AI-HED
Artificial Intelligence in Higher Education Teaching and Learning

Starter Kit

University of Zagreb Faculty of Organization and Informatics

ERASMUS+ COOPERATION PARTNERSHIP

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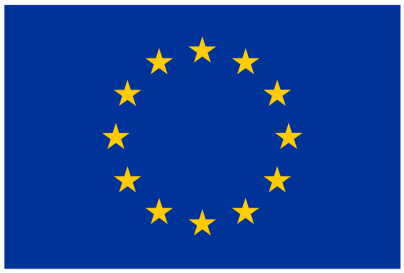
This document contains some of the results and deliverables of the Artificial Intelligence in Higher Education Teaching and Learning (AI-HED) project.



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AI-HED
Artificial Intelligence in Higher Education Teaching and Learning

Contents

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Introduction

Many aspects of modern life are under the influence and being revolutionised by the use or the presence of artificial intelligence (AI). Even though it was once considered and perceived to be simply a concept from futuristic tales, AI profoundly influences our lives in modern times, including our daily interactions, decisions, and behaviour. From personalised digital assistants such as Siri and Alexa, over the backend, serving us customised recommendations while shopping, to complex systems diagnosing various illnesses, AI technologies significantly impact the modern civilisation. The rapid advancements we have experienced recently show promise of a continual transformation in multiple disciplines across the globe, including industry, society, and education.

One of the crucial roles higher education institutions (HEIs) play in the modern society is integrating, researching, and developing many different facets of AI. They serve as state-of-the-art research hubs that combine theory with practical applications. Universities worldwide use AI to streamline administrative processes, foster innovation, improve educational outcomes, and enhance teaching and learning processes. Therefore, integrating AI into education impacts technological advancement, substantial pedagogical changes and challenges, and strategic institutional development.

The Erasmus+ Cooperation Partnership project, titled *Artificial Intelligence in Higher Education Teaching and Learning* (AI-HED), acknowledges the importance of this strategic integration. With international collaboration between Stichting Hogeschool van Amsterdam, Fachhochschule des BFI Wien, Instituto Politécnico de Lisboa, and the University of Zagreb Faculty of Organization and Informatics, the AI-HED project's objective is to empower HEIs to foster and utilise the potential of AI technologies in teaching and learning processes. The project's essential objective is enhancing the digital competencies of educators and students and fostering enriched interactive educational experiences.

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AI in Higher Education

The application of AI in higher education can be observed as both extensive and diversified, thus offering modern and innovative approaches to teaching and learning processes. More than simply adaptive learning systems or intelligent tutoring platforms, AI can be seen in HEIs in roles that could be classified in the following key areas.

Personalised learning. Various AI-based models, tools, and systems make creating a personalised learning experience for students and learners of various profiles and features easier. Furthermore, individualised and customised approaches can be realised due to the possibilities of analysing learners' performance, learning styles, and preferences. Therefore, it is possible to customise content delivery to best suit individual learners and their unique needs and preferences. An AI-powered system might suggest specific learning sources to students based on their perceived or defined preferences, or it may adjust the difficulty level of particular assignments regarding the specific student's record, thus helping create a more engaging and effective learning environment. This level of personalisation may induce better student engagement and improve retention and academic outcomes.

Intelligent tutoring. These systems may be used or implemented as simulations of individual interaction with a human tutor to provide students with real-time or immediate and personalised feedback and guidance on further learning. Such a system might offer targeted explanations, hints, or additional learning resources based on the student's perceived understanding of a given topic. The student's level of knowledge may be determined by using quizzes, simple conversations, or different types of assignments. The personalised learning experience is tightly tied to and is one of the significant points of intelligent tutoring systems.

Automated assessment and feedback. AI may facilitate the automation of grading and feedback processes, especially for assessment instances that can be graded objectively or feature multiple-choice or true/false questions. Some more advanced AI-based tools and systems may be used to analyse the content, structure, and coherence of more advanced and unstructured types of content, such as open-ended responses and essays. Such an automation opportunity should not wholly be used to automate the assessment and feedback processes. Instead, it should be used as an aide for teachers.

Virtual teaching. AI-based virtual assistants can be implemented and integrated into higher education as instructors or students. As instructors, they can be helpful to students who can have a personalised tutor available at any given moment [1]. As students, these systems may be used to test and verify learning materials, gauge the

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difficulty levels of assignments, or assess the cohesiveness and consistency of the prepared contents. Furthermore, such systems may be used to handle routine inquiries, explain the course material's content, and facilitate discussions.

Data-driven insights. While personalised learning and intelligent tutoring systems face users, i.e. the learners, the other side of such systems may provide teachers and education institutions with valuable data. Such data may contain insights into student performance, engagement levels, and possibly behaviour that may lead students to a risky situation education-wise. Patterns and trends hidden in these data may be priceless in leading teachers to make the best decisions about instructional strategies, curriculum design, and personal interventions to help students succeed. Eventually, acting on the insights provided by data analysis may give educators the necessary edge to assume a proactive role in education and address educational challenges rather than a reactive one.

Collaborative learning. It may be easier to form student groups using AI-based tools and systems in a way that would optimise peer interaction based on the complementary skills and learning styles of students. Furthermore, coupling this aspect of using AI in HEIs with personalised learning or intelligent tutoring may provide a collaborative environment that encourages inquiry-based learning and promotes critical thinking, all while fostering collaborative problem-solving skills.

Administrative tasks. Even though it is most interesting to observe and consider the use of AI-based models, tools, and systems within the constraints of student-teacher interaction, these tools may also be used in streamlining and automating administrative tasks. Enrolment management, scheduling, and resource allocation are only some of the challenges already researched as application domains of AI.

Some of the above-mentioned areas and examples of using AI in higher education have the prospect of thoroughly changing the current approach to education. Running these systems, though, usually demands constant connection to the Internet and entails a non-trivial demand towards the electricity grid. Moreover, the computational intensity and significant energy consumption associated with AI-based tools and systems contribute significantly to global electric energy consumption. Hence, using and developing such tools is critical in global environmental concerns.

Even though the end-user might not perceive the amount of energy required for a 'simple' task given to an AI-based tool or system, especially in the context of using modern large language model (LLM) agents such as Le Chat, the actual figures should not be ignored. Increased reliance on various AI-based tools and systems should be thought through in the context of environmental implications before making the final decision. Although some of the most well-known names in the domain of publicly avail-

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able LLM agents already started increasing their investments in the energy industry, the problem of a sharp increase in electric energy consumption in recent years should not be ignored in the discussions on using AI-based tools and systems.

Ultimately, HEIs should observe AI adoption as complementary to human intelligence, skills, and abilities rather than replacing them. Should AI-based tools and systems be considered educator empowerment, creative, critical, and personalised mentoring may enable new teaching and learning approaches that foster student engagement.

Many AI-based tools and systems have become widely and publicly available due to some of the most recent advancements in the domain of artificial intelligence and related research. These tools base their output on massive amounts of data collected for training the AI models in the backend. Such models are very often enriched by the conversations users have with the prepared interface to the chosen models. This approach to using AI models is beneficial in terms of ease of use and accessibility, but is a cause of concern and vigilance in the context of ethics and privacy.

Ethical and Privacy Considerations

Some of the most recent academic and professional advancements in the domain of AI made it possible for anybody with the connection to the Internet to interact with various types of AI models, most notably various types of language models (LLMs, e.g. Le Chat), including small, large, and multimodal. State-of-the-art studies [2] claim that at least one such model passed the legendary Turing test. Turing test [3] was designed by Alan Turing in 1950 as a way to test whether machines could exhibit human-like intelligence. The test involves a human evaluator who engages in a natural language conversation with both a human and a machine, trying to determine which is which. If the evaluator cannot reliably distinguish the machine from the human, the machine is said to have passed the Turing test. It is claimed in [2] that the model GPT-4.5 with 'included additional instructions on what kind of persona to adopt in responding to the interrogator' passed the test 73 percent of the time. This result ensures the relevance of ethical and privacy considerations in the context of using AI-based tools and systems.

Several issues can be observed as highlighted in recent studies [4], [5], including data-induced and algorithmic bias, lack of transparency, privacy, and data protection rights, and questions of accountability. It is clear that using AI-based tools and systems in higher education should be done with caution and vigilance in accordance with the

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latest policies and guidelines. This section details some of the enumerated issues and outlines how they might be addressed to ensure responsible use of AI-based tools and systems.

Data-induced and algorithmic bias. One of the sources of problems introduced by the increased use of AI-based tools and systems that use AI models built and trained on big amounts of data is the inherent bias in the data used to train the models. This bias can manifest in various ways, such as gender, race, or socioeconomic status bias [6]. Such bias can lead to unfair outcomes and perpetuate existing inequalities [5]. It is often that the data used to train AI models is not representative of the population it is intended to serve, leading to biased outcomes. Frequently, the average person will condone the output of an AI model and judge it is biased, while ignoring the fact that the perceived bias is based on the data the model was trained on. The bias that is shown by the model is, therefore, not the fault of the model itself, but the data it was trained on. The perceived bias is only perpetuating the bias in the data. Various examples of bias are documented in published studies, in the context of using AI-based tools and systems in higher education.

Ensuring fairness and non-biased results should be one of the fundamental features of using AI-based tools and systems. The goal is to prevent AI from hindering educational equity. Indeed, using AI should not be allowed to further deepen the digital divide or reinforce existing bias in the academia.

Lack of transparency. Various AI models are observed using the black-box approach, i.e. the models are not transparent in their inner workings. In other words, nobody, not even the model authors, are completely aware of how some models work. This is especially true for complex machine learning models. This opacity, as we may describe the lack of transparency, can obscure, for example, why a student was flagged as at-risk by an AI-based system, or how and why an automated grading system suggests a particular score. Such opacity not only undermines trust but can also makes it difficult to challenge or appeal AI-driven decisions that affect student rights (such as admission or grading outcomes). The concept that fights for greater transparency in AI is called explainability [7]. One of the identified key challenges of sustainable AI in education is 'ensuring ethics and transparency in data collection, use, and dissemination.' Increasing transparency might mean that, for example, students and staff are provided with clear information about what data an AI-based system uses, how those data are processed, and on what basis it reaches its outputs. It also means enabling explanations for individual decisions – for instance, explaining to a student why an intelligent tutoring system keeps recommending them a certain exercise.

The EU's AI Act [8] introduces requirements for explainable AI, especially for high-stakes applications [7]. High-risk AI systems (a category that includes many educa-

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tional uses) are expected to provide interpretability so that their functioning can be understood and audited. Furthermore, data collection and use practices are regulated within the EU by the EU's General Data Protection Regulation (GDPR) [9]. The GDPR requires transparency in data collection and use, particularly when automated decision-making is involved [10]. These regulations help make AI systems more transparent and comprehensible and boost accountability in using them.

Privacy and data protection. Although higher education might not be the most risk-prone domain of human activity, it relies on large amounts of data on students and employees, including academic records and learning management system logs. Storing data that may be classified as private or sensitive, including video recordings of lectures or students' personal background details and interaction with learning systems, raises significant privacy and data protection concerns [5]. In order to enhance ethical use of data, the EU's GDPR [9] directly addresses these concerns. It gives individuals enhanced rights and mandates increased transparency on how their data can be collected and processed. Under GDPR, data controllers (entities that collect data) such as universities, must inform users what will be done with their data before they are collected or processed and explain how their privacy is protected. In particular, Article 22 of the GDPR grants individuals the right not to be subject to decisions based solely on automated processing that may have significant effects, legal or otherwise, unless appropriate safeguard measures (like human review or intervention) are in place. This provision is highly relevant if, for example, a university were to use an AI model to make fully automated admissions decisions or degree grading.

Furthermore, the EU's AI Act [8] controls how the collected data may be analysed and used, through the concepts of the right to privacy and to protection of personal data. These rights 'must be guaranteed throughout the entire lifecycle of the AI system.' Furthermore, in the context of processing personal data, the GDPR recognises several principles, such as data minimisation, purpose limitation, lawfulness, fairness, and transparency. Personal data is therein defined as 'any information relating to an identified or identifiable natural person.' [9]

Within this context, universities and other higher education institutions must protect student and other personal data and obtain consent from students for the collection and use of their data in AI-based systems [5]. This may be ensured by following the 'data protection by design and by default' [9] concept mandated by the GDPR. Therefore, they uphold the privacy rights of the academic community, while leveraging data for educational benefits.

Bending perception of reality. The most recent advancement in artificial intelligence, especially generative artificial intelligence, which can be observed in some publicly available tools, services, and systems, allows the average person to bend the

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perception of reality. This poetic expression is used here to encompass all the activities that may influence others' perceptions of reality via exposure to fake content, manipulated information, or other means enabled or enhanced by AI. Models that made it possible to generate cute and innocent videos and photos can be used in more nefarious and malicious ways, such as fake reporting on natural disasters [11].

Therefore, it is obvious that AI-based tools and systems may be used to change students' and teachers' perceptions of the world. For example, AI-based tools and services may be used to generate fake student responses to assignments, fabricate sources with fake content, or manipulate images and videos to benefit either side or their loss.

The above discussion may be indicative of the considerations that must be taken into account with regard to the use of AI-based tools and systems in higher education. The concept that may be argued to encompass the above points is the concept of trustworthy AI. Such AI was described by the European Commission [12], [13] as a concept of three components: it should be lawful, ethical, and robust. In other words, trustworthy AI should be aligned with the applicable laws and regulations, respect and adhere to ethical principles and values, and be robust enough to prevent AI systems from causing unintentional harm.

Taking the above into consideration, this project aims at aiding the responsible use of AI-based tools and systems in higher education. Better education, raised awareness, and improved ethical and privacy considerations in teachers and students are the main identified drivers of change in this context.

This document is prepared to provide a solid starting point in considering the responsible use of AI-based tools and systems in higher education. Therefore, it provides:

- a glossary of a collection of fundamental terms and phrases in the domain of artificial intelligence in chapter 2;
- a collection of AI-based tools in chapter 3, categorised into several descriptive categories and combined with a heatmap of tools and DigComp 2.2 [14] competencies each tool is aligned with;
- a collection of case studies in chapter 4 that highlight the use of AI-based tools and systems in higher education;
- a collection of current practice examples in chapter 5 that highlight the use of AI-based tools and systems on the partner institutions of the project consortium.

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Glossary of Terms

As artificial intelligence (AI) continues to revolutionize fields ranging from healthcare and finance to education and the arts, a foundational understanding of its key concepts has never been more essential. In higher education, AI plays a crucial role in research and practical applications, shaping the tools we use and how we approach complex problems. Whether you're a newcomer or a seasoned researcher, this glossary guides the terminology, techniques, and core ideas that define this dynamic field.

From the basics of machine learning to the nuances of neural networks and ethical considerations, this glossary is designed to be a starting point in navigating the language of AI. Each term serves as a gateway into a specific aspect of AI, illustrating how these concepts interconnect to form the systems and technologies we engage with today. By becoming familiar with this terminology, you'll gain insight into the structure and processes that make AI a transformative force in academia and beyond.

Use this glossary as a resource for study, inspiration, or simply to deepen your understanding of the artificial intelligence landscape. Each term, while simple on its own, contributes to the broader story of AI. This field is about machines and the future of human knowledge, creativity, and discovery.

Each concept in the glossary is described using three features: a definition (🔭), a description (📜), and an example (🎴). The definition provides a concise explanation of the term, while the description offers context and insights into its applications. The example illustrates how the concept is used in practice, demonstrating its real-world relevance and impact.

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A

Adaptive learning

[15], [16]

An educational approach that adjusts the pace and path of learning based on a student's performance.

Adaptive learning systems analyze a learner's interaction and performance to dynamically adjust the content and difficulty, ensuring that each learner progresses at their own pace.

Platforms like DreamBox Learning that adapt math instruction.

Artificial intelligence (AI)

[17], [18]

A field of computer science focused on creating systems capable of performing tasks that typically require human intelligence.

AI encompasses a variety of technologies and methods, including algorithms, robotics, and cognitive computing, aimed at mimicking human cognitive functions such as learning and problem-solving.

AI applications in healthcare, autonomous vehicles, and finance.

Artificial general intelligence (AGI)

[17], [19]

AGI looks for a universal algorithm for learning and acting in any environment.

AGI refers to hypothetical AI systems that possess the ability to understand, learn, and apply knowledge across a wide range of tasks at a level equal to or beyond human capabilities.

An AGI could seamlessly switch from writing a college essay on quantum physics to composing a symphony, and then to diagnosing a medical condition, all with human-like proficiency.

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AI AS CO-TEACHER [20], [21]

AI as a co-teacher assists educators by providing personalized learning, facilitating assessments, and supporting student engagement through intelligent automation.

In higher education institutions, AI as a co-teacher assists with personalized learning, grading, resource management, and real-time feedback, enhancing faculty efforts and improving student outcomes.

AI as a co-teacher in HEIs provides personalized feedback, supports teaching, and enhances student learning experiences.

AI IN EDUCATION [22], [23]

The application of AI technologies to enhance teaching and learning processes.

AI in education leverages various technologies to create innovative teaching tools and personalized learning experiences, improving access to education and student outcomes.

Khan Academy using AI to offer personalized practice recommendations.

AI-ASSISTED GRADING [24], [25]

AI-assisted grading uses artificial intelligence to evaluate and score student work, automating assessments while improving consistency and efficiency.

AI-assisted grading in education streamlines the evaluation process by automatically scoring assignments, providing real-time feedback, and ensuring objective, consistent assessments to support personalized student learning.

AI-assisted grading in HEIs automates assessment, providing faster, consistent evaluations and personalized feedback for students.

AI-ASSISTED LEARNING [26], [27]

AI-assisted learning uses artificial intelligence to personalize education, adapt to student needs, automate tasks, and enhance learning experiences.

AI-assisted learning in higher education institutions personalizes education, offering adaptive learning paths, automating administrative tasks, and providing real-time feedback to enhance student engagement and academic performance.

AI-assisted learning in HEIs tailors educational content, offering personalized resources and adaptive assessments to enhance student outcomes.

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AI-ENHANCED CURRICULUM DESIGN [28], [29]

Using AI to create and optimize educational curricula that meet diverse learner needs.

AI-enhanced curriculum design utilizes data analytics to inform the creation and adaptation of curricula that align with student needs and learning outcomes.

Curricula designed based on data-driven insights from previous cohorts' performance.

AUGMENTED REALITY (AR) [30], [31]

An interactive experience that overlays digital information onto the real world to enhance learning.

AR enhances real-world experiences by overlaying digital information onto physical environments, offering interactive and engaging learning experiences that promote deeper understanding.

IKEA Place app allowing users to visualize furniture in their homes.

B

BLOCKCHAIN [32], [33]

The use of blockchain technology to enhance transparency and security in educational processes.

Blockchain provides a secure, decentralized way to record transactions and credentials, ensuring integrity and trust in educational records.

Decentralized systems verifying student credentials and achievements.

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C

Chatbots [34], [35]

AI programs designed to simulate human conversation and assist users with various tasks.

Chatbots can provide instant responses to user inquiries, enhancing customer service and engagement through conversational interfaces, often powered by NLP techniques.

