Learning beyond the classroom

The goal of engineering education is to produce thoughtful, ethical problem-solvers, writes BITS Pilani Group VC and former IIT Delhi director

V Ramgopal Rao

In every age, engineering has been the engine of transformation. From steam engines to silicon chips, each wave of innovation has brought with it a shift in how we teach and how we learn. But the current shift we are witnessing is more than technological. It is philosophical. It is no longer about teaching students how to solve known problems. It is about preparing them to define problems that do not yet exist.

As emerging technologies like artificial intelligence, quantum computing, synthetic biology, space tech, and advanced materials blur the boundaries between disciplines, engineering education cannot remain confined to rigid specialisations or chalk-and-talk methods. A future-ready engineer will need not only disciplinary depth but also the agility to move across domains.

The traditional model of lecture-heavy instruction and end-term evaluation is being rapidly replaced by more dynamic, outcome-focused frameworks. Industry 4.0 demands Education 4.0.

The curriculum must move from theory-heavy to application-rich. Laboratories must evolve into innovation studios. Internships must grow into structured engagements with real-world outcomes. And assessments must reward problem-solving over rote memorisation.

Learning by doing

The one principle that cuts across all these changes is that of "learning by doing".

Whether it is through undergraduate research, interdisciplinary project-based learning, startup incubation, or practice school internships, engineering students must be immersed in environments where failure is a stepping stone and iteration is the norm. At BITS Pilani, we are strengthening experiential learning pathways through a combination of curriculum reform, stronger industry engagement and new-age infrastructure across our campuses.

Our goal is to prepare graduates who can hit the ground running. Not just with skills, but with context. With the ability to think critically, adapt quickly and work collaboratively. This also means investing more in faculty upskilling.

The best teachers are not just subject experts. They are mentors, collaborators and lifelong learners themselves.

Building systems thinkers

In the past, one could be a mechanical engineer or an electrical engineer. Today, even designing a simple drone involves understanding aerodynamics, embedded systems, control theory, AI algorithms, and even ethical deployment.

The 21st-century engineer is not just a technician. They are systems thinkers. They need to understand not only how a technology works but why it should be built, who it serves, and what unintended consequences it may bring.

That's why curricula must encourage multidisciplinary thinking. AI should not just be a course for computer science students. Mechanical engineers need it for predictive maintenance. Civil engineers need it for smart city designs. Bioengineers need it for drug discovery. We must move away from rigid departmental structures to flexible learning pathways that allow students to shape their own learning journeys.

Digital tools, human values

While Gen AI and virtual labs are revolutionising how we teach, we must not lose sight of what we are teaching for.

The goal of engineering education is not to produce code-writing machines. It is to produce thoughtful, ethical problem-solvers. Technology is just a tool. The human values that guide its use matter even more.

This is especially important as we see a growing wave of mental health concerns among students. The pressure to perform, the fear of missing out, and the constant comparison through social media are all taking a toll. We need to build kinder institutions. Ones that value well-being as much as rankings. Ones that provide psychological safety along with intellectual challenge.

Equity & access in digital age

The National Education Policy has rightly emphasised flexibility, lifelong learning, and digital delivery. But access must go hand in hand with excellence. A future-ready India needs both. With only around 27 percent gross enrollment in higher education, we cannot afford to keep quality education confined to a few campuses.

This is where initiatives like BITS Pilani Digital can help bridge the gap. By offering rigorous, flexible, and modular learning pathways to students across geographies, we can create a more inclusive and diverse learning ecosystem. Our focus should be on expanding access without diluting standards. And that's a solvable problem with the right use of technology, partnerships and pedagogy.

Call to industry, policymakers

Higher education institutions alone

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cannot carry the burden of transformation. Industry must become an equal partner in shaping curriculum, mentoring students, funding research and co-creating skilling opportunities. Policymakers must enable this with flexible regulatory frameworks, ease of doing research and support for faculty development.

Engineering education is not just about supplying manpower. It is about shaping mindsets. The kind of mindset that will not only build India's first semiconductor fab but also solve its rural water problems. The mindset that can navigate complexity with clarity and design with empathy.

As we prepare for the India@2047 vision, we must see engineering not just as a profession, but as a purpose. One that empowers students to dream boldly, design wisely and deliver responsibly. ◉

V Ramgopal Rao is the group vice-chancellor for BITS Pilani institutions and former director of IIT Delhi