Mapping Physical Moroccan Sciences Student's Perceptions of AI: A Case Study on Generative AI (ChatGPT)

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***Abstract*—This study explores the integration of Artificial Intelligence (AI) and tools like ChatGPT in the teaching of physical sciences, focusing on student perceptions at the Higher Normal School (ENS) of Fez. AI offers opportunities to enhance teaching methodologies, foster interactive learning, and provide personalized educational experiences. A quantitative, descriptive, and exploratory approach was adopted with data collected through a structured questionnaire distributed via Google Forms. The sample comprised 350 undergraduate and master's students, with 300 valid responses (85.71%). Data analysis, conducted using Excel, revealed that 92.3% of participants are familiar with AI, though 63% believe it cannot fully replace human roles in various sectors. Additionally, 65% had no prior interaction with ChatGPT, and 71% do not take it as a substitute for a physics teacher. These findings highlight the need for a balanced integration of AI in education, emphasizing both its potential benefits and the limitations of over-reliance on technology in teaching.**

***Keywords*—artificial intelligence, generative artificial intelligence, teaching physics, ChatGPT, learner perceptions, chatbots**

I. Introduction

Artificial Intelligence (AI) refers to the development of machines capable of performing tasks that typically require human intelligence, such as reasoning, learning, problem-solving, and natural language understanding [1]. The field of AI formally began at the Dartmouth Conference in 1956, organized by John McCarthy, who coined the term [2]. This pivotal event brought together pioneers like Marvin Minsky and Herbert Simon, laying the foundation for AI research [3].

Since its inception, AI has evolved into several branches, including Machine Learning (ML), Natural Language Processing (NLP), Computer Vision, and Robotics. ML focuses on developing algorithms that allow systems to learn from data and make predictions, while NLP enables interactions between computers and humans through natural language [4]. Computer Vision empowers machines to interpret visual information, and Robotics integrates AI into machines capable of autonomous tasks. Together, these branches illustrate AI's diverse applications.

Throughout its history, AI has experienced periods of both significant progress and stagnation [5]. Early achievements, such as the Logic Theorist by Newell and Simon in the 1950s, and advancements in NLP with programs like ELIZA in the 1960s, demonstrated AI's potential. However, limited computational power and unmet expectations led to the "*AI Winter*" in the 1970s [6]. The resurgence of AI in the 1990s, fueled by increased computing capabilities and large datasets, has since propelled the development of powerful technologies like deep learning and neural networks [7, 8]. Notably, OpenAI's ChatGPT, based on the Generative Pretrained Transformer (GPT) architecture, has emerged as a significant contribution, particularly in the field of education.

Despite the transformative potential of AI tools like ChatGPT in enhancing educational practices, concerns about their adoption remain [9]. These include issues of accuracy, potential over-reliance on technology, and ethical considerations surrounding data privacy and academic integrity. In this context, understanding the perceptions and usage patterns of students in specific educational settings becomes crucial.

This research delves into the perceptions of Moroccan physical science students towards AI, particularly generative AI like ChatGPT. By understanding their awareness, misconceptions, and potential applications, the study aims to bridge the gap between emerging AI technologies and the student community. This localized perspective is crucial for tailoring AI education to the specific needs and cultural context of the region. Ultimately, the research seeks to contribute to the broader discourse on AI in education, empowering future scientists to harness AI responsibly and innovate in a tech-driven world. Additionally, the findings offer practical recommendations for educators, policymakers, and researchers to effectively integrate AI into the learning environment, enhancing student engagement, critical thinking, and overall learning experience.

II. Literature Review

A. Artificial Intelligence

AI has emerged as a transformative tool across multiple disciplines, including education, where its applications have the potential to significantly enhance the teaching and learning process [6]. AI encompasses systems capable of performing tasks that traditionally require human intelligence, such as reasoning, problem-solving, and natural language processing. In physics education, AI technologies play an increasingly pivotal role, offering tools ranging from personalized learning environments and intelligent tutoring

systems to advanced simulations and virtual laboratories. These technologies enable students to visualize complex physical phenomena, engage in interactive learning.

Experiences, and receive real-time feedback, fostering a deeper understanding of theoretical concepts [10].

Moreover, AI can assist educators in identifying individual learning patterns, enabling tailored instruction and more efficient performance assessments [11]. By integrating AI in physics instruction, there is considerable potential for improving student engagement, promoting inquiry-based learning, and cultivating critical thinking skills. This research focuses on assessing the impact of AI-driven tools in enhancing learning outcomes for students in the physical sciences.

A 2023 study by Holon IQ reported that 64% of higher education institutions globally are integrating AI technologies in the classroom, with STEM disciplines, including physics, leading adoption due to the need for personalized learning experiences and the capacity to simplify complex topics [12]. Notably, 40% of students using AI-driven platforms reported improvements in engagement, motivation, and comprehension, particularly in physics. The integration of AI, particularly generative AI models such as ChatGPT, presents significant opportunities to enhance traditional pedagogical practices by offering personalized support, improving conceptual understanding, and fostering student engagement. As research continues to explore the efficacy of AI in education, it is crucial to examine its long-term impacts on learning outcomes while addressing challenges related to its implementation [13].

B. ChatGPT: Advancements in Natural Language Processing and Educational Applications

ChatGPT, a cutting-edge language model developed by OpenAI, has gained widespread attention for its remarkable ability to engage in human-like conversations and provide accurate information across a broad spectrum of topics [14]. Its versatility and accessibility have positioned it as a potentially transformative tool in education, particularly for enhancing student learning in complex subjects such as physics [15]. Leveraging its underlying algorithm (Fig. 1), ChatGPT can generate and explore a vast range of topics, offering unprecedented advancements in natural language processing (NLP), which have revolutionized language-related tasks in computer science [16].

