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Technology in the Classroom: What are we looking for?

Abstract

This paper presents a critical account of the role of ICTs in meeting the need of universalization of quality education in India. It also emphasises the potentials of technology interventions in classrooms.

The New Technomania

In recent times, there is a big buzz on the use of technology in education. The discussions during the last two years on the Draft New Education Policy (in the process of making) referred repeatedly to the potential of technology towards solving many of the outstanding problems of education in India. The TechVision 2035 document of the Government of India privileges and centralizes "*the role of Information and Communication Technologies (ICT) in meeting the need of Universalization of Quality Education in India"*. Invariably, certain premises seem to be at work in such discussions:

- ICT can help overcome the serious problem of lack of "quality teachers" by providing direct access to "quality presentations" via video and other modes, perhaps with recourse to MOOCs (Massive Open Online Courses). [Consider the success of Khan Academy videos.]
- ICT would help easy access to information from a wide range of sources, thus liberating the student from dependence on teachers and textbooks.
- ICT would dissolve the boredom that hangs heavy over classrooms, make the classes more interesting.
- The new generation of children love technology, take to it easily; it is only teachers who find technology threatening, and this is all that is "holding us back".

While not all of these premises operate at equal strength in every discussion, there is an undercurrent of discourse built on such axioms. There is an element of truth in every such assertion, mixed with many problematic attitudes, and untangling the mess can be challenging, especially when governments and public opinion shout out such claims as facts. But before we discuss these assertions on ICT, we need to raise a point of order.

Technology Does Not Mean ICT

If this is stating the obvious, then it seems to be necessary to state the obvious, and to state it loud and clear. Reading any of the education policy documents or the TechVision document, one would be pardoned for assuming that technology in education only means the use of ICT and the setting up of "*smart classrooms*". One thinks, using technology is only about bringing Internet connectivity into class, and the use of multi-media, videos and hyperlinked material, so that distant voices can beam down content, and textbooks are replaced by the extensive knowledge available easily on the World Wide Web. Rarely does one see mention of technology in education refer to lathes, foundry or good old agriculture.

A similar equation of all technology with ICT is often found among critiques of technology use in classrooms. Typically, the dangers of the Internet, especially for young children, is emphasized, and with good reason: the recent disasters with the Blue Whale game underline such dangers. Another criticism is about the seductive nature of technology, again especially for the young ones, getting them hooked to fast moving images that deter sober reflection. The television has amply demonstrated how passive it can make children, and it is not a stretch to accuse 'educational technology' of similar pitfalls as well. Again, these critiques implicitly accept the equation of technology and ICT, perhaps as a backlash to the technomaniacs. Indeed when ICT is being pushed as a major "solution", such response is perhaps reasonable. Yet, we do need to examine underlying assumptions, and build our arguments on sound reasoning.

The Questions We Need to Ask

If we are to speak of technology in education, what should be our understanding of technology ? What should be the attitude to technology in our curriculum, and teaching/learning practices ?

Some years ago, inteacting with a group of 10-year olds, I met a boy named Manikandan who told me he wanted to grow up and become a scientist. When questioned, he said he wanted to build *idly-making machines*. It turned out that this child was from a single-parent family in which the mother was making a living running an idly-shop at a bus stand (a familiar sight to Tamilians). It is natural for this boy to have such an ambition. The question is: what is the probability that he would get to build such a machine, the chances that he would develop the technological capability for it ? For a moment, assume that he does extraordinarily well in his exams, gets through the Joint Entrance Examination of our Indian Institutes of Techhnology. Would the best technology education in the country be able to develop in him this capacity ? (More likely, if he got there, woud he even want to build idly machines ?)

The education that Manikandan receives in school does not address technology and its nature. School typically teaches Manikandan to see technology as given, (as a potential consumer), and not anything he can participate in. Science education is compulsory, but has little to say about the relationship between science and technology. Social studies do not at all refer to how modern societies relate to technology. Our children do not develop a healthy and yet critical attitude to technology, one that is based on principled understanding. Technology assessment is not part of the curriculum even in the prestigious institutions of technology. All this together suggest that we are not even asking the right questions about technology in the context of education, let alone have good systemic answers.

When it comes to the *use of technology for educational purposes*, there are more questions to ask:

- How does technology help the educational purposes that schools seek to achieve ?
- Can technology enhance the educational experiences that can be provided to achieve these purposes ?
- How can the education system contribute to the development of such technology ?

- How do we ensure that these educational purposes are indeed being accomplished ?

It is not the aim of this short article to provide a comprehensive answer to these questions, nor is the author competent to do so. What is hoped for is an articulation of some guiding principles that can help us answer these and related questions.

