Artificial Intelligence in Architectural Education Study on Students of the Faculty of Architecture in Egypt

الذكاء الاصطناعي في التعليم المعماري- دراسة على طلاب كلية العمارة في مصر

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Abstract:

Using artificial intelligence (AI) in education is increasing, and governments and non-governmental organizations worldwide are developing policies and guidelines to support its safe implementation. However, there is a need to bridge the gap between theoretical and practical AI applications to design and implement educational policies. AI can revolutionize architectural education by simplifying complex concepts such as design principles and formulating ideas and concepts. AI tools can help create original images from textual descriptions and enhance creativity during the conceptual design phase. Integrating AI into curricula can increase awareness of various aspects of architectural design, benefiting the field of architecture. AI applications can also help solve design challenges, from material design to architectural plan solutions, necessitating further research in this area. By leveraging AI in online education systems, institutions can enhance student engagement, assess effectiveness, personalize interactions, and address common shortcomings in traditional online teaching methods.

The research reviews some AI tools used in architectural education, followed by an analytical approach to studying the impact of these tools on a sample of students from the Faculty of Architecture in Egypt through some specialized and general courses. The study concludes by presenting the benefits of using these tools in architectural education and offering ideas for future applications and their impact on educational policies. The research concludes by presenting some artificial intelligence platforms and their impact on students' performance in architectural education curricula, with a survey of their opinions and the extent to which these technologies are compatible with their studies and their impact on their practical performance.

Keywords:

Artificial Intelligence, Architectural Education, Educational Technologies, AI in Education, AIED

المستخلص:

يتزايد استخدام الذكاء الاصطناعي في التعليم، وتقوم المنظمات الحكومية وغير الحكومية في جميع أنحاء العالم بوضع سياسات ومبادئ توجيهية لدعم التنفيذ الآمن له. ومع ذلك، هناك حاجة لسد الفجوة بين الذكاء الاصطناعي من ناحية نظرية و تطبيقية، لتصميم وتنفيذ السياسات التعليمية.

يمكن للذكاء الاصطناعي (AI) أن يُحدث ثورة في تعليم الهندسة المعمارية من خلال تبسيط المفاهيم المعقدة مثل مبادئ التصميم ، وصياغة الأفكار والمفاهيم، يمكن لأدوات الذكاء الاصطناعي أن تساعد في إنشاء صور أصلية من الأوصاف النصية، وتعزيز الإبداع في العثور على النموذج خلال مرحلة الأفكار التصميمية. يمكن أن يؤدي دمج الذكاء الاصطناعي في المناهج الدراسية إلى زيادة الوعي بجوانب التصميم المعماري المختلفة بما يفيد مجال الهندسة المعمارية. كما يمكن لتطبيقات الذكاء الاصطناعي أن تساعد في حل تحديات التصميم، بدءًا من تصميم المواد إلى حلول المخططات المعمارية، مما يستلزم المزيد من البحث في هذا المجال. ومن خلال الاستفادة من الذكاء الاصطناعي في أنظمة التعليم عبر الإنترنت، يمكن للمؤسسات تعزيز مشاركة الطلاب، وتقييم الفعالية، والتفاعل الشخصي، ومعالجة العيوب السائدة في أساليب التعليم التقليدية عبر الإنترنت.

يستعرض البحث بعض أدوات استخدام الذكاء الصناعي في التعليم المعماري، ثم يتبع البحث المنهج التحليلي لبحث دراسة اثر استخدام هذه الأدوات على عينة من طلاب كلية العمارة في مصر، من خلال بعض المقررات الدراسية التخصصية و العامة، ليصل في نهايته لعرض إيجابيات استخدام هذه الأدوات في التعليم المعماري مع طرح بعض الأفكار للتطبيقات المستقبلية و انعكاسها على السياسات التعليمية. ليصل البحث في نهايته بعرض بعض منصات الذكاء الصناعي و تأثيرها على اداء الطلاب في مناهج التعليم المعماري مع عرض استطلاع اراءهم و مدى توافق هذه التقنيات مع دراستهم. و مدى تاثيرها على أداءهم العملي.

الكلمات المفتاحية:
الذكاء الصناعي – التعليم المعماري – تقنيات التعليم – الذكاء الصناعي في التعليم

1. Introduction

Artificial intelligence is a concept introduced in the 1940s. AI can generally be defined as the science of developing intelligent machines or computer programs designed to mimic human intelligence. In recent years, the field of AI has made significant strides in diverse areas such as computer vision, robotics, autonomous vehicles, language translation, gaming, medical diagnosis, speech recognition, and generative design.

The term "AI in education" in this research refers to the use of technologies and software based on algorithms that analyze data and derive information, whether in a simple form like facial recognition technologies or sensors, or in a more complex form like algorithms that generate images from textual descriptions.

So far, the integration of AI into curricula has been limited to some STEM (Science, Technology, Engineering, and Mathematics) fields, such as data science, computer science, and engineering. While these disciplines are important and clearly where programming expertise and AI development are often found, it has also become clear that there is a critical need to teach AI more broadly across other academic disciplines. Considering the current programs in AI education, higher education institutions currently have very limited initiatives in AI across various specializations. AI is not just a set of tools to be viewed in isolation, as is often the case with technologies. Instead, AI is a comprehensive set of skills or methods for multidisciplinary requirements and should encompass the entire life experience in terms of education, learning,

teaching, and the learner. AI should be integrated into the core curriculum objectives of the university.