Customer service bots answering FAQs on websites.

Collaborative learning [36], [37]

Learning that occurs through group interactions, often enhanced by technology.

Collaborative learning facilitated by technology allows students to work together on projects, enhancing their understanding through peer interaction and shared knowledge.

Google Docs collaborative editing features for group projects.

Computer vision [17], [38]

An AI discipline that trains computers to interpret and understand visual information from the world.

Computer vision enables machines to extract meaningful information from images and videos, playing a crucial role in applications such as facial recognition and autonomous vehicles.

Self-driving cars that interpret visual data from their surroundings.

Context-aware computing [39], [40]

Computing systems that sense their environment and adapt their actions based on contextual information.

Context-aware computing enhances user experience by adapting services based on the user's context, such as location, time, and user activity.

Smart assistants adjusting recommendations based on user preferences and past behaviour.

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COPYRIGHT [41], [42]


AI-generated copyright refers to intellectual property rights over content created by artificial intelligence, often involving ownership and usage disputes.


Copyright in AI refers to the legal protection of AI-generated content, addressing ownership, usage rights, and ethical concerns regarding intellectual property created by artificial intelligence systems.


Copyright in HEIs protects intellectual property rights, ensuring proper use and attribution of academic materials and research.

D

DATA MINING [34], [38]


The process of discovering patterns in large data sets, often for the purpose of making decisions.


Data mining techniques are applied to uncover patterns and insights from large data sets, assisting educators in making informed decisions about curriculum and teaching strategies.


Market basket analysis in retail to understand shopping patterns.

DATA PRIVACY IN AI [43], [44]


Ensuring privacy of personal data in AI systems.


AI ensuring student data privacy in EdTech.


Data privacy in AI for HEIs ensures secure handling of student data, maintaining confidentiality and compliance with regulations.

DEEP LEARNING [17], [18]


A type of machine learning that uses multi-layered neural networks to analyze various factors of data.


Deep learning employs neural networks with many layers (hence 'deep') to analyze large amounts of data, making it suitable for complex tasks like image and speech recognition.


Image recognition systems used in social media platforms.

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Digital twins [39], [45]


Digital replicas of physical entities that use real-time data to improve decision-making.


Digital twins are virtual models of physical systems that use real-time data to optimize performance and predict outcomes, applied in engineering and healthcare.


Virtual replicas of cities used for urban planning and disaster management.

E

Edge computing [39], [46]


A computing paradigm that processes data near the source rather than relying on a centralized data center.


Edge computing reduces latency and bandwidth use by processing data closer to the source, enhancing real-time data processing in IoT applications.


Smart devices processing data for real-time analytics on-site.

Emotion recognition [47], [48]


AI systems capable of recognizing and interpreting human emotions from facial expressions or voice.


Emotion recognition uses AI to analyze human emotions through various inputs, providing insights for applications in marketing, therapy, and education.


Customer service systems adapting responses based on customer mood detected through voice.

Equitable AI [49], [50]


Equitable AI ensures fair treatment and outcomes for all individuals, addressing biases and promoting equal opportunities across diverse groups.


Equitable AI promotes fairness by addressing biases, ensuring diverse representation, and creating inclusive systems that provide equal opportunities and outcomes for all individuals, regardless of background.


Responsible AI in HEIs ensures ethical AI development, prioritizing fairness, transparency, and student privacy in educational applications.

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Ethical AI

[51], [52]

Ethical AI refers to the development and deployment of artificial intelligence systems that prioritize fairness, accountability, transparency, and respect for human rights.

Ethical AI focuses on developing systems that prioritize fairness, transparency, accountability, and respect for human rights, ensuring AI applications benefit society while minimizing potential harm.

Training data in HEIs helps AI models personalize learning, improve assessments, and enhance research outcomes effectively.

Ethics in AI

[18], [44]

The study of moral implications and societal impact of AI technologies.

The ethical considerations in AI encompass fairness, accountability, transparency, and the potential impacts on employment, privacy, and society.

Debates on bias in algorithmic decision-making in hiring practices.

Expert systems

[17], [39]

AI systems that mimic the decision-making abilities of a human expert in a specific domain.

Expert systems use rule-based logic to solve complex problems, providing explanations and reasoning akin to a human expert in fields like medicine or finance.

IBM Watson providing diagnostic support in healthcare settings.

Explainable AI (XAI)

[17], [53]

AI techniques that provide transparent and understandable insights into how AI models make decisions.

XAI focuses on making AI systems more interpretable and understandable, enabling users to grasp the reasoning behind automated decisions.

AI models explaining their predictions in loan approval processes.

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F

Federated learning

[17], [44]

A machine learning method that allows training on decentralized data without compromising privacy.

Federated learning enables collaborative model training across multiple devices or servers while keeping data localized, ensuring privacy and security.

Collaborative models trained on data from smartphones for predictive typing without data leaving the device.

Fuzzy logic

[17], [39]

A form of many-valued logic that deals with reasoning that is approximate rather than fixed and exact.

Fuzzy logic offers a way to deal with uncertainty and imprecision, allowing systems to reason with approximate values, which is useful in control systems.

Temperature control systems that adjust settings based on changing conditions.

G

Gamification

[54], [55]

The use of game design elements in non-game contexts to enhance engagement and motivation.

Gamification in education incorporates game-like elements such as points, badges, and leaderboards to motivate students and increase participation in learning activities.

Duolingo incorporating points and levels to motivate language learners.

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General Data Protection Regulation (GDPR)

Regulation2016679, [56]

GDPR is a European Union regulation that governs data protection and privacy for individuals within the EU.

GDPR in education ensures that institutions protect students' personal data, maintain privacy, and comply with regulations by implementing secure data handling practices and fostering transparency.

GDPR in HEIs ensures compliance with data protection laws, safeguarding student information and promoting privacy rights.

Generative adversarial network (GAN)

[17], [34]

A class of machine learning frameworks where two neural networks compete against each other to generate new data.

GANs consist of a generator and a discriminator that work against each other, leading to the creation of realistic data such as images and videos.

Deepfakes used in video content creation and entertainment.

Generative pre-trained transformer (GPT)

[57], [58]

GPT is an AI model that generates human-like text by understanding context from large datasets.

GPT is used for generating human-like text, language translation, content creation, answering questions, summarizing information, and assisting in various natural language processing applications across industries.

GPT in HEIs assists with content generation, personalized learning, tutoring, and automating administrative tasks efficiently.

H

Human-computer interaction (HCI)

[17], [59]

The design and study of user interfaces that facilitate effective interaction between humans and computers.

HCI examines how people interact with computers and designs technologies that let humans communicate with computers in novel ways.

User-friendly interfaces for software applications improving user satisfaction.

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I

Intelligent tutoring systems [60], [61]

AI systems that provide personalized feedback and guidance to learners based on their individual needs.

Intelligent tutoring systems adapt the instructional content and feedback based on learners' performance and preferences, aiming to enhance individualized learning experiences.

Knewton and Carnegie Learning providing personalized learning paths.

K

Knowledge representation [17], [39]

A field of AI concerned with how knowledge can be represented and manipulated by machines.

Knowledge representation involves various forms and structures, such as semantic networks and ontologies, that enable machines to simulate human understanding.

Knowledge graphs used in search engines to provide contextually relevant information.

L

Learning analytics [62], [63]

The measurement and analysis of data related to learners and their contexts to improve learning outcomes.

Learning analytics involves the collection and analysis of student data to inform teaching strategies, improve student engagement, and enhance educational outcomes.

Tools like Blackboard Analytics to assess student performance.

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LARGE LANGUAGE MODEL (LLM) [64], [65]

LLM is an AI model trained on vast text data to generate, understand, and manipulate natural language.

LLMs in AI process vast amounts of text data to generate, understand, and manipulate human language, enabling applications like text generation, translation, and summarization.

LLMs in HEIs support research, generate content, assist in tutoring, and enhance personalized student learning experiences.

M

MACHINE LEARNING (ML) [17], [18]

A subset of AI that enables systems to learn from data, identify patterns, and make decisions with minimal human intervention.

ML algorithms improve automatically through experience. Techniques include supervised, unsupervised, and semi-supervised learning, enabling computers to analyze data and make predictions or decisions without explicit programming.

Email filtering, fraud detection, and recommendation systems like Netflix.

MULTIMODAL LEARNING [66], [67]

Learning that integrates multiple modes of input (e.g., text, audio, video) to enhance comprehension.

Multimodal learning combines information from various sources to improve learning outcomes, allowing for richer and more engaging educational experiences.

Speech recognition systems that integrate audio and text input to enhance understanding.

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N

Natural language processing (NLP) [17], [18]

A branch of AI that focuses on the interaction between computers and humans through natural language.

NLP combines linguistics and AI to enable machines to understand, interpret, and respond to human language, facilitating applications like translation services and sentiment analysis.

Voice-activated assistants like Siri or Google Assistant.

Neural networks [17], [34]

Computational models inspired by the human brain that are designed to recognize patterns and classify data.

Neural networks consist of interconnected nodes (neurons) that process data in layers, effectively allowing the system to learn complex patterns and representations of data.

Facial recognition systems used in security and social media.

O

Online assessment tools [68], [69]

Tools and platforms that facilitate assessment and feedback in online learning environments.

Online assessment tools facilitate the evaluation of student learning through quizzes, exams, and peer assessments, enhancing feedback mechanisms.

Automated grading systems that provide instant feedback on student submissions.

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P

Parameter [70], [71]

In AI, parameters are internal variables in models, such as weights and biases, adjusted during training to optimize performance.

Parameters in AI models, such as weights and biases, are adjusted during training to optimize performance, helping models recognize patterns and make accurate predictions or decisions.

Parameters in AI for HEIs are adjusted to optimize models for grading, personalized learning, and data analysis.

Personalized learning [72], [73]

Tailoring educational experiences to meet the individual needs of students.

Personalized learning utilizes data to adapt educational content to meet individual students' needs, enhancing engagement and efficiency in learning processes.

Online learning platforms like Coursera tailoring course suggestions.

Predictive analytics [38], [44]

The use of statistical techniques to analyze historical data to predict future outcomes.

Predictive analytics uses historical data, statistical algorithms, and machine learning techniques to identify the likelihood of future outcomes, widely used in business for market forecasting.

Customer relationship management systems predicting sales trends.

Prompt [74], [75]

A prompt in AI is an input or instruction given to a model to guide its response or generate output.

In AI, a prompt is an input or instruction given to a model, guiding it to generate specific responses, solve tasks, or produce meaningful output.

Prompts in HEIs guide AI models to generate responses, aiding in personalized learning and automated grading.

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PROMPT ENGINEERING [76], [77]

Prompt engineering is the process of designing high-quality prompts that guide LLMs to produce accurate outputs.

This process involves tinkering to find the best prompt, optimizing prompt length, and evaluating a prompt's writing style and structure in relation to the task.

What are the colors in the rainbow?

R

REINFORCEMENT LEARNING (RL) [17], [18]

A learning paradigm where an agent learns to make decisions by taking actions in an environment to maximize cumulative reward.

In reinforcement learning, an agent learns by receiving feedback from its actions, optimizing strategies through trial and error to achieve maximum reward in dynamic environments.

Gaming AI that adapts difficulty based on player performance.

REASONING [17], [18]

To use the stored information to answer questions and to draw new conclusions.

AI can make decisions and solve problems, often more quickly and accurately than a human. This involves logical reasoning based on the information it has learned.

Iintelligent tutoring system that analyzes a student's responses to tailor the difficulty and content of subsequent questions, ensuring optimal learning outcomes

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Responsible AI [78], [79]

Responsible AI ensures that artificial intelligence is developed and used ethically, with accountability, transparency, fairness, and consideration for societal impact.

Responsible AI ensures ethical development and use of AI technologies, prioritizing fairness, accountability, transparency, and minimizing negative societal impacts.

Example of usage Training Data in HEI's in 15 words

Robotics [17], [80]

Machines that can be programmed to carry out a variety of tasks, often mimicking human behaviour.

Robotics integrates AI with mechanical systems to create machines capable of performing tasks autonomously or semi-autonomously in diverse environments.

Robotic vacuum cleaners that navigate and clean autonomously.

S

Secure multi-party computation (SMPC) [81], [82]

A cryptographic technique to securely compute data.

SMPC used to analyze research data securely.

SMPC in HEIs enables secure data sharing across institutions, preserving privacy while collaborating on research and analysis.

Self-directed learning [83], [84]

An approach where learners take initiative and responsibility for their learning journey.

Self-directed learning empowers students to take control of their learning process, setting their own goals and identifying resources for knowledge acquisition.

Learning platforms encouraging students to pursue topics of interest independently.

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Social learning analytics [85], [86]

The analysis of social interactions and behaviours using learning analytics to improve education.

Social learning analytics focuses on analysing interactions within social learning environments to foster collaboration and improve learning outcomes.

Analysis of forum interactions to improve online collaboration in courses.

Socratic dialogue [87], [88]

Socratic dialogue in AI involves using questioning techniques to stimulate critical thinking, promote reflection, and guide AI-driven learning processes.

Socratic dialogue in AI involves using questioning methods to promote critical thinking, reflection, and deeper understanding, guiding AI systems to assist learning and problem-solving effectively.

Socratic dialogue in HEIs encourages critical thinking, fostering interactive discussions that deepen student understanding and engagement with complex topics.

Swarm intelligence [17], [89]

An AI approach that uses the collective behaviour of decentralized and self-organized systems.

Swarm intelligence draws inspiration from social organisms, like ant colonies or flocks of birds, to solve problems collaboratively through decentralized control.

Robotic swarms used in search and rescue missions or agriculture.

T

Temperature [76], [90]

Temperature controls the degree of randomness in token selection.

A temperature close to 0 makes the sampling more deterministic (i.e., the word with the highest probability is very likely to be chosen), whereas a temperature of 1 means each word is chosen with the probability output by the model.

Generated text with a temperature of 1.0 is more adventurous and therefore less accurate than the example with a lower temperature value.

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TOKEN [17], [70]

In AI, tokens are the smallest units of text processed by models, representing words, characters, or subwords for analysis.

Tokens in AI are used to represent units of text, such as words or characters, enabling models to process, analyze, and generate language-based data for various tasks.

Tokens in AI for HEIs represent text units for processing and analysing student feedback, essays, and research.

TRAINING DATA [91], [92]

Training data for AI models consists of labelled examples used to teach algorithms patterns, enabling them to make predictions or decisions.

Training data in AI consists of labelled examples used to train models, enabling them to recognize patterns, make predictions, and improve accuracy through iterative learning.

Example of usage Copyright in HEI's in 15 words

TRANSFER LEARNING [17], [38]

A technique that reuses a pre-trained model on a new but related problem, improving efficiency.

Transfer learning accelerates the training of machine learning models by leveraging knowledge from previously learned tasks, applicable in various domains like image classification.

Image classification models adapted from general datasets to specific medical imaging tasks.

V

VIRTUAL REALITY (VR) [93], [94]

An immersive experience that uses computer-generated simulations to enhance learning.

VR technology immerses learners in a 3D environment, providing experiential learning opportunities that can enhance understanding of complex concepts and scenarios.

Google Expeditions offering virtual field trips.

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Digital Competencies and AI-based Tools

Universities worldwide are pressed to utilise AI to enhance the way they teach, learn, and collaborate. This chapter explores the synergy between the DigComp 2.2 framework, which outlines fundamental skills for digital literacy, and an array of AI-based tools selected especially for their relevance in higher education. We begin by presenting an overview of DigComp 2.2 (Sec. 3.1), a common language to describe competencies ranging from information and data literacy to problem solving and safety. Next, we introduce a set of categories (see Sec. 3.2), each describing broad scenarios of use that address various teaching and learning goals. We then offer a heatmap (Sec. 3.3) showing how AI-based tools align with Bloom's taxonomy levels across the DigComp competencies, offering a visual guide that helps educators make informed decisions. Finally, we present a comprehensive list of AI-based tools, highlighting their core features, examples what to use them for, cost structures, and estimated ease of use.

By blending theory with clear examples, this chapter emphasizes how AI can become a usable and effective asset rather than a mere novelty. Educators and learners alike can draw on these insights to integrate technology with a clear and specific goal, increasing engagement and promoting deeper understanding of the taught material. In doing so, they pave the way for more meaningful, accessible, and forward-looking educational experiences.

Identified Relevant Competencies

Digital transformation has changed the way we live, learn, and work. To thrive today, we must master practical digital skills that help us find, assess, and create online information, stay safe online, and solve problems in new ways. DigComp 2.2 [14], short for "The Digital Competence Framework for Citizens," gives us a roadmap for all these

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skills. Developed by the European Commission's Joint Research Centre, it lays out five main groups of digital competencies, with 21 specific competencies across those groups. Each group covers an important aspect of digital literacy and is described using examples of the knowledge, skills, and attitudes that citizens and learners need in modern life. Through clearly mapping these competencies, DigComp 2.2 shapes policies, sets targets for training and guides anyone who wants to help modern learners gain digital confidence. The framework and the mapping it provides also tie in with the idea that higher education must respond to societal changes, wherein we must also include the expansion of artificial intelligence.

The five main competence areas in DigComp 2.2 start with **Information and Data Literacy**. This area covers searching, evaluating, and managing information. We use online search engines daily but do not always stop to think about who wrote or funded the top results. DigComp 2.2 urges us to check sources, spot bias, and stay aware of misinformation (sometimes called "fake news"), especially when we read or share information. It also provides guidance on how to store and organise data for easy retrieval. The vast amount of online information in the modern world can be daunting, but these skills help us navigate the noise and make good decisions. TRUE The following competencies are part of the above-described group of competencies:

1.1 Browsing, Searching and Filtering Data, Information and Digital Content
Description. 'To articulate information needs , to search for data, information and content in digital environments, to access them and to navigate between them. to create and update personal search strategies.' [14]

1.2 Evaluating Data, Information and Digital Content
Description. 'To analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content. to analyse, interpret and critically evaluate the data, information and digital content.' [14]

1.3 Managing Data, Information and Digital Content
Description. 'To organise, store and retrieve data, information, and content in digital environments. to organise and process them in a structured environment.' [14]

The second area of competencies is **Communication and Collaboration**, which describes how people interact with each other using digital tools. On a fundamental level, this concerns sending a polite email or using communication software for group projects and teamwork. It also encompasses more profound concepts, such as being a responsible "digital citizen," treating others with respect in the social media context, and sharing content while acknowledging authorship and giving credit where credit

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is due. It often happens nowadays that we work or study in teams that share non-virtual and virtual spaces alike, and DigComp 2.2 guides us on how to collaborate well, whether we are simply using shared and co-authored documents, moderated wiki pages, or video chat and video calling services. This group of competencies links directly to higher education, where lecturers can promote or even demand teamwork, group assignments, and online discussions that teach students to work as teams, even if they are spread across the globe or consist of diverse individuals on whichever basis.

