

Received Date: October 20, 2025

Accepted Date: November 11, 2025

Published Date: December 01, 2025

Bloom's taxonomy revisited in the age of Artificial Intelligence

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Abstract

Bloom's taxonomy, originally developed in 1956 by Benjamin Bloom and his colleagues, proposes a hierarchical classification of learning objectives ranging from simple memorisation to creation: remembering, understanding, applying, analysing, evaluating and creating. This structure However, the advent of generative artificial intelligence (GAI) embodied by tools such as ChatGPT, DALL·E, Gemini and Copilot is profoundly transforming the way these cognitive levels are mobilised and developed. In the era of GAI, revising Bloom's taxonomy is essential. The learner is no longer a mere receiver, but a co-creator of knowledge with

the machine. AI facilitates the lower levels (memorisation and comprehension) through the automatic generation of summaries, examples and contextualised explanations. This frees up time for higher cognitive activities such as analysis, evaluation and creation, where humans retain a critical and ethical role. Generative AI tools can, for example, simulate complex situations, generate personalised case studies or offer adaptive feedback, thereby promoting differentiated and experiential teaching. However, this transformation is not without its challenges: risks of cognitive dependence, assisted plagiarism, loss of critical thinking, and the need for new digital skills. Thus, the "revisitation" of Bloom's taxonomy in the era of

generative artificial intelligence is not about replacing it, but reinterpreting it. It calls for augmented pedagogy, where humans retain cognitive and ethical leadership, while AI acts as a catalyst for learning. The goal is no longer just to create knowledge, but to co-construct meaning in an intelligent, interactive and critical environment.

Keywords: Bloom's taxonomy, generative artificial intelligence, cognitive learning, digital pedagogy, educational transformation, AI ethics, augmented education, pedagogical innovation.

1. Introduction

Since its initial formulation in 1956, **Bloom's taxonomy** has served as an essential reference in educational planning, learning assessment and the structuring of educational objectives. Designed at a time when teaching was based primarily on the transmission of knowledge, this hierarchical classification of cognitive skills has profoundly influenced modern teaching methods.

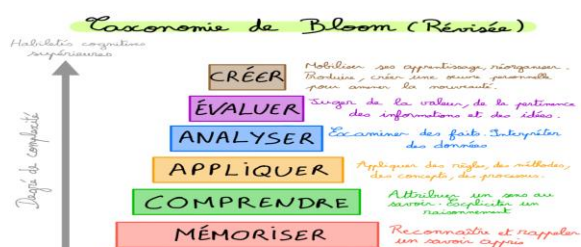


Figure 1: Six cognitive levels
Source: <https://seduc.cssdd.gouv.qc.ca/>

However, the advent of artificial intelligence (AI) and digital education is profoundly transforming the way knowledge is acquired, mobilised and assessed. AI is no longer just an assistive tool: it is becoming a cognitive actor, capable of personalising learning, automating assessment and even generating knowledge. This revolution requires a critical and adaptive re-examination of Bloom's taxonomy in order to meet the demands of intelligent, learner-centred learning.

2. A brief reminder of Bloom's taxonomy

Bloom's taxonomy is a hierarchical classification of educational objectives, developed in 1956 by **Benjamin Bloom** and his colleagues. Its main objective was to provide a systematic framework for defining, planning and evaluating learning in educational institutions.

2.1 The three domains of taxonomy

- **Cognitive:** knowledge and intellectual skills;
- **Affective:** attitudes, values, motivations;
- **Psychomotor:** physical and practical skills.

In the cognitive domain, six hierarchical levels are identified:

1. Remember;
2. Understand;
3. Apply;
4. Analyse;
5. Evaluate;
6. Create.

Bloom identified three main areas of competence:

1. **Cognitive:** this concerns knowledge and intellectual skills. It is the area most commonly used in academic teaching.
2. **Affective:** this relates to the attitudes, values, motivations and behaviours of the learner.
3. **Psychomotor:** this relates to physical skills and motor coordination.