1.1. Research Importance and Objective

Recently, rapid progress has been made in AI research and smart buildings. This rapid advancement has led to a wide and diverse range of knowledge on this subject. The research seeks to explore practical applications and experiences of AI in architectural education across various disciplines.

The research aims to discuss the use of some appropriate AI tools and platforms to aid in teaching courses in the field of architecture and construction. This is to highlight what is beneficial from them and how to take advantage of them, directing teachers and students to some useful ways to accelerate and develop the teaching of these courses by identifying the importance of each direction and the importance of its use in education systems with an application methodology.

1.2. Research Methodology

The research begins with a brief overview of AI use in education in recent years, then focuses on its use in the architectural field and architectural education. It then briefly reviews a practical experience of integrating proposed AI tools over the last two years.

The research followed an analytical approach in a study applied using AI tools on students from the Faculty of Architecture, employing surveys to investigate students' opinions and determine the benefits and responses to these applications, alongside presenting some resulting models and analyzing them from an academic perspective.

2. Use of AI in Education

AI applications used in education are evolving rapidly, with an AI-based framework designed using customized guidelines to assist teachers in their teaching. AI helps students review by providing automated response bots (visit bots), breaking down students' writing skills, linking students with teachers, and creating a game-like educational environment. Simulated intelligence is also used to foster collaboration between individuals and the entire educational framework, making learning easy and enjoyable through tools and devices. AI plays a critical role in continuing to develop and present learning strategies.[1]

2.1. AI Learning Model

In undergraduate education, AI is currently used to enhance the learning experience and improve student outcomes, generally referred to as Artificial Intelligence in Education (AIED). There are several ways to use AI in higher education, including using AI to personalize learning, facilitate communication, and enhance assessment.[2] AI can create personalized learning experiences based on each student's needs and abilities. This can be achieved through adaptive learning algorithms that adjust the content and pace of material based on student progress. Personalized learning can keep students engaged with the material, leading to better outcomes.

2.2. Curriculum Development with AI

The curriculum development initiative includes creating new course content for AI and identifying AI knowledge categories present in both current and newly developed academic courses.[3] It also involves revisiting curricula in collaboration with pre-university education institutions, incorporating AI language and machine learning into some curricula in preparation for expanding their use in university studies.

2.3. Application of AI in Education

Promising technological solutions are making universities and schools simpler and smarter. AI has great potential to redefine how students, administrators, and teachers communicate and interact with devices and technology in classroom settings. AI-based classrooms enrich the learning experience, enhance educational outcomes, and reduce costs. Some current AI educational solutions include using interactive digital media and smart whiteboards that can analyze and aggregate data for students and teachers to use in the classroom or elsewhere at any time. These tools improve teaching and enhance learning outcomes.

2.4. Generative AI and the Future of Education

Current studies and research discussing generative AI and its impact on education tend to focus on the challenges or negative aspects this technology creates for teachers, or the opportunities and benefits it offers for both teachers and students. Proponents of the first view see generative AI as a form of self-destruction (Ragnarök), leading to the destruction of the education system, while proponents of the latter view see it as a reform, ushering in a new era of accessible information to enhance the reach and quality of education. These two views highlight the inherently contradictory nature of generative AI and its role in education; it may destroy some educational practices while simultaneously supporting them.[4]

The rise of generative AI might seem like a cause for panic, amid numerous alarming articles and the swift bans imposed by many educational bodies and institutions. However, given the multiple paradoxes these tools create, generative AI is not destructive (Ragnarök) but rather a transformative resource on which teachers and students can rely for teaching and learning. Raising awareness of these tools, using them together in the classroom, and leading discussions with students about their pros and cons provide a more sustainable way forward than banning these tools or making them central to the entire curriculum. Just as with the system of collecting and using student data, educational bodies and institutions should stay informed of the latest AI developments and update their relevant policies and guidelines accordingly.[5]

3- Artificial Intelligence in the Architectural Field:

Artificial intelligence (AI) can be used in architectural education (Figure 1), but there are not many applications as of the time this research paper was written. However, it can be said that machine learning and big data processing can be applied to architectural design.[6]

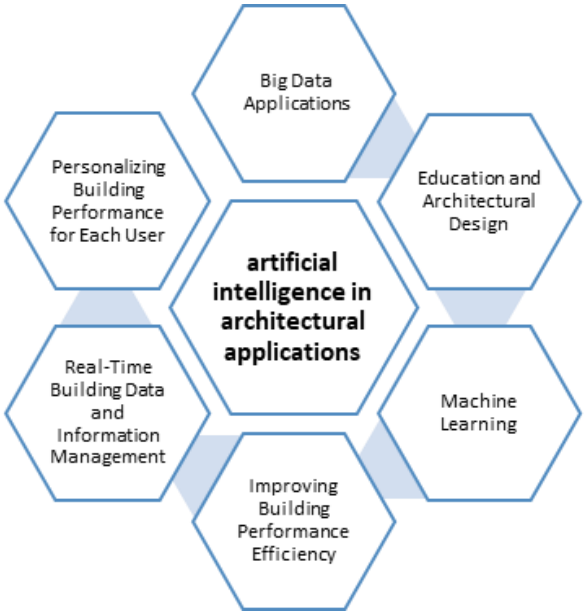


Figure 1: Areas of using artificial intelligence in architectural applications

Initially, it can be said that AI is used to improve building performance. New automation systems are being developed that can control security, comfort, and energy efficiency more intelligently. AI allows buildings to become spaces managed by real-time data and information, and they can communicate with each other like living organisms. This creates a world where buildings, [7] smartphones, cars, and public spaces can communicate with each other to improve living conditions, reduce waste, increase safety, and reduce traffic. AI can also be used to predict any challenges that may arise in the future. [8]

