Thoughts on the Proposed Changes to the M.Tech Program

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IITs have recently proposed some major changes with regards to the M.Tech program. There are many views about the proposed changes, and numerous rumors and misconceptions are getting circulated on social media. Hence, it is incumbent upon IIT faculty who have been associated with the system to educate the public at large regarding the need for the changes, and their context. It is necessary to bear in mind that the changes are a result of a long series of discussions and deliberations among faculty members in various IITs, which ultimately culminated in the IIT Council creating a three-member committee comprising eminent faculty members from the IIT system. The recommendations are broadly in line with the feelings of many faculty members who were associated with the M.Tech program in various administrative capacities. It would be incorrect to believe that such changes were externally imposed by third parties with ulterior motives.

Let me introduce myself. I currently hold the Usha Hasteer chair professorship in the Computer Science department at IIT Delhi. I have a joint appointment in the Department of Electrical Engineering. I have been the M.Tech coordinator in the CSE department for the last four years, have been a hostel Warden of a PG hostel for four and half years, and am currently the research chair in the center of cyber security. I have been involved with many curriculum development efforts and have also had the pleasure of co-chairing the committee to create a novel computer science curriculum from classes 9 to 12 (CBSE board).

Let me motivate my reasoning by presenting a few mathematical arguments that I was exposed to while designing the CBSE curriculum. Taking recourse to a formal approach reduces subjectivity to a large extent. Akin to economics, we can use game theory to reason about the effectiveness of educational policies. The most important concept in game theory is the notion of the *Nash Equilibrium*, which states that if the strategies of the rest of the players are fixed, then no player gains by unilaterally changing her strategy. In simple terms, it means that if the rest of the players have decided their strategies, then I am doing my best. A *stable Nash equilibrium* is defined as a situation where if one player makes a small change in her strategy, nobody is better off. In an educational setting that runs on public funds the players are the student, the institute, and the employer. Any system given sufficient time converges to a Nash equilibrium. It is the job of the policymakers to ensure that the Nash equilibrium is in the nation's interest. For example, an equilibrium can be where the teacher, student, and the employer collude and decide to give grades for free. In this case, if all three parties are happy then this is a stable equilibrium, but it is bad for the nation. Hence, the key learning is that all Nash equilibria should preferably be stable (or in other words unaffected by small changes) and should be in the interest of the nation.

Let me now refer to the seminal work by Correa and Gruver[1] where they analyze educational policies mathematically. Their key conclusion is:

> *Stable Nash equilibria are possible if the teacher and student assign the same value to academic work. This is true of most student-teacher settings including M.Tech classes.*

Let us now analyze the M.Tech program in the light of these results. First, let us divide the incoming M.Tech students into several categories:

[No-Int] Not interested in M.Tech at all.
[No-Course] Not interested in the coursework component (typically all of the first year).
[No-Project] Not interested in the project work component (most of the second year).
[Interested] Interested in all the components of the program.

In the current M.Tech program, did all the players roughly ascribe the same value to academic work? This was sadly not the case; hence, we did not have a Nash equilibrium – constant changes in policy without any benefit. Wherever, we did have a Nash equilibrium, it was because either because of certain fortuitous circumstances such as a very favorable job market that made both the student and teacher academically very serious, or where both the parties went light on academics. The former was a rare case, and the latter is not acceptable.

Let us now look at the factors that bedeviled the M.Tech program:

1. In many disciplines the [No-Int] category dominated because the primary interest of students in this category was a job in a public sector unit (PSU). Since their results were declared in the later half of the year, students preferred to join IITs and later leave M.Tech and join their jobs. It was not uncommon for all the students in an M.Tech program to leave midway. In many cases, such programs had to be discontinued in the middle of the semester. I recall a prestigious program being left with just 3 out of 21 students at the end of the second semester. In another department 4 out of 7 M.Tech programs had to close down because all the students left midway. This represents a serious waste of national resources in terms of scholarship money, and is unfair to meritorious students who are interested in academics (seats were wasted); M.Tech labs remained unutilized, and many courses did not have TAs (teaching assistants).
2. The other contributors to the [No-Int] category where those who pursued an M.Tech in institutes where there are good coaching centers for nationalized exams (IAS/IES/etc.) nearby. IIT Delhi was unfortunately one such institute, where we had the misfortune of seeing generations of students come only to avail good IAS coaching facilities in the neighborhood. Such indiscretions hurt the morale of students who are interested in advanced study and research.
3. Next, let us consider the [No-Course] category, where students were not interested in the course work. In many IITs, the M.Tech curriculum was not tailored to market needs and thus did not elicit good student response. Here also, a Nash equilibrium is not possible because the student and the teacher have mismatched academic priorities. Given that the curricula were not designed based on the current needs of the nation, there were frequent changes (oscillating equilibria) without any observable benefits. There was a need to ensure that there is a better alignment in terms of the aspirations of students, and the nation's needs. Furthermore, over the years, employers have not given the due weightage to CGPA in their hiring decisions; this has tilted the Nash equilibrium towards poor grades and a low interest in courses.
4. If there are a sizable number of [No-Int] and [No-Course] students, a favorable Nash equilibrium is ruled out. All stable solutions will be associated with low curricular and research output, and having students whose aspirations have a mismatch with the program, reduces the morale of the entire class. The resultant disciplinary problems consume a lot of faculty time without attendant benefits. [No-Int] students typically leave the program with outstanding dues of all kinds, and tracking them becomes a nightmarish experience for TA coordinators and hostel wardens.
5. An M.Tech program has a strong project component, where the student gains depth in a given area, and does an advanced project. Students in the [No-Project] category did not find any great

pleasure in doing the project. This was primarily because the third player, the employer, has not been able to create an atmosphere for high-technology manufacturing, and thus projects that encourage high-end work found few takers.

