative era in which technology and education are inseparable. Learning is no longer confined to the walls of a classroom, nor limited by geography, time, or even language. The rise of digital platforms, artificial intelligence, and global connectivity has enabled a new paradigm of education—one that emphasizes flexibility, adaptability, and inclusivity. Technology-based education (TBE) thus becomes not merely an instrument of instruction but an ecosystem of interaction that fosters the development of *21st-century skills*: critical thinking, creativity, communication, and collaboration.

Globalization, coupled with rapid digitalization, has led to an increasing need for individuals who can thrive in complex, uncertain, and interconnected environments. Education must therefore evolve from rote learning and standardized testing to dynamic and context-sensitive learning that integrates technology as both a tool and a learning partner. The integration of digital technology into education is not merely an upgrade—it is a revolution that redefines what it means to learn, to teach, and to know in the global era.

This essay aims to explore how technology-based education can realize flexibility in global learning by cultivating critical skills for the 21st century. Through theoretical reflection, international case narratives,

and philosophical discussion, it highlights the role of technology as a driver of global collaboration, creativity, and cultural understanding.

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## **2. From Digital Access to Digital Fluency**

Early discussions on educational technology often revolved around *access*: providing computers to schools, connecting institutions to the internet, and ensuring digital equity. However, access alone does not guarantee learning. The challenge has evolved into *digital fluency*—the ability to critically use, adapt, and create technology to solve real-world problems.

Digital fluency encompasses more than technical proficiency; it includes cognitive and social dimensions. Learners must know how to analyze information, evaluate sources, and use digital tools ethically and creatively. For example, in Finland’s education system—often cited as one of the most progressive—students are taught “media literacy” as early as elementary school, integrating critical thinking with digital exploration. The emphasis is not on memorizing facts but on constructing meaning and producing digital artifacts that demonstrate understanding.

In the global context, digital fluency also implies cross-cultural communication competence. A student participating in a virtual exchange program must not only navigate digital platforms but also adapt to linguistic diversity, social norms, and ethical considerations. Thus, technology-based education expands the concept of literacy itself: it transforms literacy from reading and writing to *reading, writing, and coding*—a trinity of communication for the modern era.

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## **3. Flexibility as the New Educational Imperative**

Flexibility in education refers to the capacity of learners and institutions to adapt to new conditions, learning modes, and knowledge flows. In technology-based education, flexibility manifests through multiple dimensions: temporal (learning anytime), spatial (learning

anywhere), pedagogical (using diverse methods), and cognitive (adapting learning strategies).

### **3.1 Temporal and Spatial Flexibility**

Online learning environments, such as Coursera or edX, enable learners from Jakarta to study machine learning from Stanford University or entrepreneurship from the University of London. This spatial flexibility breaks traditional boundaries and democratizes access to world-class education. Temporal flexibility, meanwhile, allows asynchronous learning—students can progress at their own pace, review materials multiple times, and balance study with work or family obligations.

### **3.2 Pedagogical Flexibility**

Technological integration allows educators to employ diverse instructional strategies—flipped classrooms, gamified learning, project-based collaboration, and adaptive learning systems. These approaches cater to different learning styles and promote active engagement rather than passive absorption.

### **3.3 Cognitive Flexibility**

Cognitive flexibility involves the learner’s ability to switch between concepts, think across disciplines, and adapt to changing information landscapes. Technology supports this through simulation tools, scenario-based learning, and AI-driven personalization that challenges students to think beyond static frameworks.

In short, flexibility is not a mere byproduct of technology—it is the core value of modern education. It allows for resilience in times of crisis (as seen during the COVID-19 pandemic), and it aligns education with the dynamic nature of the 21st-century workforce.

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## **4. 21st Century Skills and Global Competence**

The 21st century demands a new blend of skills that combine knowledge, behavior, and values. The *Partnership for 21st Century*

*Learning (P21)* identifies four key pillars—known as the “4Cs”: **critical thinking, creativity, communication, and collaboration**. Technology-based education enhances each of these skills in unique ways.

#### **4.1 Critical Thinking**

Digital environments inundate learners with information. The ability to discern credible sources, evaluate evidence, and construct logical arguments is essential. Technology-based learning encourages critical inquiry through data analysis tools, online debates, and virtual simulations.

#### **4.2 Creativity**

Digital tools like design software, coding platforms, and multimedia editing expand creative expression. Learners can design prototypes, produce podcasts, or develop apps that solve local problems—transforming creativity from imagination into innovation.

#### **4.3 Communication**

Global platforms require students to communicate across languages and cultures. Video conferencing, collaborative documents, and digital storytelling tools foster multilingual and multicultural literacy, enhancing empathy and understanding.