AI is expected to be utilized in many fields that serve architectural engineering work, such as:

- Using AI in the Design Process
- AI in Architectural Visualization
- Using AI in Building Materials

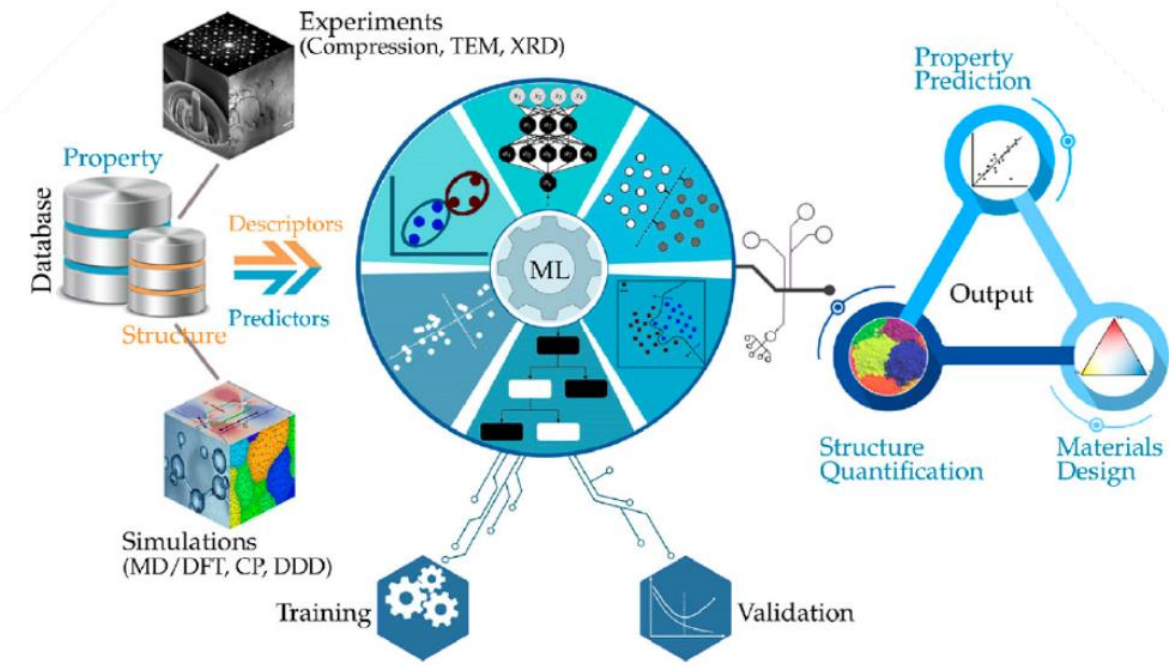


Figure (2): schematic representation of the materials design workflow using AI, consisting of a material dataset, machine learning models and enhanced material properties for the creation of advanced [9]

- Planning and Designing Urban Landscapes Guided by AI Interactive Experience.
- Improving application of BIM and AI in Building Design.
- Organizing planning ideas.
- Improving and developing architectural mapping.
- Enhancing and speeding up the creation of engineering drawings.
- Improving urban design and regional planning.
- Enhancing energy management in buildings.
- Improving construction safety and detecting risks.
- Enabling automated construction and parametric designs.
- Automating documentation of construction and building information.

- **4- The Use of AI in Architectural Education:**
- AI can be effectively used in architectural education through various methods and strategies. Here are some key ways AI can enhance architectural education, for example:
- **Data Collection and Processing**: AI can collect, store, and process data for theoretical subjects such as architectural history and theories. It can organize information for lectures, literature reviews, and architectural history, thereby enriching the learning experience.
- **Generative Design and AI-driven Creativity**: AI generative algorithms can create diverse design forms based on input data, accelerating the design process and encouraging creative exploration. By integrating generative design into education, students can learn how to interpret AI-generated designs and improve them based on AI-driven insights.
- **AI-Supported Sustainability Analysis**: AI tools can simulate and analyze building performance metrics such as energy consumption and thermal comfort, allowing architects to optimize designs for sustainability and energy efficiency. Students can use these tools to

assess the environmental impact of their designs, preparing them to create eco-friendly buildings.

- **AI in Project Management**: AI is transforming project management within architecture by improving scheduling, cost estimation, and risk assessment. Integrating AI-based project management concepts into education helps students streamline workflows, enhance efficiency, and learn how to use AI tools for project management tasks. [10]
- **AI in Urban Planning**: AI can assist urban planners in designing roads, city complexes, and even entire cities more efficiently by analyzing traffic patterns and real-time data. This technology helps create cleaner, more space-efficient, and community-oriented urban environments, influencing how architects can approach urban design.

By integrating AI concepts and tools into architectural education, institutions can equip future architects with the skills and knowledge needed to succeed in an AI-enhanced profession. This integration not only enhances the learning experience but also prepares students to effectively leverage AI technologies in their architectural practices, leading to innovation, sustainability, and efficiency in various fields (Figure 3).

