Why Hasn't AI Replaced University Teachers (Yet)?

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Abstract. In this position paper, we review the potential impacts of artificial intelligence on higher education in engineering, with a particular focus on changes in students' cognitive abilities. We describe the emerging roles of university faculty in a world transformed by AI, and propose recommendations for renewal across all areas of education. Through an elective course in an architectural engineering program, we demonstrate how the development of students' skills can be achieved by temporarily and consciously restricting the use of AI. Finally, we provide an example of relatively simple geometric tasks in which the currently most widespread artificial intelligence systems cannot yet perform at a human level.

Keywords: artificial intelligence, higher education, critical thinking, engineering education, pedagogical innovation, GeoGebra

1 Introduction

Artificial intelligence has become deeply embedded in our everyday lives, whether for simple web searches, homework assignments, or even the solution of more complex problems. Students increasingly turn to one of the popular AI tools for assistance rather than to their instructors; likewise, educators themselves are often inclined to generate simpler sets of exercises with the help of AI.

What seemed like a utopian vision one or two decades ago has now become reality: artificial intelligence has made our lives more convenient — but at what cost? The use of AI offers substantial and undeniable advantages; however, the phenomenon of "intellectual complacency" may become a source of serious problems. For this reason, university instructors need a methodological shift in their teaching practices.

2 Possible long-term effects of artificial intelligence in engineering education

Numerous publications have already addressed the use of artificial intelligence, discussing both its advantages and disadvantages (see [1], [4], [5], [10]). Since AI

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can be successfully applied in a wide range of subjects, the professional community generally agrees that it is inevitable and indispensable; therefore, its complete prohibition or neglect in education (or even in engineering practice) is neither realistic nor feasible.

Its longer-term effects, however, may lead to significant cognitive stagnation or, in more severe cases, cognitive decline among university students. We consider the following, partly interrelated areas to be the most problematic:

- Students are no longer under pressure to apply algorithms manually. While this undoubtedly accelerates problem-solving processes in professional practice, the application of formulas — which constitutes the first step toward abstract thinking — is a fundamental prerequisite for engineering reasoning.
- The emergence of cognitive laziness, cognitive offloading, and reduced intellectual engagement. Because of AI, users no longer need to formulate search keywords or evaluate and select among search results. Proper prompt engineering is often not required, since responses become progressively refined throughout the conversation; however, in such cases a substantial portion of the cognitive effort is effectively delegated to the AI system.
- The simplification and reduction of independent thinking. More advanced artificial intelligence systems, particularly paid versions, are already capable of generating ideas on behalf of the user.
- A direct consequence of the previous point is that students may become less inclined to engage in complex and sustained reasoning. The detailed and well-structured responses generated by AI, together with the additional recommendations that often appear at the end of responses, imitate the structure of sophisticated human reasoning.
- Finally, there is the uncritical acceptance of AI-generated responses. Warning statements such as "AI may make mistakes", typically displayed at the bottom of conversations, are largely ignored by users. Yet despite its rapid development, AI remains relatively immature from an information technology perspective; therefore, its outputs should still be approached with caution.

Why might these issues be "dangerous" in engineering education?

- Students become passive users. Primarily due to time constraints, they tend to accept answers obtained after a quick and superficial prompt without further verification.
- Essential engineering skills fail to develop, especially those that secondary education is already inclined to neglect. These include analytical thinking, understanding mathematical relationships (particularly in calculus and geometry), and spatial visualization.
- Owing to the convenience provided by AI, students may not feel motivated to verify the outputs generated by other software systems (for example, CAD-based applications) or to override them when necessary.

In summary, there is a risk that critical thinking becomes substantially diminished within the learning process.

3 The new role of university instructors in higher education

Few would dispute that the role of the instructor has undergone a fundamental transformation (see [2], [7], [8], [9]). Twenty or thirty years ago, university instructors were primarily responsible for transmitting factual knowledge, while the development of key skills occurred implicitly. These skills were naturally fostered by primary and secondary education, as well as by the environment surrounding students. (It is sufficient to recall that when students became interested in a particular topic, they not only searched the internet but also visited libraries, sought additional resources from their instructors, and so forth.)

Today, this role has increasingly shifted from the transmission of knowledge toward the interpretation, evaluation, and contextualization of knowledge. The immense amount of information available on the internet, together with the widespread use of artificial intelligence, has forced an "evolutionary leap" in the teaching profession: contemporary educators help students filter information while also teaching interpretation and critical thinking.