The following competencies are part of the above-described group of competencies:

2.1 INTERACTING THROUGH DIGITAL TECHNOLOGIES
Description. 'To interact through a variety of digital technologies and to understand appropriate digital communication means for a given context.' [14]

2.2 SHARING THROUGH DIGITAL TECHNOLOGIES
Description. 'To share data, information and digital content with others through appropriate digital technologies. to act as an intermediary, to know about referencing and attribution practices.' [14]

2.3 ENGAGING CITIZENSHIP THROUGH DIGITAL TECHNOLOGIES
Description. 'To participate in society through the use of public and private digital services. to seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies.' [14]

2.4 COLLABORATING THROUGH DIGITAL TECHNOLOGIES
Description. 'To use digital tools and technologies for collaborative processes, and for co-construction and co-creation of data, resources and knowledge.' [14]

2.5 NETIQUETTE
Description. 'To be aware of behavioural norms and know-how while using digital technologies and interacting in digital environments. to adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments' [14]

2.6 MANAGING DIGITAL IDENTITY
Description. 'To create, and manage one or multiple digital identities, to be able to protect one's own reputation, to deal with the data that one produces through several digital tools, environments and services.' [14]

The next area of competencies is **Digital Content Creation**. This group comprises competencies that go beyond writing a simple blog post or fundamental editing of photos – they also deal with understanding copyright and licenses, knowing how to reuse, remix, or repurpose digital content, and even some programming basics. The latter

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grows more relevant each year as software and AI-based tools get included in nearly all fields of human activity – from engineering to humanities. For example, higher education students could use AI-based tools and platforms to help them produce or refine their term papers, research papers, or theses, or they might learn to build simple software to solve mundane, repetitive, or complex problems in their discipline. DigComp 2.2 provides an overview of the competencies necessary for ensuring a solid foundation for these tasks.

The following competencies are part of the above-described group of competencies:

3.1 Developing Digital Content
Description. 'To create and edit digital content in different formats, to express oneself through digital means' [14]

3.2 Integrating and Re-Elaborating Digital Content
Description. 'To modify, refine and integrate new information and content into an existing body of knowledge and resources to create new, original and relevant content and knowledge.' [14]

3.3 Copyright and Licences
Description. 'To understand how copyright and licences apply to digital information and content.' [14]

3.4 Programming
Description. 'To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or to perform a specific task.' [14]

The fourth area of competencies is **Safety**. Data protection, privacy, and mental well-being are only some of the concepts that belong here. This set of competencies covers the need to protect user devices from malware, secure private data, and maintain mental and physical health in a digital environment. In addition to the mentioned topics of cybersecurity, it also touches on the ethics of AI use. For instance, specific AI-based systems can analyse our search history or personal details to customise a service or provide advertisements better suited to our profiles. Therefore, we must remain alert to how our data might be used or shared. Higher-education instructors can address these important topics by providing students with examples of best practices, such as carefully choosing their cloud-storage provider, recognising phishing attempts in email messages, or managing screen time to avoid stress or related mental issues.

The following competencies are part of the above-described group of competencies:

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4.1 Protecting Devices

Description. 'To protect devices and digital content, and to understand risks and threats in digital environments.to know about safety and security measures and to have a due regard to reliability and privacy.' [14]

4.2 Protecting Personal Data and Privacy

Description. 'To protect personal data and privacy in digital environments. to understand how to use and share personally identifiable information while being able to protect oneself and others from damages. to understand that digital services use a "Privacy policy" to inform how personal data is used.' [14]

4.3 Protecting Health and Well-Being

Description. 'To be able to avoid health-risks and threats to physical and psychological well-being while using digital technologies. to be able to protect oneself and others from possible dangers in digital environments (e.g. cyber bullying). to be aware of digital technologies for social well-being and social inclusion.' [14]

4.4 Protecting the Environment

Description. 'To be aware of the environmental impact of digital technologies and their use.' [14]

The final competence area of **Problem Solving** deals with competencies related to fixing technical issues, choosing the right digital tools to meet a set goal, and creatively combining various applications or data sources to solve problems successfully. Furthermore, this area includes self-identifying an individual's gaps in digital skills and seeking to improve them. For example, some AI-based systems, such as chatbots and similar assistants, can help us support creative problem-solving processes. Students in a university setting might learn to harness AI-based tools and models that suggest advanced research sources or help them code more efficiently. Nevertheless, DigComp 2.2 reminds us that people remain in charge of the problem-solving process for now; it is important not to leave the decision-making processes entirely to AI-based systems and models. We can use AI-based tools, but we must question their outcomes, check their suggestions, and remain aware of bias in the data that the used models were trained on.

The following competencies are part of the above-described group of competencies:

5.1 Solving Technical Problems

Description. 'To identify technical problems when operating devices and using digital environments, and to solve them (from trouble-shooting to solving more complex problems).' [14]

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5.2 IDENTIFYING NEEDS AND TECHNOLOGICAL RESPONSES
Description. 'To assess needs and to identify, evaluate, select and use digital tools and possible technological responses and to solve them. to adjust and customise digital environments to personal needs (e.g. accessibility).' [14]

5.3 CREATIVELY USING DIGITAL TECHNOLOGY
Description. 'To use digital tools and technologies to create knowledge and to innovate processes and products. to engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments.' [14]

5.4 IDENTIFYING DIGITAL COMPETENCE GAPS
Description. 'To understand where one's own digital competence needs to be improved or updated. to be able to support others with their digital competence development. to seek opportunities for self-development and to keep up-to-date with the digital evolution.' [14]

The reader might have recognised by now the layered approach of DigComp 2.2. It does not just name the five competence groups. Each group is broken down into individual competencies, as shown above. Furthermore, each specific competency has eight proficiency levels divided into four levels. This organisation helps teachers, trainers, and policy-makers develop lessons and tests customised to their specific courses and learning objectives. For example, a first-year student might only be expected to identify a reliable source of information. In contrast, a more experienced student can be expected to judge the credibility of sources or protect personal data without extra help. The framework's many examples show how it applies in daily life. The following is an AI-related attitude example within the competency 2.1 INTERACTING THROUGH DIGITAL TECHNOLOGIES: 'Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not).' [14] The following is an AI-related knowledge example within the competency 3.1 DEVELOPING DIGITAL CONTENT: 'Knows that AI systems can be used to automatically create digital content (e.g. texts, news, essays, tweets, music, images) using existing digital content as its source. Such content may be difficult to distinguish from human creations.' [14]

DigComp 2.2 is not necessarily for students and teachers only. The competencies therein are also for administrators and anyone who wants to help learners succeed. For example, a university professor might use the framework to design a course that teaches students to use AI-based tools in a way that respects privacy and fairness; a university librarian might use it to help students find and evaluate digital sources for their research papers; a university IT specialist might use it to train staff in secure data management. Rather than a single program or curriculum, DigComp 2.2 is a flexible

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foundation that can fit local needs across Europe and beyond.

In modern higher education, a balanced approach to digital competence is crucial [95]–[97]. On one side, students and staff expect advanced technology in the lecture hall and we witness a surge of various AI-based tools for writing, data analysis, and content creation that can foster learning. Conversely, a significant stagnation in knowledge on using these tools efficiently, safely, and ethically, protecting data, and maintaining mental well-being in the modern landscape is observed. DigComp 2.2 makes some of these questions explicit. It helps university leaders and faculty see how to train staff and students in digital ethics, integrate digital tools into classes and the teaching and learning processes, and encourage learners to keep their data safe and secure. By building strong digital competencies, colleges can turn AI from a curiosity into a positive force that helps members of the faculty, staff, and students solve problems and create new knowledge.

This framework was chosen for the activities of this project because it provides a clear, shared language for digital skills that are important to modern teaching. It can be used as a reference for designing courses, tasks, and student assessments that blend technical skills (e.g. programming or data management) with responsible, critical habits (e.g. analysing sources or protecting privacy). It recognises how the digital world keeps evolving as new technologies, including AI, reshape everything – from public services to the job market.

Defined Categories of Tools

Universities worldwide consider artificial intelligence (AI) an incentive for better teaching and learning. AI is more than simply a gadget or a tool for having fun. In higher education institutions, it is about creating an environment that fosters creativity, enhances collaboration, and allows individual learners to advance at their own pace. The following categories of AI-based tools highlight key themes identified in and drawn from the DigComp 2.2 framework [14], described in more detail in Sec. 3.1, which lays out digital competencies that matter for members of the faculty, staff, and students in higher education. In practice, these themes can be observed as guides for using technology to complement, rather than replace, the esteemed teaching and learning processes.

Once a traditional paper-and-pen affair, AI-based systems can now enrich assessments that effortlessly analyse student input, provide immediate insights, and adapt tasks to the learner's needs. However, this blend of automation and personalisation does not strip away an educator's job. It provides them with more time that they can use to focus on core educational goals instead of mechanical grading. That is not

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to say that assessment should be handed entirely to an algorithm, as currently available AI-based tools and related models might not be adapted enough for unsupervised assessment. Likewise, if collaboration is the beating heart of modern classrooms, AI-based chat tools and virtual collaboration platforms are prime mediums for rendering building group projects more effectively. Students in remote or hybrid contexts, including students with special needs or disabilities when compared to the majority, need ways to share ideas smoothly and stay engaged. Ai-driven assistants who coordinate tasks or offer real-time feedback can make that happen.

The following categories of tools are described in the paragraph above:

- Assessment and Feedback
  Description. AI tools designed for generating quizzes, automating grading, and providing personalized feedback (e.g., Cognii, Turnitin AI) aim to assist educators in creating diverse quizzes and test questions using artificial intelligence technologies and innovative learning approaches; these tools enable educators to assess student work more efficiently and provide tailored feedback.

- Collaboration and Interaction
  Description. Tools to facilitate teamwork and digital communication, such as Microsoft Copilot and MindMap AI; tools designed to enhance teamwork, communication, and collaboration in remote and in-person settings; platforms and functionalities that enable individuals and teams to share ideas, coordinate tasks, and work on projects effectively.

- Productivity for Students
  Description. These tools help educators integrate the management of time, work and learning process in the learning course; tools that help manage resources and help students manage their time, stay organized and increase efficiency in the learning process.

Content creation, which once required juggling a selection of design software and spending much time searching through stock images, receives a fresh start when AI suggestions and automated design features come together. Rather than stifling human imagination and imposing constraints on creative productivity, these tools remove barriers to quality production. Instructors and students no longer need to spend hours tinkering with colour schemes, formatting, or copywriting. Instead, they can devote more energy to shaping ideas that spark genuine learning (it is worth noting that some contest this point of view [98]). This push forward in various areas is observed in refined communication, which encourages using AI-based tools and models for language processing. As large volumes of text must often be translated or summarised, these services grow more relevant, opening opportunities for multilingual research and inclusive collaboration.

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The following categories of tools are described in the paragraph above:

- Content Creation and Enhancement
  Description. Tools for creating presentations,and visual/auditory materials/artifacts (e.g., Canva AI, Stability AI, Tome AI); these tools leverage artificial intelligence to assist educators in creating and improving various types of content, including presentations, visual designs, and auditory materials ;they provide features like automated design suggestions, content generation, and customization options, enabling users to produce professional-quality outputs with minimal effort.
- Generating Interactive Lessons, Courses, and Quizzes
  Description. Tools designed to create dynamic, engaging, and interactive educational experiences that require active participation from students; they empower educators to build custom lessons, courses, and quizzes that incorporate multimedia elements, 3D visualizations, and responsive design features; tools like Magician for Figma and 3DGPT which it requires interaction/reaction from students.
- Language and Natural Language Processing
  Description. Tools for multilingual collaboration and enhanced communication; tools that use AI to help educators improve their language skills or handle large text-based content.

Along with digitisation came heavier data traffic everywhere, including university systems, wherefore attention to cybersecurity plays an important role. AI-based tools can guide students and other stakeholders in spotting suspicious emails or password breaches, potentially warding off digital risks. Student records may not be medical or social security data but constitute valuable data nonetheless [99]. By understanding how digital footprints are left across platforms, everyone on campus can be more confident in using online tools. Data management, in this context, is not only about scanning for threats but includes perspectives on tools that help gather, sort, and evaluate information to ensure that educators and students can retrieve useful facts in seconds, freeing time and mental space for learning, deeper analysis, and applied critical thinking.

The following categories of tools are described in the paragraph above:

- Cybersecurity Awareness
  Description. These tools and resources help faculty, staff, and students at colleges and universities protect sensitive academic data and keep online activities secure. They teach how to recognize online scams, safeguard personal and institutional information, and use strong passwords. They also guide instructors on how to use digital tools safely in classrooms or online courses, follow data

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protection rules, and avoid privacy breaches involving student information.

- Data and Information Management and Evaluation
  Description. Tools for managing and evaluating data and digital content; tools designed to facilitate the organization, analysis, and assessment of data and content in digital formats; tools that improve data handling accuracy and enhance the overall quality of content management processes; data cleaning, visualization, content categorization, metadata management, and performance evaluation.

- Inquiry and Learning Process Facilitation
  Description. AI tools support exploratory and specific learning methods by helping educators create, review, and expand knowledge to foster deeper understanding; these tools can be used to implement specialized teaching methods and assist students in approaches such as project-based learning, problem-based learning, and work-based learning.

Amid the recent developments in the information technology domain, and AI in particular, there is a growing awareness of the environmental consequences of digital technology [100], [101]. Many AI-based tools need data centres and processing power, which can produce a significant carbon footprint. Universities can teach students to be mindful digital citizens by adopting energy-saving habits. Furthermore, through the efficient, mindful, and knowledgeable use of AI-based tools, environmental awareness may be turned into reality via modern and as-of-yet undiscovered solutions [102]. When instructors include these ideas in their curriculum, they show the next generation of humankind how to conserve energy and avoid waste and encourage a broader shift towards responsible use of digital resources that may or may not directly impact our environment. This theme of mindful use of technology extends to personalised learning as well. Adaptive and self-paced environments allow students to advance through content at different speeds and using different learning approaches or modalities, focusing on their challenges while receiving tailored support [103]. The latter fosters independence, promotes equity, and leads students to work more efficiently toward their academic goals, always with an eye on genuine skill development.

The following categories of tools are described in the paragraph above:

- Environmental Impact
  Description. These tools and methods help faculty, staff, and students in higher education understand how digital technology affects the environment. They focus on reducing unnecessary digital use, saving energy, and limiting waste. They also address how online activities, like video streaming or data storage, can affect carbon emissions. By including these ideas in the curriculum, educators can guide students toward eco-friendly habits and more responsible digital choices.

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- Personalised Learning
  Description. These tools are designed to create adaptive learning environments by enabling educators to tailor content and learning pace to each student's unique abilities and preferences; this personalized approach not only boosts student engagement and retention but also helps educators address diverse learning needs, fostering a more inclusive and efficient learning experience; adaptive platforms cater specifically to individual learning styles and requirements.

- Self-Paced Acquisition of Foundational Skills
  Description. Tools that enable educators to create safe and personalized learning environments where students can acquire skills; these tools use artificial intelligence to create a digital environment for language learning (including conversational practice), facilitate the acquisition of technical skills, provide suggestions for learning techniques, and support self-paced learning of basic programming knowledge and skills; additionally, these tools help identify bugs in students' coding, provide instant feedback, and offer tailored answers to their questions.

Another trend worth mentioning here is interactive learning through AI-driven simulations. These simulations are used to create virtual spaces wherein it is possible to create life-like situations for students to practice various skills, making abstract theories more tangible (e.g. virtual reality system for immersive multi-user firefighter-training scenarios [104]). When learners can test solutions in a digital sandbox, they get immediate feedback on their choices and observe the effects of their actions and the introduced changes to the situated environment. A similar approach can be utilised in the context of academic research tasks. With the right AI-based tool, an educator or a researcher can sift through extensive studies in a fraction of the time it would take them to do it by hand or build advanced datasets for academic writing. Graduate students, in turn, can use these tools to refine theses, improve their written language and document structure, or design more thorough literature reviews, growing a richer understanding of their field along the way. These application examples must be taken with a grain of salt, as the tools are imperfect and may not always provide the best results. Hence, it is crucial to exercise critical thinking and verify the results obtained through AI-based tools.

The following categories of tools are described in the paragraph above:

- Research and Academic Writing
  Description. Tools that support literature reviews, data analysis, academic writing, and research design across various research domains; these tools assist educators with research tasks, help organize content efficiently, and ensure academic integrity.

- Simulations and Interactive Learning

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Description. Tools for creating immersive environments that simulate real-world scenarios by educators; tools designed to provide students with immersive, hands-on experiences by recreating real-world scenarios in a controlled, virtual environment; they enable educators to create environments to practice skills, explore complex concepts, and solve problems in a risk-free setting by students, fostering deeper understanding and engagement

- VIRTUAL TEACHING ASSISTANTS
  Description. Tools assisting educators with communication, such as ChatGPT or Bard; these tools assist educators by providing personalized help, explanations, and feedback, helping them understand complex concepts or complete tasks; AI tools assist educators in administrative tasks, grading, and classroom management.

These categories underline how AI-based tools work best in education when the underlying models and algorithms align with solid pedagogical aims. Indeed, a virtual assistant might reduce the time needed to prepare class materials, but actual teaching depends on human insight and empathy. More so, preparing an AI-based tool for a specific course or lecture might take longer than preparing more traditional course materials. However, the prospect of providing students with a richer learning experience is a rewarding feature of the finalised product. In addition, an AI-based collaboration platform might help a class stay organised or motivate interaction, but meaningful dialogue and intellectual curiosity remain essential to higher learning. The advantage of using these tools is that they may help fight redundant, repetitive, and uninspiring tasks of solving various logistic obstacles of planning lessons or managing data, thus letting faculty members spend more time connecting with learners and focusing on outcomes that truly matter.

Ultimately, the collection of AI-based tools presented here in Sec. 3.4 aims at providing the perspective of an evolving classroom, where the role of technology is to support educators rather than overshadow them. By embracing the help of these tools in enhancing the ways to assess learners and teachers alike, collaborate in teams, create content, and safeguard data, teachers and students gain new media for growth. The motivation for designing and defining these categories – and the reason they resonate with DigComp 2.2 – is that technology should serve as an enabler, especially within the context of this project and higher-education institutions. AI-based and related tools should open doors for active participation, ethical use, and deeper engagement while leaving space for human creativity and critical thought.

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Heatmap

The heatmap we present here shows, in one sweeping view of Fig. 3.1, how each AI-based tool presented in Sec. 3.4 connects to the DigComp 2.2 competencies (described and presented in Sec. 3.1) and how its functionality lines up with Bloom's taxonomy levels [105], [106]. These competencies, grouped by colour in their respective areas, from Information and Data Literacy to Problem Solving and Safety, are laid out across the horizontal axis, visible at the bottom and the top of the graphic. The set of AI-based tools runs along the vertical axis. Within that grid, each cell has a colour- and pattern-coded marker that reflects the tool's degree of alignment with a given DigComp competency, using Bloom's taxonomy, where 0 (white tile) designates no perceived overlap, and 6 represents the highest Bloom's taxonomy level of *creating*. An utterly white cell means the tool is not applicable in that particular spot, i.e. it cannot be related to the observed competency on any of Bloom's taxonomy levels, whether because it does not address the competency or because its features serve another purpose. A value of one refers to a *remembering* function, while two suggests *understanding*. Three indicates *applying*, four corresponds to *analysing*, five points toward *evaluating*, and six signals *creating*. Though arranged in ascending order, these six levels should not be seen as strict hierarchies but more as a spectrum of thinking skills that each level requires from learners [106].