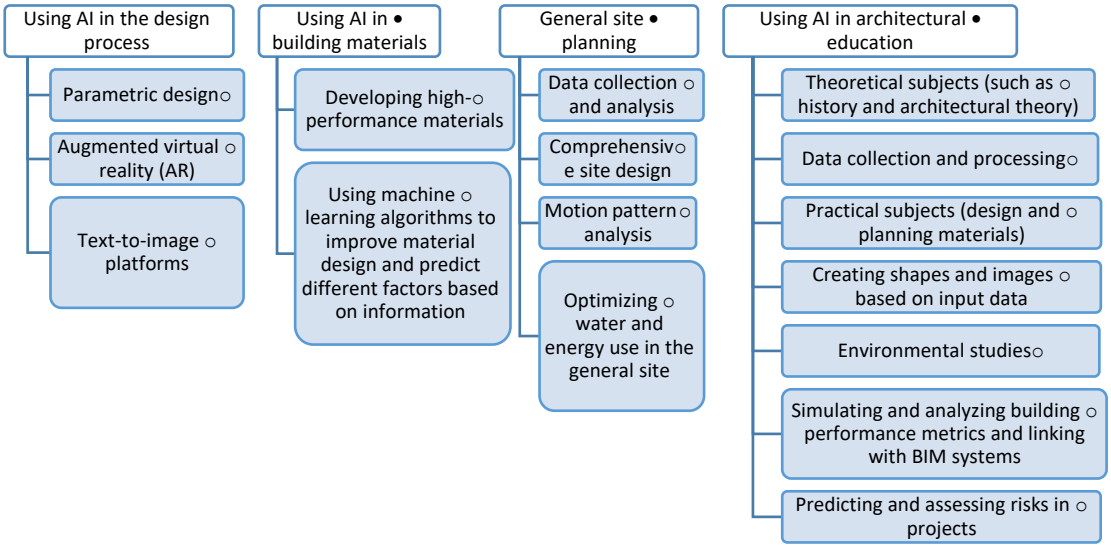


Figure (3): Using artificial intelligence in teaching various architectural disciplines.

4-1: Areas of AI Application in Architectural Education Curricula:

Architectural education courses can generally be divided into two categories: Theoretical courses, such as core courses that build general knowledge in the field, and practical courses, which include drawing, architectural visualization, and architectural design.

AI can contribute to each category in different ways. For theoretical courses, AI assists in data collection, storage, and processing. In design courses, AI offers tools for design creation, evaluation, and collaboration, allowing students to explore more creative possibilities. Additionally, AI helps instructors prepare more focused and engaging educational materials and aids in crafting objective questions to evaluate student performance effectively.

4-2: Application of AI in Teaching Architectural Courses:

During the 2023-2024 academic year, AI technologies were applied in teaching various courses at the Faculty of Architecture at King Salman International University in Sharm El-Sheikh, Egypt. The practical study was conducted on a total of 51 students from the second to fourth

levels. With the proliferation of AI platforms launched in recent years, a set of smart platforms specifically useful in the academic context of architectural studies was identified.

Study sample: 51 Students from Faculty of Architecture - King Salman International University - Sharm El-Sheikh - Egypt

Study sample diversity: There are male and female students - from 16 different regions in Egypt.

Age group: from 19 to 22 years (from the second to the fourth year)

Study period: Full academic year 2023 - 2024

Practical study methodology:

The first stage: Explaining how to use artificial intelligence platforms for students (the platforms mentioned in the following experiments) and training students to use them in theoretical and practical subjects.

The second stage: Applying using artificial intelligence platforms in formulating a question bank in theoretical modules. The students were divided into two groups: A group who knew that the questions were formulated with an artificial intelligence engine and a group that did not know.

The third stage: Measuring the performance of students in the two groups and comparing it to their general performance, and measuring their impressions of the experience.

The fourth stage: Using artificial intelligence platforms as an assistant in the design process and correcting students' architectural projects.

The fifth stage: Comparing the level of students' performance with their level in a similar architectural project designed with standard methods.

4-2-1: Details of the Practical Study:

- **Objectives:** Improve Learning Efficiency: Provide personalized learning resources for each student based on their individual needs. Enhance Problem-Solving Skills: Train students to utilize AI to analyze complex problems and propose innovative solutions.
- **Courses in which AI was applied:**
- **Theoretical Courses:**
  - General Courses: Sanitary Installations, Acoustics, Lighting, and Ventilation.
  - Specialized Courses: Contemporary Building Materials, Detailed Drawings.
- **Practical Courses:**
  - Engineering Drawing: Digital Visualization.
  - Architectural Design: Green Architecture Design Studio, Eco-Resort Design.
- **AI Tools Used:**
- **Midjourney (versions 3-5):** A platform for converting text into images, used in architectural design courses to generate inspirational ideas for projects. Students provided keywords describing the general idea of their projects, and the platform generated images that served as the basis for idea development. Additionally, earlier versions of ChatGPT were used to assist with writing project-related codes.
- **mnml.ai:** This platform improves architectural images and designs. It was used during the exterior facade design phase to develop designs based on reference images depicting the desired style. It also acted as an alternative to traditional rendering and lighting processes, which can be time-consuming, especially in digital visualization.

- **Perplexity.ai:** A search engine used for theoretical, general courses to aid in research.
- **Bard (and later Gemini):** Google's smart search engines were utilized for formulating objective questions in the specialized questionwell platform. These tools also helped create a question bank for specialized courses and assisted students in solving these questions.
- **Scispace:** A smart academic assistant for research, used in theoretical courses to help students prepare research papers or to conduct preliminary research for architectural design projects.
- **semanticscholar.org:** A platform for smart scientific research, used to summarize scientific research in specialized fields, offering quick results during lectures.
  - semanticscholar.org platform for smart scientific research, summarizing scientific research in specialized fields to produce quick results during lectures.