In the age of AI, university instructors therefore require substantially more pedagogical and psychological knowledge in order to meet contemporary challenges. Methodological development and adaptation are of key importance; among these, we would highlight the following:

- In certain subjects, particularly those related to information technology, instructors must recognize that the rapid development of AI may render parts of a course outdated or less relevant even within a single semester. Consequently, continuous curriculum development becomes a fundamental professional necessity.
- Traditional lecture-based teaching conducted at the blackboard largely belongs to the past. Although every subject still contains knowledge that must be transmitted by the instructor as an information source, it is important to recognize that young people are exposed to an enormous number of stimuli in their daily lives. Consequently, teaching materials must also be sufficiently engaging to maintain students' attention. Graphical materials, interactive illustrations, and videos can effectively support the instructor's work.
- Students often require motivation, which demands psychological competencies from instructors. We must be able to answer the question: "Why should I solve this problem if AI can do it for me?" (The answer is, of course, straightforward: to develop thinking skills.)
- Due to the influence of social media, many young people struggle with serious concentration difficulties and have become accustomed to systems of

immediate gratification. The emergence of artificial intelligence further intensifies this tendency. It is the instructor's responsibility to systematically increase students' attention span, highlight causal relationships, and even teach students to develop an intrinsic desire to discover such relationships. This, once again, requires pedagogical and psychological competencies on the part of the educator.

Even at the university level, instructors must design curricula and course structures that respond effectively to these challenges. Our primary objectives are to teach and strengthen critical thinking, foster independent thinking, awaken intrinsic motivation, and help students learn how to use artificial intelligence effectively — how to remain in control of it rather than becoming dependent on it.

4 Methodological opportunities in the age of AI

The methodology of higher education differs fundamentally from the methodological issues of primary and secondary education, as those levels involve not only teaching but also educational and developmental responsibilities. Furthermore, higher education is often characterized by mass instruction, which significantly complicates the implementation of modern pedagogical practices.

Within higher education, it is necessary to distinguish between the methodological considerations of lectures and those of practical classes and seminars; special attention must also be given to assessment methods. In the following, we outline several possible approaches that remain applicable in a world permeated by artificial intelligence. Beyond knowledge transfer, these approaches aim to develop abilities and skills. In engineering education, it is particularly important to cultivate the competencies required for complex problem solving: analytical thinking, a systematic and synthesizing attitude, critical thinking, and creativity.

4.1 Lectures

University lectures may involve several hundred students; therefore, they are unlikely to undergo radical transformation in the near future. Traditional lecture-based instruction continues to play an important role in higher education. Fortunately, the classical model — consisting of a brief explanation before or after dictation — has largely been replaced by explanation-centered lectures built upon lecture notes provided in advance.

Due to the increasing stimulus threshold of students, such lectures can be enriched with videos, interactive learning materials, physical models provided by the lecturer, and experimental demonstrations. Educational research has frequently emphasized the value of presenting information through multiple complementary channels. At present, artificial intelligence is still unable to replace collaborative experimentation or interactive activities.

4.2 Practical classes and seminars

Practical classes and seminars, owing to their smaller group sizes, provide substantially greater opportunities for methodological innovation. The following examples may be integrated into traditionally lecture-based practical sessions:

- After discussing and practicing fundamental tasks, students should be encouraged to think independently. While this is common practice in primary and secondary education, it is less frequent at the university level. Problem-solving activities that require genuine reasoning may be completed under instructor guidance and scaffolding, or assigned as entirely independent tasks. For simpler exercises, it may be beneficial to temporarily prohibit the use of AI. Such activities clearly contribute to the development of students' problem-solving abilities.
- Small-group work develops not only problem-solving skills but also soft skills such as communication, cooperation, and conflict management. If the use of artificial intelligence is permitted during these activities, student groups will naturally discuss and evaluate the AI-generated responses. In this way, critical thinking can be strengthened. Group discussion may reduce the likelihood of uncritical acceptance of AI-generated responses; skepticism tends to emerge instinctively, as no student group is ever completely homogeneous in terms of knowledge or attitudes.
- Reward unique, creative, and distinctly "human" (i.e., AI-free) solutions. Bonus points and other forms of recognition are classical elements of the instructor's toolkit, well-known motivational techniques from a psychological perspective, and consistently effective means of encouraging student engagement.

