Journal of Applied Research in Science and Humanities

Artificial intelligence technology as a method to simplify physics learning

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Abstract

We faced a problem while teaching activities and experiments in physics due to a lack of imagination and a good understanding of physical phenomena. Therefore, we used artificial intelligence (AI), especially simulation experiments, to solve this problem. This study examined the determinants of adopting AI for teaching physics. It aimed to explore the basic concepts of AI, its various applications in learning physics, and the benefits and challenges associated with its implementation. The selected studies were analyzed and synthesized to develop a coherent framework for understanding the different ways of using AI in teaching physics. Questionnaires were used to determine the extent of students' satisfaction with the use of AI by answering several questions after this technology was used through simulation to facilitate and simplify the explanation of physics. The collected data were analyzed using numbers of frequencies and percentages. The results showed that there was a strong demand and satisfaction with the use of this technology in explaining the physics lessons. The obtained results showed that the AI had great potential in the world of education, one of which was in learning physics. AI could also help improve students' understanding and comprehension skills, with 42% strongly agreeing and 30% agreeing, making the overall approval percentage 72%. In this study, the percentage between neutral and disagreeing was 28%.

Key Words:

AI, Simulations, Education, physics experiments

1. Introduction:

In the ever-evolving landscape of education, where the quest for knowledge and skills remains paramount, certain disciplines stand out as pivotal pillars upon which the edifice of progress is constructed. Among these, physics occupies a central position, serving as the cornerstone of scientific inquiry and technological innovation. Yet, despite its foundational importance, the effective transmission of physics knowledge presents a perennial challenge, exacerbated by the diverse learning needs and limited resources inherent in modern educational settings. In recent years, however, the rapid advancement of artificial intelligence (AI) has emerged as a transformative force, offering novel solutions to age-old pedagogical dilemmas, and revolutionizing the way physics is taught and learned (Baidoo-Anu, D., & Owusu Ansah, L., 2023, 52–62). In addition, the ascent of AI has been nothing short of extraordinary, heralding a new era of innovation and disruption across virtually every sector of society. From intelligent algorithms to sophisticated computing systems, AI has permeated diverse domains, promising to reshape industries, economies, and human experiences in unprecedented ways. Within the realm of education, AI has emerged as a catalyst for change, challenging traditional paradigms and unlocking new possibilities for personalized, adaptive, and data-driven learning experiences.

This study embarks on a comprehensive exploration of the potential of AI in physics education, endeavouring to illuminate the myriad ways in which AI can augment teaching practices, enhance student learning outcomes, and propel educational institutions toward greater efficiency and effectiveness. For instance, physics, as the study of energy and its interaction with matter, stands as a cornerstone of scientific inquiry, providing insights into the fundamental principles that govern the universe. Its applications permeate virtually every aspect of modern life, from the development of cutting-edge technologies to our understanding of natural phenomena. However, despite its critical importance, physics education often faces significant challenges, ranging from student perceptions of abstractness to outdated pedagogical methods (Tschisgale, P., Wulff, P., & Kubsch, M., 2023).

In recent years, the emergence of AI has sparked a revolution in education, offering transformative opportunities to enhance teaching and learning processes. AI, with its ability to mimic human intelligence and perform tasks autonomously, holds immense promise for revolutionizing physics education. By leveraging AI-powered tools and platforms, educators can create dynamic and interactive learning environments that cater to diverse learning styles, promote deeper conceptual understanding, and foster a lifelong passion for physics (Ukoh, E. E., & Nicholas, J., 2022, 2121–2131). AI has emerged as a disruptive force across various industries, including education. In recent years, its application in physics education has garnered significant attention, offering new avenues to enhance teaching methodologies, personalize instruction, and improve learning outcomes. AI encompasses a diverse array of techniques and technologies designed to simulate human intelligence, analyze data, and make informed decisions. Within the educational context, AI has demonstrated remarkable potential in adapting to individual learner needs, facilitating interactive learning experiences, and optimizing educational processes. The integration of AI into physics education represents a paradigm shift, challenging traditional pedagogical approaches and providing educators with powerful tools to engage students and deepen conceptual understanding. Physics, as a fundamental science, plays a crucial role in fostering critical thinking skills, problem-solving abilities, and scientific literacy among students. However, conventional teaching methods often struggle to capture the complexities of physics phenomena and cater to diverse learning styles. By leveraging AI technologies, educators can create dynamic learning environments that promote inquiry-based learning, collaborative problem-solving, and active engagement with course material (Mahligawati, F., Allanas, E., Butarbutar, M. H., & Nordin, N. A., 2023, 2596). So, in the vast landscape of physics education research (PER), qualitative research methods have emerged as indispensable tools for delving into the intricacies of teaching and learning physics. Through the lens of qualitative inquiry, researchers have been able to unravel complex phenomena such as students' misconceptions, teachers' epistemic cognition, and the nuanced dynamics of problem-solving processes. These qualitative investigations, characterized by their rich descriptions and deep insights, lay the foundation for the development of substantive theories that inform and shape educational practices. Moreover, qualitative research serves as a springboard for subsequent quantitative analyses, facilitating the creation of concept inventories and assessment instruments that measure learning outcomes with precision. At the heart of qualitative research in PER lies the meticulous analysis of non-numerical data, ranging from textual transcripts to video recordings. Across various qualitative approaches, whether grounded theory or phenomenology, researchers embark on the dual tasks of identifying patterns within the data and interpreting their significance within the broader context of physics education. Yet, despite the invaluable contributions of qualitative methods, they are not without their challenges. Traditional qualitative methodologies, such as grounded theory, often rely heavily on the subjective judgments of human analysts, leading to concerns regarding validation, reproducibility, and scalability. Furthermore, the labor-intensive nature of qualitative analysis poses significant limitations when applied to large-scale datasets, such as those generated by online learning platforms (Tschisgale, P., Wulff, P., & Kubsch, M., 2023). In addition, at the heart of AI's transformative potential lies its capacity to provide personalized and adaptive learning experiences tailored to the unique needs and preferences of individual learners. By harnessing the power of intelligent algorithms and data analytics, AI systems possess the ability to decipher complex patterns in student learning behavior, thereby customizing educational content, pedagogical strategies, and assessment methodologies to align with diverse aptitudes and learning styles. Such personalized learning pathways hold the promise of fostering deeper conceptual understanding, cultivating intrinsic motivation, and nurturing a lifelong passion for learning among students of all backgrounds and abilities. Furthermore, the advent of supercomputers represents a quantum leap in the capabilities of AI, endowing machines with cognitive faculties akin to those of human beings. These computational behemoths boast immense processing power, adaptive functionalities, and sensory capabilities, facilitating enhanced human-computer interactions and enabling a wide array of applications in education. Beyond the realm of supercomputing, AI finds expression in intelligent buildings, robotic companions, and embedded computing devices, permeating everyday experiences with its transformative potential. In the context of physics education, the integration of AI holds immense promise, offering a plethora of opportunities to augment traditional pedagogical approaches and enrich student learning experiences in unprecedented ways (Baidoo-Anu, D., & Owusu Ansah, L., 2023, 52–62). Additionally, artificial intelligence encompasses a diverse range of methodologies, including machine learning, natural language processing, expert systems, and intelligent tutoring systems. These technologies enable AI-powered platforms to adapt to individual student needs, provide personalized feedback, and facilitate real-time interaction with course content. Moreover, AI-driven educational tools offer innovative solutions to longstanding challenges in physics education, such as the abstract nature of concepts, the limited availability of hands-on experiments, and the need for personalized instruction. In recent years, research studies and practical implementations have provided valuable insights into the potential benefits and challenges of integrating AI into physics education. Case studies have explored the effectiveness of AI-driven tutoring systems, virtual laboratories, and simulation-based learning environments in enhancing student engagement and improving learning outcomes. Additionally, theoretical frameworks have been developed to guide the design and implementation of AI-powered educational interventions, emphasizing the importance of pedagogical alignment, usability, and scalability material (Mahligawati, F., Allanas, E., Butarbutar, M. H., & Nordin, N. A., 2023, 2596). In addition to personalization, AI holds the promise of providing instantaneous and precise feedback to students, thereby facilitating timely interventions and promoting iterative learning cycles. By leveraging real-time data analytics and machine learning algorithms, AI systems can detect misconceptions, pinpoint areas of difficulty, and offer targeted remediation, empowering students to address their learning gaps proactively and constructively. Furthermore, AI's data analysis capabilities extend beyond individual student performance to encompass broader pedagogical insights, enabling educators to refine instructional strategies, optimize curriculum design, and tailor learning resources to meet the evolving needs of learners. However, the integration of AI in education, particularly in the domain of physics learning, is not without its challenges and considerations. From infrastructural constraints to ethical dilemmas, the deployment of AI necessitates careful deliberation and meticulous planning. Issues such as access to technological infrastructure, teacher training, data privacy, and algorithmic bias underscore the complexities inherent in AI adoption and underscore the imperative for comprehensive frameworks to govern its ethical and equitable implementation. Nevertheless, with prudent foresight and rigorous research, the potential benefits of AI in physics education far outweigh its challenges, offering a transformative pathway toward more inclusive, adaptive, and effective learning environments. Against this backdrop, this essay embarks on a multidimensional exploration of the potential of AI in physics education, encompassing theoretical insights, empirical evidence, and real-world case studies (Nachman, B., & Shimmin, C., 2019.