4-2-2: AI Application Models in Teaching Theoretical courses

First: Google's AI engine Bard & Gemini and the Questionwell platform were used to create a question bank in some subjects by writing the syllabus topics. Here is an example from the experiment:

- **Objectives:** Improve Learning Efficiency: Provide personalized learning resources for each student based on their individual needs.
- **Course Name:** Acoustics (Sound Studies in Buildings)
- **Syllabus Topics for Gemini Platform:** "I want to extract exam questions from the following topics: Workplace Noise, Basics in Acoustics, Sound waves fundamental properties, Room Acoustics, Absorb sound Materials and Managing Reverberation, Blocking Sound, Covering Sound (Using Sound Masking), Sound Transmission Class."
- **Platform Outputs**: The platform generated 8 multiple-choice questions, 8 essay questions, and 8 short answer questions. Each topic had three varied questions. It was noted that the questions included practical applications and variety in the presentation. Here are some questions on Room Acoustics:
  - Short Answer: Define reverberation time and explain its importance in room acoustics.
  - Multiple Choice: Which of the following materials would be most effective for absorbing sound in a large, echoey hall?

  a) Concrete walls b) Plush carpets c) Glass windows d) Metal pipes
  - Application: You are tasked with improving the acoustics in a noisy restaurant. Suggest three specific measures you could take to reduce noise levels and enhance speech intelligibility.
- **Using the questionwell platform**: PDF files of lectures from the subject "Lighting and Ventilation in Buildings" were uploaded to the platform. The level of questions (undergraduate students) and the number and type of questions required were specified.
- **Platform Outputs**: The platform generated the specified number of questions (10 multiple-choice questions and 6 essay questions), and these are some of the questions:

1. To what extent do the key factors determining natural light influence architectural design?
2. How do different window design characteristics impact the effectiveness of natural lighting in various spaces?
3. Which design characteristic of windows can significantly affect natural lighting in a space?

- The style of the window curtains.
- The type of glass panel used.
- The height of the window from the floor.

- The color of the window frame.

- **Secondly**: **Full Exam Creation Using AI Platforms**

- An experiment was conducted to create a complete exam using AI platforms in the Eco-Resort Design, Acoustics, Lighting and Ventilation, and Detailed Drawings courses. This experiment was carried out in two different settings: One group of students was informed that the exam had been created by AI, while the other group was not. After the exam, a questionnaire was distributed to gather feedback on the students' experience with the AI-generated exam compared to traditional exams throughout the 2023-2024 academic year.

- The quality of the exam was assessed based on student feedback, which was collected through a five-star rating system. The questionnaire evaluated aspects such as the students' understanding of the questions and their overall experience, comparing the AI-generated exam with traditional exam formats.

- The results of the questionnaire answers to some questions were as follows (using a five-star rating system):

Table (1): Results of the students' opinions who did not know that the questions were created through AI platforms.

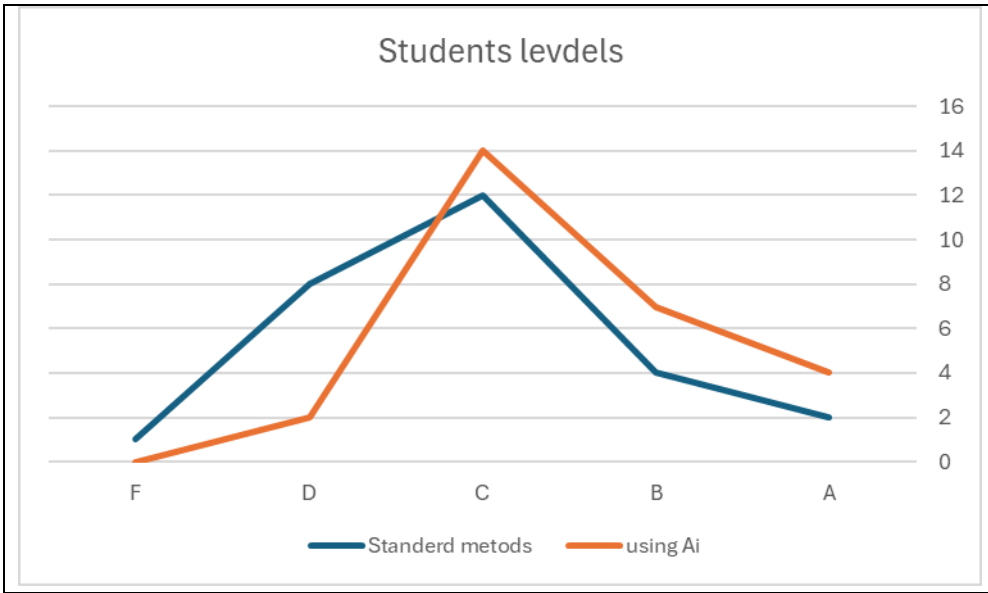
Question		Rating	
1	What is your evaluation of the exam's difficulty level compared to the traditional exam?	3	⭐ ⭐ ⭐
2	Did you understand the words and terms easily?	3.5	⭐ ⭐ ⭐
3	Did you understand what was required from all the questions easily?	4	⭐ ⭐ ⭐ ⭐
4	The quality of the questions and whether they allowed for multiple understandings or more than one answer	3.5	⭐ ⭐ ⭐
5	Was the time sufficient to answer all the questions?	5	⭐ ⭐ ⭐ ⭐ ⭐
6	What is your overall evaluation of the experience?	4	⭐ ⭐ ⭐ ⭐

Table (2): Results of the students' opinions who knew that the questions were created through AI platforms

