Urgent questions for engineering education in the age of genAI:
knowledge,
teaching &
assessment

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Recent rapid developments in generative AI have brought with them a raft of urgent pronouncements urging the rethinking of education at all levels. Part of this breathlessness is likely associated with the business imperative: there is potentially significant money to be made, for example, if paid licenses for these tools become a necessary part of all education institutions globally (Singer, 2025). But profit is not the only driver at play. It's undeniable that this (currently) freely available technology, on everyone's laptop and phone, raises significant questions for education. There's already substantial research showing that students are most definitely using these tools (Mulford, 2025). Some faculty are using them too, and students are not always happy about this (Hill, 2025). And engineers are also incorporating these tools into their work (Johri et al., 2025).

In engaging with this moment, one finds oneself drawn to adopting a position between the poles of enthusiastic adoption and anxious resistance. The enthusiastic tech adopters at their most enthusiastic envision (yet again) a utopian vision of teacher-proof and cheap (not actually) education. The anxious resisters envision all hell breaking loose if we don't batten down the hatches. I want to suggest that this false dichotomy is not only of limited use but also ultimately uninteresting (Ganesh, 2025). Far more productive will be doing what good educators always do: engage deeply in the present context with all its constraints and opportunities, but stay full centred on what it is we are really trying to achieve in our educational programmes and endeavours.

So I do think that this is an important moment for a renewed and urgent engagement with the core issues at the heart of engineering education. The questions I want to focus on here are perhaps not the questions that currently catch the headlines. This is a tech disruption, and not the first in our times –- we are still in the long digital revolution that started in the 1960s, arguably not a "fourth industrial revolution" (Cooper, 2021). Every time we hit a new phase of this revolution, we have many educators and innovators exploring these new IT based tools. This is all fine and good, and certainly one should be joining in this conversation (for an excellent overview, check Johri, 2025).

But the key thing is that the core educational questions can't be found within an examination of the features of the tools themselves (Hodges & Kirschner, 2024).

To answer educational questions, we need to think about educational foundations. Some of these questions may seem familiar. Some of the answers may be the same ones we've always had. Some of the answers might need to change. We need to reconsider these questions and maybe ask some new ones. So here are the questions I want to focus on in this article:

1. What do students need to know, as well as what do they need to do, and who do they need to become?
2. How do we create educational environments in which such learning can occur? What is the role of the teacher?
3. How can we be sure that learning has happened?

I'll acknowledge that going down this road isn't always popular. People might accuse you of being conservative or insufficiently enthusiastic about new shiny technology. But if we don't ground ourselves in some basics, I believe we run serious risks in our educational endeavours.

The Knowledge Question

What do students need to know? This question is prominent in the age of GenAI, where not only is information widely available through the internet, but we have tools that can quickly produce seemingly humanlike outputs. What is knowledge? What does it mean to be knowledgeable? Is there a difference between knowledge and information? Ironically, these are times where knowledge is easily dismissed but arguably more important than ever.

Being able to access information is not the same as understanding it. Knowledge is all about understanding. And professionals need to make critical judgments that are grounded in a deep understanding of the specialized knowledge basis for their field. In engineering education, we tend to get misled on these matters when we (quite correctly) research what engineers actually do in the workplace and how this relates to their formal education. Asking this question, one tends to obtain answers that are centred on skills like problem-solving (for example, Jonassen et al., 2006). You will also hear many professionals say that they only use a tiny part of what was in their university courses. But the kind of professional skills we need to build cannot be learnt in isolation to knowledge. There is limited value in a generic skills course focusing on "problem solving" or "critical thinking", etc. This is most probably one of the most serious and consequential misadventures in the whole of progressive educational thinking in the late 20th century and only slowly being rectified now (Surma et al., 2025).

While the engineering curriculum must therefore be oriented toward what engineers need to be able to do in the workplace, there is no simple reverse engineering from practice to curriculum. Formal education has its own internal logic, and outcomes are emergent and not fully determined from inputs. In this way education differs fundamentally from on-the-job training. Education is its own structured phenomenon. It requires specific forms and logic to build students' understanding coherently over time. There is no content-free critical thinking or lifelong learning. Crucially, a professional will always be defined by the knowledge they are able to recruit to address complex real-world problems.