Even at a glance at the heatmap in Fig. 3.1, it can be observed that specific tools are related to higher levels of Bloom's taxonomy in specific competencies. Some might be strong at *creating* in the area of Digital Content Creation. Others might shine at *applying* or *analysing* within Problem Solving or Communication and Collaboration. This visualisation system helps educators understand how different AI-based tools and software can be used in class activities, projects, or even in more advanced research tasks. The color-shaded and pattern-coded patches offer a simple but powerful way to understand a tool's most potent uses since Bloom's levels represent the range of cognitive engagement that a tool can help bring to students or teachers. For example, an AI program that helps students generate entirely new content for a research project might sit at level six for Digital Content Creation, indicating it fosters a high degree of creative output. In contrast, another tool might hold a solid place at level three or four, focusing on the application or analysis of data, which is extremely useful in a wide range of courses but not necessarily intended for the final creation of a completely original work. Therefore, Bloom's taxonomy levels should not be observed hierarchically and as a scale but as individual indicators of cognitive engagement.

The notion of Bloom's taxonomy goes back decades [105], to a time when educational theorists sought to categorise the complexity of learning tasks. It starts with

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remembering (the recall of facts), moves on to understanding (the ability to interpret those facts), and then heads into applying (putting knowledge to use in new scenarios). Analysing means breaking down problems or ideas into components; evaluating involves forming judgments based on criteria or evidence and creating stands on top at the highest level, where new products, concepts, or syntheses emerge. Though many educators still refer to these categories linearly, the learning process often spirals across these levels, moving forward and backwards as needed. The advantage of mapping them to AI-based tools is that the reader can quickly spot the types of mental activity a tool might prompt in real classroom or research settings. A data-visualisation tool may prompt plenty of analysis, while a text-generation tool may push toward creativity, but each can also support other forms of thinking if used imaginatively.

The heatmap's alignment with DigComp 2.2 ensures that we also see how these AI tools measure up against the set of key digital competencies that educators, students, and institutions require to navigate a complex digital landscape. Suppose a tool shows strong alignment in Problem Solving at a higher Bloom's level. That might be an ideal solution for a design-thinking module, a capstone project, or a lab environment where students tackle real-life challenges. Similarly, if a tool was designated with a zero value for a particular competency, it does not necessarily mean it lacks quality or value. Such a value means it probably does not focus on that specific area of digital competence, so educators should look elsewhere for that purpose. In many cases, one might notice partial alignment, where the heatmap indicates a moderate or medium level of propriety. That information can help one fine-tune lesson plans by integrating multiple tools that complement one another, ensuring broad coverage of the competencies a teacher might aim to foster in their course.

By reading the heatmap carefully, one can also notice which tools seem more appealing than others. These might feature a combination of remembering and applying levels in fields like Information and Data Literacy or show advanced levels in Communication and Collaboration, Problem Solving, or Safety. A single tool can span several DigComp areas, giving it a broad potential use in higher education. Seeing these patterns in a single graphic allows the instructor or administrator to make quicker, more informed decisions. They can match a tool's strengths with the goals of a particular module, a group assignment, or the overarching learning outcomes for the entire course.

In practical terms, using these AI-based tools should never be viewed as a way to avoid thoughtful engagement with the subject matter or learners. The essence of Bloom's taxonomy is that it emphasises the depth and type of thinking involved. A tool that fosters high-level "evaluation" or "creation" does not become a magic solution unless teachers and students wield it with discernment. The heatmap, therefore, stands as a reference point. Scanning it shows whether a tool might help novices learn basic

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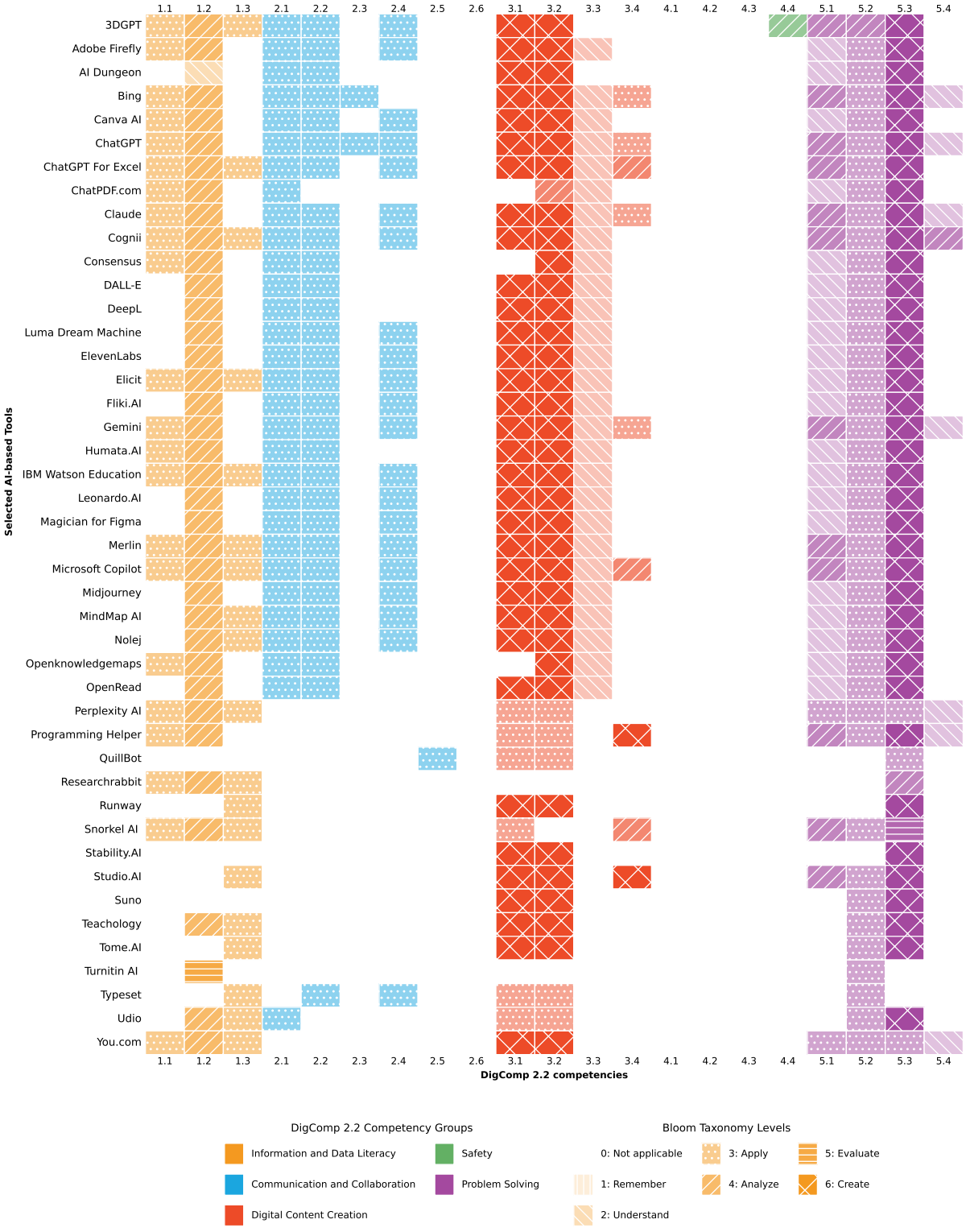

Figure 3.1: Heatmap mapping AI-based tools to DigComp 2.2 competencies with Bloom's taxonomy levels from 0 (not applicable) to 6 (create).

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concepts, give intermediate students a way to apply and analyse material, or let advanced groups of learners produce highly original work or in-depth evaluations. It is one more layer of information, but an important one because it cuts across both digital competence and cognitive complexity.

Ultimately, this graphic encourages the reader to step back and see the bigger picture. The DigComp competencies on one axis remind us how each tool aligns with the essential areas of digital life and learning. The vertical listing of AI-based tools reveals, at a glance, a set of distinct functionalities. Bloom's taxonomy levels detail the specific type of thinking or learning moment that each tool best supports. This combination gives the user the power to choose technologies more precisely and clearly. It reminds us that not every tool suits every goal and helps us spot where the synergy might spark new approaches to emerge. Finally, the heatmap is there to guide educators in the quest to orchestrate robust, meaningful learning experiences, leveraging AI in ways that align with sound pedagogical principles and the evolving demands of today's digital world.

AI-Based Tools

Universities worldwide are pushed to transform their classrooms, lecture halls, and activities by applying artificial intelligence in fresh and creative ways. The tools explored in this section are not aimed at simply adding flashy tech for its own sake but rather at offering practical help to faculty and students to enhance and evolve their teaching and learning activities and processes. They do so by encompassing application domains, including but not limited to research, content creation, and collaboration, all in a user-friendly manner. Each tool is described with its name and a concise description. Furthermore, an example is given to show how it is supposed to work in a real scenario. Then, whether the tool is free to use, works on a freemium plan (providing some features for free but charging for more advanced features), or is wholly located behind a paywall, and whether it can be considered easy to use or fair to use. Because technology can be stressful when it complicates learning, we excluded tools that might leave casual users feeling lost so that only easy or fair options can be found here, with difficult-to-use tools omitted. Therefore, nothing here will likely cause undue frustration when ease of use is considered.

What matters in higher education is that the technology provided by the selected tools becomes a resource for educators who want to improve lessons in a way that supports, rather than replaces, their teaching style. Although each described tool has its flair and features that make it different from the others, they can usually be used to implement more transparent communication, smoother collaboration, or enhanced

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student engagement. By observing and testing each tool's particular features, faculty members can choose the right software for each course and situation, confident that all the pieces of information – the tool's aim, real-world application, cost structure, and how difficult or simple it is to get started – are laid out straightforwardly. We strongly believe that that sense of clarity matters, especially for the teachers who want to spend their energy not on wrestling with complex software but on building better lesson plans and engaging student activities. Students, for their part, can experience more dynamic teamwork activities, up-to-date research support, and improved and more timely feedback loops, all of which help achieve learning outcomes and create a sense of deeper understanding and motivation for their course.

In order to avoid using modern tools as mere gimmicks, the tools listed here have been selected to tackle meaningful tasks in the educational environment. They might assist with analysing large datasets, generating cohesive ideas for written assignments, simplifying the steps of a group project, guiding multimedia content creation, or facilitating administrative work. Depending on the course's goals, faculty members can see which solution best fits the teaching challenge they are prepared to tackle. A language-focused course might benefit from AI-based tools that support translation or textual analysis. In contrast, an engineering class might benefit from design and simulation tools that speed up the process of building models. Regardless of the exact field, these tools and platforms are meant to empower users, assisting them with activities that might otherwise unnecessarily take valuable time.

Within this section, the names of each tool appear in plain sight. The function of each becomes clearer when the example showcases how one might use it in everyday instruction or research. Sometimes, free tools (depicted using) might offer fewer features, while freemium services (depicted using) may unlock additional options for those who pay. Paid tools (depicted using) can, in some cases, feature advanced modules that justify the investment for larger or more specialised projects. However, faculty need to weigh such costs against their department's budget and the actual needs of their course. As for the user-friendliness scale, a tool tagged as easy (depicted using) should take little time to master, whereas fair (depicted using) should take little time to master, whereas fair indicates that the tool may need a short learning curve before educators feel comfortable. Even then, no one should shy away because fair tools often bring powerful functionality.

This introduction prepares the reader for the extensive list of tools that follow. By appreciating the nature and purpose of each of the included AI-based tools, discovering how they relate to practical scenarios, and noting both cost and ease of use, readers can find the right resource to enrich their teaching, support their research, and make learning more exciting for everyone involved. The tools are listed in alphabetical order, with each one providing a unique set of features and benefits that can be explored

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further by visiting the tool's website or by reading the full description in the following pages.

3DGPT

we recommend for simulations and interactive learning.

Free

Easy to use

Description. Authentise 3DGPT is an AI-powered tool designed to streamline additive manufacturing by offering instant, intelligent insights and solutions. It combines GPT-driven natural language processing with real-time manufacturing data to enhance decision-making, improve workflows, and reduce operational complexity in 3D printing processes.

Example. 3DGPT allows teachers to interact with 3D models through conversational queries, making complex concepts more accessible. In higher education, educators can use it to demonstrate intricate designs or mechanical components in disciplines like engineering, architecture, and science, enabling real-time analysis, visualization, and enhanced student understanding of 3D structures.

...

Adobe Firefly

we recommend for content creation and enhancement.

Freemium

Easy to use

Description. Adobe Firefly is a generative AI tool that empowers creators to produce stunning visuals, text effects, and designs with ease. Seamlessly integrated with Adobe's creative suite, it uses advanced AI to enhance creativity, enabling users to generate and customize content rapidly while maintaining professional quality.

Example. Adobe Firefly enables teachers in higher education to quickly generate custom visuals, text effects, and other design elements for their teaching materials. Educators can use it to create engaging presentations, visually enhanced lesson content, and unique digital resources, saving time while fostering a visually immersive learning environment for students.

...

AI Dungeon

we recommend for content creation and enhancement.

Freemium

Easy to use

Description. AI Dungeon is an interactive storytelling platform powered by advanced AI, enabling users to create and explore limitless text-based adventures. It adapts dy-

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namically to player input, offering personalized and immersive narratives in any genre, fostering creativity and endless possibilities.

Example. AI Dungeon enables educators to design creative, immersive learning experiences for students. Teachers in higher education can use it to craft scenario-based exercises, such as historical reenactments or ethical decision-making simulations, fostering critical thinking, creativity, and student engagement in disciplines like literature, history, and philosophy.

...

Bing

Freemium 

Easy to use 

we recommend for data and information management and evaluation.

Description. Microsoft Bing AI is a cutting-edge search and conversational tool that utilizes advanced AI to provide precise answers, creative insights, and tailored assistance. By leveraging natural language processing and deep learning, it enhances web searches, generates contextual responses, and simplifies complex tasks. Integrated into Microsoft's ecosystem, it offers seamless functionality for both personal and professional use, delivering smarter, faster, and more intuitive online experiences.

Example. Bing enables teachers in higher education to streamline lesson planning, find reliable resources, and generate creative ideas for teaching materials. By leveraging its conversational capabilities and contextual insights, educators can efficiently research complex topics, create engaging content, and provide students with accurate, real-time information during classroom discussions.

...

Canva AI

Freemium 

Easy to use 

we recommend for content creation and enhancement.

Description. Canva Magic Design is an AI-powered tool that simplifies and accelerates the design process by generating professional-quality templates and creative suggestions. Whether for presentations, social media, or branding, it customizes designs based on user inputs, ensuring visually appealing and impactful results in seconds. This innovative feature makes design accessible and effortless for users of all skill levels, enabling creativity without compromising quality or efficiency.

Example. Canva AI helps teachers in higher education create professional-quality presentations, infographics, and course materials with ease. Educators can use it to quickly design visually engaging lecture slides, assignment templates, or learning

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aids, saving time while enhancing the visual appeal and effectiveness of their teaching resources.

...

ChatGPT

we recommend for language and natural language processing.

Freemium

Easy to use

Description. ChatGPT by OpenAI is a powerful conversational AI tool designed to understand and respond to natural language inputs with precision and context-awareness. It assists users with tasks like drafting content, answering questions, brainstorming ideas, and more, offering a seamless blend of creativity and functionality. Ideal for both personal and professional use, ChatGPT delivers intelligent, human-like interactions that enhance productivity and engagement.

Example. ChatGPT supports educators in higher education by generating lesson plans, creating quiz questions, and providing explanations for complex topics. Teachers can use it to streamline administrative tasks, enhance classroom discussions, and design personalized learning materials, fostering a more efficient and engaging teaching process.

...

ChatGPT For Excel

we recommend for productivity for students.

Freemium

Fair to use

Description. The AI-powered Workflows for Office app streamlines productivity by automating routine tasks and integrating intelligent solutions directly within Microsoft Office. It leverages AI to enhance efficiency, enabling users to simplify document management, data analysis, and collaboration. This tool is ideal for professionals looking to save time and boost productivity, seamlessly integrating advanced capabilities into familiar Office applications.

Example. ChatGPT For Excel integrates seamlessly into Office applications, providing educators with smart features like content generation, data analysis, and task automation. Teachers in higher education can use it to create dynamic lesson plans, automate grading spreadsheets, and generate engaging teaching materials, saving time and improving efficiency in managing classroom and administrative tasks.

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Freemium  Easy to use 

ChatPDF.com

we recommend for data and information management and evaluation.

Description. ChatPDF is an AI-powered platform that allows users to interact with PDF documents using natural language. By uploading a PDF, users can ask questions and receive answers directly from the content, making document review and analysis more efficient. With advanced AI capabilities, ChatPDF enables quick extraction of relevant information, making it a valuable tool for students, researchers, and professionals working with large documents.

Example. ChatPDF assists educators in higher education with lesson planning, content generation, and simplifying complex topics. Teachers can use it to create tailored learning materials, generate quiz questions, and provide instant support for student inquiries, enhancing classroom engagement and streamlining their teaching workflow.

...

Freemium  Easy to use 

Claude

we recommend for language and natural language processing.

Description. Claude AI, developed by Anthropic, is an advanced conversational AI designed to assist with tasks such as writing, summarization, data analysis, and brainstorming. With a focus on safety and reliability, it uses deep language understanding to deliver context-aware and human-like interactions. Ideal for both personal and professional use, Claude offers efficient, intuitive solutions to enhance productivity and decision-making while maintaining user-friendly engagement.

Example. Claude provides in-depth insights, content generation, and contextual assistance. Teachers in higher education can leverage Claude to draft course materials, generate detailed explanations for complex concepts, and create engaging classroom discussions, enabling a more efficient and interactive teaching process.

...

Paid  Fair to use 

Cognii

we recommend for personalised learning.

Description. Cognii is an AI-powered educational platform that leverages natural language processing to deliver personalized learning experiences and intelligent as-

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sessments. Designed for educators and students, it provides real-time feedback, adaptive learning paths, and automated grading to enhance engagement and efficiency. Cognii's conversational AI promotes critical thinking and deeper understanding, making it a powerful tool for modern, interactive education across various subjects and levels.

Example. Cognii enhance educational experiences by providing personalized feedback and supporting open-ended learning assessments. Teachers can use Cognii to automate grading of essay-style responses, offer detailed feedback on student submissions, and support adaptive learning, allowing educators to focus on creating deeper engagement and improving learning outcomes.

...

Consensus

we recommend for inquiry and learning process facilitation.

Freemium 

Easy to use 

Description. Consensus is an AI-driven research tool designed to extract and summarize insights from scientific literature quickly and accurately. By leveraging advanced natural language processing, it helps users find evidence-based answers to complex questions, streamlining the research process for professionals and academics. Consensus empowers informed decision-making by providing clear, reliable summaries from credible sources, saving time while enhancing the depth and quality of analysis.