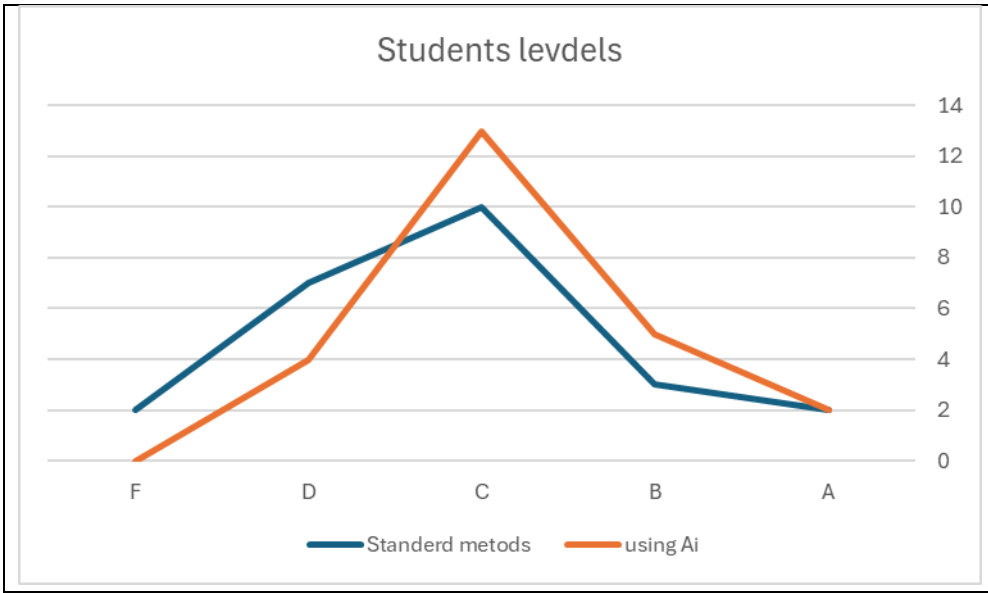
Question		Rating	
1	What is your evaluation of the exam's difficulty level compared to the traditional exam?	4	⭐ ⭐ ⭐ ⭐
2	Did you understand the words and terms easily?	3.5	⭐ ⭐ ⭐
3	Did you understand what was required from all the questions easily?	4.5	⭐ ⭐ ⭐ ⭐
4	The quality of the questions and whether they allowed for multiple understandings or more than one answer	4	⭐ ⭐ ⭐ ⭐
5	Was the time sufficient to answer all the questions?	5	⭐ ⭐ ⭐ ⭐ ⭐
6	What is your overall evaluation of the experience?	4.5	⭐ ⭐ ⭐ ⭐

Results of the Experiment Based on Student Feedback and Data Analysis:

- AI-generated questions used precise terminology that differed from the conventional terms students were accustomed to.
- The questions were highly specific and required precise, well-understood responses.
- Multiple-choice questions (MCQs) were challenging, with answer choices that were closely related, requiring students to select the single best answer.
- Students who were informed in advance that the exam was AI-generated appeared to be better prepared to handle the unique style of the questions.
- When the experiment was repeated with the same group, their performance improved significantly, indicating enhanced preparation and familiarity with AI-generated questions.
- AI academic search platforms provided quick and concise results, but the outputs needed careful review before final submission of research.
- The multilingual and translation features of smart search platforms saved a considerable amount of time, aiding in deeper research and generating direct summaries of multiple studies simultaneously.
- Figure 4 shows a significant improvement in students' grades after using AI tools to formulate questions, due to the following reasons:
  - Improving the method of formulating multiple-choice questions.
  - Helping teacher formulate questions from lessons professionally.
  - The student can easily understand what is required from the questions.



Results of the students' performance who knew that the questions were created through AI platforms.



Results of the students' performance who *didn't knew* that the questions were created through AI platforms.

Figur (4). Student level results show improvement in grades compared to grades in the regular system.

4-2-3: Examples of AI Application Outputs in Teaching Practical Courses

Objectives: Enhance Problem-Solving Skills: Train students to utilize AI to analyze complex problems and propose innovative solutions. Develop Digital Skills: Equip students with the technical skills required to work in a digital design environment.

Platforms Used:

AI platforms such as Midjourney 3-4-5 were used throughout the academic year in architectural design and digital visualization courses. ChatGPT was also utilized to help with writing codes.

Example of a descriptive code: "Project type + Architecture style + (Architecture Name) + Facade + Rendering style + View + Environment + Light".

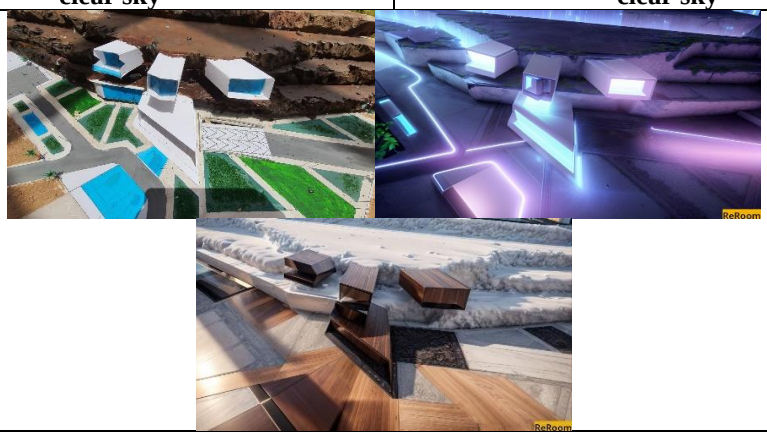
Examples of platform outputs:

Table (3): Experiences of using artificial intelligence platforms with different cases of drawings and architectural outputs for students in different subjects, whether using direct description in words, or using images or preliminary designs.