2.2 Cognitive hierarchy (cognitive domain)

The original version distinguishes six cognitive levels, ranked from the simplest to the most complex form of thinking:

1. **Knowledge (Memorisation):** the ability to remember factual or procedural information.
2. **Comprehension (Understanding):** the ability to interpret, summarise or explain concepts.
3. **Application (Application / Apply):** the ability to use knowledge in concrete situations.

4. **Analysis (Analyse):** the ability to break down information to identify relationships and structures.
5. **Synthesis (Creating):** the ability to combine elements to create a coherent whole.
6. **Evaluation (Evaluate):** the ability to make judgements, compare ideas or validate solutions according to criteria.

2.2.1 Educational importance

2.2.2 Modern revision



Figure 2 : New forms of learning

Source:

<https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.didask.com%2Fpost%2F1a-taxonomie-de-bloom-revisee-vers-une-approche-cognitive-plus-moderne-apprentissage&psig>

In 2001, **Anderson and Krathwohl** proposed a revised version that:

- Renames and restructures certain levels: *Creating* becomes the highest level, and *Evaluating* precedes *Creating*.
- Introduces a dynamic dimension, with **two axes**: type of knowledge (factual, conceptual, procedural, metacognitive) and cognitive process.

This taxonomy remains a fundamental tool for educational planning today, but it needs to be revisited to take into account new forms of digital learning and the integration of AI in education.

2.2.3 Origin and objectives of Bloom's taxonomy

2.2.3.1 Historical origins

- **Cognitive:** knowledge and intellectual skills;
- **Affective:** attitudes, values, motivations;

Bloom's taxonomy enables teachers to:

- **Structure their educational objectives** in a progressive order of complexity.
- **Design activities and assessments tailored** to the target cognitive level.
- **Promote thoughtful educational progression**, from simple memorisation to creativity and critical thinking.

Bloom's taxonomy originated in the work of **Benjamin S. Bloom**, an American psychologist at the University of Chicago, who in 1948 led a committee of educators seeking to define a standardised classification of educational objectives. Their goal was to create a framework for harmonising teaching assessment and planning practices at a time when educational approaches lacked consistency between institutions.

The first publication, entitled "*Taxonomy of Educational Objectives: The Classification of Educational Goals*" (1956), proposed a hierarchy of the cognitive domain, i.e. intellectual knowledge and skills. Bloom presented a model with six progressive levels: **knowledge, comprehension, application, analysis, synthesis and evaluation.**

This taxonomy was subsequently expanded by other researchers such as **Krathwohl, Bloom & Masia (1964)** for the affective domain, and **Simpson (1972)** for the psychomotor domain. Over time, it has established itself as a universal reference tool in educational design, the definition of learning objectives and the construction of formative or summative assessments. Bloom's taxonomy, developed by Benjamin Bloom and his colleagues, aimed to provide a framework for classifying educational objectives according to increasing levels of complexity.

It is based on three domains:

- **Psychomotor:** physical and practical skills.

In the cognitive domain, six hierarchical levels are identified:

- Remember;
- Understand;
- Apply;
- Analyse;
- Evaluate;
- Create.

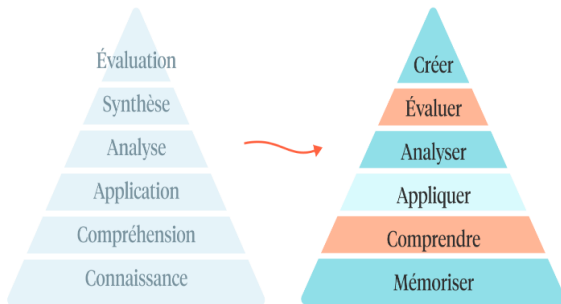


Figure 3: Six hierarchical levels

Source:

<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=images&cd=&>

2.2.3.2 Educational objectives of taxonomy

The main objectives of Bloom's taxonomy are as follows:

- **To structure learning** according to a logical order of cognitive complexity;
- **To guide teachers** in formulating clear and measurable objectives;
- **To align teaching methods and assessments** with the targeted levels of learning;
- **To encourage critical thinking and creativity** in learners, going beyond simple memorisation;
- **Establish a common language** among educators, instructional designers, and researchers to describe learning.