By unravelling the intricacies of AI's transformative potential, this study seeks to inform educational policymakers, practitioners, and stakeholders about the opportunities and challenges presented by AI in reshaping the future of physics education. Through a holistic examination of AI's capabilities and limitations, this essay endeavors to catalyze informed discourse, spur innovative practices, and chart a course toward a more equitable, accessible, and empowering educational landscape shaped by the transformative potential of artificial intelligence. Through a multidimensional exploration, this paper argues that the integration of artificial intelligence (AI) in physics education offers transformative opportunities to enhance teaching practices, personalize learning experiences, and address longstanding challenges in pedagogy. By analyzing theoretical insights, empirical evidence, and real-world case studies, this research contends that AI holds the potential to revolutionize physics education by fostering inclusive, adaptive, and effective learning environments, while also highlighting the complexities and considerations inherent in its implementation.

2. The Theoretical Framework:

The theoretical framework guiding this study is based on several key concepts and theories from the fields of physics education, artificial intelligence, and educational technology.

Firstly, the Constructivist Learning Theory emphasizes the importance of active engagement and hands-on experiences in the learning process. According to this theory, learners construct their own understanding of the world through interaction with their environment and the integration of new information with existing knowledge. In the context of physics education, constructivist approaches emphasize the use of inquiry-based learning, problem-solving activities, and practical experiments to promote deeper understanding and conceptual mastery.

Secondly, the Technological Pedagogical Content Knowledge (TPACK) framework provides a theoretical lens for understanding the complex interplay between technology, pedagogy, and content knowledge in educational settings. TPACK emphasizes the importance of integrating technology into teaching practices in ways that enhance student learning and engagement. In the context of physics education, TPACK can inform the design and implementation of AI-powered instructional strategies and tools that align with the specific needs and goals of students and teachers.

Finally, the Diffusion of Innovation Theory offers insights into the process by which new technologies are adopted and implemented in educational settings. According to this theory, the adoption of innovations follows a predictable pattern, beginning with awareness and interest, followed by experimentation and evaluation, and ultimately leading to adoption (Ukoh, E. E., & Nicholas, J., 2022, 2121–2131).

3.Methods of Research and the tools used:

The students were greatly impacted by the work we began using websites and simulations (**illustrated in Figs. 1–6**), as well as the readily available experiments. We used to let the students use the activities themselves and give feedback beforehand, and some of the available sites were easy when we did the experiments with our own hands.

The learners also benefited greatly from this method of teaching. We do not explain, and they claim to have observed what happened. Because the strategy was new and different, it was amazing simple and kept the pupils' attention on us. Because the students were actively involved in the process, it attracted their interest, simplified the subject matter and the overall experience, and made it simpler to recall and wrap up the experiments. Additionally, questionnaires were used to determine the extent of students' satisfaction with the use of AI by answering several questions after this technology was used through simulation to facilitate and simplify the explanation of physics. The collected data were analyzed using numbers of frequencies and percentages.

We looked at other websites, such as **Pet**, **Physics Classroom**, **and Physics Lens**. The experiments we worked on and showed to the students will be reviewed. In this section, we demonstrate some lessons on simulation sites and show methods and tools used in this study (**each experiment is followed by the corresponding link and barcode to the simulation**).

1. **Ohms-law**

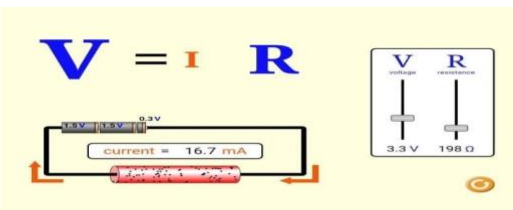

Figure (1): **Explanation of Ohm's Law, which states that the intensity of the electric current and the electric potential difference are directly proportional when the temperature is constant**.

https://phet.colorado.edu/en/simulations/ohms-law

2. **Circular-and-Satellite-Motion**

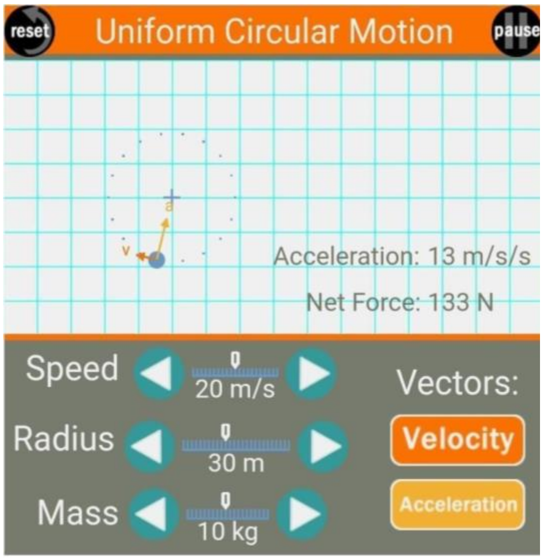

Figure (2): **Analyze circular motion and record the centripetal force, the direction of the velocity, and the centripetal acceleration**.