The architecture of ChatGPT is based on self-attention mechanisms, enabling it to compute contextual relationships between words and tokens within input sequences. This innovation represents a significant leap in NLP, allowing for more nuanced understanding of linguistic structures, semantics, and discourse across various contexts. Trained on extensive datasets from diverse textual sources, ChatGPT is capable of handling complex linguistic tasks, including understanding intricate sentence structures, identifying subtle meanings, and adapting to different writing styles [17].

Moreover, ChatGPT applications extend beyond education, contributing to fields such as information retrieval, sentiment analysis, and automated content generation [18]. Continuous advancements in its model architecture, training methods, and fine-tuning strategies have consistently improved its performance, making it highly adaptable and effective across multiple NLP applications [19]. As such, ChatGPT represents a pivotal innovation in AI-driven language technologies, with far-reaching implications for both academic and industrial fields.

C. The ChatGPT Algorithm

ChatGPT, an advanced AI model developed by OpenAI, is designed to generate text that mimics human-like conversation and provides information on a wide range of topics [20]. It operates through sophisticated processes that enable it to learn from large data sets, enhance its responses, and engage in meaningful interactions. The algorithm's capabilities have made it a breakthrough in the field of natural language processing (NLP) and an important tool in education, especially in areas requiring complex linguistic comprehension [21].

The ChatGPT algorithm can be described in three key stages:

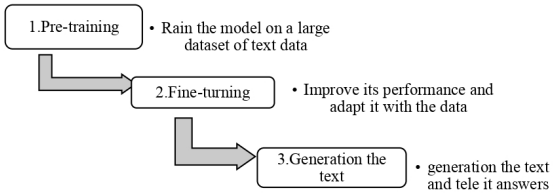

Fig. 1. The ChatGPT algorithm.

1) Pre-training on large-scale text data

In the initial phase as indicate in Fig. 1, ChatGPT is pre-trained on extensive amounts of textual data from diverse sources such as books, websites, and academic papers. This allows the model to develop a robust understanding of language structures, syntax, word associations, and contextual meanings. During pre-training, ChatGPT predicts the next word in a sequence based on the preceding words, which helps it grasp intricate linguistic patterns and relationships [22].

2) Fine-tuning with human feedback

After pre-training, the model undergoes a crucial fine-tuning process to improve its performance in specific tasks as show in Fig. 1. This phase, known as Reinforcement Learning from Human Feedback (RLHF), involves human annotators reviewing and ranking the model's responses to various inputs [23]. Through this guided learning, ChatGPT refines its ability to provide more accurate, relevant, and contextually appropriate responses, especially in conversational settings. This feedback loop is essential to ensuring the model's adaptability in real-world applications [24].

3) Text generation and contextual analysis

When generating text, ChatGPT processes input by breaking it down into tokens—small units of text—and analyzes the input context. The model then predicts the most suitable subsequent tokens based on its vast pre-training knowledge [25] looking at the Fig. 1. This iterative process

continues until a complete response is generated. The self-attention mechanism used by the underlying Transformer architecture plays a pivotal role in this process, allowing the model to maintain context and coherence over longer pieces of text [26].

In its applications, ChatGPT demonstrates remarkable versatility, from performing tasks like information retrieval and automated conversations [27]. As advancements in its architecture and training methodologies continue, ChatGPT is poised to enhance its role across various fields, particularly in education, where it facilitates learning in challenging domains such as the physical sciences [28].

D. The Integration of Chat GPT in Education

The rapidly advancing field of artificial intelligence (AI), particularly generative AI, is ushering in transformative changes across various domains, including education. Models like GPT (Generative Pre-trained Transformer) are at the forefront of this revolution, reshaping not only text generation but also areas such as image creation, language translation, programming, and complex problem-solving [28, 29]. These capabilities mark a significant shift in how knowledge is produced, disseminated, and applied, with generative AI playing a pivotal role in the evolving landscape of education [30].

In educational contexts, AI-driven technologies (EdTech) have the potential to redefine pedagogical methodologies by offering unprecedented opportunities for personalization, scalability, and accessibility [31]. The integration of generative AI into education allows for the development of adaptive learning systems capable of tailoring educational content to individual learning patterns, offering personalized feedback, and suggesting alternative approaches for students struggling with specific concepts [32]. For example, AI-powered tools can provide real-time explanations or simulations to help students grasp complex topics in the physical sciences, thereby enhancing engagement and comprehension [33].

From an educator's perspective, AI serves as an intelligent assistant, streamlining tasks such as grading, tracking student progress, and curating tailored learning materials. In doing so, it is not only improving teaching efficiency but also freeing up valuable time, enabling educators to focus on more personalized, human-centered aspects of teaching [34]. AI models, like GPT, further contribute to academic research by automating literature reviews, summarizing extensive bodies of an academic work, and even identifying gaps in existing researches, all of which support and enhance scholarly inquiry.

However, the integration of AI in education also presents several challenges that must be addressed. Critical issues, such as data privacy, ethical use, inherent biases in AI models, and the risk of over-reliance on automated systems, call for careful consideration. Educational institutions need to ensure that AI tools are employed to complement rather than replace human-led teaching, fostering a balanced and ethical approach. Additionally, educators must be adequately trained to leverage AI tools effectively, ensuring that technology enhances rather than complicates the learning experience [35].