4.3 Project assignments

In the case of semester-long projects, mid-term projects, or other take-home assignments, it is very difficult to determine whether students have used any form of AI assistance. The vast majority of today's students make use of such tools; therefore, prohibiting AI in these contexts is virtually impossible. The pedagogical objective should instead be to design assignments that remain educationally valuable even when AI is used.

- Project assignments should involve tasks that current AI systems are still unable to solve independently. Instead of traditional exercises that primarily require algorithmic thinking, students should be assigned unique and complex problems that demand creative problem solving. Although AI is becoming increasingly capable of solving complex tasks with every new development, in many cases, indicators of extensive AI assistance remain detectable in student work.
- Closely related to the previous point, students should be expected to explain their submitted projects and justify the individual solution steps and ideas

involved. This requirement compels students to engage deeply with the material at home. Ideally, students solve the assigned task independently while making limited use of AI. Such an approach strongly supports a global understanding of the subject matter, the exploration of relationships between concepts, complex problem solving, and critical thinking. Even when students rely heavily on AI assistance, understanding the generated solution still promotes concentration and the comprehension of complex ideas.

- Require documentation and files that AI may not be able to generate reliably. A good example is the combined use of Microsoft Excel and AutoCAD (or ArchiCAD): if students must perform calculations in Excel and subsequently visualize the results in a CAD-based or other software environment, current AI systems are generally unable to generate the entire workflow automatically. Popular open-source and freeware applications are also suitable for this purpose; one example is GeoGebra.

4.4 Mid-term tests and quizzes

For mid-term assessments, the partial or complete exclusion of artificial intelligence is recommended in order to ensure objective evaluation of student knowledge. In many cases, however, this is difficult to achieve when the nature of the subject requires the use of computers.

It is therefore essential that instructors clearly specify at the beginning of the semester when and to what extent the use of artificial intelligence is permitted within the course.

- If the use of artificial intelligence is prohibited during assessments, tasks should be designed so that unauthorized AI use can be clearly identified. A traditional solution is the use of paper-based examinations without computer access. In computer-based assessments, instructor supervision becomes crucial, as AI systems are capable of providing complete solution procedures. Detecting such misuse is therefore an instructional responsibility. Another possible solution is the use of stricter time limits, where seeking external assistance requires more time than solving the task independently. While students will almost certainly use AI when preparing for AI-free assessments, the organization and synthesis of knowledge remain fundamentally human cognitive processes that ultimately contribute to the development of the desired competencies.
- If the use of artificial intelligence is permitted during assessment, tasks should contain elements that necessarily require human intervention, as discussed previously in relation to project assignments.

4.5 Examinations

With regard to examinations, the possibilities available for written exams are largely identical to those discussed for mid-term assessments. In mass-oriented

engineering education, the overwhelming majority of examinations are written. However, precisely because of the growing influence of AI, it is worth considering the more frequent use of oral examinations.

We believe that, in the age of AI, oral examinations may experience a renaissance if the goal is to assess students' knowledge and abilities thoroughly. Although oral examinations place a greater burden on instructors and departments, they offer numerous advantages, of which only the most important are listed below.

- The examination process itself is free from AI assistance. During an oral examination, students have no opportunity to use AI. Since students are aware of this during their preparation, home study necessarily requires more substantial intellectual effort.
- They develop students' communication skills. As genuine face-to-face communication is declining in today's digitally mediated world, strengthening this area is of particular importance.
- During preparation, students are compelled to rely not only on artificial intelligence but also on their own abilities and knowledge. The organization and structuring of knowledge therefore remain their own responsibility, fostering the development of complex thinking and critical reasoning. Ideally, it is during this process that students truly understand the deeper relationships within the course material and may even extend their thinking beyond the topics covered.

The aforementioned logistical challenges can be mitigated, for example, by introducing a short computer-based test serving as a preliminary screening instrument, administered under supervised conditions. In a well-designed learning management system, such as Moodle, results can be obtained immediately. This approach may reduce the duration of the oral examination.

5 Example from an architectural engineering course

In the following, we briefly present a course in which artificial intelligence could readily be applied; however, by deliberately limiting its use, significant skill development can be achieved. The course is discussed in detail in [6].

