Would it be proper to say that mathematics is blocking students in engineering?

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We discuss the question from the title: Would it be proper to say that mathematics is blocking students in engineering? We consider it from the perspective of the current curricular developments in engineering and related fields and the role of the mathematics component in the education of future engineers and scientists.

Data analytics is entering into all aspects of our lives. This is, in particular, true nowadays for the instructional aspects of higher education. For example, there are new data analytics tools that study the complexity of degree programs and indicate "bottle necks" and "blockers". I have recently encountered a claim, based on the results of such a study, that mathematics is blocking engineering students. In relation to that, I would like to present three analogies which should help us illustrate this issue better and provide a wider and easily understood perspective.

First, I would like to ask the following: Would it be proper to say: "mathematics is blocking students in engineering"?

To understand the question better, we may consider an example that is not directly related to academia. The ongoing Winter Olympics direct our thoughts to ice hockey. Suppose I would like to become an ice hockey player and I do not ice skate. I can try to say:

"Ice skating is blocking me from becoming a hockey player."

But would it be proper? It seems to me that everybody would agree that the answer is no, though the sentence is grammatically correct. At the same time, if a branch has fallen on my driveway due to a recent snowfall, I can easily say:

"The fallen branch is blocking me from driving out."

And now everybody would agree that this last statement makes a perfect sense.

Thus, we have two sentences of a similar syntax structure, but with opposite semantic validity:

"Ice skating is blocking me from becoming a hockey player."

"The fallen branch is blocking me from driving out."

The latter is logical and assumes that I will spend a few hours removing the branch that by accident ended on my driveway and which prevents my driveway from fulfilling its basic purpose: to let me park my car in the garage and take it from there. The former is senseless because no one can play ice hockey without being quite proficient in ice skating.

Developing this statement a bit further in a mental experiment, one can envision an academia for ice hockey without ice skating. There are some obvious advantages to this new form of ice hockey education compared with the traditional one. It is more affordable and more accessible than the pathways that assume ice-skating skills. There are also a variety of jobs which graduates of such an academy can do: they can be very knowledgeable hockey fans, sports journalists, logistic officers in professional hockey clubs, or be active competitors in electronic hockey games. The only thing that these graduates would not be able to do is just to play hockey. So, it may well be that there is a niche for such a new program. And this is all perfectly fine as long as the founders of such an academy clearly state that this is a hockey academy without ice skating. However, if they do not stress that clearly enough, disappointed students and parents can come back to them asking for explanations and compensations, since they were misled into false expectations.

The second analogy is brought by the COVID-19 pandemic, which has been overwhelming for all of us for about two years now. The death toll of the pandemic in the US exceeded 900 000 a few days ago. We all remember the panic that the situation caused one year ago, when the death toll approached 100 000. The death toll per capita in the United States is among the highest in the world, despite the most advanced health institutions, the capacity to create, produce and deliver a significant number of vaccines of the highest quality. We all appreciate the work of the first responders, and no one blames them for this toll. On the contrary, we all try to support them and show our appreciation of their hard work and sacrifice. We all understand that the issues are much deeper and of a systemic nature, above and beyond the reach of the first responders.

In terms of mathematical illiteracy, we are embedded in another pandemic, which has existed much longer. It is not going to go away by itself and for this disease there are no quick and efficient solutions like two bouts of a vaccine. This pandemic is not as lethal, and thus the public awareness of its existence is much lower. The first responders include math departments all around the world. These first responders also deserve appreciation and

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public support. It should be clear that the roots of this pandemic are equally systemic and beyond the reach of the first responders, as in the case of the COVID-19 pandemic. Hurting the mission of the first responders only helps the pandemic to propagate further and faster.

For the third analogy, we can recall that data analytics entered another branch of academia, research, much earlier than the instructional component, a few decades ago. That brought us impact factors, H-indices, and other numerical tools connected with scientific publication. I remember how enthusiastic my colleagues, all excellent mathematicians, were at the early stage of this process. They believed that the objective data would finally bring a well-deserved recognition to them and eventually distinguish them from those who were, in their opinion, not that faithfully devoted to the research ideals.

Some of these other colleagues, however, managed to reorganize and quickly adapt to a new situation. Nowadays we have farms of citations and a variety of tricks and ways to produce good numbers. The issues are so massive that, for example, two committees of the European Mathematical Society are jointly preparing a public awareness campaign about predatory journals. This is all a consequence of a common situation where a measure transforms into a goal. When that happens, we all know that it cannot serve as a measure anymore.

We may assume that there are already predatory degree programs and that soon this may become even more massive and dangerous. We may expect that in the process separating genuine degree programs from the predatory ones, for example, a main criterion for the validity of an engineering program will be the validity and the rigor of its mathematics component. Thus, we are coming to a clear answer to the question posed in the title of this note. Mathematics provides foundational skills and knowledge that engineering students need to grasp in order to successfully embark on their professional careers. Mathematics constitutes an essential part of the engineering education and can't be seen as a road-blocker for students in STEM (science, technology, engineering, and math). Mathematicians need to get out of their shell and reach out to colleagues in other fields, especially the ones for which mathematics serves as foundation. They should also use the data and accumulated experience to improve their mission, their image, and the public awareness of the importance of mathematics, both in research and in teaching. We should be proactive in educating all constituents, stakeholders in higher education, students and parents about the paramount importance of mathematics in contemporary education and society. We should also help our colleagues from neighboring fields not to forget the significance of the mathematics component of their programs for the professional competence and employability of their graduates in the decades to come. This way we will assist our colleagues from other academic areas to avoid traps of rushing into easy, short-term, half-baked interventions that would eventually cause more harm than benefit for their students and their programs in the long run. This is a service to the whole scientific community, and thus to the entire society, that mathematicians should take upon themselves. No one else is going to trace that path for us.

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