The future of education lies at the intersection of human and machine intelligence. As AI continues to evolve, its role in shaping education will likely expand, promoting continuous learning and democratizing access to high-quality education [36]. The true transformative potential of AI in education goes beyond automating routine tasks; it empowers educators and students alike to engage in richer, more inclusive, and more equitable learning environments [37].

The Role of AI in Physics Education: Transformative Approach

The integration of AI into the teaching of physics signifies a major shift in educational methodologies, fundamentally transforming how students learn and understand complex scientific concepts [38, 39]. Physics, as a subject, often presents significant challenges due to its reliance on abstract theoretical models and intricate quantitative analyses. AI-based educational technologies, such as Intelligent Tutoring Systems (ITS), AI-driven simulations, and problem-solving platforms, have emerged as powerful tools to help students navigate these difficulties by offering real-time, personalized feedback and guidance [40]. This adaptive learning environment enables students to learn at their own pace, receiving tailored support aligned with their individual learning needs.

E. AI Simulations in Physics Education

AI-powered simulations are particularly transformative, offering students an opportunity to visualize and interact with abstract concepts that are otherwise difficult to grasp through traditional learning methods [41]. For example, in areas such as quantum mechanics or electromagnetism, AI-driven tools allow learners to experiment with variables in virtual environments, enabling them to see how different parameters affect outcomes in real time. These interactive simulations not only improve students' conceptual understanding but also foster deeper engagement by providing hands-on learning experiences [42].

Furthermore, AI can assist students in breaking down complex physics problems into more manageable components, offering hints and generating alternative solutions, thereby enhancing problem-solving skills.

F. AI as a Tool for Educators

For educators, AI plays a pivotal role in enhancing curriculum design and student assessment. By leveraging machine learning algorithms, AI systems can analyze extensive datasets on student performance to identify trends, knowledge gaps, and areas of difficulty. This data-driven insight allows educators to tailor their instructional approaches, ensuring that teaching strategies are responsive to student needs [43].

AI also automates time-consuming administrative tasks, such as grading quantitative assignments, providing detailed and consistent feedback. This automation is particularly useful in large classes, where manual grading can be labor-intensive and prone to inconsistencies [44].

G. Collaborative Learning and Accessibility

Beyond individual learning, AI also facilitates collaborative learning environments [45]. Virtual labs and AI-powered platforms allow students to work together on experiments and simulations, even when physically apart. These platforms encourage peer learning and foster collaborative problem solving in physics, thereby enhancing critical thinking and teamwork skills [46].

Moreover, AI technology enhances accessibility by offering multilingual support and providing accommodations for students with disabilities, ensuring an inclusive learning environment where all students can fully participate in physics education [47].

H. Challenges and Ethical Considerations

Despite its numerous benefits, the integration of AI in physics education is not without challenges. Issues related to AI biases, student data privacy, and the risk of over-reliance on automated systems requires careful consideration. AI models, like any algorithm, can inadvertently perpetuate biases present in their training data, which may lead to inequitable learning outcomes. Additionally, maintaining the balance between AI-assisted learning and traditional, human-centered teaching methods is crucial [35]. AI tools should complement rather than replace human educators, preserving the importance of human interaction and guidance in the classroom [48].

To summarize, the application of AI in physics education holds immense promise, offering innovative solutions to long-standing challenges in the field. By creating more personalized, interactive, and data-driven learning experiences, AI has the potential to significantly enhance student engagement and comprehension of complex physics concepts [49]. As AI technologies continue to evolve, their role in transforming physics education will only expand, shaping the way future generations learn and explore the physical world [50].

To comprehensively examine the impact of generative Artificial Intelligence (AI) on academic and research practices, we propose the following research questions aimed at understanding the experiences and perceptions of students in the physical sciences:

Attitudinal Perspectives:

1) What are the attitudes of Moroccan physical sciences students regarding the utilization of generative AI tools, such as ChatGPT, in their academic and research endeavors?

Perceived Enhancements:

2) How do Moroccan physical sciences students perceive the role of generative AI, including ChatGPT, in augmenting their learning and research processes?

Assessment of Benefits and Challenges:

3) What advantages and disadvantages do Moroccan physical sciences students associate with generative AI tools, such as ChatGPT, in the context of their academic pursuits?

III. Materials and Methods

A. General Background

This research delves into the perceptions of Moroccan physical science students towards AI, with a particular focus on generative AI like ChatGPT. Our primary objective is to bridge the gap between emerging AI technologies and the student community, providing a comprehensive analysis of their current perceptions, awareness levels, and potential misconceptions. This understanding is crucial for educators and policymakers to tailor AI education effectively, ensuring it aligns with both students' needs and industry standards.

By conducting a case study in Morocco, the research adds significant value by contextualizing AI perceptions within the region's unique cultural and educational landscape. This localized perspective is essential, as AI adoption and its implications can vary greatly across different geographical and socio-cultural settings. Hence, the findings could inform strategies not just in Morocco but also in similar educational contexts globally.

Furthermore, the study contributes to the broader academic discourse on AI in education, particularly within the physical sciences. It examines how students perceive the role and impact of AI in their field, potentially influencing their future career choices and research directions. As AI becomes increasingly integrated into scientific research and industry, understanding these perceptions helps ensure that future scientists are well equipped to harness AI technologies responsibly and innovatively.

To achieve these objectives, our research employs a rigorous quantitative methodology to examine physics students' perceptions of AI in their educational journey. A well-structured questionnaire was developed, incorporating propositions aimed at engaging students cognitive processes. Five expert professors in the field, ensuring its scientific soundness and alignment with research objectives, validated the questionnaire. Additionally, the development of the instrument was informed by thorough consultations with students, allowing the questions to closely mirror their perspectives and cognitive frameworks. This collaborative approach enhanced the relevance of the questionnaire, enabling the capture of meaningful insights into their understanding of AI.