Thus, taxonomy bridges the gap between learning theory and educational practice,

enabling rigorous content planning, better assessment of skills, and harmonious progression of knowledge.

2.2.3.3 Limitations of classical taxonomy in the digital age

Bloom's taxonomy was designed in a linear, teacher-centred teaching context. However, the digital age is characterised by:

- **An abundance of information** and constant connectivity;
- **Network collaboration** and open learning;
- **The automation of memorisation** through digital tools;
- The emergence of **hybrid skills** (digital, critical, creative).

As a result, Bloom's cognitive hierarchy has become partially obsolete: learning is no longer just a vertical progression, but a dynamic, interactive and adaptive process, often assisted by AI.

2.2.3.4 Revisiting Bloom's taxonomy in the age of AI

2.2.3.4.1 An adaptive and non-linear approach

Thanks to AI, learning paths can be personalised according to the needs, pace and preferences of each learner. This leads to a reconfiguration of Bloom's model into a circular and intelligent system, where cognitive levels are no longer sequential but interconnected.

2.2.3.4.2. New cognitive dynamics: from memory to augmented creation

Table 1: New cognitive dynamics

Level	Traditional taxonomy	Taxonomy revisited with AI	Example
01	Memorise	Access augmented information	Use ChatGPT to find a contextualised definition
02	Understand	Co-construct meaning with AI	Interactive dialogue to clarify a complex concept
03	Apply	Simulate and experiment with AI	Using an intelligent simulator to solve a scientific problem
04	Analyse	Analyse data using AI	Use a text or data analysis tool
05	Evaluate	Co-create the assessment with algorithms	Self-assessment and intelligent feedback
06	Create	Create with generative assistance	Generate a project, idea or text using creative AI

3. Towards an augmented cognitive taxonomy

The integration of AI leads to an augmented taxonomy, where each level is enriched by cognitive abilities shared between humans and machines:

- **Augmented perception:** automatic recognition of images, sounds, patterns;
- **Semantic understanding:** natural language processing (NLP);
- **Adaptive reasoning:** intelligent recommendation of solutions;
- **Generative creation:** synthesis of new content.

Thus, AI does not replace human cognition, but extends and enhances it. Educational technologies and their impact: educational technologies (EdTech) comprise a set of digital tools designed to facilitate, enrich and individualise learning. They include digital work environments (ENT), online learning platforms (LMS), simulators, virtual classrooms and automated assessment applications.

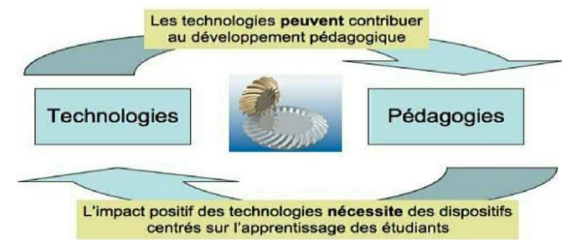


Figure 4: Contribution of technology to educational development

These tools promote flexibility in learning, allowing students to learn at their own pace and according to their needs. In addition, the widespread availability of connectivity and open resources (MOOCs, OERs, etc.) has made knowledge more accessible, democratising education on a global scale.

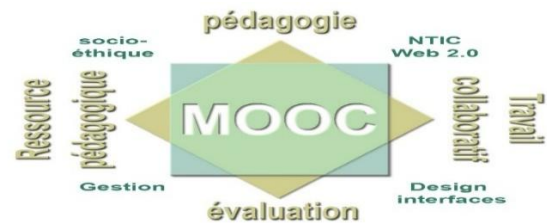


Figure 5: Massive Open Online Course

4. Learning from a hybrid MOOC

Learners in a hybrid MOOC (*Massive Open Online Course*) are participants who combine online learning (e-learning) with face-to-face activities. They benefit from great flexibility thanks to digital content that is accessible at any time, while also enjoying direct interaction and face-to-face collaboration for discussions, role-playing and putting their knowledge into practice.