https://www.physicsclassroom.com/Physics-Interactives/Circularand-Satellite-Motion/Uniform-Circular-Motion/UniformCircularMotionInteractive

3. Wave–interference

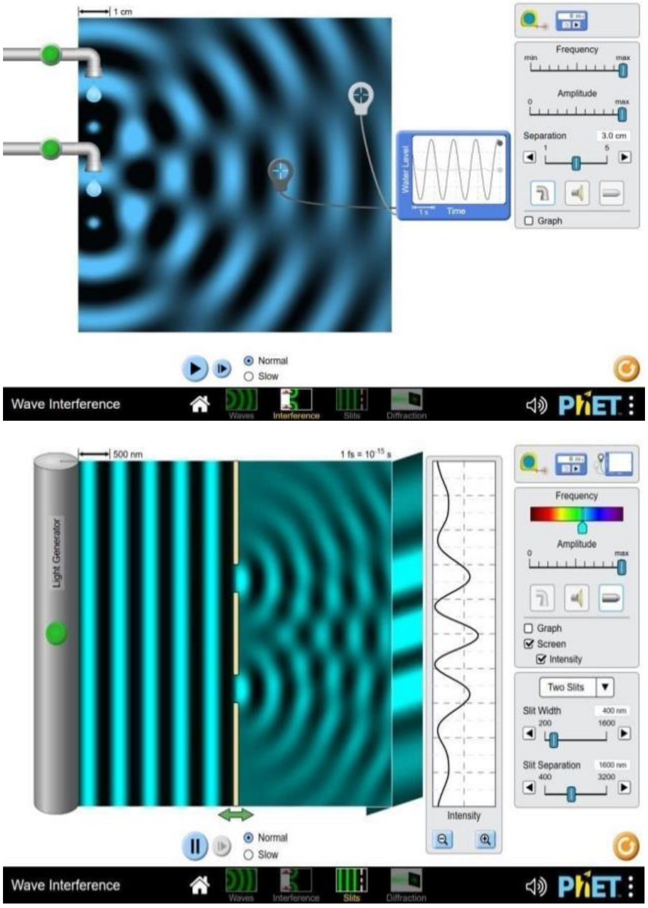

Figure (3): Explaining interference and the difference between destructive interference and constructive interference.

https://phet.colorado.edu/ar_SA/simulations/wave-interference

4. Density

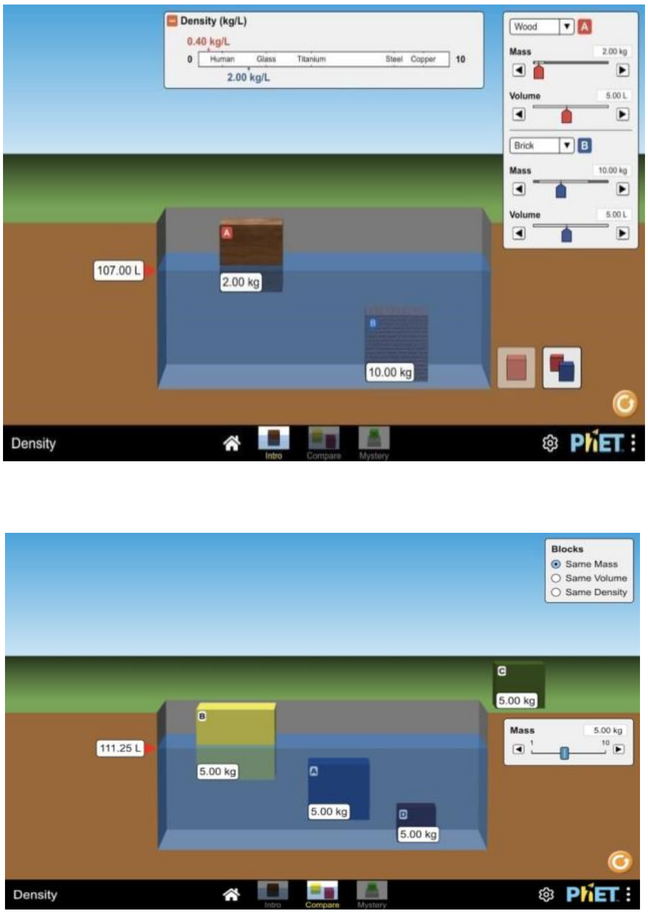

Figure (4): Explaining the concept of density, the difference in density of materials, and the factors affecting density.

https://phet.colorado.edu/en/simulations/density

5. <u>States of matter</u>

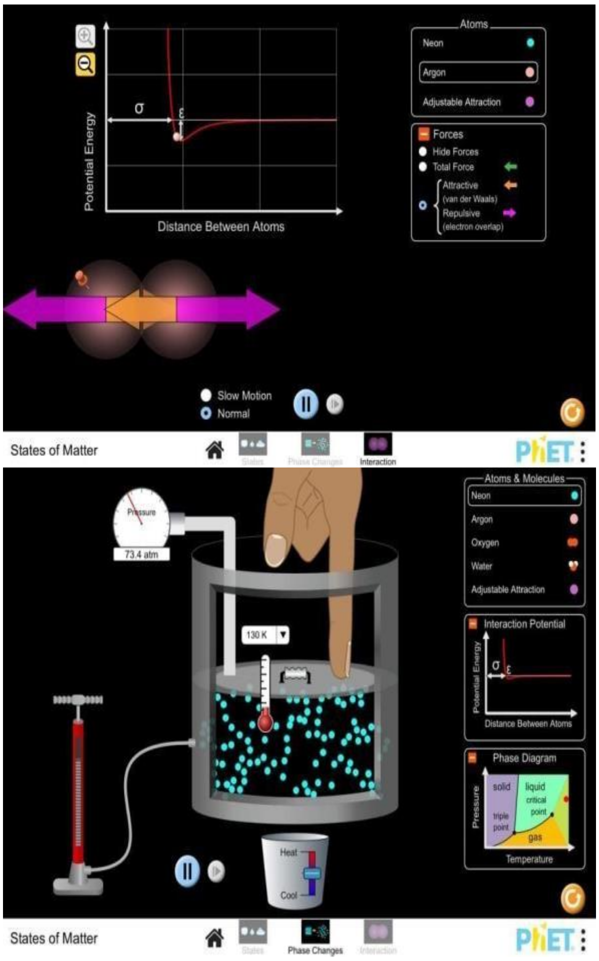

Figure (5): Explaining the states of matter, the factors affecting them, and how to transform from one state to another.

https://phet.colorado.edu/sims/html/states–of–matter/latest/states– Ofmatter_all.html

6. <u>Projectile</u>:

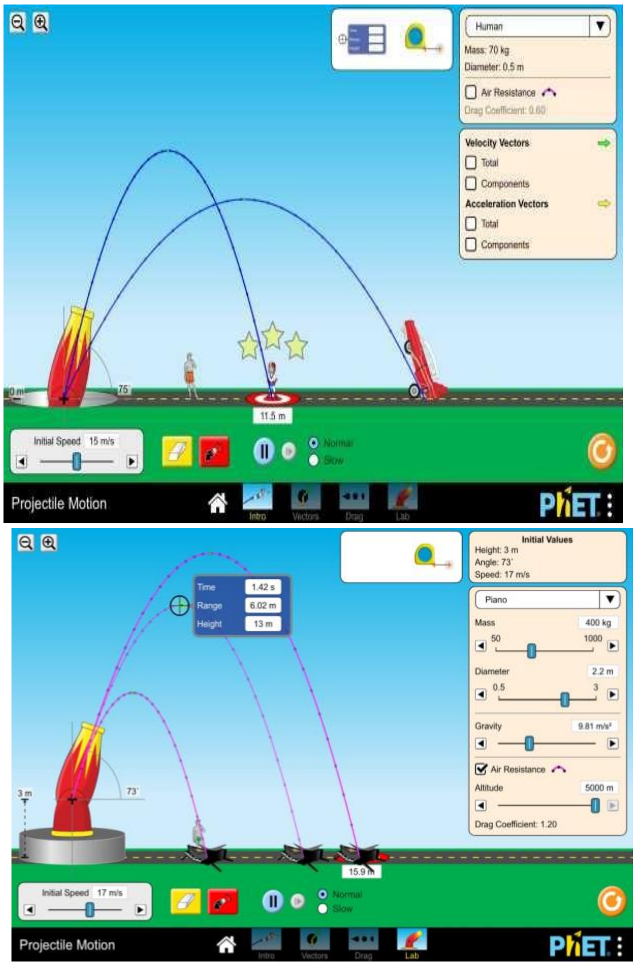

Figure (6): Explain the difference between horizontal projectiles and angled projectiles and the difference between them.

https://phet.colorado.edu/sims/html/projectilemotion/latest/proj ectile–motion_all.html

Through surveys conducted, we found that 72% of the students strongly agree or agree with the effectiveness of using simulations in their learning experience. This indicates a high level of satisfaction and suggests that the use of AI has a significant impact on their understanding and comprehension skills. Only 28% expressed a neutral and disagreeing stance, indicating that the majority of students recognize the value and benefits of this approach.

Following are the results of questionnaires for different stages and experiments.

4. Results of Research

In our project, where we integrate artificial intelligence (AI) with simulation to enhance student experiments, the response from the students has been overwhelmingly positive.

1– Ohm's Law:

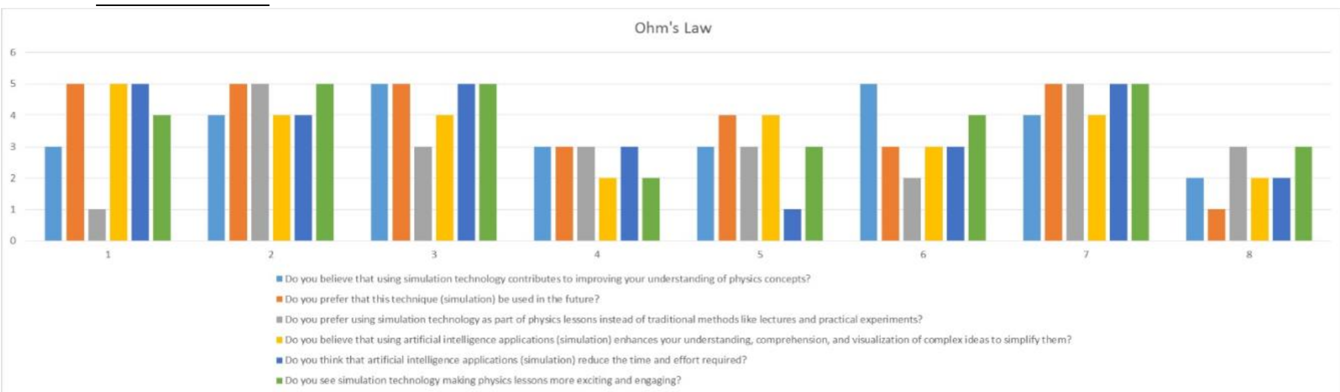

Figure (7): Student results on the experiment of investigating Ohm's law.

Table (1): Students' responses for simulating Ohm's Law experiment.

Number of students strongly disagreeing	**Number of students disagreeing**	**Number of neutral students**	**Number of students agreeing**	**Number of students strongly agreeing**	**Questions**
0	1	3	2	2	**Do you believe that using simulation technology contributes to improving your understanding of physics concepts?**
1	0	2	1	4	**Do you prefer that this technique (simulation) be used in the future?**
1	1	4	0	2	**Do you prefer using simulation**

					technology as part of physics lessons instead of traditional methods like lectures and practical experiments?
0	2	1	4	1	**Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?**
1	1	2	1	3	**Do you think that artificial intelligence applications (simulation) reduce the time and effort required?**
0	1	2	2	3	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (2): Percentage of students' responses for simulating Ohm's Law experiment

	General response to questions	**The percentage of strongly disagreeing students**	**The percentage of disagreeing students**	**The percentage of neutral students**	**The percentage of agree students**	**The percentage of strongly agree students**
Neutral	37.5	–	12.50	37.5	25	25
strongly agree	50	12.50	–	25.00	50	50
Neutral	50	12.50	12.50	50.00	0	25
agree	50	–	25.00	12.50	50	12.5
strongly agree	37.5	12.50	12.50	25.00	12.5	37.5
strongly agree	37.5	–	12.50	25.00	25	37.5

Table (3): Final results of the questionnaire.

The number of questions strongly agreed upon by the students	**3**
The number of questions agreed upon by the students	**1**
The number of neutral questions.	**2**

2– Circular Motion

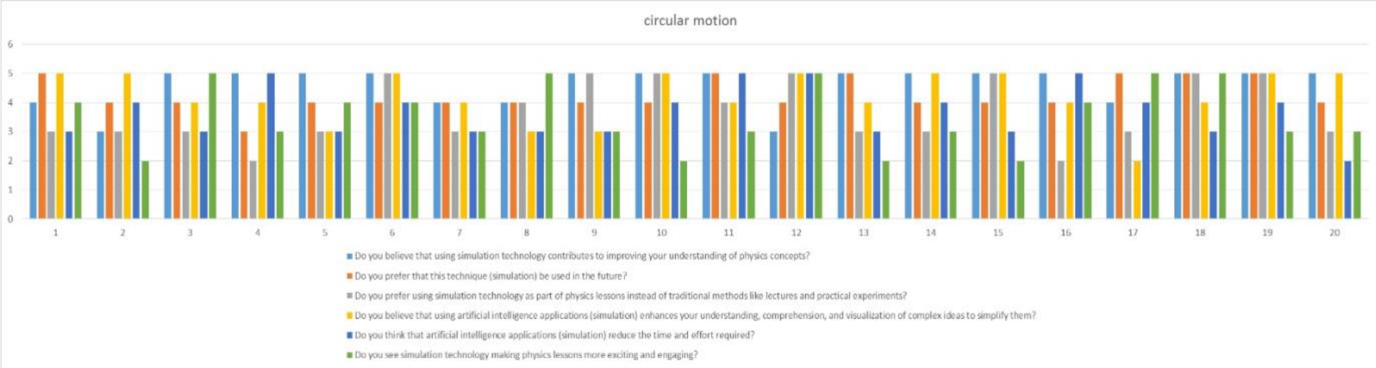

Figure (8): Student results on the experiment of circular motion experiment (part one).