The design of the questionnaire ensured comprehensive, mutually exclusive response options to avoid any overlap, thereby eliminating bias. This structure was critical in assessing students' comprehension of AI concepts without guiding them toward specific answers, ensuring genuine understanding rather than pattern recognition. Each response option was thoughtfully crafted to explore the students' perspectives on AI, reflecting their knowledge, experiences, and opinions. By involving students in the development phase, we ensured a strong alignment between the questions and their cognitive processes, leading to more authentic data on their perceptions of AI in the educational context.

In summary, this carefully designed and expert-validated questionnaire provided a robust framework for gathering reliable data on how students perceive, interact with, and conceptualize AI in their academic environment.

B. The Sample

From the 350 responses collected, 300 were validated, representing 85.71% of the initial sample. The participants comprised Moroccan students studying physics at ENS of Fez, across various academic levels: first-year (L1), second-year (L2), third-year (L3) undergraduates, as well as first-year (M1) and second-year (M2) master's students. Additionally, final-year high school students specializing in physical sciences aged 19 and above, were included in the sample. The gender distribution was 60.9% female and 39.1% male, with 86.8% being university students and 13.2% high school students (Fig. 2 and Table 1).

Table 1. Demographic description

Variable	Demographic	Frequency	Percent%	Valid Percent
Gender	Female	183	61	61
	Male	117	39	39
Age	17-19	37	12.3	12.3
	19-24	258	86	86
	More24Years	5	1.7	1.7
The cycle	The high school	39	13	13
	The college	261	87	87

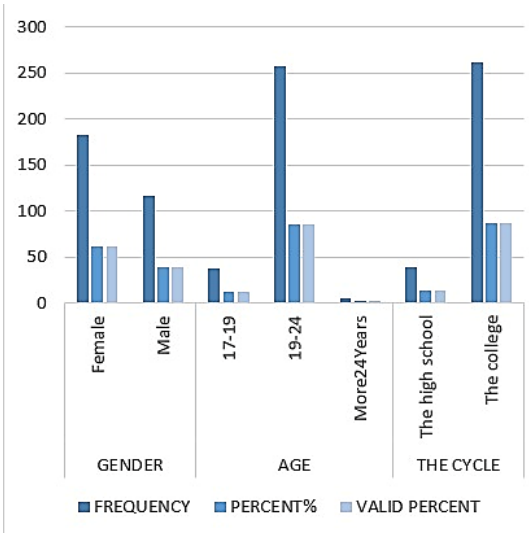

Fig. 2. The Demographic description.

C. Instrument and Procedures

This quantitative study seeks to explore students' perspectives on artificial intelligence (AI), particularly focusing on their understanding of AI and their experiences with ChatGPT.

The questionnaire is structured into three key sections. The first section contains two questions aimed at identifying the most common definitions of AI among the participants. This allows the study to gauge how familiar the learners are with the concept of AI. The second section investigates whether the learners have used ChatGPT, and if so, in what ways.

The final section delves into their opinions on the potential for ChatGPT to replace teachers or even humans in general. This approach provides insights into both the current usage of AI tools and learners' outlook on the broader implications of AI in education and society

D. Data Collection

The questionnaire for this study was distributed via Google Forms, providing an efficient and structured platform for data collection. This approach facilitated seamless management of responses and ensured that we effectively reached our target audience. Google Forms was selected due to its accessibility and user-friendliness, enabling participants to complete the questionnaire at their convenience, which likely contributed to an improved response rate and a more representative sample.

The data collection method employed was an online self-administered survey, a technique that can present challenges, such as the potential for non-response bias if specific groups of participants choose not to respond. To mitigate this, the study was designed to encourage participation across all demographics.

Prior to administering the questionnaire, preliminary discussions were held with students to gather insights into their understanding of artificial intelligence and their perspectives on whether AI could replace physical science teachers. These discussions offered valuable qualitative context that informed the final questionnaire design.

IV. Result and Discussion

This section presents the findings of our study investigating the perceptions of Moroccan physical sciences students regarding generative AI tools, with a focus on ChatGPT.

The results offer insight into how these students engage with and evaluate the role of AI in their academic and research activities. Through an analysis of their responses, we identify key trends and perspectives on the perceived benefits and challenges associated with AI tools.

These findings serve as a basis for discussing the broader implications of AI in education within the Moroccan context, contributing to a more comprehensive understanding of its influence on learning and research practices.

A. Result

The question1: "Are you familiar with the concept of Artificial Intelligence (AI)?" was designed to assess the respondents' awareness and understanding of AI. Based on the provided response table, most respondents demonstrated a strong familiarity with AI:

Yes: 276 respondents (92.3%)

No: 24 respondents (7.7%)

The results (Fig. 3 and Table 2) indicate a high level of awareness of AI among the participants, with 92.3% responding affirmatively. This suggests that AI is widely recognized and understood within the respondent group. The relatively small percentage (7.7%) of participants who are not familiar with AI may indicate gaps in exposure or education related to AI, which could be addressed through targeted informational or educational efforts.