#### **4.4 Collaboration**

Projects conducted via cloud-based platforms (e.g., Google Workspace, Microsoft Teams) allow students in different continents to co-create projects in real time. This mirrors global work environments and develops social-emotional intelligence crucial for cross-border teamwork.

Together, these competencies form the foundation for what UNESCO calls *global citizenship education*—a holistic approach that prepares learners to engage responsibly and constructively in an interconnected world.

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## **5. The Role of Teachers as Digital Facilitators**

In technology-based education, teachers evolve from knowledge transmitters to *learning architects*. Their role is to design experiences that guide students through self-directed discovery. Digital pedagogy demands educators who can curate, contextualize, and connect content to learners' real lives.

Teachers also model *digital ethics*—demonstrating responsible online behavior, data protection, and respectful communication. For example, Singapore's *Smart Nation Schools* program includes teacher-led modules on cybersecurity and online citizenship, ensuring that technology use is accompanied by moral discernment.

Moreover, teachers need continuous professional development in digital pedagogy. Global initiatives like *UNESCO's ICT Competency Framework for Teachers* encourage lifelong learning among educators, ensuring that teaching keeps pace with innovation.

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## 6. Technology as a Bridge for Global Collaboration

Technology transcends borders. It connects classrooms in different hemispheres, enabling cultural exchange and collaborative learning. Examples include:

- **eTwinning (Europe):** A European Commission program that connects schools across 43 countries to collaborate on shared projects—from climate change to cultural heritage—using digital platforms.
- **Virtual Exchange Programs:** The Stevens Initiative (funded by the U.S. Department of State) brings together youth from the Middle East, North Africa, and the U.S. for online dialogue and joint innovation projects.
- **Global Learning XPrize:** An initiative to develop open-source learning software that teaches literacy and numeracy to children in remote areas.

These initiatives demonstrate that technology-based education can foster not just academic knowledge but also intercultural empathy and shared global responsibility.

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## **7. Case Study: Indonesia's Digital Education Transformation**

Indonesia, with its vast archipelago and diverse population, exemplifies both the challenges and potentials of technology-based education. The *Merdeka Belajar* (Freedom to Learn) policy initiated by the Ministry of Education aims to empower schools with autonomy, creativity, and technology integration. The pandemic accelerated this transformation through platforms like *Rumah Belajar* and collaborations with tech companies such as Google for Education and Ruangguru.

### **7.1 Successes**

- Increased accessibility of educational materials in remote areas through mobile platforms.
- Expansion of teacher training in digital literacy.
- Growth of EdTech startups providing affordable, localized learning solutions.

### **7.2 Challenges**

- Unequal digital infrastructure between urban and rural regions.
- Inconsistent teacher readiness.
- The risk of reducing learning to “screen time” without reflective pedagogy.

Indonesia's journey illustrates that technology must be integrated with cultural context, ethical awareness, and social inclusion to achieve equitable flexibility in learning.

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## **8. Theoretical Frameworks: From Connectivism to Constructivism**

Technology-based education aligns closely with *connectivist* learning theory, proposed by George Siemens and Stephen Downes, which posits that learning occurs through networks of people, information, and digital systems. Knowledge is distributed, and learning is the process of connecting specialized nodes of information.

However, TBE also retains constructivist principles from Piaget and Vygotsky: learners actively construct meaning through social interaction and experience. Technology, in this sense, provides the scaffolding—digital tools, collaborative spaces, and multimodal content—that enable knowledge construction across contexts.

In the global classroom, connectivism and constructivism converge. Learning is both individualized and collective, structured yet open-ended—a dynamic ecosystem reflecting the complexity of modern knowledge.

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## **9. Challenges and Ethical Considerations**

Despite its promise, technology-based education raises critical concerns that must be addressed to ensure equitable and ethical learning.

### **9.1 Digital Divide**

Not all learners have equal access to reliable internet, devices, or digital literacy. Global education must prioritize inclusivity through affordable technology and community-based digital hubs.

### **9.2 Data Privacy**

Learning analytics, while useful for personalization, involve data collection that may compromise privacy. Policies like the EU's GDPR and UNESCO's recommendations on data ethics are essential safeguards.

### **9.3 Algorithmic Bias**

AI-driven education systems can perpetuate biases if datasets are unrepresentative. Ethical oversight and transparent design are crucial to prevent technological determinism.

#### **9.4 Overreliance on Technology**

Education must remain human-centered. Excessive dependence on technology can erode interpersonal skills, empathy, and critical reflection. Therefore, the goal is *techno-human harmony*, not replacement.