Table (4): Students' responses for simulating circular motion experiment (part one).

Number of students strongly disagreeing	Number of students disagreeing	Number of neutral students	Number of students agreeing	Number of students strongly agreeing	Questions
0	0	2	4	14	Do you believe that using simulation technology contributes to improving your understanding of physics concepts?
0	0	1	13	6	Do you prefer that this technique (simulation) be used in the future?
0	2	9	2	7	Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?
0	1	3	7	9	Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?
0	1	9	6	4	Do you think that artificial intelligence applications (simulation) reduce the time and

					effort required?
0	4	7	4	5	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (5): Percentage of students' responses for simulating circular motion experiment (part one).

	General response to questions	The percentage of strongly disagreeing students	The percentage of disagreeing students	The percentage of neutral students	The percentage of agree students	The percentage of strongly agree students
strongly agree	70	0	0	10	20	70
Agree	65	0	0	5	65	30
Neutral	45	0	10	45	10	35
strongly agree	45	0	5	15	35	45
Neutral	45	0	5	45	30	20
Neutral	35	0	20	35	20	25

Table (6): Final results of the questionnaire.

The number of questions strongly agreed upon by the students	**2**
The number of questions agreed upon by the students	**1**
The number of neutral questions.	**3**

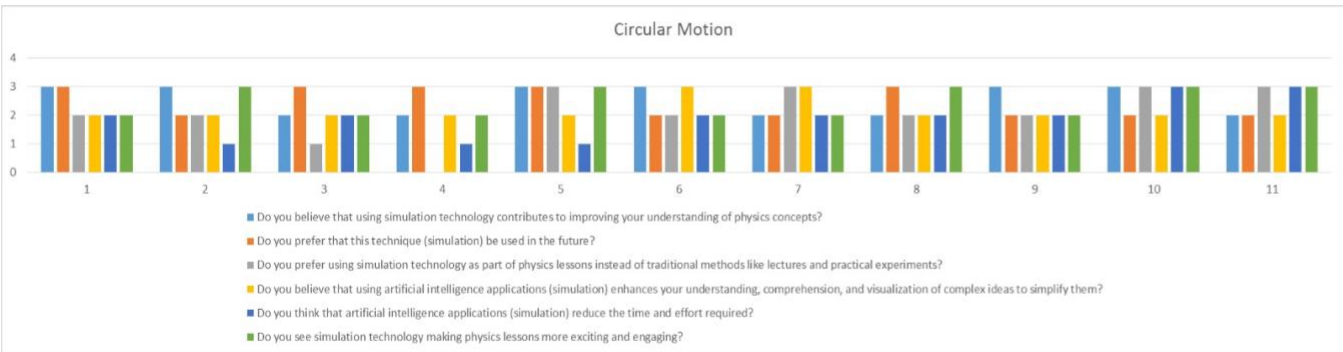

Figure (9): Student results on the experiment of circular motion experiment (part two).

Table (7): Students' responses for simulating Circular Motion experiment (part two).

The number of disagreeing students	The number of agreeing students	The number of students strongly agree	Questions
0	5	6	Do you believe that using simulation technology contributes to improving your understanding of physics concepts?
0	6	5	Do you prefer that this technique (simulation) be used in the future?
1	5	4	Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?
0	9	2	Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?
3	6	2	Do you think that artificial intelligence applications (simulation) reduce the time and effort required?
0	6	5	Do you see simulation technology making physics lessons more exciting and engaging?

Table (8): Percentage of students' responses for simulating Circular Motion experiment (part two).

	General response to questions	The percentage of disagreeing students	The percentage of agree students	The percentage of strongly agree students
strongly agree	54.54	0	45.45	54.54
agree	54.54	0	54.5	45.45
agree	45.45	9.09	45.45	36.36
agree	81.81	0	81.81	18.18
agree	54.54	27.27	54.54	18.18
agree	54.54	0	54.54	45.45

Table (9): **Final result of questionnaire**.

The number of questions strongly agreed upon by the students	**1**
The number of questions agreed upon by the students	**5**
The number of questions disagreed upon by the students	**2**

3– Interference

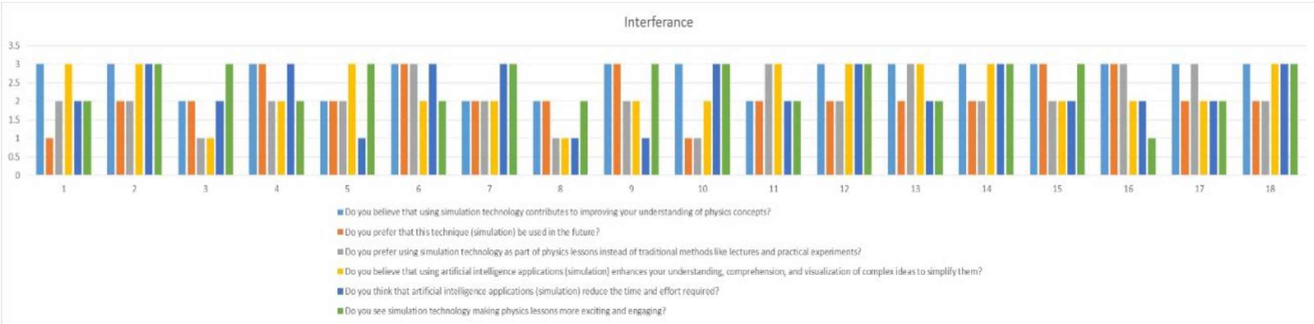

Figure (10): Student results on the experiment of interference experiment.

Table (10): Students' responses for simulating interference experiment.

The number of disagreeing students	The number of agreeing students	The number of students strongly agree	Questions
0	5	13	**Do you believe that using simulation technology contributes to improving your understanding of physics concepts?**
2	11	5	**Do you prefer that this technique (simulation) be used in the future?**
3	10	5	**Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?**
2	8	8	**Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?**
3	7	8	**Do you think that artificial intelligence applications (simulation) reduce the time and effort required?**
1	7	10	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (11): Percentage of students' responses for simulating interference experiment.

	General response to questions	**The percentage of disagreeing students**	**The percentage of agree students**	**The percentage of strongly agree students**
strongly agree	72.22	0	27.78	72.22
agree	61.11	11.11	61.11	27.78
agree	55.56	16.67	55.56	27.78
strongly agree	44.44	11.11	44.44	44.44
strongly agree	44.44	16.67	38.89	44.44
strongly agree	55.56	5.56	38.89	55.56

Table (12): Final result of questionnaire.