Example. Consensus provides evidence-based answers by analyzing and summarizing scientific literature. Teachers in higher education can use it to quickly gather reliable data for lectures, design research-focused assignments, and guide students in conducting evidence-based studies, fostering a deeper understanding of research methodologies and critical analysis.

...

Copilot

we recommend for collaboration and interaction.

Paid 

Easy to use 

Description. Microsoft Copilot is an advanced AI assistant seamlessly integrated into Microsoft 365 applications to enhance productivity and creativity. It leverages generative AI to assist with tasks such as drafting content, analyzing data, creating presentations, and automating workflows. Designed to simplify complex processes, Copilot empowers users to work smarter and more efficiently, offering intuitive, context-aware suggestions that save time and boost professional output across various applications.

Example. Microsoft Copilot is designed to enhance productivity and streamline con-

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tent creation. Teachers in higher education can use Copilot to draft lesson plans, automate grading spreadsheets, and generate teaching materials, enabling them to focus more on student engagement and delivering effective instruction.

...

DALL-E

we recommend for content creation and enhancement.

Paid 

Easy to use 

Description. DALL-E by OpenAI is a cutting-edge AI tool that generates unique, high-quality images from text descriptions, revolutionizing creative workflows. It uses deep learning to interpret natural language prompts, producing visually stunning and imaginative results tailored to user specifications. Perfect for designers, marketers, and innovators, DALL-E simplifies the creation of custom visuals, offering endless possibilities for artistic and professional projects.

Example. DALL-E generates unique images from textual descriptions, enabling teachers to create customized visual content for their lessons. In higher education, educators can use DALL-E to design engaging lecture slides, generate illustrations for complex concepts, and develop creative visual aids for art, design, or interdisciplinary subjects, enhancing students' understanding and interest.

...

DeepL

we recommend for language and natural language processing.

Freemium 

Easy to use 

Description. DeepL Translator is a powerful AI-based language translation tool renowned for its accuracy and natural phrasing. It supports multiple languages, providing high-quality translations for both personal and professional use. With its user-friendly interface and advanced neural network technology, DeepL ensures seamless communication and understanding across language barriers.

Example. DeepL enables teachers in higher education to translate academic resources, create multilingual teaching materials, and support language learning courses, ensuring accessibility and enhancing cross-cultural understanding in the classroom.

...

KnowBe4

we recommend for cybersecurity awareness.

Paid 

Fair to use 

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Description. Description text

Example. Example description

...

ElevenLabs

we recommend for content creation and enhancement.

Freemium 

Easy to use 

Description. ElevenLabs is an advanced AI tool specializing in natural-sounding voice synthesis and speech generation. It allows users to create realistic voiceovers, customize tones, and generate high-quality audio content for various applications like podcasts, audiobooks, and media productions. Leveraging cutting-edge deep learning, ElevenLabs delivers lifelike vocal performances with precision and flexibility, making it an essential solution for creators and businesses seeking professional-grade audio solutions.

Example. ElevenLabs generates realistic and expressive voiceovers from written text. Teachers in higher education can use ElevenLabs to create audio versions of lecture notes, develop engaging multimedia resources, and support students with diverse learning needs, including those who benefit from auditory learning formats.

...

Elicit

we recommend for inquiry and learning process facilitation.

Freemium 

Fair to use 

Description. Elicit is an AI-powered research assistant designed to streamline evidence-based decision-making by analyzing and summarizing academic literature. It helps users quickly identify relevant studies, extract key insights, and organize findings, making the research process faster and more efficient. Ideal for academics, professionals, and organizations, Elicit enhances productivity and ensures informed decision-making through its intuitive interface and advanced natural language processing capabilities.

Example. Elicit is designed to streamline the process of finding and synthesizing academic literature. Teachers in higher education can use Elicit to quickly identify relevant studies, summarize findings, and generate evidence-based insights for lectures and course materials, saving time and enhancing the depth of their teaching content.

...

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Freemium Easy to use

Fliki.AI

we recommend for content creation and enhancement.

Description. Fliki is an AI-driven platform that transforms text into lifelike voiceovers and engaging videos. With a variety of natural-sounding voices and customizable video templates, it simplifies content creation for podcasts, tutorials, and social media. Fliki empowers users to produce professional-quality multimedia content quickly and effortlessly.

Example. Fliki AI converts text into engaging videos and voiceovers, making it easy for educators to create multimedia content. Teachers in higher education can use Fliki to design visually rich lecture materials, develop instructional videos, and create accessible content for online learning platforms, enhancing student engagement and comprehension.

...

Freemium Easy to use

Gemini

we recommend for personalised learning.

Description. Google Gemini is an advanced AI tool designed to integrate cutting-edge generative AI capabilities into search, productivity, and creative workflows. By combining deep learning with real-time data processing, Gemini provides users with personalized insights, creative content generation, and seamless task automation. Ideal for both individuals and businesses, it enhances efficiency, fosters creativity, and delivers smarter, context-aware solutions across a range of applications.

Example. Gemini enables teachers in higher education to create interactive learning activities, answer complex student queries in real-time, and streamline lesson planning, fostering a more engaging and efficient teaching process.

...

Freemium Fair to use

Humata.AI

we recommend for data and information management and evaluation.

Description. Humata.ai is an AI-powered tool that simplifies document analysis by providing instant summaries, answers, and insights from uploaded files. It streamlines workflows for professionals by enabling quick comprehension and data extraction from complex documents.

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Example. Humata AI helps educators quickly extract insights and summarize key points from academic papers, PDFs, and other documents. Teachers in higher education can use Humata to streamline research preparation, create concise summaries for lectures, and provide students with focused insights, enhancing both teaching efficiency and content clarity.

...

IBM Watson Education

Paid 

Fair to use 

we recommend for virtual teaching assistants.

Description. IBM Watson Education Classroom is an AI-powered platform designed to enhance learning experiences by providing personalized insights and recommendations. It supports educators with data-driven tools to tailor teaching strategies, improve student engagement, and streamline classroom management for better outcomes.

Example. IBM Watson Education Classroom assist educators in personalizing learning experiences and streamlining classroom management. Teachers in higher education can use Watson to analyze student performance, create tailored lesson plans, and provide individualized feedback, enabling a more efficient and impactful teaching process.

...

Leonardo.AI

Freemium 

Fair to use 

we recommend for content creation and enhancement.

Description. Leonardo.ai is a powerful AI platform designed for creating high-quality, customizable visual content, including game assets, concept art, and digital designs. Using advanced generative AI, it empowers artists and creators to produce unique and professional-grade visuals with efficiency and precision. Leonardo.ai streamlines the creative process, making it an essential tool for professionals in gaming, design, and digital media industries.

Example. Leonardo AI helps educators generate high-quality visuals, illustrations, and designs tailored to their teaching needs. Teachers in higher education can use Leonardo to create engaging lecture materials, design interactive content, and develop unique visuals for presentations, enhancing the overall learning experience for students.

...

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Freemium Easy to use

Luma Dream Machine

we recommend for content creation and enhancement.

Description. Luma Labs AI is an innovative tool that leverages advanced AI to create lifelike 3D visuals and immersive content from simple inputs. Ideal for creators, developers, and businesses, it simplifies 3D asset generation, enabling high-quality results with minimal effort. Luma Labs AI empowers users to bring their ideas to life quickly and efficiently, enhancing creativity across industries.

Example. Luma Labs AI enables teachers in fields like engineering, architecture, and biology to create immersive, interactive visualizations of objects and concepts, fostering more dynamic and engaging teaching experiences.

...

Freemium Fair to use

Magician for Figma

we recommend for content creation and enhancement.

Description. Magician.design is an innovative AI-powered tool that enhances design workflows by generating creative ideas, illustrations, and content directly within design platforms. Tailored for designers, it uses advanced AI to automate repetitive tasks, suggest improvements, and bring imaginative concepts to life. With its seamless integration and intuitive interface, Magician.design empowers users to accelerate their creative process while maintaining high-quality and professional standards.

Example. Magician for Figma helps educators create visually compelling and interactive design elements tailored for teaching materials. Teachers in higher education can use it to design engaging presentations, develop dynamic visual aids, and enhance the aesthetic appeal of course content, making lessons more captivating and effective for students.

...

Freemium Easy to use

Merlin

we recommend for productivity for students.

Description. Merlin is an AI-driven productivity tool designed to streamline workflows by integrating intelligent automation and data analysis into daily tasks. It helps users manage information, generate insights, and automate repetitive processes, enhancing efficiency across various industries. With its intuitive interface and advanced

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capabilities, Merlin empowers professionals to save time and focus on high-value work, making it an essential tool for boosting productivity and decision-making.

Example. Merlin assists educators in automating repetitive tasks, managing workflows, and enhancing teaching efficiency. Teachers in higher education can use Merlin to organize lesson plans, generate summaries for complex topics, and streamline administrative tasks, freeing up time to focus on student engagement and effective instruction.

...

Midjourney

Paid

Fair to use

we recommend for content creation and enhancement.

Description. MidJourney is an AI-powered creative platform that generates stunning, high-quality images from text prompts, enabling users to visualize concepts effortlessly. Ideal for artists, designers, and innovators, it uses advanced generative AI to transform ideas into captivating visuals, tailored to user preferences. MidJourney enhances creative workflows by providing fast, customizable, and professional-grade results, making it a valuable tool for digital content creation and artistic exploration.

Example. MidJourney enables teachers in higher education to create custom illustrations, visual aids, and concept art for subjects such as design, art history, or creative writing, fostering a more engaging and visually enriched learning experience.

...

MindMap AI

Freemium

Fair to use

we recommend for personalised learning.

Description. MindMap AI is an intuitive tool that combines AI with mind mapping to help users organize ideas, brainstorm, and plan effectively. It simplifies complex workflows by generating dynamic, visually engaging mind maps, enabling clearer thinking and better decision-making.

Example. MindMap AI helps educators create detailed and dynamic mind maps to visually organize and present complex ideas. Teachers in higher education can use MindMap AI to design course outlines, illustrate conceptual relationships, and facilitate collaborative brainstorming sessions, enhancing student understanding and engagement in subjects across disciplines.

...

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Freemium

Fair to use

Nolej

we recommend for generating interactive lessons, courses, and quizzes.

Description. Nolej.io is an AI-powered platform designed to transform content into interactive and engaging learning experiences. It enables educators and organizations to create personalized, adaptive learning materials quickly, enhancing knowledge retention and learner engagement.

Example. Nolej enables teachers in higher education to quickly convert lecture notes, research papers, or textbooks into dynamic learning resources, making lessons more interactive and accessible for students.

...

Free

Easy to use

Openknowledgemaps

we recommend for inquiry and learning process facilitation.

Description. Open Knowledge Maps is an AI-driven tool that visually organizes research topics into interactive knowledge maps, making it easier to explore and understand complex academic content. By clustering related papers and concepts, it provides an intuitive overview of the research landscape, helping users quickly identify key areas, connections, and insights. Ideal for researchers, students, and professionals, Open Knowledge Maps enhances discovery and promotes efficient, structured learning.

Example. Open Knowledge Maps visualizes academic research topics through interactive knowledge maps. Teachers in higher education can use it to help students explore research areas, understand connections between studies, and gain a comprehensive overview of complex subjects, making it a valuable resource for fostering critical thinking and research skills.

...

Freemium

Fair to use

OpenRead

we recommend for research and academic writing.

Description. OpenRead Academy is an AI-powered platform designed to enhance reading comprehension and learning through personalized insights and interactive tools. It helps users analyze texts, extract key information, and develop critical thinking skills, making it ideal for students and educators. By leveraging advanced AI, Open-

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Read Academy streamlines the learning process, fostering deeper understanding and engagement with complex materials while promoting efficient study practices.

Example. OpenRead enhance reading comprehension and engagement by providing interactive summaries and insights into academic texts. Teachers in higher education can use OpenRead to guide students through complex readings, highlight key concepts, and assess understanding, enabling a more efficient and interactive approach to academic learning.

...

Perplexity AI

Freemium 

Easy to use 

we recommend for inquiry and learning process facilitation.

Description. Perplexity.ai is an advanced AI-powered search and answer engine that delivers precise, context-aware responses to user queries by analyzing vast amounts of data in real time. It combines cutting-edge natural language processing with intuitive design, making information retrieval faster and more efficient. Ideal for researchers, professionals, and everyday users, Perplexity.ai simplifies complex searches, offering reliable insights and fostering informed decision-making across a variety of topics.

Example. Perplexity AI enables teachers in higher education to support lesson planning, gather reliable academic sources, and provide students with clear, evidence-based insights, fostering a more informed and efficient teaching process.

...

Programming Helper

Paid 

Easy to use 

we recommend for productivity for students.

Description. Programming Helper is an AI-driven platform designed to assist developers with coding tasks, debugging, and learning new programming concepts. It simplifies complex problems by providing instant solutions, code explanations, and best practices, making it an essential tool for both beginners and professionals.

Example. Programming Helper enables teachers in higher education to create coding examples, explain programming concepts, and provide real-time solutions to student queries, enhancing the teaching process in computer science and related courses.

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Freemium  Easy to use 

QuillBot

we recommend for content creation and enhancement.

Description. Quillbot is an AI-powered writing assistant designed to enhance and streamline the writing process by offering tools for paraphrasing, grammar checking, and summarizing. It helps users improve clarity, tone, and style, making it ideal for students, professionals, and content creators. With its intuitive interface and advanced AI capabilities, Quillbot saves time while ensuring polished, high-quality writing tailored to individual needs.

Example. QuillBot enables teachers in higher education to assist students in refining their writing, creating concise summaries of complex materials, and crafting clear and effective communication for assignments and academic purposes.

...

Free  Fair to use 

Researchrabbit

we recommend for research and academic writing.

Description. ResearchRabbit is an AI-powered platform that revolutionizes academic research by helping users discover, organize, and track relevant literature efficiently. It offers personalized recommendations, interactive visualizations, and real-time updates on related studies, streamlining the research process. Ideal for researchers and students, ResearchRabbit enhances productivity and fosters deeper insights by providing a dynamic, user-friendly approach to exploring scholarly content.

Example. ResearchRabbit helps educators explore academic literature and identify connections across studies. Teachers in higher education can use ResearchRabbit to streamline literature reviews, curate relevant resources for lectures, and guide students in exploring related research, enhancing the depth and efficiency of their academic teaching.

...

Freemium  Fair to use 

Runway

we recommend for content creation and enhancement.

Description. Runway ML is an innovative AI platform that empowers creators to generate, edit, and enhance multimedia content, including images, videos, and animations. With its user-friendly interface and advanced machine learning tools, it simplifies

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complex creative tasks, making professional-grade content creation accessible to all.

Example. Runway enables teachers in higher education to develop visually engaging multimedia content for lectures, create dynamic instructional materials, and demonstrate AI-driven creative workflows in art, media, and design courses, fostering innovative learning experiences.

...

Snorkel AI

Paid 

Fair to use 

we recommend for data and information management and evaluation.

Description. Snorkel AI is a powerful platform that streamlines data labeling and model development through programmatic techniques. By leveraging AI-driven automation, it accelerates machine learning workflows, enabling rapid creation of high-quality training datasets for AI applications.

Example. Snorkel AI enables teachers in higher education to introduce students to advanced data science techniques, create labeled datasets for machine learning projects, and facilitate hands-on learning in AI and data-driven courses, enhancing practical understanding.

...

Stability.AI

Freemium 

Fair to use 

we recommend for content creation and enhancement.

Description. Stability AI is an innovative platform specializing in the development of open-source generative AI models and tools. It empowers users to create high-quality visual content, such as images and designs, from text prompts, fostering creativity and accessibility. With its focus on democratizing AI and promoting ethical innovation, Stability AI is a valuable resource for creators, developers, and professionals across various industries.

Example. Stability AI enables teachers in higher education to create customized illustrations, visual aids, and conceptual designs for art, media, and STEM courses, enhancing the visual engagement and creativity of their teaching materials.

...

Studio.AI

Freemium 

Fair to use 

we recommend for content creation and enhancement.

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Description. Studio AI is an intuitive platform designed to simplify the creation, prototyping, and deployment of AI-driven applications. With user-friendly tools, pre-built templates, and advanced machine learning capabilities, it empowers users to rapidly develop and customize AI solutions for various use cases. Ideal for both beginners and professionals, Studio AI streamlines workflows, fosters innovation, and accelerates the development of intelligent, impactful applications.

Example. Studio AI enables teachers in higher education to produce engaging lecture videos, design interactive tutorials, and create visually compelling course materials, enhancing the effectiveness and accessibility of their teaching.

...

Suno

we recommend for content creation and enhancement.

Freemium 

Fair to use 

Description. Suno is an advanced AI platform specializing in generative audio and speech technology, enabling users to create lifelike voiceovers and audio content with ease. Ideal for creators, developers, and businesses, it simplifies the production of high-quality audio, enhancing efficiency and creativity in various projects.

Example. Suno enables teachers in higher education to create audio-based learning materials, develop immersive sound environments for interactive lessons, and support students with auditory learning preferences, enriching the educational experience across various disciplines.

...

Teachology

we recommend for self-paced acquisition of foundational skills.

Freemium 

Fair to use 

Description. Teachology AI is an innovative platform designed to empower educators by streamlining lesson planning, grading, and student engagement through AI-driven solutions. It offers personalized teaching strategies, automated administrative tasks, and insights into student performance, enabling teachers to focus on impactful instruction. Teachology AI enhances classroom efficiency and fosters better learning outcomes, making it an essential tool for modern education.

Example. Teachology assist educators in optimizing lesson planning, automating administrative tasks, and personalizing student learning experiences. Teachers in

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higher education can use Teachology AI to create tailored course content, track student progress, and streamline grading processes, allowing for more efficient and impactful teaching.

...

Tome.AI

we recommend for content creation and enhancement.

Freemium 

Fair to use 

Description. Tome is an AI-powered storytelling platform that helps users create dynamic, visually engaging presentations and narratives. By combining text, images, and multimedia seamlessly, it streamlines content creation for professionals, educators, and creatives, making storytelling more impactful and efficient.

Example. Tome enables educators to create visually stunning and interactive presentations with minimal effort. Teachers in higher education can use Tome to design engaging lecture slides, organize course content effectively, and create dynamic storytelling experiences, making their teaching materials more captivating and accessible for students.

...

Turnitin AI

we recommend for assessment and feedback.

Paid 

Fair to use 

Description. Turnitin's AI Detector is a powerful tool designed to identify AI-generated content in academic submissions, ensuring integrity and originality. Leveraging advanced algorithms, it provides educators with reliable insights to uphold academic standards and foster authentic learning.

Example. Turnitin AI enables teachers in higher education to evaluate the originality of assignments, detect potential misuse of AI in writing, and promote ethical academic practices, fostering a fair and accountable learning environment.

...

Typeset

we recommend for research and academic writing.

Freemium 

Fair to use 

Description. Typeset.io is an AI-powered platform designed to simplify and enhance the research writing process, offering tools for formatting, citation management,

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and collaboration. It automates complex tasks like journal submission formatting and provides a user-friendly interface for organizing and sharing academic work. Ideal for researchers, students, and professionals, Typeset.io streamlines workflows, ensuring high-quality, publication-ready documents with minimal effort.