5.1 About the course

The elective course is entitled Advanced Computational Geometry and is available to students in the fourth and fifth years of an architectural engineering program. Its objective is to provide fundamental knowledge of differential geometry, ranging from an introduction to curve theory to the basics of freeform surfaces. During the course, students acquire only the theoretical knowledge that is strictly necessary and are then immediately given application-oriented tasks, ranging from simple exercises based on formulas to problems requiring complex

reasoning and, occasionally, mathematical insight and ingenuity.

To support skill development, the course utilizes the GeoGebra software package, which is freely available and already familiar to most students from secondary school. Consequently, students are generally capable of using it at a basic level from the outset. A natural question arises: why use a relatively simple software package instead of modern design applications? The answer is provided below.

5.2 Methodological objectives of the course

A recurring problem in architectural practice is that newly graduated students often treat design software (such as Rhino & Grasshopper) as a "black box": they do not understand the differential-geometric properties of the surfaces generated by the software, and building designs are frequently produced through trial and error rather than through deeper geometric reasoning. At the same time, the foundational mathematics and geometry courses taught during the first and second years rarely include substantial differential-geometric content.

The course is intended to address these two major issues. Its didactic objectives are therefore the following:

- The teaching of differential geometry should not be dry or purely theoretical; students should immediately recognize the practical usefulness and application possibilities of each surface type.
- Students should work with software (GeoGebra) that is suitable for solving the assigned tasks, but where the desired forms cannot be obtained merely through trial and error.
- Students' abilities in form recognition and form finding should be developed through problem solving. These two abilities are of crucial importance for architects, and current AI systems possess only limited capabilities in form recognition and form finding.
- Students' mathematical and geometric skills should be strengthened. The tasks require calculations and small-scale proofs, thereby deepening the understanding of geometric cause-and-effect relationships and reducing the tendency toward purely visual trial-and-error approaches.
- Students should learn to integrate creative and analytical modes of thinking.

Precisely because of its mathematically oriented design, GeoGebra offers several advantages:

- It explicitly requires a mathematical-geometric perspective and analytical thinking.
- It is capable of displaying three-dimensional curves and surfaces in both implicit and parametric form.
- It lacks many "convenience" features, making it difficult to obtain satisfactory results through mere clicking and experimentation.

- As a dynamic geometry software package, it allows geometric objects to be modified after construction or defined in advance through parameters, making it conceptually similar to modern design software.

During the semester, students were required to complete two mid-term tests and one project assignment. In all cases, the course notes, handwritten calculations, and internet resources could be used; however, the use of AI was prohibited during the mid-term tests.

5.3 Human versus AI in the classroom

At the beginning of the course, during an introductory form-finding exercise, we conducted a small, spontaneous action research activity. One student entered the problem into ChatGPT, while the rest of the group solved it collaboratively using a formula that had already been introduced earlier. (The group consisted of eight students, as the course is offered as an elective within a specialization. Consequently, all practical activities can be regarded either as individual work or as small-group work.)
One of the course rules was the following: "You may use AI, but you must always be able to explain why and how you obtained the result."

The task was stated as follows: "Construct in GeoGebra three-quarters of a torus with rotational axis z, whose meridian circle has radius 3 and whose center on the x-axis is located 5 units from the axis."
At the beginning of the exercise, we instructed the students to represent the surface in parametric form.
For such a relatively simple problem, performing the calculations manually required approximately the same amount of time as entering the prompt. The selected student initially failed to formulate the prompt precisely and therefore received the implicit equation of the surface, which required further clarification of the query. Meanwhile, the other students had not only derived the parametric representation but had already visualized the torus segment in GeoGebra.
When we asked the student whether they could explain why the obtained result was correct, they were unable to answer. Reading and understanding the explanation accompanying the AI-generated result would have required additional time.

The group then discussed the lessons learned from the exercise. First, the use of artificial intelligence does not necessarily constitute the most efficient solution in every context. Second, proper prompt engineering is of fundamental importance when using AI. Third — and most importantly — excessive reliance on artificial intelligence may reduce opportunities for independent reasoning and problem interpretation.
The impact of this small "competition" was entirely positive. Every student immediately understood the importance of critical and independent thinking, as well as the necessity of using artificial intelligence in an informed and reflective

manner. Throughout the semester, students focused much more attentively — not because of external pressure, but due to intrinsic motivation — on the instructor's explanations, on understanding geometric relationships, and on articulating those relationships. They also concluded that, in many situations, solving a problem independently is easier than repeatedly modifying AI-generated results.

