

# Redefining the Role of Chemistry Teachers in the Age of Artificial Intelligence

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**Abstract:** *Artificial Intelligence (AI) is changing chemistry education by giving students easy access to information, calculations, and simulations. However, getting quick answers is different from truly understanding chemistry, developing practical laboratory skills, and learning ethical scientific practices. These are areas where chemistry teachers remain very important. This article explains how AI can both support and challenge traditional teaching. It also discusses the changing role of chemistry teachers as mentors, guides, laboratory instructors, and role models for ethical learning. Finally, it suggests teaching methods such as active learning, project-based activities and improved assessment techniques. The article concludes that the best chemistry education in the AI era will combine AI technology with teacher guidance to help students develop strong concepts, scientific thinking, practical skills, and responsible decision-making.*

**Keywords:** Artificial intelligence; chemistry education; pedagogy; laboratory safety; teacher role; active learning

## 1. Introduction

The rapid expansion of artificial intelligence in education has created both opportunities and uncertainties for chemistry teaching. Students can now obtain instant explanations of concepts, solve numerical problems, and access advanced scientific content with unprecedented ease. This development has prompted an important academic and pedagogical question: if information is available everywhere, what distinctive role remains for the chemistry teacher? The answer lies in recognizing that chemistry education is not limited to the transmission of information; it also involves conceptual understanding, experimental discipline, critical thinking and ethical judgment. In this context, the role of the chemistry teacher is not diminishing but transforming. Teachers are increasingly required to guide students in interpreting knowledge, questioning AI-generated outputs, connecting theory with laboratory practice and developing scientific responsibility. Against this background, the present article discusses the changing role of chemistry teachers in the age of artificial intelligence and argues that meaningful chemistry education depends on the productive integration of technological tools with human mentorship.

A growing concern is emerging in classrooms and laboratories. When students can watch lectures from top institutions, use artificial intelligence to solve chemical equations and obtain instant explanations of reactions and mechanisms, it is natural to ask: what role remains for the chemistry teacher? Has teaching reached its limits? <sup>[1-3]</sup>

This concern is understandable, but it is based on a flawed assumption. While access to information has become effortless, true understanding of chemical principles and the ability to think scientifically have not become automatic. Having answers available is not the same as knowing how those answers are formed, why they are valid, or when they can be applied.

Traditionally, chemistry teachers were the main source of knowledge. Students depended on textbooks, classroom teaching and laboratory exposure to learn concepts. Access to

advanced materials, research journals or expert explanations was limited. Today, however, a student with a smartphone can explore topics like quantum chemistry, reaction kinetics and computational modelling within seconds. This change is significant, but it does not reduce the importance of teachers. It reshapes their role in a more meaningful way.

It is important to clearly understand the difference between information, knowledge and wisdom in chemistry. Information refers to data such as chemical formulas, equations, reaction conditions and numerical values. Knowledge develops when students understand concepts like chemical bonding, thermodynamics, equilibrium and reaction mechanisms. Wisdom is the ability to apply this understanding in real-life situations, such as environmental monitoring, pharmaceutical development or industrial chemical processes. Artificial intelligence can quickly organize and present large amounts of chemical information, but it cannot replace human reasoning, curiosity or scientific judgment that are essential for transforming knowledge into wisdom.

This brings us to a critical question: is artificial intelligence truly “intelligent,” or is it mainly an advanced system for organizing and presenting accumulated chemical information? AI can predict reaction outcomes, suggest possible mechanisms and analyse complex datasets with speed and efficiency. However, it does not possess genuine understanding, scientific curiosity or responsibility. It cannot question assumptions, evaluate the ethical implications of chemical applications or take accountability for experimental outcomes. While AI can provide answers, it is the chemistry teacher who develops in students the ability to ask meaningful, relevant and scientifically sound questions. <sup>[4, 5]</sup>

### Evolving Role of the Chemistry Teacher

Consider a simple example. A student can use AI to balance complex chemical equations or solve thermodynamics numericals within seconds. However, when asked to design an experiment, explain unexpected results or describe reaction pathways in real-life systems, many students struggle. <sup>[4, 6]</sup>

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This is where a chemistry teacher becomes essential. The teacher is no longer just a source of information, but a mentor who builds analytical thinking, experimental skills and scientific confidence. In chemistry, where many problems are interdisciplinary and open-ended, this role becomes even more important. <sup>[1,3]</sup>

A major concern in today's education system is the focus on problem-solving without a strong understanding of basic concepts. Students are often pushed to solve numerical or application-based questions without fully grasping fundamentals like atomic structure, chemical bonding, or equilibrium. Routine textbook problems, though often overlooked, are very important because they help students understand how chemical problems are framed. Once this foundation is clear, students are better prepared to handle complex, real-world challenges in chemistry.