Example. Typeset enables teachers in higher education to guide students in adhering to specific formatting styles, streamline the review process for research assignments, and ensure professional-quality submissions, enhancing the academic writing experience.

...

Udio

Freemium  Easy to use 

we recommend for self-paced acquisition of foundational skills.

Description. Udio is an AI-powered learning platform designed to personalize and enhance educational experiences for students and educators. It offers adaptive learning paths, real-time insights, and interactive tools to improve engagement and outcomes. With its user-friendly interface and data-driven approach, Udio supports efficient teaching and learning, making it an essential tool for modern education.

Example. Udio helps educators create interactive and personalized learning experiences through dynamic content and real-time insights. Teachers in higher education can use Udio to develop customized course materials, track student engagement, and adapt lessons to meet individual learning needs, fostering a more engaging and effective educational environment.

...

You.com

Freemium  Easy to use 

we recommend for data and information management and evaluation.

Description. You.com is an AI-powered search engine that offers personalized, ad-free search experiences while integrating advanced tools for productivity and creativity. It combines natural language processing with customizable preferences, allowing users to find information, generate content, and explore resources tailored to their needs. Designed for efficiency and privacy, You.com empowers users to search smarter and work faster in a seamless, intuitive environment.

Example. You.com enables teachers in higher education to gather reliable academic resources, generate ideas for course content, and provide students with tailored research guidance, enhancing both teaching preparation and classroom engagement.

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Select Case Studies

This chapter explains how we selected and analysed the fifteen case studies presented here, offers an overview of their collective findings, and provides a detailed account of each case study based on the collected data. The methodology involves identifying publications that apply AI in higher education contexts, focusing on specific or diverse student populations, with disciplines ranging from computer science to communication and management. We reviewed these studies from both qualitative and quantitative perspectives, observing how they integrate AI-based tools and measure teaching and learning outcomes.

Our brief overview highlights key themes and insights, including ethical considerations, the benefits and limitations of AI-based solutions, and how these tools shape student engagement. The subsequent in-depth look at the fifteen case studies draws from the collected data, aiming to give readers a solid grasp of the practical approaches and outcomes observed, while emphasizing the importance of thoughtful and responsible AI adoption in higher education.

Methodology of Selecting the Case Studies

To identify case studies that highlight the use of AI tools, potential sources for case studies were first identified. These included academic journals and databases such as Scopus, Web of Science (WoS), SAGE, SpringerLink, and Elsevier's ScienceDirect (including journals like Computers & Education and the Journal of Educational Technology & Society), as well as Taylor & Francis Online (featuring Interactive Learning Environments and Educational Technology Research and Development). Open-access publications were accessed via online repositories such as ERIC (Education Resources Information Center) and arXiv.org. Additionally, relevant literature was found in books

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and Google Scholar, which were searched using the identified keywords.

In the first phase, scientific databases were searched using the below queries with keywords. It is important to emphasise that the search was limited to scientific papers published from October 2022 to the end of 2024, focusing on the application of artificial intelligence in teaching. The search for relevant case studies on AI in teaching involved several academic sources described in continuance of this section:

SAGE The search query yielded 25 initial papers, of which nine were selected for further consideration.

Web of Science Core Collection (WoS CC) The following query resulted in 579 papers, with 50 selected based on citation criteria:

```
TI=("artificial intelligence" OR "AI") AND TI=(teach)*
```

Scopus The search query below initially retrieved 1,402 papers, which increased to 1,952 after including the keyword "Teaching". From this, 50 papers were selected based on citation criteria.

```
TITLE ("artificial intelligence" OR "AI") AND TITLE ("teach")*
```

SpringerLink Search using the query provided below produced 1,018 results. After refining the search by applying filters for Research Articles, Last 24 Months, English language, and subdisciplines, including Educational Technology and Computers & Education, the number of relevant papers was reduced to 74.

```
title:(("artificial intelligence" OR "AI") AND ("teach"))*
```

ScienceDirect The following query yielded 3,410 papers.

```
TITLE(("artificial intelligence" OR "AI") AND ("teach"))
```

After applying selection criteria, 58 papers were chosen, filtered by:

- Publication years: 2024 (28 papers), 2023 (16 papers), 2022 (14 papers).
- Article type: "Research articles" (42 papers).
- Journal titles: Computers and Education: Artificial Intelligence (30 papers), Procedia Computer Science (21 papers), Educational Research Review (4 papers), Computers & Education (3 papers).
- Research fields: Social sciences (37 papers), Computer science (21 papers), Psychology (4 papers).
- Access type: Open Access & Open Archive (58 papers).

Google Scholar The first search query, provided below first returned 14 results, while the second query, following second below, yielded 93 results.

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```
(allintitle: "artificial intelligence" "teaching" "case study")

(allintitle: "artificial intelligence" ("education" OR "learning") "case study"
-teaching)
```

Google Books No relevant results were found in the past two years using the following query.