Sadly, in most programs students in the fourth and desirable category, [Interested], were in a minority. The only stable Nash equilibrium that is possible in this case is students are not interested, teachers are not interested, and the employers turn a blind eye – the nation loses.

The only way to remedy this situation is to completely discourage [No-Int], and ensure that the academic interest of students and teachers match in the [No-Course] and [No-Project] categories. Unfortunately, this is a constant sum game, discouraging [No-Int] students by raising financial costs comes at the expense of increasing the hardships of students in the rest of the three categories. This is particularly of importance for needy students, and for students whose families are supported with their scholarship funds. However, it is possible to arrive at an equilibrium solution with a proper combination of incentives.

Measures to discourage [No-Int] students:

1. Increase the M.Tech fee to match the B.Tech fee (2 lakhs per year). We need to note that the program as of now was heavily subsidized (cost per M.Tech student: 6 lakh rupees).
2. Discontinue the stipends (12,400 Rs. Per month).

The advantage that [No-Int] students get by coming to an IIT is that they can avail IAS/IES coaching facilities in the neighbourhood, wait till an offer comes from a PSU, and keep getting a stipend till then. If nothing works out, the M.Tech degree is an acceptable fallback option; this is seldom the case though.

Had [No-Int] students not come to an IIT, they would have continued in their previous job. If the expected benefit of studying in an IIT is offset by the additional financial burden (because of steps (1) and (2)), then [No-Int] students have no incentive of coming to an IIT. Regardless of the choices made by students in other categories or the institutes, their choices are fixed.

Unfortunately, increasing the financial burden discourages students in the other categories and is unfair to students who do not have the wherewithal to support themselves. The following steps are proposed:

1. Easy access to study loans (study now, repay later).
2. Method to recover at least half the fees by doing TA (teaching assistantship) or RA (research assistantship) work. This will also increase the quality of TA/RA work. At the moment M.Tech students do not have any incentive to excel in TA/RA work given that the stipend is guaranteed. Once it is made contingent on performance, the quality will improve.

This is however not enough for students who are in the [No-Course] and [No-Project] categories because for them the payoff (mathematical term for benefit) from an M.Tech has reduced given the financial burden. To offset this the following steps have been proposed:

1. Weed out unpopular programs that are not connected with the nation's needs or market needs. This is also a collateral of the increased fees, where students will become more discerning.
2. Increase the benefits of pursuing an M.Tech degree by making it industry linked, and also by creating an ecosystem that has a huge connect with industry.

We would still have interested students who might find the prospect of taking a loan and repaying it later an uncomfortable proposition. In such cases, the committee has proposed to provide Ph.D scholarships that include fee waivers to the top 1% students in each GATE discipline. Given the flexibility of PhD programs, many students in the [Interested] and [No-Course] categories might consider migrating to them. This will enrich the Ph.D pool in IITs, and provide manpower for high-quality research.

Summary and Conclusion

Designing any policy, particularly education policy, is a very difficult task in a diverse country like India. Hence, a certain degree of stasis had set in and the M.Tech programs were rendered mostly ineffectual. There was thus the need for a change.

We now need to ensure that the new policies lead to a stable Nash equilibrium that is in the interest of the nation.

1. In this case, merely increasing the fees and discontinuing stipends is enough to discourage [No-Int] students and keep their numbers in check. However, it is much more difficult to tilt the Nash equilibrium in the favor of interested students. This is where a combination of approaches – study loans, better industry focused programs, incentive to earn on-campus with TA/RA work – need to work.
2. At a Nash equilibrium, the best option for a [No-Course] student is to still do the courses with a reasonable amount of interest, the best option for a [No-Project] student is to find a project that aligns with his/her career goals. Given better industry participation, it should be possible for most students to find projects that align with their long-term goals. This will help them get the motivation for doing their project.
3. Finally, interested students need to retain their levels of motivation and not get demotivated by the increased fiscal burden. This is possible if they see a better future after M.Tech or avail the Ph.D Fellowship, and transition to a research career.

The different knobs in this scheme (fees, incentives, industry programs) need tweaking in the coming years to ensure that we arrive at a robust operating point. Nevertheless, this new policy captures the thoughts of faculty members very well, and in my view is in the right direction.

References

1. Correa, Hector, and Gene W. Gruver. "Teacher-student interaction: A game theoretic extension of the economic theory of education." *Mathematical Social Sciences* 13.1 (1987): 19-47