	
Office Building, Modern, termite houses, v-ray render, Day light render, human eye camera, clear sky	**Library, Green Architecture, v-ray render, Day light render, human eye camera, night shoot**

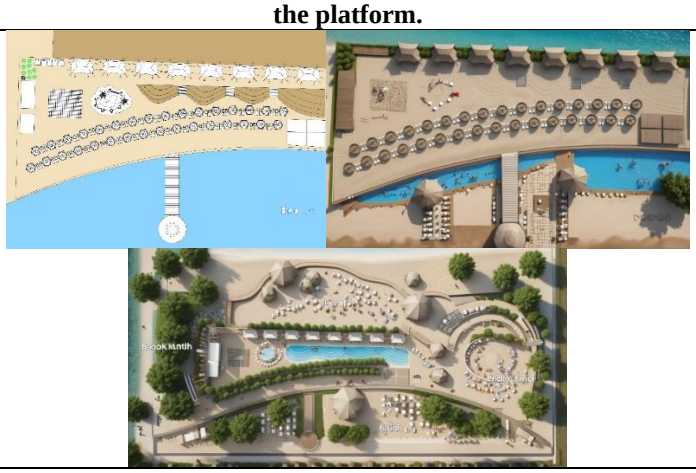
Theater Form Concept, Inspired by mashrabiya, modern Islamic style v-ray render, Day light render, human eye camera, clear sky

Mall Form Concept, Inspired By mashrabiya, modern Islamic style v-ray render, Day light render, human eye camera, clear sky



Entering the study model image for the museum design project (image on the far right), AI platforms were used to reproduce shots with different lighting and material display styles, depending on the written description of the platform.

Inputting a perspective shot from AutoCAD (picture on the far right), AI platforms were used to re-export shots with different material display styles depending on the written description of the platform.



Entering 2D lines from AutoCAD (picture on the far right), AI platforms were used to re-export shots with different material display styles depending on the written description of the platform.

AI platforms were used to generate visual outputs and conceptual designs based on the provided descriptive codes, serving as inspiration and initial foundations for the students' projects. These outputs demonstrated the potential of AI in generating creative and dynamic architectural designs.

Training Students to Use Design Modification Platforms

Students were trained to utilize platforms such as **mnml.ai**, which employs AI algorithms to transform simple hand-drawn sketches into highly detailed images, incorporating appropriate digital visualization elements that align with the desired style. These platforms have recently advanced to the point where they can create designs that are almost 100% identical to the original sketch. This allows designers to explore endless alternatives by uploading just one design that retains the original project's proportions (see Figure 5 for an example).

Figure (5): Converting a simple hand drawing into an image through a written description of artificial intelligence.

4-3: Analysis of the Experiment Based on Student Feedback:

- Using AI platforms that convert writing into images during the initial thinking stage in architectural projects helps students quickly clarify their ideas and provides them with different directions for idea inspiration.
- Platforms for developing architectural images and facades save a lot of time in the digital visualization process and have started to produce accurate results with continuous development. Even without sufficient descriptive writing, it has become possible to include an image of a specific style as an alternative to the written description.
- The use of AI in architectural design courses simplifies the teaching process and enhances thinking during the initial design and idea stages.

Table 4: Results of the opinion of students who are using AI platform in design process.

Question		Rating	
1	To what extent did artificial intelligence platforms help develop your project idea?	4.5	⭐ ⭐ ⭐ ⭐
2	How easy is it to deal with artificial intelligence platforms to generate ideas for your architectural project?	3	⭐ ⭐ ⭐
3	Do you easily reach the ideas you aspire to using artificial intelligence platforms?	4	⭐ ⭐ ⭐ ⭐
4	How important is it to include these platforms in your specialization?	5	⭐ ⭐ ⭐ ⭐ ⭐
5	What is your assessment of the time saved in the design or drawing process when using artificial intelligence platforms?	5	⭐ ⭐ ⭐ ⭐ ⭐
6	What is your overall assessment of the experience?	4.5	⭐ ⭐ ⭐ ⭐

- Figure 6 shows: The students' level improved when using artificial intelligence platforms during the architectural design process of projects, compared to traditional methods at the same time consumed in both methods. This is due to the following reasons:

- Reducing time consumed in generating ideas process.
- Artificial intelligence platforms help generate different ideas quickly.
- Reducing time consumed in drawing and visualization process.

- Table 3 shows a remarkable diversity in generating and development of different architectural ideas in less time than standard methods.