```
intitle: "artificial intelligence" ("teaching" OR "learning" OR "education") "case study"
```

This systematic approach ensured that only the most relevant and high-impact studies were considered for further analysis. It is important to emphasise that only papers available for download were considered. In cases where many papers were retrieved, such as in Scopus, only the 50 most significant papers were selected to ensure a feasible literature review within the researchers' realistic capacity.

Papers were initially screened based on their titles and abstracts. Those that did not focus on higher education were excluded from further consideration. Although the search yielded many papers, only a smaller portion was suitable for analysis. The primary focus was on identifying studies that described real cases of AI tool implementation, where results were presented based on interviews, experimental outcomes, or survey data. Some literature review papers were also included, as they provided valuable insights for this project phase.

Ultimately, **15 key papers** were identified and categorised as described below. The analysed papers were categorised based on key features, including the case study name, reference, year, short description, educational level and participants, education field, approach/methods, research goal, AI tool used, challenges, ethical considerations, outcomes/effects, pedagogical design/teaching methods, and additional comments. It is important to note that the categories and subcategories within each category were also defined based on recent and relevant literature related to applying AI tools in higher education. In this way, the presented results can be interpreted and positioned in alignment with the current state of the art and existing classifications from scientific literature.

For example, the category goal of the study is linked to key areas of AI tool application (role), including assessment, learning, teaching, and administration, as a means of supporting these processes. This categorisation aligns with findings in [107], who conducted a systematic literature review on AI's opportunities, challenges, and future research directions in education. According to the authors, for learning, AI is applied to facilitate personalised and adaptive learning experiences, including task assignment based on competence, human-machine interaction, student work analysis for feedback, and adaptability in digital environments. AI enhances teaching by offering adaptive strategies, improving teaching capabilities, and supporting professional development through intelligent systems. AI automates grading and marking in assessment

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and predicts student performance using learning data and activity patterns. The last subcategory is administration – AI tools support libraries, career centres and outer university services.

Furthermore, the research approach and methodology were categorised based on qualitative and quantitative methods commonly used in social sciences and IT research, including:

- Experimental (EXP): Controlled experiments examining AI interventions.
- Quasi-Experimental (QE): Studies comparing pre-existing groups where random assignment is not feasible.
- Survey (SUR): Using questionnaires and opinion polls to gather data.
- Discourse Analysis (DA): Analysis of communication, discussions, and textual data.
- Interview (INT): Collection of qualitative data through participant discussions.
- Systematic Literature Review (SLR): Comprehensive analysis of existing research on AI in education.

The selected subcategories align with the most commonly used research methods in AI education studies, as [108] identified in their review of AI in education from 2010 to 2020. However, we also introduced additional categories better to capture the methodological approaches of the analysed studies.

Since challenges in AI tool use are widely recognised in the literature, they were included in the template for literature analysis, covering three key areas identified in [109]: technological challenges (such as accuracy issues in AI models and system constraints), design and methodological challenges (including difficulties in developing AI-based teaching methods, data collection issues, and bias in evaluation), and teacher and student concerns(such as digital literacy gaps, cognitive load, ethical considerations, and the adaptability of AI tools in education).

Additionally, challenges related to limitations in empathy and human interaction – acknowledging AI's inability to provide emotionally intelligent and empathetic responses compared to human instructors – were included to address human-computer interaction (HCI) issues in people – AI communication, as identified in [110].

Even though many perceive them as a broader challenge, ethical considerations were highlighted as a separate category. However, according to existing literature, ethical concerns can be divided into specific subcategories directly related to the practical use of AI tools in educational activities, as identified in [111]. These include cheating (students using AI to generate answers dishonestly), creating bias (AI-generated

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content reflecting underlying biases that impact fairness and inclusivity), ethical issues (broader concerns regarding AI's role in education), and legal issues (such as copyright and data privacy challenges).

The outcomes and effects of AI tools were described from either a student or teacher perspective, in line with the approach taken in [107]. The outcomes of AI in education can be categorised into academic performance, perceptions, and broader impacts. Academic outcomes include student scores, achievements, and completion rates, while perception-based outcomes focus on students' and teachers' satisfaction, motivation, and acceptance of AI tools. Other impacts extend to creativity, critical thinking, collaboration, and personal development, with digital citizenship skills being a key outcome of the project.

For teachers, AI improves work efficiency by automating routine tasks, enhances teaching competence by supporting instructional strategies, and influences attitudes toward AI in education. **For students**, AI fosters motivation and engagement, contributes to academic success, and helps develop 21st-century skills such as collaboration, creativity, and problem-solving. Additionally, AI impacts non-cognitive aspects by supporting emotional and social development, including confidence building and stress management. However, due to the specific nature of the studies, a free-text description was generally used to provide a more detailed explanation of the effects or outcomes of AI tools in each case.

Finally, for the included studies, it was essential to categorise pedagogical approaches and teaching methods. The following subcategories were used, covering various teaching models that incorporate technology in education, specifically applicable to AI-enhanced learning: Active and Experiential Learning, Adaptive Learning, Adaptive Teaching, Blended Learning, Collaborative Learning, Distance Learning, Flipped Classroom, Gamification and Game-Based Learning, Inquiry-Based Learning, Learner-Centered Learning, Online Learning, Personalized Learning, Problem-Based Learning, Technology-Enhanced Learning, and Thinking-Based Learning.

Overview of the Selected Case Studies

The following papers containing descriptions of case studies on using AI-based tools or platforms in higher education have been selected, listed here in no particular order:

- Damiano, Lauría, Sarmiento *et al.* [112]: 'Early Perceptions of Teaching and

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Learning Using Generative AI in Higher Education'

- Adetayo, Aborisade and Sanni [113]: 'Microsoft Copilot and Anthropic Claude AI in Education and Library Service'
- Barrot [114]: 'Leveraging Google Gemini as a Research Writing Tool in Higher Education'
- Yilmaz and Karaoglan Yilmaz [115]: 'The Effect of Generative Artificial Intelligence (AI)-Based Tool Use on Students' Computational Thinking Skills, Programming Self-Efficacy and Motivation'
- Kostikova, Holubnycha, Besarab *et al.* [116]: 'Chat GPT for Professional English Course Development'
- Pillai, Sivathanu, Metri *et al.* [117]: 'Students' Adoption of AI-Based Teacher-Bots (T-Bots) for Learning in Higher Education'
- Barrett and Pack [118]: 'Not Quite Eye to A.i.'
- Lozano and Blanco Fontao [119]: 'Is the Education System Prepared for the Irruption of Artificial Intelligence?'
- Aure and Cuenca [120]: 'Fostering Social-Emotional Learning Through Human-Centered Use of Generative Ai in Business Research Education'
- Tham, Howard and Verhulsdonck [121]: 'Extending Design Thinking, Content Strategy, and Artificial Intelligence into Technical Communication and User Experience Design Programs'
- Yang [122]: 'Preparing Public Relations' Practitioners for the AI Era: Advancing Pedagogical Principles in Public Relations' Artificial Intelligence Education'
- Huang, Huang and Cummings [123]: 'Exploring the Integration and Utilisation of Generative Ai in Formative E-Assessments'
- Irfan, Murray and Ali [124]: 'Integration of Artificial Intelligence in Academia'
- Chanpradit, Samran, Saengpinit *et al.* [125]: 'Paraphrasing Strategies and Levels of Proficiency of an AI-generated QuillBot and Paraphrasing Tool'
- Punar Özçelik and Yangın Ekşi [126]: 'Cultivating Writing Skills'

All the selected case studies discuss how AI shapes higher education, in the context of undergraduate or graduate programs. Some concentrate on specific groups, like undergraduates or master's students, while others take a broader look at AI's role across higher education. The selected case studies explore multiple fields, including but not limited to information and communication sciences, computer science, social sciences

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(especially pedagogy), management, and communication. In most cases, AI-based tools are introduced in a flexible way that can be applied to different disciplines.

Research designs that can be found in the papers presenting the case studies found in this chapter combine quantitative and qualitative methods, such as experimental setups, surveys, literature reviews, and close-up case studies. The goals of these research approaches focus on improving teaching and learning through the use of AI, examining AI's potential as an academic support tool, and finding strategies for adaptive learning that boost student engagement and personalisation. Many of those studies also look at the role of AI in academic research, whether for literature reviews, content creation, or quality checks.

Common tools mentioned over all the analysed case studies include ChatGPT (specifically models GPT-3.5 and GPT-4), Microsoft Copilot, Claude, Google Gemini (formerly Bard), and AI-driven teacher bots that act as virtual teaching assistants. When educators incorporate these tools into their classrooms, these AI-based tools and models often help with research, writing, and administrative work, providing easier access to information and speeding up tedious daily tasks.

Although these studies showcase the clear advantages of AI, they also pinpoint difficulties. On the technical side, AI remains imperfect at solving certain academic challenges. Ethical questions remain one of the major issues, from academic dishonesty and over-automation to potential drops in critical thinking. Researchers face further problems with ensuring that AI-based lessons would stimulate real participation rather than just automating or mechanizing tasks. Lacking in emotional intelligence, any AI struggles with the more human sides of teaching, such as empathy and personal guidance. Therefore, learners struggle when coping with the constraints imposed on the learning process by the inhuman AI models, however human-like they pose to be.

Concerns about ethics are rooted in academic integrity, since AI can enable and ease plagiarism and foster over-reliance on generated text. Bias in AI-based tools and systems, which can replicate harmful stereotypes, raises serious issues as well. Privacy and data safety must be observed and taken into account as well, ensuring careful handling of delicate data when interacting with AI-based tools. Furthermore, it is crucial for teachers and students to consider AI as a useful aid rather than a stand-in for real social interaction.

When it comes to results, AI frequently speeds up learning, helps in adapting lessons to different needs, and keeps students more active. Still, not all students can tell good AI-based or AI-generated responses from poor ones, and reliance on AI technology greatly influences student motivation in various ways – some students thrive with the extra push, while others lean too heavily on it. On the teaching side, most studies follow the logic of technology-enhanced learning, using adaptive methods and the

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power of AI-based tools, models, and systems to shape lessons to individual learners. Many selected case studies encourage group work and peer review of AI outputs, thus prompting students to think critically. The flipped classroom model shows up often as well, as one of the preferred pedagogical design approaches, with AI helping students prepare before they meet face-to-face. In many cases, researchers embed AI in a structured setup so they can test the impact of including AI-based tools on students' performance.

Overall, these studies give a clear sense of AI's strengths and drawbacks in higher education. They confirm that AI can broaden learning opportunities, customize how students gain knowledge, and support research work, but only when used properly. Teachers must be aware and steer clear of shortcuts that undermine integrity, avoid unethical uses of AI-based tools, and preserve academic quality. Through careful planning and awareness, AI-based tools, models, and systems can fit into the educational landscape as powerful companions without undermining the core values of academic integrity.

Details of the Selected Case Studies

This section presents each of the fifteen collected case studies in detail, giving readers a clear sense of how AI is being integrated into higher education. Every case is described using several features. At the beginning, the title of the paper presenting the case study is given, followed by the year of publication and a reference to the bibliography item. Following is the summary description of the chosen case study and the related observed outcomes including a summary of the main results and the conclusions drawn. Additional details include: a) the educational setting, discipline, and the utilised pedagogical design or teaching method, illustrating the study's context; b) the specific chosen tools, employed research methods, and set goals; c) a note on any key challenges or ethical considerations mentioned in the referenced paper.

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Early Perceptions of Teching and Learning Using Generative AI in Higher Education

Y. 2024 [112]

Description. This paper investigated perceptions of ChatGPT in higher education among students and faculty, examining its implications for teaching and learning. Guided by Diffusion of Innovation theory and the Technology Acceptance Model, the study surveyed 380 participants. Findings revealed that while participants did not intend to use ChatGPT for plagiarism, they suspected others might. Many struggled to accurately assess ChatGPT's outputs, with over half misjudging incorrect responses or being unsure of their accuracy. Results varied by demographics, highlighting the importance of teaching data literacy and critical thinking for effective integration of Generative AI in education.

Outcomes. The study found that older participants had higher awareness and trust in ChatGPT, while younger participants saw more educational benefits but struggled to discern the accuracy of its output

Education level	**Education field**	**Pedagogical design**
Tertiary education in general	Computer Science and Mathematics, Communication and the Arts, Social and Behavioral Sciences, School of Management, Science, Liberal Arts	Technology-Enhanced Learning

Methods	**Goal**	**Tool**
Survey (SUR)	Assessment	Chat GPT

Challenges	**Ethical considerations**
N/A	Cheating

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MICROSOFT COPILOT AND ANTHROPIC CLAUDE AI IN EDUCATION AND LIBRARY SERVICE

Y. 2024 [113]

Description. This article explores the integration of Microsoft Copilot and Anthropic Claude AI in educational and library contexts. It discusses the tools' unique capabilities, including Microsoft Copilot's productivity features, real-time internet access, and image generation, alongside Claude AI's advanced contextual comprehension, file ingestion, and metadata generation. The study highlights their potential to revolutionize information management, research assistance, and educational content creation. By integrating these tools, users can leverage Copilot's broad information access and Claude's deep analytical capabilities for enhanced learning and research workflows.The paper also addresses challenges like algorithmic biases, data security, and AI governance, emphasizing the need for ethical and transparent implementation to maximize their impact responsibly.

Outcomes. The partnership between Copilot and Claude AI provides an integrated approach to revolutionizing education and library services. The study highlights the effective synergy of real-time internet connectivity, advanced information retrieval, and sophisticated comprehension capabilities as its core strengths.

Education level	**Education field**	**Pedagogical design**
Tertiary education in general	Library services on university	Technology-Enhanced Learning and Adaptive Learning,

Methods	**Goal**	**Tool**
Literature review	Administration	Copilot and Claude AI

Challenges	**Ethical considerations**
Technological Challenges, Limitations in Empathy and Human Interaction, Teacher and Student Concerns	Ethical Issues, Legal Issues, Creating Bias

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Leveraging Google Gemini as a Research Writing Tool in Higher Education

Y. 2024 [114]

Description. The article explores the application of Google Gemini, an artificial intelligence tool powered by advanced large language models (LLMs), in research writing within higher education. Gemini offers functionalities such as idea generation, content organization, paraphrasing, summarizing, and automated feedback. Its capabilities include generating research questions, creating outlines, and providing concise summaries, significantly streamlining the writing process. The article explores the potential of Google Gemini, an AI-powered chatbot, as a tool to enhance research writing processes in higher education. The study highlights Gemini's capabilities, including idea generation, outlining, paraphrasing, summarizing, and providing automated feedback, which support students and researchers in addressing common challenges like writer's block, organizing ideas, and language clarity. However, the article also discusses limitations such as occasional inaccuracies, potential for plagiarism, lack of critical thinking engagement, and its inability to handle advanced data analysis or primary data collection. The paper emphasizes the need for ethical guidelines, critical evaluation of outputs, and institutional policies to effectively and responsibly integrate AI tools like Gemini into academic practices.

Outcomes. The article highlights the potential outcomes of using Google Gemini for students and teachers. For students, positive effects include improved writing support, productivity, and engagement, with timely AI feedback enhancing grammar and structure. However, risks include overreliance on AI, plagiarism, limited skill development, and misleading content. For teachers, Gemini can streamline support, enhance collaboration, and provide insights into student challenges, but it also raises concerns about assessing genuine student work, ethical use, and the need for adapting teaching methods to incorporate AI effectively. Balancing benefits and challenges is essential for its responsible use in education.

Education level	**Education field**	**Pedagogical design**
Tertiary education in general	All education fields applicable	Collaborative learning, P2P learning
Methods	**Goal**	**Tool**
Literature review	Learning, Teaching, Assessment, Administration	Google Gemini/ Google Bard
Challenges		**Ethical considerations**
Technological Challenges, Design and Methodological Challenges, Teacher and Student Concerns		Ethical Issues, Legal Issues

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THE EFFECT OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)-BASED TOOL USE ON STUDENTS' COMPUTATIONAL THINKING SKILLS, PROGRAMMING SELF-EFFICACY AND MOTIVATION **Y.** 2023 [115]

Description. The article examines ChatGPT's impact on programming education, focusing on computational thinking, programming self-efficacy, and motivation. An experimental study with undergraduates compared a ChatGPT-supported group to traditional learning, controlling for pretest scores. Results highlight benefits but also concerns about AI reliance in complex problem-solving, emphasizing the need for guided integration aligned with pedagogical goals.

Outcomes. This study examined the impact of ChatGPT-supported programming education on university students' computational thinking, programming self-efficacy, and motivation in a pretest-posttest experimental design. The experimental group used ChatGPT in the learning process, while the control group did not. Results showed that ChatGPT significantly improved students' computational thinking skills, programming self-efficacy, and motivation, with notable differences in creativity, algorithmic thinking, cooperativity, critical thinking, problem-solving, programming tasks (simple and complex), and motivation-related factors (attitude, direction, reward, social pressure, and competition). However, no significant difference was observed in the "challenging goals" dimension, indicating that AI tools like ChatGPT do not inherently enhance motivation when students face complex programming challenges. Teachers are advised to adopt diverse motivational strategies for such tasks. For optimal student outcomes, providing training in prompt writing is crucial, as effective prompts enhance the use of AI tools like ChatGPT. Teachers should also develop AI literacy skills to integrate such tools effectively into lessons. Additionally, incorporating metacognitive strategies, including prompts that encourage self-reflection, can support students in understanding and regulating their learning processes. These approaches can maximize the benefits of AI tools in programming education for both students and teachers.

Education level	**Education field**	**Pedagogical design**
Undergraduate level	Computer programming	Flipped classroom
Methods	**Goal**	**Tool**
Experimental (EXP)	Learning, Teaching	ChatGPT
Challenges		**Ethical considerations**
Design and Methodological Challenges		N/A

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CHATGPT FOR PROFESSIONAL ENGLISH COURSE DEVELOPMENT **Y.** 2024 [116]

Description. The article showcases the use of ChatGPT to create a specialized English course for law students. ChatGPT was employed to generate a curriculum, syllabus, textbook content, and learning materials aligned with specific objectives, such as international law topics. Authors are demonstrating how ChatGPT can aid in designing professional English courses by generating content, tasks, and testsIt provided lesson structures, reading texts, discussion prompts, and vocabulary lists while also assisting in crafting assignments and testing materials. The tool streamlined the course creation process by offering quick, coherent outputs, although educators refined and adapted the AI-generated content to meet educational standards and ensure relevance. This highlights ChatGPT's role as a valuable support tool in enhancing language education (language teaching and learning in general).

Outcomes. The article highlights both positive and negative outcomes of using ChatGPT for professional English course development. For students, positive effects include access to diverse and engaging learning materials, such as tailored reading texts, assignments, and activities that enhance skills in speaking, writing, reading, and listening. However, negatives include the risk of overreliance on AI, which may hinder critical thinking and problem-solving skills, and the potential misuse of AI for academic dishonesty, such as submitting unedited AI-generated assignments. For teachers, ChatGPT provides significant advantages by giving flexibilty of ourse creation, saving time, and offering a foundation of materials to adapt and refine, thereby fostering innovation in teaching methods. Conversely, challenges for educators include the need to thoroughly review and adjust AI-generated content to ensure accuracy and cultural relevance and to address ethical concerns around AI use in education. Creating a balance between AI-generated content and human-guided instruction is critical to ensure the effective and complete development of any course in education

Education level	**Education field**	**Pedagogical design**
Master level	Law course	Technology Enhanced Learning
Methods	**Goal**	**Tool**
Case study, Quasi-Experimental (QE)	Learning, Teaching	ChatGPT 3.5
Challenges	**Ethical considerations**	
Technological Challenges, Limitations in Empathy and Human Interaction	Cheating, Creating Bias, Ethical Issues, Legal Issues	

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STUDENTS' ADOPTION OF AI-BASED TEACHER-BOTS (T-BOTS) FOR LEARNING IN HIGHER EDUCATION

Y. 2023 [117]

Description. The purpose of the paper was to investigate the use of Teaching-bots (T-bots) supported by artificial intelligence by students for learning. Variables such as perceived ease of use, perceived usefulness, personalization, interactivity, perceived trust, anthropomorphic and perceived intelligence were investigated and their influence on the intention to adopt T-bots in education and the use of T-bots. The results showed that developers and designers of T-bots should ensure greater interactivity of T-bots, provide personalized information to students and provide anthropomorphic characteristics of T-bots.

Outcomes. Motivation and engagement

Education level	**Education field**	**Pedagogical design**
Postgraduate level	Courses on private and government colleges	Personalized Learning

Methods	**Goal**	**Tool**
Survey (SUR), Other	Learning	AI-based teacher-bots

Challenges	**Ethical considerations**
Design and Methodological Challenges, Technological Challenges	N/A

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NOT QUITE EYE TO AI: STUDENT AND TEACHER PERSPECTIVES ON THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE IN THE WRITING PROCESS **Y.** 2023 [118]

Description. The survey in paper included displays of user prompts and output from ChatGPT, a GenAI chatbot, for each of the six tasks of the writing process (brainstorming, outlining, writing, revising, feedback, and evaluation). Students and teachers were asked via a survey to share their experience of using ChatGPT for the specified writing process tasks.

Outcomes. AI helps students in creativity and innovation in creating new ideas

Education level	**Education field**	**Pedagogical design**
Undergraduate level	N/A	Personalized Learning
Methods	**Goal**	**Tool**
Survey (SUR)	Learning	ChatGPT
Challenges		**Ethical considerations**
Design and Methodological Challenges		Ethical Issues

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Is the Education System Prepared for the Irruption of Artificial Intelligence? A Study on the Perceptions of Students of Primary Education Degree from a Dual Perspective: Current Pupils and Future Teachers

Y. 2023 [119]

Description. The paper includes the following three objectives: (O1)To study the level of prior knowledge and use of ChatGPT by students.; (O2) To assess the perception of the application by students. (O3) To assess the perception of the application by prospective teachers. A survey was conducted in research.

Outcomes. Students outcomes: personalized learning tool, ChatGPT saves much more time on doing tasks than with other online resources or textbooks, easy to access and use; Teacher outcomes: to generate high-quality content, know-how artificial intelligence works to understand how the students can use it in their tasks, to be able to evaluate it in a way that prevents/detects plagiarism

Education level	**Education field**	**Pedagogical design**
Undergraduate level	Teaching and Learning of Experimental Sciences	Personalized Learning

Methods	**Goal**	**Tool**
Survey (SUR)	Learning, Teaching	ChatGPT

Challenges	**Ethical considerations**
Design and Methodological Challenges, Teacher and Student Concerns	Cheating

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FOSTERING SOCIAL-EMOTIONAL LEARNING THROUGH HUMAN-CENTERED USE OF GENERATIVE AI IN BUSINESS RESEARCH EDUCATION: AN INSIDER CASE STUDY **Y.** 2024 [120]

Description. This paper examines a 14-week undergraduate business research course integrating AI tools for literature gathering, summarization, drafting, and editing. The pedagogy emphasizes foundational research skills, APA-style writing, and a human-centered approach incorporating Social-Emotional Learning (SEL) and Human-Centered AI (HCAI) principles. Students maintained meta-reflective journals to track AI engagement, while the instructor provided feedback through online and in-person sessions. Findings highlight AI's role in enhancing research efficiency, critical thinking, and self-awareness while addressing ethical concerns and dependency risks. Data from 72 student journals and instructor reflections offer insights for fostering responsible AI use in education.

Outcomes. Students improved their research skills by effectively using AI tools for tasks like brainstorming, summarization, and drafting, enhancing efficiency and comprehension. Through reflective practices, they developed critical thinking, ethical awareness, and practical AI competencies, including prompt engineering and fact-checking. Social-emotional learning (SEL) principles fostered self-regulation and responsible decision-making, while students also gained awareness of AI's limitations, such as producing generic outputs or potential dependency. Teachers adopted a facilitator role, guiding ethical and practical AI use while encouraging independent and collaborative learning. Meta-reflective journals provided valuable insights for assessing student progress and refining pedagogy. By balancing technical skill-building with SEL principles, educators promoted holistic student development and explored innovative teaching strategies, leveraging AI to enhance both learning outcomes and instructional practices.

Education level	**Education field**	**Pedagogical design**
Undergraduate level	Business Research Methods	Student centered/ collaborative learning
Methods	**Goal**	**Tool**
Thematic Analysis, Case study	Learning, Teaching	ChatGPT,Perplexity, Claude,AIElicit, BuzzCaptions

Challenges	**Ethical considerations**
Technological Challenges, Teacher and Student Concerns	Cheating, Ethical Issues, Creating Bias

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Extending Design Thinking, Content Strategy, and Artificial Intelligence into Technical Communication and User Experience Design Programs: Further Pedagogical Implications

Y. 2022 [121]

Description. This article builds on the discussion of emerging approaches in technical communication and user experience (UX) design—specifically, design thinking, content strategy, and artificial intelligence (AI)—and their implications for professional practice. By extending these insights to technical communication pedagogy, the authors highlight the importance of integrating these trends into program development and offer strategies for effective implementation.

Outcomes. The article highlights that design thinking enhances the team experience because it provides a mechanism for productive collaboration while empowering collaborators to contribute to their projects.

Education level	Education field	Pedagogical design
Tertiary education in general	TPC and UX practices	N/A

Methods	Goal	Tool
Sistematic Literature Review (SLR)	Learning, Assessment	N/A

Challenges	Ethical considerations
Design and Methodological Challenges	N/A

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Preparing Public Relations' Practitioners for the AI Era: Advancing Pedagogical Principles in Public Relations' Artificial Intelligence Education

Y. 2024 [122]

Description. This essay draws insights from recent research on AI value alignment, dialogic communication, and PR ethics, articulating three foundational principles for AI education in PR: authentic dialogue, client value centricity, and legal and ethical considerations. Aligned with these principles, the essay outlines four essential knowledge areas for PR AI education: programming and coding proficiency, AI fundamentals, the retrieval-augmented generation (RAG) system, and the LangChain framework for information security, as well as AI deployment and model optimization. An illustrative syllabus is presented to solidify these concepts. The essay further explores potential future directions and implications of integrating AI into PR education.

Outcomes. Advancements in AI suggest opportunities for higher productivity and more influential roles for strategic communicators, AI tools can significaly enhance the efficiency of tasks such as monitoring, sentiment analysis and data-driven insights

Education level	Education field	Pedagogical design
Master level	Programming	N/A
Methods	**Goal**	**Tool**
Other	Learning, Assessment, Teaching	N/A
Challenges		**Ethical considerations**
Limitations in Empathy and Human Interaction		Ethical Issues

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Exploring the integration and utilisation of generative AI in formative e-assessments: A case study in higher education