### AI vs Chemistry Teachers

AI tools are very useful in chemistry for calculations, simulations and predicting reactions. However, they do not take responsibility for experimental results or safety. A chemistry teacher plays a crucial role in helping students understand the consequences of their decisions, whether in the laboratory or in industrial applications. <sup>[4]</sup>

There is an important paradox in modern learning: as answers become easier to access, the need to ask the right scientific questions becomes even more important. Simply having information does not ensure real understanding. <sup>[4,5]</sup>

The National Education Policy 2020 recognizes these changes by encouraging multidisciplinary learning, flexibility and reducing dependence on rote memorization. While these reforms are valuable, real change happens mainly through direct interaction between teachers and students in classrooms and laboratories. <sup>[7]</sup>

A flexible chemistry curriculum can only be successful if teachers are properly supported. Activities like project work, case studies and experimental learning need sufficient time, proper infrastructure and strong institutional backing to be effective.

### Transforming Chemistry Teaching Methods

Teaching chemistry should go beyond just lectures. While theory is important, students also need opportunities to ask questions, discuss ideas and perform experiments. A teacher's role is to create engaging learning experiences through laboratory work, real-life examples and interactive discussions so that students actively participate in the learning process.

At the same time, maintaining a balance between theory and practice is essential. Practical work is important, but it should not replace conceptual understanding. A strong theoretical foundation helps students make sense of experimental results, solve complex problems and contribute to areas like materials science, pharmaceuticals, Industrial and environmental chemistry. <sup>[1,2]</sup>

### Rethinking Assessment in Chemistry

Assessment is still a major challenge in education. Although we say creativity and problem-solving are important, most exams still mainly test memory and how quickly students can answer. As long as students are rewarded for rote learning, teaching methods will not change much. <sup>[3,8]</sup>

To improve chemistry education, assessments need to change. They should include open-ended questions that allow students to think and explain, real-world problems that connect chemistry to daily life, questions that require applying concepts across different topics and tasks where students interpret experimental data. This approach will help students develop deeper understanding and true scientific thinking. <sup>[3,8]</sup>

### Challenges Faced by Students

Modern students have access to a huge amount of chemical information and often depend on AI tools. While they can easily generate answers, many do not fully understand important concepts like reaction mechanisms or thermodynamics. This can create a false sense of learning, where students feel confident but lack real understanding. <sup>[4,5]</sup>

A good chemistry teacher helps students move beyond this confusion. By guiding them step by step, the teacher ensures that students truly understand what they are learning and why it matters. To develop clear thinking, students should always ask themselves three basic questions:

- 1) What am I studying?
- 2) Why is it important in chemistry?
- 3) How can I apply it in real situations?

### The Future: Working Together, Not Competition

Overdependence on AI can create real problems in learning chemistry. If students rely too much on copying answers instead of thinking on their own, they may struggle to connect different concepts. Human interaction is still very important for meaningful learning. A thoughtful question, a hands-on lab activity or timely guidance from a teacher can greatly improve a student's understanding and scientific thinking. <sup>[4,5]</sup>

The future of chemistry education is not about choosing between teachers and technology, but about using both together. AI can handle routine tasks and quickly provide chemical information, which gives teachers more time to focus on explaining concepts clearly, guiding students and developing their critical thinking skills.

The real challenge for teachers is not to compete with AI, but to do what AI cannot do. Chemistry teachers who adapt to these changes will become even more valuable. They will guide students in asking the right questions, thinking scientifically and maintaining honesty in learning.

The fear that teachers will become irrelevant is understandable, but it is not true. Today, a chemistry teacher is not just someone who gives information, but someone who helps build scientific thinking, guiding students not only to

find answers but also to understand which questions are truly important.

## 2. Conclusion

Artificial intelligence has undoubtedly changed the way students access and use knowledge in chemistry, but it has not eliminated the need for teachers. On the contrary, the growing availability of instant information makes the role of the chemistry teacher even more significant in developing conceptual clarity, laboratory skills, ethical awareness and scientific thinking. AI can help students solve problems, organize information, and learn at their own pace. However, it cannot replace teachers, who provide guidance, motivation, and encourage students to think critically. The future of chemistry education is not about choosing between AI and teachers, but about using both together. Chemistry teachers will continue to play a vital role in helping students understand concepts, apply their knowledge, and develop scientific thinking and good values.

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