Note: We plan to replicate the above experiment with the next student cohort in a more systematic and pre-planned manner.

5.4 Example of a typical assignment

As an example, we present a typical medium-difficulty task in which students were required to reconstruct the roof structure shown in the figure using GeoGebra.



Fig. 1. An example of form-recognition exercise 1 (detail, source: [3], 2023; edited by author)

It is immediately apparent that form recognition requires human visual perception and reasoning. Prior to this exercise, students had already studied ruled surfaces, including surfaces generated by connecting two curves. Consequently, solving the task did not present significant difficulties.

Following the course, purely as an experiment, we queried the paid versions of two widely used AI systems in early 2026 (ChatGPT Plus 5.2 and Google Gemini Pro) using the following prompt: "What geometric forms is this building composed of?"

We highlight only the portions of the responses concerning the roof structure:

- ChatGPT Plus: "Torus-like roof geometry (elliptic torus / warped annular surface): The roof behaves like a flattened torus: it rises toward the outer edge and dips toward the inner courtyard, forming a continuous doubly curved annular surface."

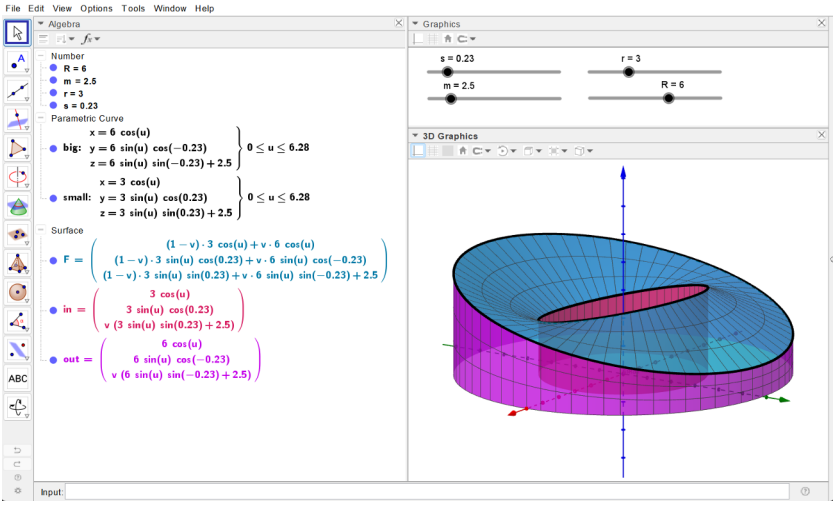


Fig. 2. An example of form-recognition exercise 2

- Google Gemini Pro: “Roof Transition – Möbius Strip – Blurs the line between roof, wall and floor.”

In both cases, the generated responses did not correctly identify the geometric nature of the roof structure.
We then reformulated the prompt and provided substantial contextual assistance by including the name of the building: “What geometric forms is the Dymak (Odense) building composed of?”
For the roof structure, the systems produced the following responses:

- ChatGPT Plus: “Undulating roof surface: Curved geometry tuned for solar performance.”
- Google Gemini Pro: “Roof – Undulating/Sinusoidal – Solar energy harvesting and noise mitigation.”

In this case, the AI systems provided more application-oriented descriptions; however, they still failed to identify the actual geometric form. This small experiment illustrates an important point: current AI models remain prone to significant errors. They function primarily as probabilistic search tools operating on large datasets rather than as pure computer algebra systems; consequently, their outputs should not be trusted without human verification.

This simple form-recognition experiment clearly highlights the weaknesses of current artificial intelligence systems while simultaneously serving as a motivation for students to approach AI-generated responses critically. Future engineers may thus realize that artificial intelligence is an excellent support tool and highly useful, for example, for verification purposes, but that its use without human oversight is not advisable.

6 Conclusions

- In the age of AI, the development of students' skills requires substantial pedagogical and psychological preparedness on the part of instructors. ("Thinking itself can be rewarding.")
- Students must be motivated to approach AI-generated results with a critical mindset.
- Students must be taught how to interact effectively with artificial intelligence systems through appropriate prompt engineering.
- Methodological research and innovation in higher education should receive increased attention and further development.

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