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Our very challenging task as engineering educators is to create environments in which students can master the core knowledge in their discipline and be able to apply it. Which brings us to the next question:

The Teaching Question

The core challenge for engineering educators is this: Learning scientific concepts is hard. A major finding of the then emerging field of Science Education research back in the 1980s, was that students can even pass difficult exams, but not necessarily understand the key concepts in the discipline. In my own PhD in the late 1990s, I followed a set of students through a second-year chemical engineering course to understand why they struggled to grasp key concepts, even though the course had a sophisticated and explicit focus on concepts. What helped me make sense of this was the idea of approaches to learning, demonstrating the central challenge of creating a course environment that fosters a focus on understanding (Case & Gunstone, 2002). Not only is learning concepts hard, for a student to change their approach to learning to focus on concepts while in a packed engineering curriculum is really hard. And this is where teaching comes in. And why sitting in front of a computer, even with a sophisticated chatbot, is less likely to foster that change. The key to unlocking all of this is the relational dimension of teaching. But this leaves us with a real challenge: if a lecturer stands at the front of a theater mumbling away, not doing much more than what a video or ChatGPT can do (Flenady & Sparrow, 2025), then why should students pay all this money to attend those classes? We really have to make lectures and in-person classes into valuable opportunities.

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This led me to a more recent study, also with second-year chemical engineering students (Case et al., 2024). This study looked across different institutions. We wanted to respond to the popular idea that lectures are bad, and that we should get rid of them all and move everything into small group work. But through interviews with students, we found strong support for the value of lectures. Three things came up. First, unsurprisingly, students valued clear explanations of difficult concepts. Second, they appreciated being able to interact with the lecturer. Even if the bar was low, they still wanted the chance to ask questions. And they valued lecturers who incorporated active learning strategies. Third, somewhat surprisingly, they talked about lectures as a kind of bridge into their own private study. What they valued was the curation of resources: the direction and support that helped them navigate what to focus on and how.

Finally, to address the question that is getting most of the educational headlines: the potential for cheating with the help of GenAI tools. Some people are focused on AI detection but again this might more productively be a moment for critically looking at some of our approaches to assessment that have always been problematic.

The Assessment Question

How can we be sure that learning has happened, now that so many homework assignments and take-home exams can be easily answered by AI? The main point I want to make here is that this isn't entirely new. Students have always had ways to bypass real learning in order to pass. When I was a student, there were past exam "archives" with worked solutions that would get passed around the student residences. Later, there were online tools like Chegg. Now it's ChatGPT. But I do acknowledge that these current AI tools have supercharged those possibilities for bypassing real learning.

We're going to see more in-person assessments. More oral assessments. These come with resource and time challenges, for sure. This also pushes us to think harder about the distinction between summative and formative assessment. Summative assessment must indicate whether a student has met the learning outcomes. But formative assessment, testing and developing understanding during the course, remains crucial. And what we do in the classroom to support that also remains crucial. Thus, back to the teaching question again!

Concluding Thoughts

Why does all of this matter? I like this point made by McKenna and Tshuma (2025):

> If students haven't developed their own knowledge foundations, they'll be increasingly marginalized in a world that, paradoxically, values human expertise more, not less, as AI advances.

In conclusion then I want to acknowledge that these are questions that do not have simple answers, and that context always matters. Here I think there is an important role for scholarly work done by academics who care.

Engineering Education Research (EER) has a crucial role to play in addressing these questions. Importantly, we must move beyond research focused solely on "what works". The questions we now face require a deep engagement with the purposes of engineering education and the core values that underpin it. A focus on knowledge requires that we identify the core concepts needed for each engineering discipline and formulate the pedagogical content knowledge that teachers will need to deploy to enable students to master difficult concepts. Much of the current discussion around generative AI has of course been focused on the validity of assessment given the ubiquity of new tools that can allow for the bypassing of actual learning and mastery. It also seems unavoidable that we must seriously rethink our methods of assessment to be able to be confident that we are producing engineering graduates equal to the challenges that they will face in their future careers.

There is a key role here to be played by those who are focused on Engineering Education Research, but there is also a big space for academics whose primary research is in technical disciplines, but who still want to engage with educational practice. They might pursue scholarly teaching, drawing on scholarship to inform their teaching. And honestly, one could argue that every university academic should be a scholar in their teaching. Then there's the scholarship of teaching and learning (SoTL), a newer idea (see Hutchings & Shulman, 1999). It's a practice-based, scholarly activity, but it doesn't require a lab or postgraduate students. It's something any educator can take up in their own classroom.

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Let's abandon the tired either/or polarities on genAI and use this opportunity to push for engineering curricula and classrooms that are focused squarely on what students need to know and getting them there. This is also work that demands creative and contextualized scholarship and research.

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