The number of questions strongly agreed upon by the students	**4**
The number of questions agreed upon by the students	**2**
The number of questions disagreed upon by the students	**0**

4– Density:

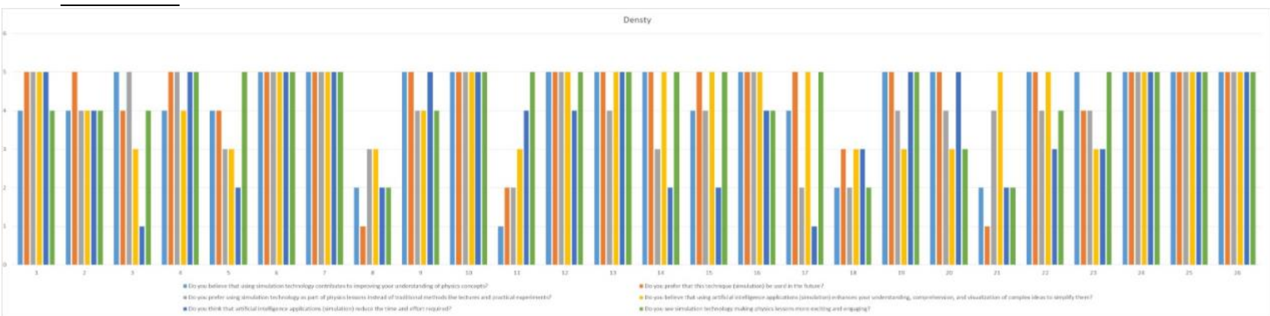

Figure (11): Student results on the experiment of density experiment.

Table (13): Students' responses for simulating density experiment.

The number of strongly disagreeing students	**The number of disagreeing students**	**The number of neutral students**	**The number of agreeing students**	**The number of students strongly agree**	**Questions**
1	3	0	6	16	**Do you believe that using simulation technology contributes to improving your understanding of physics**

					concepts?
2	1	1	3	19	**Do you prefer that this technique (simulation) be used in the future?**
0	3	3	9	11	**Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?**
0	0	8	3	15	**Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?**
2	5	3	4	12	**Do you think that artificial intelligence applications (simulation) reduce the time and effort required?**
0	3	1	6	16	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (14): Percentage of students' responses for simulating density experiment.

	General response to questions	**The percentage of strongly disagreeing students**	**The percentage of disagreeing students**	**The percentage of neutral students**	**The percentage of agree students**	**The percentage of strongly agree students**
strongly agree	61.53	3.85	11.54	0	23.07	61.53
strongly agree	73.07	7.69	3.85	3.84	11.53	73.07
strongly agree	42.30	–	11.54	11.53	34.61	42.30
strongly agree	57.69	–	–	30.76	11.53	57.69
strongly agree	46.15	7.69	19.23	11.53	15.38	46.15
strongly agree	61.53	–	11.54	3.846	23.07	61.53

Table1 (15): Final result of questionnaire.

The number of questions strongly agreed upon by the students	6
The number of questions agreed upon by the students	0
The number of neutral questions.	0

5– State of matter:

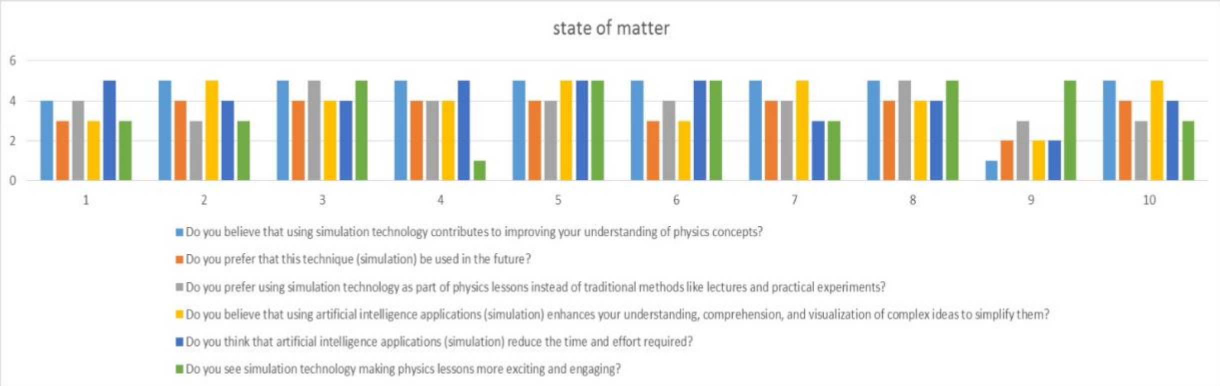

Figure (12): Student results on the experiment of state of matter experiment (part one).

Table (16): Students' responses for simulating state of matter experiment (part one).

The number of strongly disagreeing students	The number of disagreeing students	The number of neutral students	The number of agreeing students	The number of students strongly agree	Questions
1	0	0	1	8	Do you believe that using simulation technology contributes to improving your understanding of physics concepts?
0	1	2	7	0	Do you prefer that this technique (simulation) be used in the future?
0	0	3	5	2	Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?
0	1	2	3	4	Do you believe that using

					artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?
0	1	1	4	4	**Do you think that artificial intelligence applications (simulation) reduce the time and effort required?**
1	0	4	0	5	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (17): Percentage of students' responses for simulating state of matter experiment (part one).

	General response to questions	**The percentage of strongly disagreeing students**	**The percentage of disagreeing students**	**The percentage of neutral students**	**The percentage of agree students**	**The percentage of strongly agree students**
strongly agree	80	10	0	0	10	80
agree	70	0	10	20	70	0
agree	50	0	0	30	50	20
strongly agree	40	0	10	20	30	40
strongly agree	40	0	10	10	40	40
strongly agree	50	10	0	40	0	50

Table (18): Final result of questionnaire (part one).

The number of questions strongly agreed upon by the students	**4**
The number of questions agreed upon by the students	**2**
The number of neutral questions.	**0**

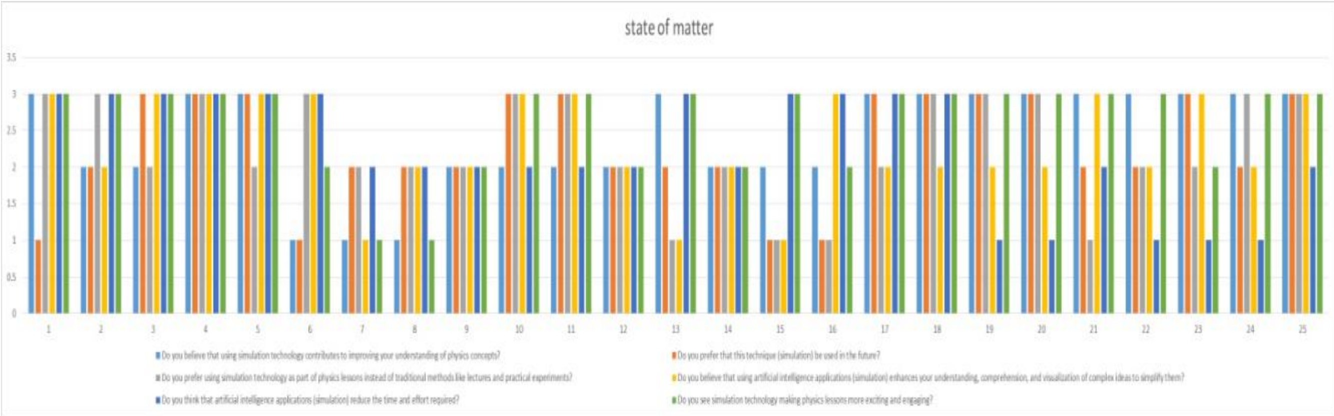

Figure (13): Student results on the experiment of state of matter experiment (part two).