Technology in the Science Classroom

The 1986 Policy on Education asserts: "… all areas of development are science and technology based and for that we need experts, middle - order workers and scientifically literate citizens."

It goes on to discuss how the curriculum should be designed: " … for conscious internalization of healthy work ethos. This will provide valuable manpower for economic growth as well as for ideal citizenship to live effectively in the science/technology based society. " Such coupling of science and technology is natural to policy but alien to the classroom.

If there is one domain that calls for curricular action in school, it is that of technology. The current school curriculum considers science education to be central, but tehnology is largely peripheral within it. Other subjects of study, such as social studies, hardly ever refer to the role of technology in shaping modern society, let alone critique that role. At the tertiary level, technological studies are termed professional and separated from science. This works well for the large industrialised modes of production, with all technology creation patented and owned by big industry, and the general public being merely consumers of technology. Unfortunately, in the poor countries, this has largely led to the import of technology in the large, and citizens' ability to innovate confined to the small.

On the other hand, there is an increasing perception that 21st century modes of production will allow for small industries innovating in technology, created by groups of individuals without exclusive technological training. The East Asian and Western European countries have integrated technology education into school science education, and the study of technology in relation to society is also given curricular stature in these systems. In Sweden, for instance, every high school has a workshop that includes a foundry and carpentry, and science laboratories are integrated with the workshop. The Chinese school system is transforming itself to such a model.

The science classroom is the best place to introduce technology to children. This cannot be achieved by "lessons" on X-technology or Y-technology, to be learnt as information items and memorized. In fact, what is needed is nothing less than what ought to be the central goal of science education any way: to provide not only a factual and conceptual understanding of natural phenomena, but also a fluency in working with the material world in a way that builds on experimentation, observation, prediction and critical inquiry. This needs the active and simultaneous engagement of the mind, the heart and the hands. Technology is best learnt by doing, by active engagement with material and energy conversion.

Articulating the goals of science education to include active hands-on engagement with the material world implies according primacy to wood and metal, to leaves and stones, to life forms and crystals -- not by seeing them as pictures (or worse, reading their descriptions) in books but touching and feeling them, working with them, and manipulating them. This is essential for not only understanding science but also for developing an integrated feel for technology.

Coupled with experimentation, an emphasis on **quantification** is a characteristic of science. Measuring, estimating, approximating, calculating and model building are everyday processes for any form of science, and these again are habits to be inculcated in the learning child, not only for sharpening her own abilities but also in building a society that can critically engage with issues of technology use and its impact on the environment.

Children need to perceive the rootedness of technology in science, as also the technological potential embedded in science. That technology is the conversion of material and energy in different forms by work, and that this is based on sound scientific principles, is a realisation that every child learning science must internalise. Prioritising this in science education is important not only for addressing a lacuna in the system but also for giving an important direction for the future of our children.

Apart from hands-on experience, science pedagogy itself needs to actively make connections with technology. For instance, rarely is the teaching of Pascal's law accompanied by pointing out that this is indeed the principle that literally enables huge trucks to be held up on mere rubber tyres pumped with air. On one hand, the sheer wonder of air holding up a heavy truck is important for the learning child, and on the other, the tremendous opening up of possibilities in the child's mind is critical for planting the seeds of technological innovation. Biodegradation is a phenomenon to be understood, but it is also important to see the possibilities of composting in technological terms. This is a connection mostly missing in our science curriculum, and a careful reworking of curriculum can make science learning not only immensely enjoyable to children, but also useful to them and to society in later life.

The Hands and Minds Disconnect

Why is it that such a disconnect between conceptual science learning and a hands-on culture of making things, accepted for so long, as a matter of course ? Is it perhaps impossible to achieve an integration of the two ? Are we perhaps talking of a new idea so revolutionary that nobody has thought of it before ?

On the contrary, this is a very old idea, whose seeds were sown in India long ago. In the 1930's Mahatma Gandhi advocated **Nai Talim**, a new style of education for a new country. Gandhi and Kumarappa built a curricular framework on a principle that called for integration of work and education. The village-based society they envisioned would not see education as preparation for entering the lab out force post-education, but as education through work. In Nai Talim, work raises questions inside the child's mind: why does this work and not that? How does material get transformed? Science provides answers, and the child is able to see how the learning improves his/her work and results. This is admittedly a crude summary of the idea, but the critical point to note here is that Gandhi was not speaking of vocational education or work education but education through work. What is relevant to this discussion is that such a viewpoint builds a natural healthy attitude to technology and the understanding of how material and energy are transformed through work.