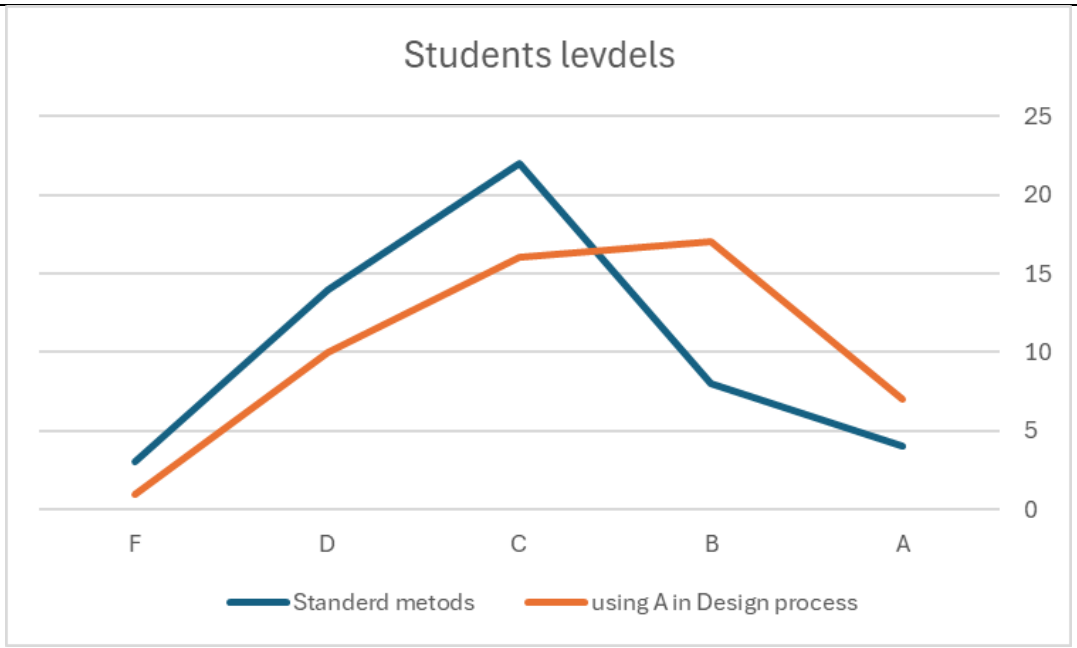


Figure 6: Students' level improved when using artificial intelligence platforms during architectural design process of projects, compared to traditional methods at the same time.

5. Results:

Integrating AI platforms into architecture design education presents new opportunities for both students and instructors. By careful planning and support, educators can harness these technologies to foster creativity, enhance problem-solving skills, and equip students with the digital competencies required for the future.

- **A Comprehensive Plan for Integrating AI Tools into Architecture Design Education:**

Objectives:

- Foster Creativity: Encourage students to explore novel design ideas using AI tools.
- Enhance Problem-Solving Skills: Train students to utilize AI to analyze complex problems and propose innovative solutions.
- Develop Digital Skills: Equip students with the technical skills required to work in a digital design environment.
- Improve Learning Efficiency: Provide personalized learning resources for each student based on their individual needs.

Steps:

- Define Learning Objectives.
- Specify the skills and knowledge students should acquire by the end of the course.
- Align these objectives with the institution's learning outcomes.
- Select Appropriate AI Tools:
  - Identify AI tools suitable for students' levels and course topics.
  - Consider tools that can generate design ideas, analyze data, create 3D models, and provide design feedback.
  - Suggested tools: Midjourney, ChatGPT, Gemini, mnml, Questionwell
  - Integrate AI Tools into the Curriculum:

Phases:

- Phase 1: Tool Familiarization: Introduce students to AI tools and their functionalities.
- Phase 2: Exploration: Encourage students to explore the tools' capabilities through simple tasks.
- Phase 3: Application: Utilize the tools in a design projects.
- Phase 4: Evaluation: Assess students' performance in using the tools and provide constructive feedback. Evaluate the effectiveness of AI tools in enhancing the learning process.
- Gather feedback from students and instructors on their experiences.
- Make adjustments to the plan based on evaluation results.
- Phase 5: Provide Technical Support: Offer technical support to students throughout the course.
- Organize training workshops to help students develop their tool proficiency.
- AI tools can enhance efficiency in the design process, saving valuable time and resources for architects.
- AI-supported design programs help reduce planning errors, leading to lower costs and projects that stay on schedule.

- AI-based energy modeling tools allow architects to create more sustainable and energy-efficient designs, reducing energy costs over the lifespan of a building.
- AI can assist in creating accurate digital models of buildings, significantly minimizing waste during construction.
- By utilizing AI in project management, faster project completion can be achieved, leading to improved profitability and customer satisfaction.
- AI can also create virtual assistants or chatbots that help students communicate with teachers and classmates, support answering questions, and free up teachers to focus on more complex tasks.
- AI can enhance assessments by automating grading and creating adaptive tests that adjust the difficulty of questions based on student progress.

6. Future Directions and Recommendations:

Although AI has made significant strides in architecture, there remains a need for fundamental scientific innovations and broader industrial applications. Future potential areas for AI include:

1. **Integrating Architectural Art and Structural Construction**: A new model for smart design can be developed by integrating architecture and structural engineering, particularly in organic forms. A universal mathematical principle that merges art, culture, and mechanics could establish a theoretical framework for smart design aesthetics and construction.
2. **Innovating Construction Techniques**: New principles, techniques, devices, and systems for global construction development need to be explored. This includes creating a smart tool for structural maintenance that can predict durability and handle complex service scenarios.
3. **Smart Disaster Prevention and Mitigation**: Machine learning-based physical frameworks should be developed for urban-scale disaster prevention. Multi-source data and physical models could be used to simulate and assess disasters more accurately.
4. **Virtual Assistants and Adaptive Learning**: AI can enhance educational environments by supporting virtual assistants, chatbots, and virtual reality simulations. These tools will help students practice skills and interact in simulated environments, along with adaptive tests to personalize the learning experience.

Recommendations for AI Development and Industry Participation:

- Educate students about the role of AI in changing workforce dynamics. Help students articulate the AI skills and abilities they've developed.
- Facilitate AI applications in internships and experiential learning, exposing students to AI career paths and real-world experience.
- Collaborate with universities to introduce comprehensive learning records that highlight AI-related skills, bringing workplace competencies into focus across curricula.

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