Table (19): Students' responses for simulating state of matter experiment (part two).

The number of disagreeing students	The number of agreeing students	The number of students strongly agree	Questions
3	9	13	**Do you believe that using simulation technology contributes to improving your understanding of physics concepts?**
4	10	11	**Do you prefer that this technique (simulation) be used in the future?**
4	10	11	**Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?**
3	11	11	**Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?**
5	9	11	**Do you think that artificial intelligence applications (simulation) reduce the time and effort required?**
2	6	17	**Do you see simulation technology making physics lessons more exciting and engaging?**

Table (20): Percentage of students' responses for simulating state of matter experiment (part two).

	General response to questions	The percentage of disagreeing	The percentage of agree students	The percentage of strongly agree

		students		students
strongly agree	52	12	36	52
strongly agree	44	16	40	44
strongly agree	44	16	40	44
strongly agree	44	12	44	44
strongly agree	44	20	36	44
strongly agree	68	8	24	68

Table (21): Final result of questionnaire.

The number of questions strongly agreed upon by the students	**6**
The number of questions agreed upon by the students	**0**
The number of questions disagreed upon by the students	**0**

6– Projectile:

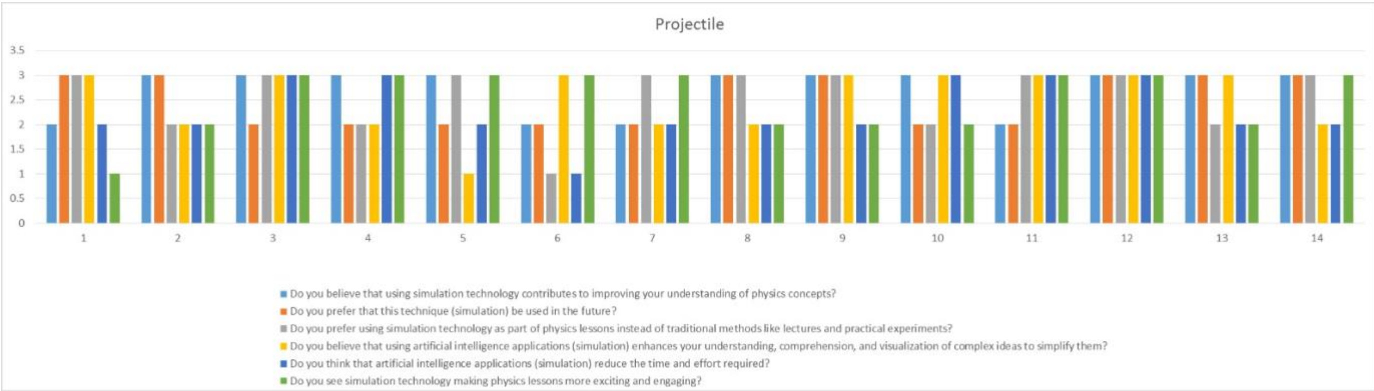

Figure (14): Student results on the experiment of projectile experiment (part one).

Table (22): Students' responses for simulating projectile experiment (part one).

The number of disagreeing students	**The number of agreeing students**	**The number of students strongly agree**	**Questions**
0	4	10	**Do you believe that using simulation technology contributes to improving your understanding of physics concepts?**
0	7	7	**Do you prefer that this technique (simulation) be used in the future?**
1	4	9	**Do you prefer using simulation technology as part of**

			physics lessons instead of traditional methods like lectures and practical experiments?
1	5	8	Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?
1	8	5	Do you think that artificial intelligence applications (simulation) reduce the time and effort required?
1	5	8	Do you see simulation technology making physics lessons more exciting and engaging?

Table (23): Percentage of students' responses for simulating projectile experiment (part one).

	General response to questions	**The percentage of disagreeing students**	**The percentage of agree students**	**The percentage of strongly agree students**
strongly agree	71.42	0	28.57	71.42
strongly agree	50	0	50	50
strongly agree	64.28	7.14	28.57	64.28
strongly agree	57.14	7.14	35.71	57.14
agree	57.14	7.14	57.14	35.71
strongly agree	57.14	7.14	35.71	57.14

Table (24): Final result of questionnaire (part one).

The number of questions strongly agreed upon by the students	**5**
The number of questions agreed upon by the students	**1**
The number of questions disagreed upon by the students	**0**

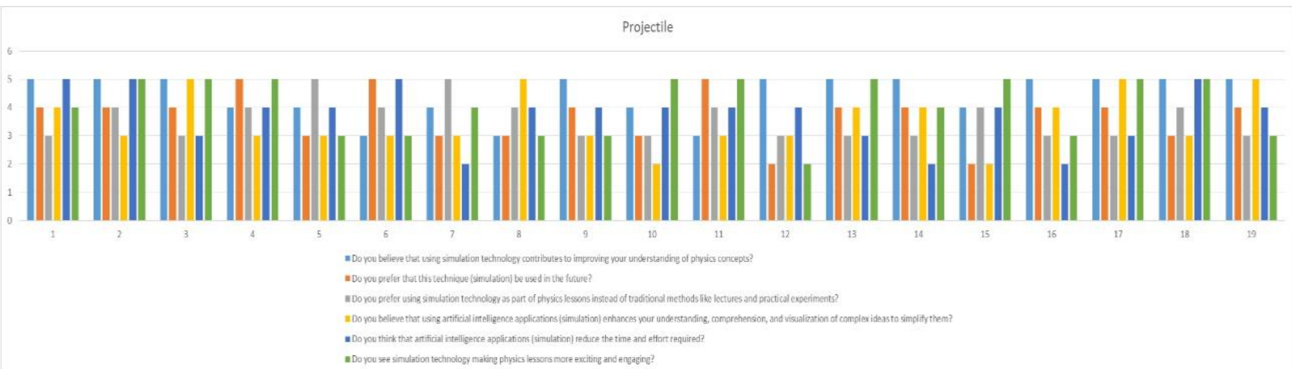

Figure (15): Student results on the experiment of projectile experiment (part two).

Table (25): Students' responses for simulating projectile experiment (part two).

The number of strongly disagreeing students	The number of disagreeing students	The number of neutral students	The number of agreeing students	The number of students strongly agree	Questions
0	0	3	5	11	Do you believe that using simulation technology contributes to improving your understanding of physics concepts?
0	2	5	9	3	Do you prefer that this technique (simulation) be used in the future?
0	0	10	7	2	Do you prefer using simulation technology as part of physics lessons instead of traditional methods like lectures and practical experiments?
0	2	9	4	4	Do you believe that using artificial intelligence applications (simulation) enhances your understanding, comprehension, and visualization of complex ideas to simplify them?
0	3	3	9	4	Do you think that artificial intelligence applications (simulation) reduce the time and effort required?
0	1	6	3	9	Do you see simulation technology making physics lessons more exciting and engaging?