4.1 Characteristics of learners in a hybrid MOOC

- **Flexibility and autonomy:** They manage their own timetable for the online modules and progress at their own pace, while meeting deadlines ;
- **Constant access to materials:** They have continuous access to the training platform to review videos and documents and to complete practical exercises ;
- **Synchronous and asynchronous interaction:** They participate in real-time online sessions,

such as masterclasses or webinars, but also in activities at their own pace, asynchronously ;

- **Collaboration and exchange:** The face-to-face component encourages debates, discussions and case studies, which strengthens group dynamics and interactions between learners ;
- **Support and guidance:** They can ask questions to trainers, receive personalised guidance and interact with other learners via forums, chats or mentoring sessions ;
- **Practical work:** They move from online theory to practice during face-to-face sessions,

4.2 Pedagogical implications

4.2.1 For the teacher

Teachers become cognitive architects, guiding the ethical and critical use of AI:

- They design activities that integrate human reflection and intelligent automation;
- They learn to interpret the results produced by AI and to develop learners' critical thinking skills.

4.2.2 For learners

Learners become autonomous and augmented actors:

- They learn to interact with intelligent systems;
- They develop metacognitive skills (learning to learn with AI);
- They are encouraged to become creators of knowledge, not mere consumers.

5. The role of data and artificial intelligence in education

The collection and analysis of educational data, or learning analytics, now makes it possible to

enabling them to apply and consolidate what they have learned.

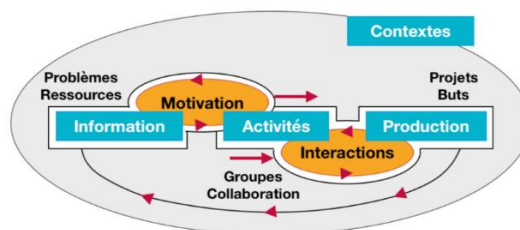


Figure 6: Learners in a hybrid MOOC

observe and understand learner behaviour in order to adjust teaching strategies.

Artificial intelligence, meanwhile, introduces adaptive systems capable of offering tailor-made content, detecting learning difficulties and providing personalised support. This data-driven approach transforms traditional teaching into a predictive and proactive teaching approach, focused on the specific needs of each learner.



Figure 7: Limitations of artificial intelligence in education

6. Bloom's taxonomy in the age of artificial intelligence

La taxonomie de Bloom à l'ère de l'intelligence artificielle		
Regard sur les activités classiques d'apprentissage et d'évaluation	Capacités de l'IA générative	Compétences humaines distinctives
CRÉER	Suggérer une gamme d'alternatives, énumérer les inconvénients et avantages potentiels, décrire des cas réels.	Formuler des solutions originales intégrant le jugement humain, collaborer spontanément.
ÉVALUER	Identifier les avantages et les inconvénients des différentes possibilités d'action, développer des grilles d'évaluation.	S'engager dans une réflexion métacognitive, évaluer de manière holistique les conséquences éthiques des différentes possibilités d'action.
ANALYSER	Comparer et différencier les données, déclarer les tendances et les thèmes, calculer, prédire.	Penser et raisonner de manière critique dans les domaines cognitifs et affectifs, interpréter et rapporter des problèmes, prendre des décisions et faire des choix.
APPLIQUER	Utiliser un processus, un modèle ou une méthode pour illustrer comment résoudre un problème de nature quantitatif.	Opérer, mettre en œuvre, conduire, évaluer, expérimenter et tester dans le monde réel ; mettre en œuvre la créativité et l'imagination pour le développement d'idées et de solutions.
COMPRENDRE	Décrire un concept avec d'autres mots, reconnaître un exemple té, traduire.	Contextualiser les réponses en tenant compte des considérations émotionnelles, morales ou éthiques.
MÉMORISER	Rappeler une information factuelle, énumérer les réponses possibles, définir un terme, construire une chronologie.	Se rappeler de l'information dans des situations où la technologie n'est pas facilement accessible.