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### **10. The Future of Learning: Hybrid, Adaptive, and Human-Centered**

The future of education will be hybrid: blending digital and physical spaces, global and local contexts, human intuition and artificial intelligence. Adaptive learning systems will customize instruction, while immersive technologies—like virtual and augmented reality—will make abstract concepts experiential.

#### **10.1 AI Tutors and Personalization**

AI-powered tutors can assess learner performance in real time, offering feedback tailored to cognitive style. For example, Duolingo's AI dynamically adjusts exercises based on user behavior, while Coursera's algorithm recommends personalized courses.

#### **10.2 Metaverse and Immersive Learning**

The metaverse offers virtual campuses where students can experiment in simulated labs, attend lectures, or collaborate on 3D models. However, it requires careful pedagogical design to ensure depth, not distraction.

#### **10.3 Lifelong Learning and Micro-Credentials**

As job markets evolve, individuals will pursue *lifelong learning* through micro-credentials—short, stackable courses verified by digital badges. These portable certifications allow flexible re-skilling in the global economy.

### **11. Narrative Example: A Virtual Bridge Across Continents**

Consider a real-world narrative from the *Global Classroom Project* (2022), in which high school students from Indonesia, Canada, and Kenya collaborated virtually to design sustainable community solutions. Using video conferencing and shared online workspaces, they developed a project on “Smart Water Harvesting Systems.”

Students in Indonesia contributed local insights about rainwater management; Canadian students provided design expertise; Kenyan students applied field testing. Through virtual mentorship, they learned not only engineering concepts but also intercultural collaboration, empathy, and shared responsibility. This story embodies the transformative potential of technology-based education: knowledge without borders, learning beyond curricula.

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### **12. Pedagogical Innovation: From Passive to Participatory Learning**

Traditional education follows a *teacher-centered* model, where students passively receive knowledge. Technology-based education reverses this dynamic, promoting *learner agency* and *participatory learning*.

Tools like Padlet, Miro, and Canva enable collaborative creation, while Learning Management Systems (LMS) facilitate peer feedback and co-assessment. Gamification platforms such as Kahoot or Classcraft enhance engagement, blending entertainment with education. These innovations cultivate intrinsic motivation—a crucial ingredient for lifelong learning.

Moreover, participatory pedagogy nurtures *metacognition*—learning how to learn. Students become reflective thinkers who can self-assess progress, manage digital distractions, and engage with knowledge communities.

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### **13. Cross-Cultural and Global Citizenship Learning**

Technology-based education inherently exposes learners to diverse perspectives. Intercultural collaboration develops *global competence*, defined by OECD as the ability to “examine local, global, and intercultural issues, understand and appreciate the perspectives of others, and take action for collective well-being.”

Virtual exchange programs—such as *Soliya Connect* or *Global Nomads Group*—allow students from conflict-prone regions to engage in dialogue, reducing stereotypes and building empathy. Through shared projects, learners discover common challenges, from climate change to digital ethics, and co-create solutions grounded in mutual respect.

Thus, global learning is not merely about exporting Western models of education; it is about co-constructing knowledge that reflects pluralism, justice, and humanity.

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## **14. Policy Implications: Building a Global Learning Infrastructure**

For technology-based education to realize flexibility, it must be supported by robust policy frameworks at national and international levels.

### **14.1 Infrastructure and Investment**

Governments must invest in broadband connectivity, affordable devices, and open educational resources (OER). Partnerships between public and private sectors can expand reach and innovation.

### **14.2 Curriculum Integration**

Curricula should integrate digital skills, not as standalone subjects but as interdisciplinary competencies across science, humanities, and arts. Coding, ethics, and communication should be embedded from early education.

### **14.3 Global Standards and Recognition**

International accreditation systems for online courses—such as UNESCO’s Global Education Coalition—can ensure quality and facilitate credit transfer across borders.

#### **14.4 Educator Empowerment**

Policies must recognize teachers as innovators, providing incentives, digital training, and autonomy to experiment with pedagogy.

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#### **15. Reflection: Technology as a Humanistic Endeavor**

Technology-based education is often framed as a technological challenge—but fundamentally, it is a human project. The ultimate goal is not to create smarter machines but wiser humans. Technology must serve *human flourishing*—enabling individuals to think deeply, act ethically, and collaborate compassionately.

In this sense, flexibility in learning is also moral flexibility: the openness to listen, to adapt, and to evolve with others. It echoes Paulo Freire’s vision of education as the “practice of freedom”—a means to empower individuals to transform their world.

The 21st-century learner, therefore, is not just a digital native but a *global citizen*: one who navigates between cultures, synthesizes information critically, and contributes meaningfully to society.