Table 2. Results of the first question

Answers	Frequency	Percent%	Valid Percent
No	24	7.7	7.7
Yes	24	92.3	92.3

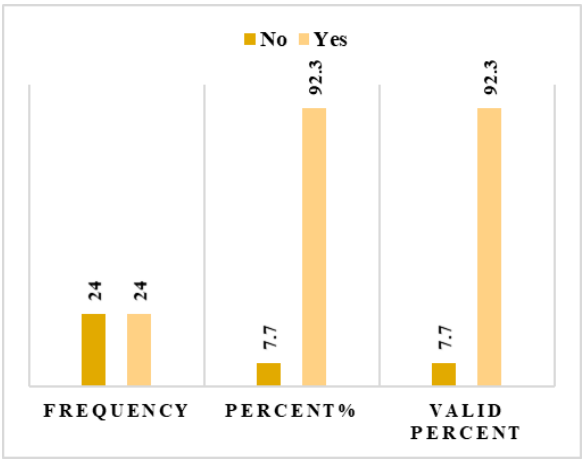

Fig. 3. The result of the first question.

The high level of familiarity sets a strong foundation for further analysis in terms of how respondents perceive AI's applications in their academic or professional activities. Given the prominence of AI in various fields, this high awareness level could also indicate an openness or readiness to adopt AI-based tools for academic or scientific purposes.

The second question "Which of the following best defines AI in your opinion?" aims to assess respondents' conceptual understanding of Artificial Intelligence by presenting them with multiple definitions of AI. Each option offers a different perspective on AI, ranging from a technical description to more general or application-focused interpretations.

By evaluating which definition resonates most with the participants, the survey attempts to capture how AI is perceived within the specific respondent group, which can be indicative of their knowledge, experiences, and exposure to the field.

The results (Fig. 4 and Table 3) reveal diverse understandings of AI among respondents, with the majority leaning towards a more technical and process-based definition (34.8%). This suggests that the respondents, likely with some familiarity with AI, see it primarily in terms of its computational capabilities. However, the significant number of inquirers who selected the other options indicates varying levels of focus—some on AI's interaction with its environment, others on its practical applications, and still others on its broader societal impact.

Table 3. Results of the second question

Answers	Frequency	Percent%	Valid percent
Answer1:AI is a set of technologies that enable machines to perceive their environment, understand the data they receive, and adapt their behavior accordingly	84	28.1	28.1
Answer2: AI is a form of data processing that enables machines to make intelligent decisions using algorithms, models, and pattern recognition systems.	104	34.8	34.8
Answer3: AI can be used to automate tasks, solve complex problems, and improve process efficiency.	58	19.5	19.5
Answer4: AI is often perceived as a powerful and revolutionary technology that can bring about significant changes in many fields.	54	18	18

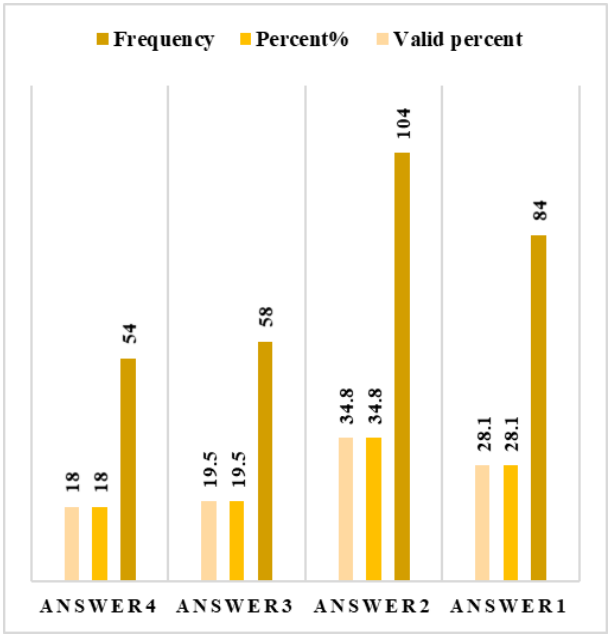

Fig. 4. The result of the second question.

Moreover, the findings highlight that it is not evident to establish a single, universally accepted definition of AI. The concept of AI varies significantly depending on the domain of application and the individual perception of respondents. AI can be seen as a set of technologies enabling intelligent behavior, a tool for decision-making through data processing, or a revolutionary force capable of transforming industries. This variability underscores the complex, multi-dimensional nature of AI and suggests that any definition must be contextual, adapting to the specific field and the objectives of those engaging with the technology.

These results provide valuable insights into the inquirers' perceptions of AI, which can help in understanding how AI is viewed and discussed in educational and research contexts. They also emphasize the need for tailored educational strategies that address the multi-faceted nature of AI, encompassing both its technical aspects and broader applications

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However, the significant number of respondents who selected the other options indicates varying levels of focus—some on AI's interaction with its environment, others on its practical applications, and still others on its broader societal impact.

The question 3: "Do you believe that Artificial Intelligence (AI) has the potential to fully replace human roles and responsibilities in various sectors in the future?" seeks to assess respondents' perceptions regarding the potential of AI to supplant human involvement across different industries and professional domains (Fig. 5 and Table 4).

Table 4. The results of the third question

Answers	Frequency	Percent%	Valid Percent
No	189	63	63
Yes	111	37	37

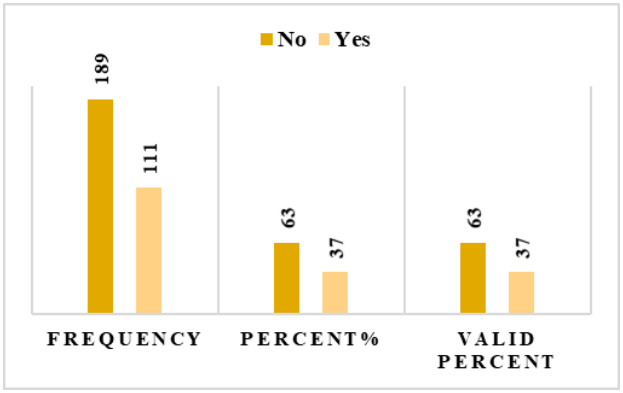

Fig. 5. The result of the third question.