Y. 2024 [123]

Description. This study investigated the use of GenAI within an 8-week undergraduate-level research methods courseat a university in the United States of America, aiming to understand how students leverage GenAI tools during individual formative e-assessments questions.

Outcomes. Firstly, the varied success and challenges students face when interacting with ChatGPT underscore the need for AI literacy programmes. These programmes would aim to equip students with the skills necessary to effectively use AI tools, including understanding their capabilities and limitations, how to interpret AI-generated responses, assess their reliability and how to formulate queries to obtain useful responses.Secondly, the strategic use of ChatGPT for assistance with formative e-assessments, including direct copying of questions into the tool, highlights the need for clear guidelines on the ethical use of AI in academic settings. Educational policies should clearly define what constitutes ethical AI use in coursework and formative e-assessments, providing examples of acceptable and unacceptable practices. This would help maintain academic integrity while allowing students to benefit from AI technologies.Thirdly, the effectiveness of ChatGPT in providing explanations and verifying students' thought processes suggests that GenAI tools can play a complementary role in learning and assessment. However, the findings also suggest that traditional study methods and resources (e.g., textbooks, class notes) still remain crucial in supporting students' learning. Educators should consider how GenAI tools can be integrated with traditional teaching methods to enhance learning outcomes. This could involve using AI to support flipped classroom models, personalised learning, and as a supplementary resource for explaining complex concepts.

Education level	**Education field**	**Pedagogical design**
Undergraduate level	Social Sciences Research Methods	Technology Enhanced Learning

Methods	**Goal**	**Tool**
Survey (SUR)	Assessment, Learning	ChatGPT

Challenges	**Ethical considerations**
Design and Methodological Challenges, Teacher and Student Concerns	Ethical Issues, Other

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Co-funded by the European Union

INTEGRATION OF ARTIFICIAL INTELLIGENCE IN ACADEMIA: A CASE STUDY OF CRITICAL TEACHING AND LEARNING IN HIGHER EDUCATION

Y. 2023 [124]

Description. This study scrutinizes the role of AI literacy and ChatGPT-3 in enhancing critical reasoning and journalistic writing competencies among 50 third-term journalism students at Tajik National University.

Outcomes. Research findings suggest a significant improvement in students' critical thinking and journalistic writing skills with ChatGPT-3 usage. The integration of AI tools in the classroom encourages in-depth analysis and collaboration, thereby enhancing students' writing skills. The results underline the importance of AI literacy in journalism education, preparing students for the rapidly transforming, AI-centric journalism industry.

Education level	Education field	Pedagogical design
Undergraduate level	Journalism	Thinking-Based Learning

Methods	Goal	Tool
Interview (INT), Survey (SUR)	Learning	ChatGPT3

Challenges	Ethical considerations
Technological Challenges, Teacher and Student Concerns	Ethical Issues, Legal Issues

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Co-funded by the European Union

Paraphrasing Strategies and Levels of Proficiency of an AI-generated QuillBot and Paraphrasing Tool: Case Study of Scientific Research Abstracts

Y. 2024 [125]

Description. The study by explores the effectiveness of AI-based paraphrasing tools, specifically QuillBot and Paraphrasing Tool, in rewording scientific research abstracts. Core focus is on the assessment of paraphrasing quality and strategies in AI-generated academic writing.The research focuses on identifying the paraphrasing strategies used by these tools and assessing their proficiency levels based on established frameworks Using 30 research abstracts from the Journal of Second Language Writing, the study evaluates the tools' paraphrased outputs according to the Keck (2014) taxonomy and Nabhan et al. (2021) strategies. The analysis examines various techniques, including synonym substitution, sentence restructuring, word-order changes, and condensation. Both tools were tested in their standard modes, and their outputs were categorized based on the extent of textual modification..

Outcomes. The study found that while AI paraphrasing tools (QuillBot and Paraphrase Tool) assist in avoiding direct plagiarism, they primarily rely on synonym substitution and minor structural changes, often requiring human post-editing to ensure accuracy, coherence, and academic integrity in research writing.

Education level	Education field	Pedagogical design
N/A	Applied Linguistics and English Language Education	N/A

Methods	Goal	Tool
Qualitative descriptive analysis	Assessment	AI-based paraphrasing tools (QuillBot and Paraphrasing Tool)

Challenges	Ethical considerations
Technological Challenges	Creating Bias, Ethical Issues

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CULTIVATING WRITING SKILLS: THE ROLE OF CHATGPT AS A LEARNING ASSISTANT—A CASE STUDY

Y. 2024 [126]

Description. The study by Punar explores the role of ChatGPT as a learning assistant in cultivating writing skills, with a specific focus on register knowledge in English language writing. The study aims to examine the impact of ChatGPT on the acquisition of register knowledge (formal, informal, and neutral) during different writing tasks. It explores whether students can improve self-editing skills through AI-assisted feedback and how they perceive ChatGPT's effectiveness in academic writing.

Outcomes. The study involved 11 university students from different faculties (Engineering, Economics and Administrative Sciences, and Education) at a state university in Türkiye, aged 19–21, with an English proficiency level above B1.

Education level	**Education field**	**Pedagogical design**
Undergraduate level	Language Education	Experiential Learning

Methods	**Goal**	**Tool**
Quasi-Experimental (QE)	Learning	ChatGPT-3.5

Challenges	**Ethical considerations**
Technological Challenges, Limitations in Empathy and Human Interaction	Ethical Issues, Creating Bias, Other

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Co-funded by the European Union

Current Practice Examples

In order to provide the reader with some specific examples of how AI-based tools can be used in the teaching and learning processes, we have compiled a set of select examples of using AI-based tools, systems, and solutions from the partner institutions of the consortium of this project. These examples help paint the current state of affairs concerning AI-based solutions. Each example illustrates how AI-based solutions are used in various tasks and their impact on lecturers and learners. Our goal was to provide the reader diverse activities and approaches to AI-based solutions applied across various disciplines. It can be observed that the leitmotiv is a drive to enable and motivate more meaningful human interaction, automate routine tasks, and evolve, promote, and emphasise the significance of critical thinking in the face of emerging AI-generated outputs.

The following sections provides an overview of the collected examples of current practice, each example presented with the name of the related course and a summary of the provided data. A detailed account of every presented practice example is provided in [127].

This chapter contains concise overviews of several real-world applications of AI-based solutions in higher education. While the specific details vary between the selected examples, all these cases highlight a shared theme: AI makes it possible to streamline routine tasks, boost collaboration, promote humane interaction between people, and encourage new ways of thinking. Educators are finding ways to integrate AI so that it amplifies rather than overshadows the human element. These summaries underscore a practical approach where AI is integral to teaching practices with clear objectives and transparency. By examining these snapshots, the reader is expected to gain insight into how different teams manage the capabilities and challenges of AI-based tools, platforms, and solutions in everyday academic life.

Co-funded by the European Union

The Course Description-Review Bot

The Course Description-Review Bot at the University of Applied Sciences BFI Vienna (UAS BFI) is a custom AI-based tool that helps lecturers refine their course descriptions. This chatbot is designed to align with the institution's academic standards and quality principles, following guidelines on constructive alignment and competence-oriented examination requirements. Teachers paste their draft course descriptions into the chatbot conversation and receive instant, AI-generated feedback. The feedback motivates them to reflect on whether each aspect of their course supports clear objectives and learning outcomes or if the examination method is aligned with the stated competencies. The idea is to ensure course descriptions across the university follow a consistent format and depth, i.e. the same standard.

Access to the chatbot is provided through a Moodle-based system set up by the Teaching and Learning Center of UAS BFI, making it readily available to all faculty members. Lecturers are encouraged to use the tool's suggestions critically, adding or revising content to match their real teaching intentions best. Although the bot is helpful, it does not replace human oversight and should not be trusted unquestioningly. Quality managers and didactic experts still conduct traditional reviews of the submitted curricula for accreditation and compliance. The main advantages of this approach are the short feedback loop and the chance to detect gaps or inconsistencies that might otherwise be overlooked by a human, freeing staff time for more profound curriculum improvements.

Detailed account of this example is presented in [127, pp. 2–6].

Co-funded by the European Union

Global Collaboration and Networking

In this international collaborative course, students at the University of Applied Sciences BFI Vienna (UAS BFI) join forces with peers from a Peruvian university and analyse cross-cultural marketing. The class relies heavily on remote teamwork, and AI-based solutions help free up time for genuine interaction by streamlining the research process. Rather than sifting through an endless collection of resources, the students rely on ChatGPT (described on p. 45) to fetch preliminary information, which they later refine and expand on together. This approach lets them focus on communication skills, cultural exchange, and cooperation – the fundamental driving forces of the course. Each group is tasked with projects set within an actual or simulated business context and uses AI-based output as a starting point in developing a project solution, continuously and increasingly adding depth.

Lectures and in-person classes are reserved for group discussion, motivating students to critically observe, examine, and analyse the received AI-based output. Students are thus motivated to get immersed in critical and valuable activities such as data and content analysis instead of wasting time on the tedious and uninteresting groundwork. This leads to improved quality of the final outputs, more frequent and fruitful peer discussions, and increased engagement. Lecturers can track the groups' progress through Moodle logs and the submitted student-used prompts, ensuring active and authentic participation. Since the core objective is cross-cultural communication, using AI as a scaffold to ease and foster research tasks helps students concentrate on international collaboration and practical activities.

Detailed account of this example is presented in [127, pp. 7–14].

Co-funded by the European Union

Scientific Working

In this master-level course on scientific methods at the University of Applied Sciences BFI Vienna (UAS BFI), AI-based tools like researchrabbit.ai (described on p. 56) and elicit.com (described on p. 49) have been included in the curriculum to transform how students discover and analyse academic sources and literature. The goal is to sharpen students' ability to develop good research questions and propose well-founded hypotheses. Students are tasked with a traditional search to identify a key paper, which later anchors their AI-assisted exploration. Using citation-based networks enhances their research for thematic connections. Afterwards, the students examine the methodological structures and soundness of the studies they discover and retrieve. This approach saves time and promotes deeper reflection because the students compare AI-driven results with those gained using conventional searching approaches.

Students are instructed to keep a research diary throughout the course, focusing on several aspects, including but not limited to documenting their experience with AI-based tools, their prompt engineering choices and finalised prompts, and the verification process of the received results. Through this process, they notice how effectively AI can lay out relevant theories or conceptual links while recognising its flaws. Some students discover new lines of inquiry they would not have spotted alone, but they still have to verify the received content's truthfulness, correctness, and relevance. The overall impact is noticeable and significant in structured thinking, which leads to stronger hypotheses and better grounding in proper scientific practices.

Detailed account of this example is presented in [127, pp. 15–21].

Co-funded by the European Union

Introduction to Political Science

At the University of Applied Sciences BFI Vienna (UAS BFI), this first-year bachelor's course on political science blends in-person sessions with online self-study segments, where students learn how to utilise AI in analysing political speeches. The teaching method focuses on introducing the concept of prompt writing and encouraging repeated adjustments until ChatGPT's (described on p. 45) output lines up with the theories the students studied in class. This assignment is focused on the real-world application of knowledge about various rhetorical strategies and populism, making the course and study material feel more authentic and usable in real life. During online sessions, students realise that simply inputting a vague query is insufficient. They must clearly reference the relevant theoretical concepts to receive accurate or meaningful replies. The lecturer increases awareness of how crucial it is to refine and question AI-based output by allowing the students to use ChatGPT while documenting each prompt iteration freely.

In many cases, ChatGPT suggests points of view or nuanced details that students might overlook should they be analysing the topics on their own. Since the assignment promotes constant revision and enhancement of the used prompts, students are motivated to employ a critical mindset. They must observe and notice if the AI-generated response mixes various political themes or fails to pick up cultural nuances. The class then discusses how well ChatGPT's suggestions fit actual theories and whether specific rhetorical topics within the response enhance or distort the source.

Detailed account of this example is presented in [127, pp. 22–30].

Co-funded by the European Union

Intelligent Interactive Systems

This bachelor-level course at the University of Zagreb Faculty of Organization and Informatics (UNIZG FOI) focuses on building AI-driven software with which human users can interact naturally. Students learn how to merge large language models, such as GPT (described on p. 45) or Claude (described on p. 46), with traditional machine learning solutions. The students are guided and engaged through the entire development cycle, from conceptualising how humans and AI solutions should interact and collaborate to implementing responsible design principles that avoid reckless and overbearing reliance on automation. Student projects might include, for example, building chatbots that respond contextually to user queries or interactive dashboards that offer real-time feedback on specific tasks.

Lecturers want students to grasp the positives and negatives of different AI architectures. Therefore, they encourage side-by-side comparisons between older machine learning methods, modern large and small language models, and the related state-of-the-art solutions. Working in teams, learners gain, e.g. first-hand experience in linking language model capabilities with human oversight – an approach that provides insight into the importance of controlling the AI-provided output when mistakes or unexpected, unsolicited, or unusual responses are received. This example also highlights the ethical dimension of using AI because the final implemented system must consider and preserve user trust. This design approach, combining multiple AI methods with well-thought-out user interactions, helps students model, implement, and refine interactive tools with increased awareness of real-life demands and limitations.

Detailed account of this example is presented in [127, pp. 31–35].

Co-funded by the European Union

Informatics Services Management

In this course at the University of Zagreb Faculty of Organization and Informatics (UNIZG FOI), teams of three or four students learn how to design and deliver IT services in a project-based setup. The emphasis is on bridging real business needs with IT solutions, and while using AI-based tools and platforms is permitted, it is neither mandated nor guided by the lecturer. Each student group creates user personas, journey maps, and value propositions, then moves on to their solution's wireframes and prototypes. Teachers give direct feedback on the student teams' work during practical classes. In contrast, at home, students often turn to tools like ChatGPT (described on p. 45) or DALL-E (described on p. 48) to see if the available existing AI-based solutions can fill-in creative gaps and help them create some multimedia content. This open and unregulated approach reveals how students use AI-based solutions when left to their devices. Some students find using AI-based tools and platforms speeds up specific tasks they are faced with or sparks new and interesting ideas, but others see no real difference in the quality of the finalised product.

Teachers of this example notice that overall familiarity with AI remains inconsistent. By mid-semester, student projects are presented as a business-style pitch, allowing the lecturers to provide feedback on whether using AI-based solutions added significant value to the produced student deliverable or simply spent some of their time with no observable beneficial outcome. Although using AI-based solutions sometimes supports and enhances fresh thinking and novel ideas, many student teams realise that it is not a magical solution to their tasks and challenges. The final verdict emphasised in this example is that integrating AI-based solutions in a freeform way boosts the learners' digital literacy but does not consistently boost creativity, speed, or quality of the final output.

Detailed account of this example is presented in [127, pp. 36–43].

Co-funded by the European Union

Business Decision Making

Students pick a real-world company in this bachelor-level course at the University of Zagreb Faculty of Organization and Informatics (UNIZG FOI). They are tasked with solving a strategic or tactical decision problem. ChatGPT (described on p. 45) is recommended here as an optional assistant to help the students identify a set of criteria that would help them solve the received task, i.e. they might not consider or discover through standard non-AI-enhanced processes. Students use the traditional approach first. Afterwards, they interact with ChatGPT to receive additional points of view or sub-criteria to evaluate their problem, comparing the AI-generated output with their own. Through this exercise, the students can experience first-hand that an AI-based solution can highlight fresh insights or alternative perspectives.

Nevertheless, AI-based solutions occasionally produce incomplete or questionable ideas and related content. The focus is on the course learning outcome related to applying quantitative, qualitative, and risk-assessment methods to decision-making processes and information and communication technology (ICT) projects in real business challenges. Through the evaluation activities of the AI-generated outputs containing suggestions and potentially valuable data, students become more aware of how and when it is fitting to include AI-based solutions in structured decision-making processes. A short survey captures the level at which the students liked or disliked the technology and whether it improved their group work. The lecturer reviews how the students integrate AI-based output into their conclusions and the finalised problem solution. Students find that while AI fosters a more diverse approach to the problem they face, it still demands scrutiny and careful consideration of the received output. Ultimately, the students gain a balanced understanding of combining quick AI-powered brainstorming with systematic methods, resulting in more substantial insights in complex business contexts.

Detailed account of this example is presented in [127, pp. 44–48].

Co-funded by the European Union

Communication and Virtual Teams in the Organization

At the University of Zagreb Faculty of Organization and Informatics (UNIZG FOI), this bachelor-level course focuses on effective communication strategies and dynamics of virtual teams, especially in business, management, and information sciences. Students engage with AI-based solutions by using Bing Chat, now rebranded to Copilot (described on p. 47), to collect and evaluate information for structured team presentations. Each team of students picks a specific topic, formulates queries for the AI-enhanced chatbot, and then compares the generated responses against more traditional academic resources, such as sources found via Google Scholar or local library books. Participating students are required to document their findings using screenshots accompanied by their reflections on the conducted process to develop and enhance students' critical thinking and digital literacy skills. The students are thus given the opportunity to experience and learn first-hand how AI-generated content can be unreliable or prone to "hallucinations," reinforcing and emphasising the importance of cross-referencing and questioning the AI-generated output.

This supervised introduction to AI-based solutions promotes ethical awareness in the context of emerging AI-based technologies. In addition, it engages students to observe and recognise how AI-based solutions fit broader communication contexts while remaining mindful of potential pitfalls and challenges. For the instructors, the exercise is a window into how learners adopt emerging AI-based tools and a prompt for implementing and utilising more innovative teaching practices. Since students must present and discuss the AI-generated output in class, they also develop their teamwork abilities and sense of responsibility. In essence, this task promotes and establishes academic rigour and helps form a foundation for responsible AI-enhanced and AI-driven collaboration.

Detailed account of this example is presented in [127, pp. 49–55].

Co-funded by the European Union

Corporate Communication and Artificial Intelligence

At the School of Communication and Media Studies in Lisbon, a course in Corporate Communication and Artificial Intelligence helps students become agile and forward-thinking in an evolving industry. The class demystifies AI tools and shows learners how to use them ethically and responsibly. By teaching them to generate summaries, translate texts, create strategies, and even animate images, the course allows students to discover ways AI can speed up their workflow while expanding their creative thinking.

Students learn how to polish press releases, prepare client Q&A sets, and plan digital content more efficiently. They are free to explore popular platforms like ChatGPT (described on p. 45), Midjourney (described on p. 53), Runway (described on p. 56), and Sora, which offer them tangible ways to bring their ideas to life. The class also stresses oral evaluation, so students must explain how they used these tools and why they chose specific prompts. This method ensures they don't lose their own critical thinking skills.

Because the world is moving fast, the course's goal is to keep pace and show learners that technology isn't off-limits or dangerous. Instead, they discover that AI offers deeper research possibilities and frees them to focus on higher-level strategy. The result is better engagement, richer classroom discussions, and a glimpse of how communication will look in tomorrow's workforce.

Detailed account of this example is presented in [127, pp. 56–60].

Co-funded by the European Union

Interactive Applications Lab

At the School of Communication and Media Studies in Lisbon, the Interactive Applications Lab blends core programming skills with emerging AI tools to help students create dynamic projects. In this course, learners dive into JavaScript and PHP, building interactive modules that respond to events and user input. By integrating GitHub Copilot, students discover how AI can help them spot errors and even suggest new features. Instead of spending hours stuck on a debugging loop, they find more time for bigger questions about why and how certain features should be built. This leaves them free to explore new possibilities and to produce complex, creative work.

Because the course is large – nearly a hundred students – the AI assistant reduces teacher workload by answering some of the simpler troubleshooting questions. However, in-person support and face-to-face discussions remain vital. The overall approach emphasizes a strong foundation in logical thinking, so learners can talk fluently to the AI tool, turning their abstract ideas into effective code. The final project, carried out in partnership with a journalism course, blends the technical and conceptual in a way that boosts creativity. Though the process of activating GitHub's free student license can be tricky, most participants see it as a valuable gateway to coding success.

Detailed account of this example is presented in [127, pp. 61–66].

Co-funded by the European Union

AI and Marketing

In the AI and Marketing course offered at the School of Communication and Media Studies in Lisbon, students explore how artificial intelligence is reshaping marketing tactics, from day-to-day decision-making to broader strategic planning. Over two semesters, the class dives into what AI really is, how it works, and why it matters in marketing. Students discuss key AI categories and examine how machine learning tools can enhance the marketing mix, particularly when it comes to fine-tuning the famous 4Ps. They look at how AI assists in generating content, predicting trends through linear regression, and adapting strategies across digital and traditional channels. Although practical examples are shown – like ChatGPT (described on p. 45) or DALL-E (described on p. 48) for content creation – the emphasis remains on understanding AI's capabilities and spotting its real-world applications, rather than building or coding tools from scratch.

By offering a broad overview and integrating discussions of ethics and future trends, the course ensures that learners walk away with both theoretical insights and a sense of what's already possible. Students generally come from communication or marketing backgrounds, so they approach the subject knowing at least the basics of branding and consumer outreach. Because the course is less about mastering specific AI tools and more about grasping AI's big picture, participants feel inspired to keep experimenting on their own.

Detailed account of this example is presented in [127, pp. 67–70].

Co-funded by the European Union

Project Seminar in Audiovisual and Multimedia

In the Project Seminar on Audiovisual and Multimedia, master's students at the School of Communication and Media Studies in Lisbon learn how to plan the initial stages of their final work – be it a dissertation, a project, or an internship report. AI is introduced as a powerful new tool that can guide them through their research, enabling them to explore topics, theories, and references quickly and efficiently. By consulting large language models like ChatGPT (described on p. 45), they not only refine their research questions but also uncover lesser-known references and narrow the scope of their work to suit their personal or professional interests. The process is straightforward: in a classroom setting, the lecturer demonstrates a hands-on example of how to query ChatGPT for specific concepts, types of documentaries, or detailed theoretical frameworks.

Though AI usage is not formally assessed, the lecturer notes that student projects tend to improve when learners use these resources responsibly. The challenge, of course, lies in teaching them to recognize and filter out AI-generated hallucinations so that incorrect information does not seep into their final drafts. Despite this pitfall, the course takes a positive stance on the potential of AI, encouraging students to develop their critical thinking while harnessing AI as a genuine research assistant.

Detailed account of this example is presented in [127, pp. 71–75].

Co-funded by the European Union

Communication and Human Computer Interaction

In this Bachelor-level course on Communication and Human-Computer Interaction, students at the School of Communication and Media Studies in Lisbon discover how generative AI tools, like ChatGPT (described on p. 45), DALL-E (described on p. 48), and Midjourney (described on p. 53), can transform both their learning process and creative projects. They explore concepts of interface design, usability, and interaction through real-world applications of AI that help them process data, brainstorm ideas, translate text, and even analyze user experiences through rapid interview transcription. This new approach grants them deeper insights that go beyond the constraints of traditional resources, as they test creative ideas with AI partners and work on complex datasets.

With class sizes nearing thirty, AI serves as a natural extension of teacher feedback. Lecturers can monitor projects more efficiently while encouraging students to refine the prompts they give to AI tools. This promotes clearer communication skills, which is crucial for students venturing into design, marketing, and strategic thinking. Though AI is not directly evaluated in their final work, lecturers provide straightforward guidelines on referencing tools so students learn how to use them responsibly. The technology has sparked greater motivation and resilience, especially when tasks seem mundane. By embracing AI, students gain real-world competencies that foster problem-solving and innovative thinking in digital environments.

Detailed account of this example is presented in [127, pp. 76–79].

Co-funded by the European Union

Management Control

At the Amsterdam University of Applied Sciences, the Management Control course embraces the reality that students already use generative AI, such as ChatGPT (described on p. 45), for their assignments. Instead of banning this technology, the lecturer urges a balanced approach: AI is allowed, provided students refine and question its outputs. This gives learners a chance to do deeper research and analysis, rather than simply relying on canned text. Thanks to AI, students can quickly identify trends in corporate financial data or summarize complex industry reports, freeing them to spend more time forming their own arguments. They also benefit from AI-driven writing support, which can improve clarity and style if used correctly.

Still, the course includes checks and balances. Students must present their findings in person, demonstrating a real grasp of the material. If they rely too heavily on AI content, it becomes clear during these oral assessments. With around 150 students enrolled, the lecturer sees this blend of AI and human insight as opening fresh possibilities, while carefully safeguarding academic integrity. Although the formal impact of AI is still under study, both staff and students sense the potential for more engaging, in-depth coursework. Going forward, department-wide AI literacy training might ensure even stronger results across other courses.

Detailed account of this example is presented in [127, pp. 80–85].

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Personal Development 1 and 2

At the Amsterdam University of Applied Sciences, first-year students in Personal Development 1 and 2 have learned to use AI as a tool that boosts their research, communication, and interview skills. They begin by crafting open-ended questions with the help of generative AI, then use transcription and coding tools to handle real interviews. Instead of relying on AI as a shortcut, they are shown how to refine its suggestions and verify its outputs against credible sources. This approach broadens their ability to spot relevant data and produce well-structured reports. Because of this, many students gain the confidence to reach out to high-profile industry professionals, knowing their initial email drafts have been polished by AI.

By integrating AI via structured presentations, the instructor ensures students develop a critical mindset when working with automated outputs. The class does not grade them on AI use; rather, it evaluates the final quality of their interviews, analysis, and presentations. Instructors note that AI helps reduce time spent on repetitive tasks like email formatting and transcript editing, leaving more room for deeper discussions and practical insights. For many learners, this is their first taste of how technology can uplift professional skills. The result is an active environment where AI complements, rather than replaces, genuine human thought.

Detailed account of this example is presented in [127, pp. 86–94].

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