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#### **16. Reflection and Discussion**

The global shift toward technology-based education compels us to rethink foundational assumptions about learning, teaching, and knowledge. Several reflective questions arise:

**1. How can flexibility coexist with academic rigor?**

Flexibility should not mean lowering standards but expanding pathways to mastery. Adaptive assessments and project-based evaluation can measure deep learning while allowing individual pace.

**2. What is the role of culture in digital education?**

Technology must respect local identities. A global platform that ignores linguistic diversity risks cultural homogenization.

Localization of content—through translation, context adaptation, and inclusive examples—is essential.

**3. Can artificial intelligence replace human teaching?**

AI can augment but not replace educators. The empathy, intuition, and moral guidance offered by teachers remain irreplaceable in shaping human character.

**4. How do we ensure equity in global learning?**

Equity demands intentional policies: subsidized internet access, inclusive design for differently-abled learners, and gender-sensitive approaches to technology.

**5. What does “success” mean in 21st-century education?**

Success is not solely academic achievement but the capacity to adapt, to collaborate, and to contribute meaningfully to global challenges.

As technology continues to evolve, the measure of progress will be not how efficiently we learn, but how ethically and inclusively we educate.

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## **Glossary**

<b>Term</b>	<b>Definition</b>
<b>Technology-Based Education (TBE)</b>	A learning approach that integrates digital tools, online platforms, and data analytics to enhance teaching and learning.
<b>Digital Fluency</b>	The ability to use, create, and evaluate digital technologies effectively and ethically.
<b>Flexibility in Learning</b>	The adaptability of learning systems to accommodate diverse needs, contexts, and learning styles.
<b>21st Century Skills (4Cs)</b>	Critical Thinking, Creativity, Communication, and Collaboration—core competencies for modern learners.
<b>Connectivism</b>	A learning theory that views knowledge as a network and learning as the process of making connections.
<b>Hybrid Learning</b>	A model combining online digital media with traditional face-to-face classroom methods.
<b>Global Citizenship Education (GCE)</b>	An educational framework promoting awareness, empathy, and responsibility toward global challenges.
<b>Micro-Credentials</b>	Short, stackable learning certifications recognizing specific skills or competencies.
<b>Lifelong Learning</b>	Continuous, self-motivated pursuit of knowledge for personal or professional growth.

<b>Term</b>	<b>Definition</b>
<b>Digital Divide</b>	The gap between those who have access to modern technology and those who do not.

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### **Closing Thought**

*“The flexible tree bends in the storm and survives; the rigid one resists and breaks. In the global economy, the same law of nature applies: those who adapt endure, those who learn lead, and those who lead with integrity transform the world.”*

— Rudy C. Tarumingkeng, 2025

## Reflection and Discussions

### ***On Technology-Based Education and 21st Century Skills: Realizing Flexibility in Global Learning***

*By Rudy C. Tarumingkeng*

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#### **1. Rethinking Learning in the Age of Digital Civilization**

Technology has transformed education from a local to a global enterprise. No longer bound by geography, students and teachers now participate in a *shared intellectual ecosystem*. The classroom has become a space without walls — a network of interconnected learners, each contributing knowledge, culture, and creativity.

Yet, this transformation demands reflection. What does it mean to *learn* in a world where information is ubiquitous? How do we cultivate wisdom in an era where data is abundant but discernment is scarce? The shift toward technology-based education must be accompanied by a renewed vision of *purposeful learning* — one that balances speed with depth, innovation with ethics, and global reach with local meaning.

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#### **2. The Human Core of Digital Learning**

While technology facilitates access, it cannot replace the *human experience* of learning. True education involves empathy, dialogue, and the pursuit of shared understanding. As Paulo Freire emphasized, education is the “practice of freedom,” not a process of consumption.

Teachers remain central as moral and intellectual guides. Their role is not diminished by technology but redefined: from lecturer to *learning designer*, from authority to *facilitator of discovery*. A teacher who integrates technology with compassion helps

students navigate the digital realm with critical awareness and ethical grounding.

Thus, the human element — curiosity, moral imagination, and relational intelligence — must anchor every digital innovation. Without this, education risks becoming mechanistic, detached, and devoid of meaning.

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### **3. Flexibility as a Pathway to Inclusion**

Flexibility in learning is not only a matter of convenience; it is a matter of *equity*. By allowing diverse learners to access knowledge in their own ways — asynchronously, remotely, or collaboratively — technology becomes an instrument of inclusion.

For students in rural Indonesia, Africa, or small island nations, digital education opens doors once closed by distance or infrastructure. Yet flexibility must go beyond infrastructure—it must include cultural, linguistic, and cognitive diversity.