1) Key insights

Majority Skepticism: A significant majority (63%) of respondents believe that AI will not fully replace human roles and responsibilities in the future. This indicates that most individuals are either skeptical of AI's complete takeover or acknowledge the irreplaceable aspects of human involvement, such as emotional intelligence, creativity, critical thinking, and ethical decision-making, which are difficult to replicate through AI technologies.

Minority Optimism or Concern: Conversely, 37% of respondents believe that AI could fully replace humans in various sectors. This could reflect the growing awareness of AI's capabilities in automating tasks, improving efficiency, and solving complex problems, leading some to anticipate that advanced AI systems might significantly reduce the need for human labor in certain areas.

These results highlight a divided perception regarding the future impact of AI on human employment. While the majority do not foresee AI completely replacing human roles, a substantial portion of respondents recognize the transformative potential of AI, perhaps based on current advancements in fields like automation, machine learning, and robotics.

B. Broader Implications

The skepticism could stem from an understanding that while AI may excel in repetitive, data-driven tasks, it is unlikely to fully substitute human qualities like empathy, ethical reasoning, and adaptability, which are essential in many professions, particularly those involving direct human interaction (e.g., education, healthcare).

Those who responded "yes" might be more focused on the rapid progression of AI in sectors such as manufacturing, finance, and data analytics, where AI-driven systems have already begun to replace specific human tasks, leading to concerns about job displacement in the future.

The findings underscore a broader debate in the discourse around AI—whether its advancements will result in the replacement or augmentation of human labor. It also reflects the uncertainty and mixed perceptions regarding the balance between AI capabilities and the unique contributions of humans in professional environments. These insights are crucial for policymakers, educators, and business leaders as they navigate the evolving relationship between AI and the workforce

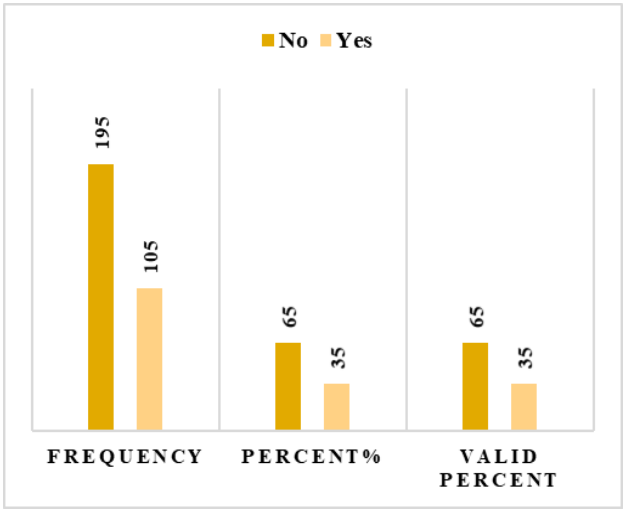

Fig. 6. The result of the fourth question.

The question 4: "have you ever engaged with or utilized ChatGPT in any professional, academic, or personal context?" is closed-ended, requiring a simple "yes" or "no" response. This format is effective for quantifying the data. (Fig. 6 and Table 5).

Table 5. The results of the fourth question

Answers	Frequency	Percent%	Valid Percent
No	195	65	65
Yes	105	35	35

1) Implication

Awareness and Training Needs: The high percentage of non-users may reflect a need for increased awareness, education, or training regarding AI tools like ChatGPT. This could inform future initiatives aimed at integrating AI into various sectors.

Potential for Growth: The 35% of users may represent an opportunity for further research into their experiences, perceptions, and the contexts in which they have used ChatGPT, providing insights into best practices and barriers to adoption.

Question 5: In your opinion, how could the integration of ChatGPT potentially transform the future of physics education, particularly in terms of instructional methods,

student engagement, and assessment practices?

Possible answers:

1) Enhancing Learning Engagement: ChatGPT can make physics more interactive by providing real-time explanations and personalized learning experiences for students.
2) Automating Administrative Tasks: It can assist teachers by automating grading, feedback, and content creation, allowing more time for direct student interaction.
3) Personalized Learning: ChatGPT can tailor physics lessons to individual students' learning needs, helping them understand complex concepts at their own pace.
4) Challenges and Ethical Concerns: While promising, the use of AI like ChatGPT in education may raise concerns regarding accuracy, dependence on technology, and the need for human oversight

V. Analysis of Responses:

The analysis of participant responses to the question "In your opinion, how could the integration of ChatGPT potentially transform the future of physics education, particularly in terms of instructional methods, student engagement, and assessment practices? "reveals diverse perspectives. The following four key trends were identified based on the distribution of responses:

Enhancing Learning Engagement (Fig. 7 and Table 6). (35%): The largest group of respondents (35%) highlighted ChatGPT's potential to improve student engagement and interaction in physics learning. These participants emphasized that AI tools could make the subject more accessible by offering real-time answers to questions, creating interactive simulations, and fostering active learning through dialogue-based instruction. This suggests a strong belief in ChatGPT's ability to transform the learning experience by making complex concepts more approachable.