The country chose a different pathway in education, and the Gandhian vision of education was sidelined alongwith the Gandhian vision of development. There was a fear that bringing work into schools would perpetuate caste hierarchies. On the other hand, elitist attitude privileges intelllectual work over physical work took root in school education. By now, theoretical insights and conceptual understanding are seen as important, hands-on activity gets mentioned only in the context of "making classes interesting". Slowly, memorization and rote learning have taken over, and concepts took a backseat as well. The Indian **pathashalas** were famous for remarkable feats of memory, and so our current toppers are in examinations. Neither the Gandhian vision of work in education nor the Nehruvian vision of inculcating the scientific temper in children have been realised in our school system.

With such a history, it is perhaps not suprising that our recent discussions on technology in education equate technology with ICT use. Here is technology that is not messy, one does not need to muddy one's hands, deal with hot metal, make errors in measurement. Even the dangers relate to the mental world, not the material one.

The Potential

If we would reorient ourselves on the lines we have been discussing, the potential benefits would be immense. Providing linkages for schools with technology institutions requires more re-orientation on our part than great resource investment. A visit to a bicycle shop or a motor garage has immense educational value. Agriculture and animal husbandry are practised all around, but they are not seen as opportunities for ``science tours". Indeed, within a few kilometres of every school, some manufacturing or industrial processing activity does take place, but active linkages for school and science curriculum with these institutions are almost entirely absent. Science laboratories are integrated with workshop practice, as the Scandinavians do. Even while we wait for such a possibility to become a reality for our children, we need to begin by opening windows and doors to simply make use of opportunities for technological education that are present around schools.

This only calls for an enabling mechanism to be set up in terms of curriculum, syllabus, school functioning and new practices in teaching and learning.

Every time someone speaks of ICT and mentions how children take to such technology, how their 4-year olds could operate mobiles when they couldn't, it is worth remembering that for lakhs of Indian children, working with wood and metal comes naturally too. They have always been good at handling **any** technology with their nimble fingers, not only ICT. It is the education system that never took this ability seriously.

On the other hand, the benefits ICT can bring to our education are immense too. ICT has a disruptive power that needs to be harnessed. The higher echelons of our system are characterised by many kinds of barriers: entry barriers, language barriers, disciplinary barriers, performance barriers. ICT offers us wonderful opportunities for breaking these barriers. We simply cannot enter many of our elite institutions, but ICT can take us right into their offices and laboratories. If speaking English is a difficulty and hence a passport denied into many realms, ICT can offer a backyard route in. Practitioners of one discipline may never talk to those of another discipline but ICT platforms can ease conversation and collaboration between them. We can go on in this vein, it suffices to say that the potential of ICT for democratization of education is immense.

But there are many down-to-earth ways in which the benefits of ICT are immediate in education. We are all acutely aware of the tyranny of the textbook in our schools. Breaking into the linear structure of our textbooks and deconstructing it is easy for ICT with the highly flexible modes of navigating educational material it can offer. It can also tremendously help in localizing and even personalizing content, which is most welcome in a scenario that creates a false uniformity. The combination of these two, flexible navigation and personalized content, opens doors to new ways of learning. Consider a child interested in light, exploring art and photography on one side and physics on the other. Such breaking down of compartments is natural in ICT enhanced education.

Once we start envisioning the possibilities, we can see that ICT not only has the potential to enrich our education but indeed can also provide a tool for educational objectives that we *cannot* accomplish without it. As an instance of the latter, consider the question: how would the world look and behave if the acceleration on earth due to gravity were just a tiny bit less ? It is hard to imagine such a thing, harder to quantify what we imagine. A computer simulation can achieve this very well, can make us think, and indeed lead us to more related questions and open-ended exploration. In a mathematics class, we could not only graph a cubic polynomial, but pull the curve down, predict how the quadratic coefficient would change, and verify it. Try doing it on paper! Consider zooming into topographic maps in geography. Consider visits to distant museums.

All such singing glories of ICT should always be viewed with healthy suspicion. In a country where socio-economic disparities are reflected in access to and use of technology, we cannot further create technology dependence without universality of access. The dangers of unsafe use of Internet are far too real and immediate to be ignored.

To conclude, we can perhaps offer some guiding principles for technology in education:

- ICT and its visual/simulational ability does offer a tremendous opportunity for empowerment in education, but this is only one dimension for a Technology Vision in Education.
- We need to see students as constructors of knowledge and technology, and not merely consumers of the potential offered by technology.
- Working with nature and material is essential in education, and this means innovative incorporation of other forms of technology.
- Technology can play a significant role in *engaging* students in learning, and this needs to be understood and used carefully.

Understanding of technology and a healthy attitude to technology are a fundamental aspect of modern life, and our education system needs to respond significantly in this regard.