Figure 8: Bloom's taxonomy in the age of AI
Source: cadre21, 2025

7. Transformation of teaching practices and 21st-century skills

The digital revolution has led to the emergence

7.1 New learning models and digital inclusion

Learning models are evolving towards greater personalisation and universal accessibility. Digital devices make it possible to integrate a variety of audiences, including learners with disabilities or those living in remote areas. Mobile learning (m-learning) and immersive environments such as augmented reality and virtual reality promote a multisensory and interactive learning experience. Digital inclusion is thus becoming a major issue in contemporary education policy. Most learners and the general population are not fully immersed in digital technology.



Figure 10: Digital technology in the classroom in two steps – Evaluation of a continuing education scenario

of active, learner-centred teaching methods: project-based learning, flipped classrooms, collaborative learning, hybrid learning, etc. These approaches promote autonomy, creativity, critical thinking and the ability to solve complex problems — essential skills in the information society. The role of the teacher is changing: they are becoming facilitators, coaches and designers of learning experiences enriched by technology.

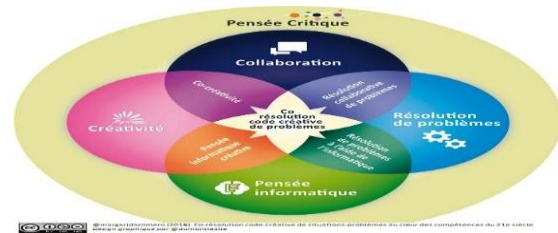


Figure 09: Teaching practices and skills

7.2 Capabilities of generative artificial intelligence

Talking about artificial intelligence (AI) leads us to think about intelligence based on our human perception of what it can be. Its boundaries are poorly defined, but we generally agree on a common understanding that relates to our ability to perform certain tasks with a certain degree of competence. The computer analogy, with the addition of the word "artificial", does not help us understand what AI is or what it can do, because it does not share the same mapping of skills. Artificial intelligence: machines capable of performing tasks characteristic of human intelligence. **McCarty, 1956**

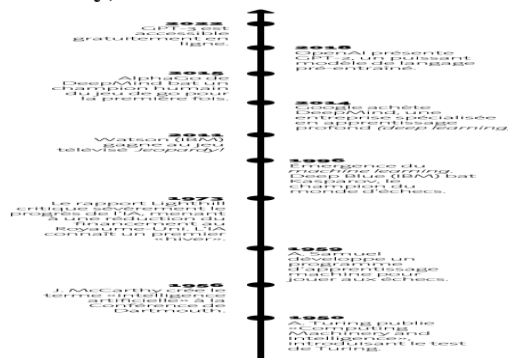


Figure 11: Characteristics of human intelligence

The phrase "AI is the new electricity" comes from **Andrew Ng**, a renowned computer scientist, entrepreneur and professor at Stanford University. Just as electricity transformed various industries in the past, AI has the potential to have an equally revolutionary impact in many areas of contemporary society. In this context, AI is emerging as a transformative force, shaping our lives in ways that were once unimaginable.

Generative AI is a type of artificial intelligence that creates realistic content by using existing data to learn. Generative artificial intelligence can provide realistic and creative text, images and other media to transform the entertainment, marketing and healthcare sectors, for example.

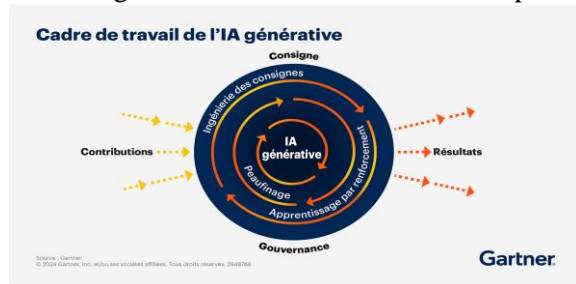


Figure 12: Generative AI

7.3 Distinctive human skills

Distinctive human skills are unique and difficult-to-imitate *knowledge, know-how and interpersonal skills* that enable a company to differentiate itself from its competitors and create a sustainable competitive advantage. They are the source of the organisation's strategic performance and can be technical skills such as technological expertise, or behavioural skills such as leadership. Identifying and strategically managing these competencies is essential to ensuring a company's success and sustainability. Distinctive human competencies are behavioural qualities (soft skills) sought after by employers, such as communication, problem solving, critical thinking and adaptability. They differ from technical competencies (hard skills) and are essential for gaining a competitive advantage because they are difficult to imitate.