A flexible education system adapts to human difference rather than forcing uniformity. It respects learners' contexts and allows multiple pathways toward mastery. This is the essence of *personalized global learning*: global in resources, local in relevance.

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### **4. The Ethics of Digital Learning**

As the digital classroom expands, ethical questions intensify. Who controls data? How are biases embedded in algorithms? How can we ensure that technology empowers rather than exploits?

Ethics in education must evolve to address these challenges. Students must learn *digital citizenship*: how to use information responsibly, how to respect privacy, and how to discern truth

from manipulation. Likewise, institutions must uphold transparency, fairness, and inclusivity in digital design.

A global learning ecosystem must be grounded in justice — technological justice that ensures all voices are heard, all learners are seen, and all data are protected.

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## **5. The Balance Between Innovation and Reflection**

The temptation of modern education is to chase every new tool or trend. Yet, wisdom lies in reflection — asking not only “*What can we do?*” but “*Why should we do it?*”

Innovation without reflection risks superficiality. Reflection without innovation risks stagnation. The future of education depends on maintaining this dialectical balance. Educators must integrate continuous experimentation with philosophical inquiry, combining *techne* (craft) with *sophia* (wisdom).

As learners engage with AI tutors, virtual reality labs, and global peer collaboration, they must also be guided to contemplate meaning: What kind of world are we creating? What kind of humans are we becoming?

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## **6. Global Citizenship and Collective Intelligence**

Technology has turned humanity into a collective brain — millions of minds interconnected through digital synapses. But the question remains: will this network produce collective *wisdom* or collective *noise*?

Global learning platforms offer the potential for empathy, shared problem-solving, and planetary consciousness. When students from Indonesia collaborate with peers in Finland or Nigeria, they don’t just exchange facts; they exchange worldviews. Such collaboration cultivates *intercultural competence*, a cornerstone of 21st-century citizenship.

However, collective intelligence requires humility — the willingness to listen, to unlearn, and to co-create knowledge beyond cultural egocentrism. Technology can unite us, but only humanity can make that unity meaningful.

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## **7. Lifelong Learning and the Evolving Self**

In a world where skills evolve faster than institutions, *lifelong learning* becomes not just a career necessity but a moral imperative. The learner of the future is a *self-evolving being*: adaptable, reflective, and globally minded.

Technology enables continuous learning through micro-credentials, online communities, and self-paced modules. Yet the deeper transformation is existential. Lifelong learning nurtures humility — the recognition that knowledge is never finished, that growth is perpetual, and that learning is an act of faith in one's potential and in humanity's shared progress.

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## **8. Lessons from the COVID-19 Pandemic**

The COVID-19 pandemic served as a global laboratory for flexibility in education. Overnight, schools migrated online, revealing both the promise and the fragility of digital systems. Some students flourished in the autonomy of remote learning; others struggled with isolation and inequity.

The lesson is clear: flexibility must be designed, not improvised. It requires resilient infrastructure, digital pedagogy, and emotional support systems. The pandemic revealed that education is not merely about transferring content — it is about sustaining connection, meaning, and community in times of uncertainty.

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## **9. Technology and the Philosophy of Hope**

In the philosophy of education, hope is a generative force. Technology, when aligned with humanistic values, can become a *technology of hope* — empowering learners to imagine better futures and to act upon them.

The challenge is to prevent technological determinism — the belief that technology itself dictates destiny. Instead, we must reclaim technology as an ethical choice, a creative expression of human agency. Every digital classroom, every virtual dialogue, becomes a site of possibility: a place where humanity reinvents itself through learning.

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## **10. Concluding Reflection: Toward a Flexible, Ethical, and Human Future**

Education in the 21st century stands at a crossroads between speed and depth, between information and wisdom, between global networks and personal meaning. Technology-based education offers unprecedented opportunities to expand human potential — but only if guided by ethics, empathy, and equity.

Flexibility, then, is not just a structural principle; it is a *philosophy of education* — a commitment to adapt, to include, and to evolve with integrity. It is about enabling every learner, anywhere, to grow intellectually and morally within a connected world.

The global learning ecosystem of the future will not be built solely by machines or algorithms. It will be built by educators, learners, and leaders who believe that technology is most powerful when it serves humanity — when it enhances our capacity to think critically, act compassionately, and live responsibly in an ever-changing world.

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## THE HUMAN JOURNEY IN GLOBAL LEARNING



**In essence:**

“Technology gives us tools; education gives us meaning. Together, they create not only smarter learners but wiser humans.”

— *Rudy C. Tarumingkeng, 2025*

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