Table 6. The results of the fifth question

Answers	Frequency	Percent%	Valid Percent
Answer1: Enhancing Learning Engagement: ChatGPT can make physics more interactive by providing real-time explanations and personalized learning experiences for students.	105	35	35
Answer2: Automating Administrative Tasks: It can assist teachers by automating grading, feedback, and content creation, allowing more time for direct student interaction.	75	25	25
Answer 3: Personalized Learning: ChatGPT can tailor physics lessons to individual students' learning needs, helping them understand complex concepts at their own pace	60	20	20
Answer 4:Challenges and Ethical Concerns: While promising, the use of AI like ChatGPT in education may raise concerns regarding accuracy, dependence on technology, and the need for human oversight	60	20	20

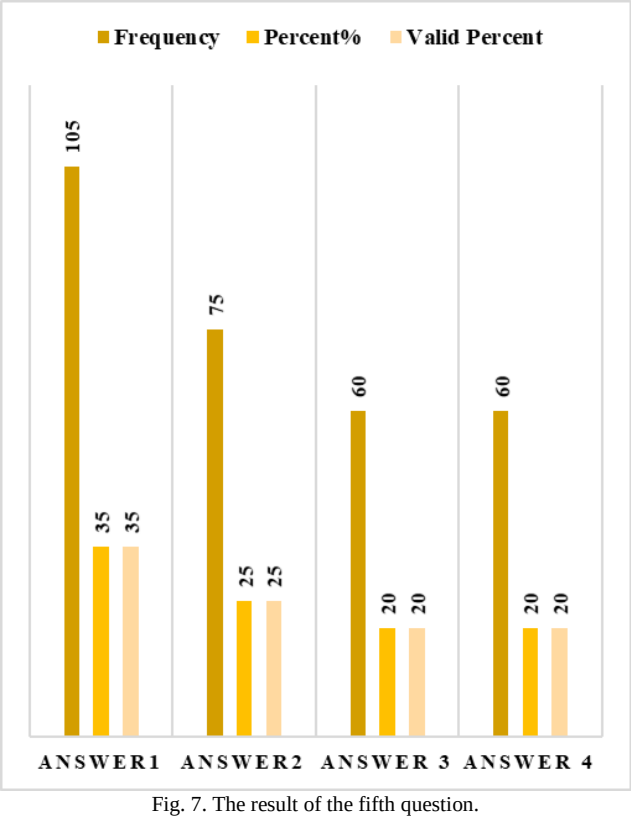

Fig. 7. The result of the fifth question.

Automating Administrative Tasks (25%): A significant proportion of respondents (25%) saw the main advantage of ChatGPT in its ability to automate routine administrative tasks, such as grading homework, providing feedback, and answering basic queries. These participants have seen Chat GPT as a timesaving tool for teachers, enabling them to focus on more complex teaching activities and student engagement. This response underscores the practical benefits of AI in reducing the workload associated with teaching and administrative duties.

Personalized learning (20%): About 20% of respondents emphasized the potential for Chat GPT to personalize learning experiences. They noted that AI could tailor explanations and examples to individual student needs, allowing for adaptive learning paths and customized feedback. This view aligns with the growing trend in education toward individualized learning, where AI systems like ChatGPT play a role in accommodating different learning styles and abilities.

Challenges and Ethical Concerns (20%): Another 20% of respondents raised concerns about the use of AI, particularly ChatGPT, in education. These concerns included potential issues with accuracy, over-reliance on AI tools, and the ethical implications of replacing traditional teaching methods

with technology. Participants also highlighted the need for cautious integration of AI, ensuring that it complements rather than replaces human teaching. This point to a segment of educators and students who are wary of AI's limitations and emphasize the importance of human oversight in education.

The responses suggest a generally positive attitude towards the use of ChatGPT in teaching physics, with most participants recognizing its potential to enhance engagement and automate tasks. However, there remains a notable level of caution regarding the ethical and practical challenges of relying on AI. This highlights the importance of developing balanced strategies that leverage AI's strengths while addressing concerns related to its limitations and ethical use in educational settings

The aim of this question: "To what extent do you believe ChatGPT could potentially complement or replace the role of a physics teacher in the educational process?" Is to explore respondents' views on whether AI tools, particularly ChatGPT, can complement or fully replace physics teachers in the educational process. The responses provide insights into perceptions of AI's role in the classroom, specifically in a subject requiring human expertise and interaction.

Key Insights:

Dominant Perception (Fig. 8 and Table 7). (71% - "No"): Most respondents (71%) do not believe that ChatGPT could replace or even significantly complement the role of a physics teacher. This suggests a prevailing view that AI cannot substitute the essential role of teachers in physics, particularly in areas such as fostering critical thinking, practical instruction, or the nuanced understanding of complex concepts.

Table 7. The results of the sixth question

Answers	Frequency	Percent%	Valid Percent
I don't know	48	16	16
No	213	71	71
Yes	39	13	13

Uncertainty (16% - "I don't know"): Significant portions of respondents (16%) are uncertain about the potential of AI in replacing or complementing physics teachers. This might reflect a lack of exposure to AI tools in education, limited awareness of ChatGPT's capabilities, or hesitation to assess AI's role without further evidence or examples.

Support for AI's Role (13% - "Yes"): A smaller group (13%) believes that ChatGPT could complement or even replace the physics teacher. This group may recognize AI's strengths in automating administrative tasks, providing supplementary explanations, or offering personalized feedback that can aid the teaching process.

Interpretation:

Teacher's Unique Role: The overwhelming "No" response highlights the belief that teaching, especially in subjects like physics, requires human skills such as emotional intelligence, adaptive communication, and real-time interaction. These elements are seen as critical in helping students grasp difficult concepts, making AI a tool that complements rather than replaces teachers.