In the early days, training AI systems required significant human intervention, posing considerable challenges in terms of data organisation, labelling, time, cost and updates. With the advent of AI models called Neural Networks, a revolution has taken place, and now AI systems can be trained without requiring direct human intervention, offering extraordinary efficiency gains. This explosive transition, which we now call Generative AI, marks... **Jose Antonio Ribeiro Neto (Zezinho) (16 April 2024).**



Figure 13: Representative illustration of Generative AI (credit: MS Image Creator)

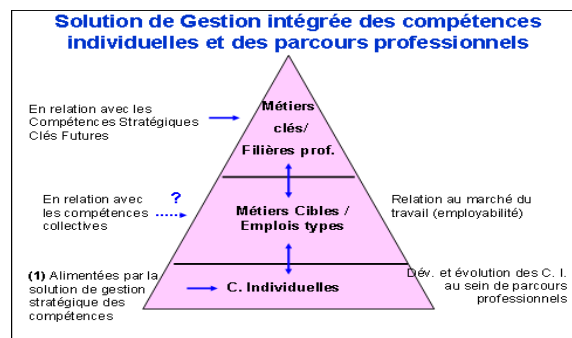


Figure 14: Distinctive human skills

8. Challenges and prospects

8.1. Ethical and critical challenges

Given the complexity and growing impact of artificial intelligence (AI) on our lives, ethical challenges and criticism are on the rise. A page summarises these major issues, organised around a few fundamental themes. We have ethical challenges:

- Risk of cognitive dependence on AI;
- Manipulation of learning data;

- Algorithmic biases affecting evaluations.

8.2. Outlook

Beyond the current challenges, AI raises existential questions about the future of humanity, including the control of super-intelligent systems. For a responsible future, the development of AI requires global collaboration and a constant ethical commitment from all stakeholders.

- Development of hybrid taxonomies integrating emotions, cognition and AI;
- Use of explainable AI for educational transparency;
- Creation of intelligent educational standards aligned with 21st-century skills.

9. Conclusion

Bloom's taxonomy in the age of AI means rethinking the way we define the act of learning. AI is profoundly transforming cognitive levels: it automates memorisation, amplifies understanding, facilitates analysis and inspires creation. However, it does not abolish the human role; it elevates it to reflective and creative cognition. The pedagogy of the future will therefore be one of augmented intelligence, where humans and machines co-construct knowledge, critical thinking and innovation.

Revisiting Bloom's taxonomy in the age of artificial intelligence (AI) is much more than a simple exercise in educational modernisation: it is a fundamental rethinking of the very nature of learning, cognition and assessment. In a world where cognitive technologies automate certain mental functions, learners are no longer just recipients of information, but co-creators of knowledge. AI, with its ability to process massive amounts of data, personalise learning paths and provide intelligent feedback, is transforming the traditional cognitive levels of Bloom's taxonomy:

- **Memorisation** is now assisted by intelligent knowledge recall and anchoring systems ;

- **Comprehension** is enriched by AI-powered conversational agents, simulators, and visualisation tools;
- **Application** becomes an interactive process, where learners experiment in immersive or adaptive environments;
- **Analysis** relies on data mining and computational thinking, encouraging critical reading of algorithms;
- **Assessment** is redefined through automated performance analysis and real-time measurement of skills;
- Finally, **creation**, the pinnacle of the taxonomy, extends to augmented creativity, where humans collaborate with AI to generate new ideas, artefacts or innovative solutions.

Thus, Bloom's taxonomy revisited in the age of AI becomes a dynamic and interactive framework, integrating critical thinking, human-machine collaboration and digital ethics as new dimensions of modern cognition. This reconfiguration invites teachers to redefine their roles: from transmitters to facilitators of intelligent, human-centred learning experiences. Ultimately, AI does not replace human thinking, it reinforces, extends and transforms it, paving the way for a more adaptive, inclusive and reflective education. Revisiting Bloom in the light of AI means preparing the schools and universities of the future, where learning becomes a shared act between machines and human consciousness.

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