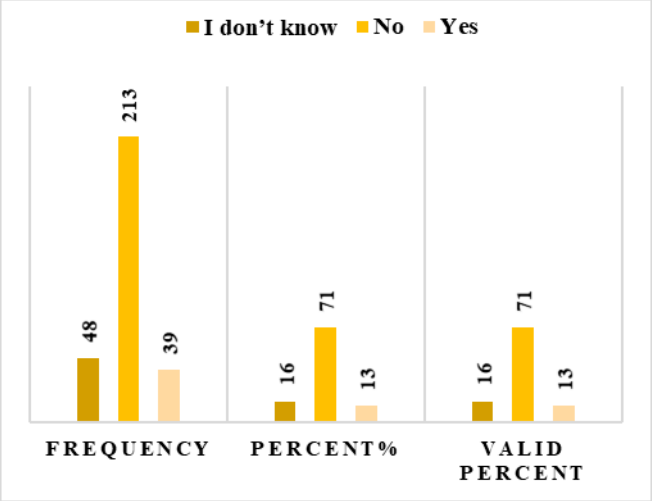

Fig. 8. The result of the sixth question.

Lack of Knowledge (16% "I don't know"): A considerable percentage of respondents are uncertain, suggesting that more education or demonstrations of AI's current capabilities may be necessary for people to form informed opinions.

AI as a Complementary Tool (13% "Yes"): For those who see AI as capable of replacing or complementing teachers, this highlights the growing awareness of AI's potential to handle repetitive tasks, provide personalized learning, and support students outside the classroom. However, this minority suggests that AI's potential is still underappreciated or its practical applications are not yet fully embraced.

A. Discussion

This study provides valuable insights into Moroccan science students' perceptions of AI and its potential in education. The findings reveal a high level of awareness of AI among the participants, coupled with a generally positive attitude towards its use in teaching. While most respondents recognize the potential of AI to enhance teaching and learning, they also express concerns about the ethical and practical challenges associated with its integration.

The study's comparison of responses to questions about AI familiarity, ChatGPT experience, and AI's potential in physics education highlights the complexity of student perceptions. While many students are familiar with AI and see its potential benefits, there is also a significant portion that remains uncertain or hesitant about its full integration. This suggests that a nuanced approach is needed to effectively integrate AI into educational settings.

The results indicate that while there are some recognitions of ChatGPT's potential in education, most respondents are not convinced that it can replace or even play a major complementary role in teaching physics. The data reflects a cautious or skeptical attitude toward AI in education, particularly in subjects requiring deep, interactive learning. This underscores the need for further research, demonstrations, and clear applications of AI in teaching to

better understand its place in educational settings

Our study extends the existing body of literature by providing a nuanced perspective on Moroccan physical sciences students' perceptions of generative AI, a demographic that has been relatively understudied in this context. By focusing on ChatGPT within a specific educational setting, we offer valuable insights into the challenges and opportunities presented by AI in the classroom. While our study provides valuable data, it is important to acknowledge its limitations. The relatively small sample size and reliance on self-reported data may affect the generalizability of our findings. Moreover, our focus on ChatGPT may not fully capture the diverse range of AI applications in education. Future research could address these limitations by expanding the sample size, employing mixed-methods approaches, and investigating the impact of other AI tools in different educational settings

This research aligns with previous research demonstrating a positive perception of AI among students, as evidenced by studies conducted in the United States and China [51]. However, unlike their international counterparts, Moroccan students exhibit a more cautious approach, reflecting the findings in South Korea [52]. While some students acknowledge AI's potential for quick explanations, many express reservations about its ability to foster deeper problem-solving skills, echoing the concerns raised by Schmidt et al. in Germany [53]. Furthermore, the limited digital infrastructure and teacher training in Morocco pose significant barriers to AI integration, a challenge less prevalent in countries with more advanced educational technologies [54]. Thus, while the global enthusiasm for AI in education is evident, our study emphasizes the unique hurdles that must be overcome in the Moroccan context, particularly within the field of physical sciences, to fully realize its potential.

VI. Conclusion

This study explored the integration of AI, specifically ChatGPT, into the teaching of physical sciences at the ENS of Fez. Our findings indicate that students generally perceive AI as a valuable tool with potential to enhance learning, but they also express concerns about over-reliance and the need for human interaction in education.

While students recognize the limitations of AI, they are open to its integration as a supplementary tool. However, the study highlights the need for a balanced approach, considering both the benefits and challenges of AI integration.

Future research should focus on addressing the limitations of this study, such as exploring the impact of AI on learning outcomes and addressing ethical concerns. By doing so, we can contribute to a more comprehensive understanding of the role of AI in higher education and inform the development of effective AI-enhanced teaching strategies that support student success

VII. Limitations

While this study offers valuable insights, it is essential to acknowledge its limitations. The sample size, although substantial, might not be entirely representative of the entire student population at the ENS of Fez, potentially limiting the generalizability of the findings. Additionally, the questionnaire design, while effective in capturing general perceptions, could be further refined to delve deeper into specific aspects of AI integration, such as students' preferences for AI-powered tools, their concerns about potential biases in AI algorithms, and their experiences with using AI in their studies. Furthermore, the study primarily focused on student perceptions, and future research could explore the actual impact of AI tools on student learning outcomes, engagement, motivation, and overall satisfaction with the learning experience.

Moreover, the study was conducted at a single institution, the ENS of Fez, which may limit the applicability of the findings to other educational contexts. Additionally, the study focused on ChatGPT, a specific AI tool, and future research could explore the integration of other AI tools and technologies in the teaching of physical sciences.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

O.T is the main author of this research article; O.T and M.L analyzed, interpreted the data and wrote the paper; K.E.K is the Supervisor of this research article; F.O and A.C participated in this article. All authors had approved the final version.

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