Table (26): Percentage of students' responses for simulating projectile experiment (part two).

	General response to questions	The percentage of strongly disagreeing students	The percentage of disagreeing students	The percentage of neutral students	The percentage of agree students	The percentage of strongly agree students
strongly agree	57.89	–	–	15.78	26.31	57.89
agree	47.36	–	10.53	26.31	47.36	15.78
Neutral	52.63	–	–	52.63	36.84	10.52
agree	47.36	–	10.53	47.36	21.05	21.05
agree	47.36	–	15.79	15.78	47.36	21.05
strongly agree	47.36	–	5.26	31.57	15.78	47.36

Table (27): Final result of questionnaire.

The number of questions strongly agreed upon by the students	**2**
The number of questions agreed upon by the students	**3**
The number of neutral questions.	**1**

5. Interpretation of Results

5.1. Ohm's Law

The traditional method of teaching the concept of Ohm's Law and the relationship between potential difference and current intensity relied solely on mentioning the relationship, which diminished the students' comprehension of voltage and current as well as their understanding that resistance is a component of a wire or device. However, this is not the case when the experiment is presented through simulation. As shown in **Fig**. (**1**), a significant portion of students found it admirable. **Table** (**2**) listed the percentage of students who strongly agreed, the percentage of students who were neutral, and the percentage of students who rejected. These data demonstrate that students found the tool to be satisfactory and approved of its ability to support the learning process.

5.2. Circular Motion

When explaining circular motion using traditional methods, students often face difficulties in visualizing the changes in direction and speed of the object as it moves from one place to another. This contrasts with using simulation systems, where these problems are effectively addressed, as shown in **Fig**. (**2**). We conducted a survey among students to measure their satisfaction with this experience, and it was well-received by the students. The percentage of students who agreed with the experiment was high. **Tables** (**5–9**) showing the percentage of students who strongly agree, agree, and disagree. Upon examining this table, we find that the percentage of students who strongly agree and agree is the majority, indicating the students' approval of and satisfaction with this experiment, and its success.

5.3. Interference

When explaining light interference using traditional methods, especially with the use of a wave generator, we encounter significant difficulties in visualizing the interference of waves, leading to a high level of confusion among students. Additionally, presenting the variables of this experiment becomes challenging.

On the other hand, using simulation systems made it much easier to demonstrate how waves interfere with each other and display the results clearly without overwhelming the students with complex interferences, as often happens with traditional methods. Moreover, presenting different variations in this experiment, such as changing the wavelength or slit distance, becomes very flexible using simulation programs. This flexibility allows us to use more variables, leading to a deeper understanding of the relationship, which is what simulation methods offer in explaining the experiment, as demonstrated in **Fig**. (**3**).

Afterwards we conducted a survey among students to gauge their acceptance and appreciation of this method and the new technology. This is reflected in **Tables** (**10–12**), where the percentage of strongly agree and agree responses was very high compared to disagree responses, indicating the students' approval of and the tangible success of this experiment.

5.4. Density

In the traditional way of explaining density, we were having difficulty getting students to imagine how the density of materials differs in which materials float and which sink in water. It was also difficult for students to understand the concept of density and when using the simulation technique in this experiment, as shown in **Fig**. (**4**).

Explanation the concept of density, the difference in the density of materials, and the factors affecting density, where the students had a greater understanding, as they were able to see several different types of materials and their different densities, which ones sink and which float on the surface of the water, and they were able to identify and understand the reason for this, as the theoretical scope was transformed To a practical scope, it makes learning more exciting. As summarized in **Tables** (**13&14**), the percentage of strongly agree and agree was very large, and their percentage was much higher than the percentage of agree and neutral. This indicates that they understood density and its concepts smoothly and more usefully than before. In the traditional way of explaining density.

5.5. State of Matter:

We have faced great difficulty with students imagining, i.e., how one substance becomes another substance or the difference in the distribution of molecules for each of the special cases and how they want the temperature, but when using visual techniques such as shown in **Fig**. (**5**), explaining the cases and the factors affecting them and how to switch to another. The students also became more understanding of the experiment, as the theoretical scope turned into a practical scope, and their understanding of the experiment, the concept, and the factors influencing it increased, as stated in **Tables** (**16&17**). It showed that the percentage of agreement and approval was very large, and it reached much higher than appreciation and quality. This refers to understanding the states of matter, the factors affecting them, and how to transform one state into another.

5.6. Projectile

When elucidating projectiles using the traditional method, one highlights the distinctions between angular and horizontal projectiles and how they differ from one another. Additionally, emphasizes how the projectile's height and horizontal travel distances are affected by the angle at which it is fired. This isn't the case, though, when the experiment is run using a simulation, which shows how the projectiles move, allows for control over the angles, and shows the horizontal distances travelled. As shown in **Fig**. (**6**), it was well-received by a sizable portion of the student body, as seen in **Tables** (**25&26**), which display the proportion of strongly agreed, neutral, and rejected students, which indicates that it gained satisfaction.

6. Conclusion

The results of this study highlight the efficacy of AI technology in simplifying physics learning. Through the analysis of data and outcomes, it is evident that AI-powered methods can significantly enhance comprehension and retention of complex physics concepts. This suggests promising prospects for integrating AI tools into educational practices to facilitate better understanding among students.

Moving forward, it is recommended to further explore and refine AI-driven approaches in physics education. Institutions and educators should consider incorporating AI-based platforms and resources into their teaching methodologies to optimize learning outcomes. Additionally, ongoing research in this field is crucial to continually improve AI algorithms and applications tailored for physics education. By leveraging these insights, we can enhance educational practices, develop effective policies, and pave the way for future advancements in physics education through AI technology.

Acknowledgement

We extend our sincere thanks to all the individuals and institutions that helped us and facilitated our overcoming the difficulties during the preparation of this research, and that provided us with the necessary data to complete our work successfully, especially the administration of the Al-Shaheed Ibrahim Al-Rifai Official Language School under the supervision of Mr. Saad Al-Jundi, the school director, and Mrs. Asmaa Touson, the subject supervisor at the school. We extend our sincere thanks to Dr. Osama Ashraf, the general supervisor of the project, who took care of our research to follow up on the conduct of this study and provide us with sufficient information.

References and Sources

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the era of Generative Artificial Intelligence (AI): Understanding the potential benefits of CHATGPT in promoting teaching and learning. Journal of AI, 7(1), 52–62. https://doi.org/10.61969/jai.1337500

Tschisgale, P., Wulff, P., & Kubsch, M. (2023). Integrating artificial intelligence-based methods into qualitative research in physics education research: A case for computational grounded theory. Physical Review Physics Education Research. https://journals.aps.org/prper/abstract/10.1103/PhysRevPhysEducRes.19.020123

Ukoh, E. E., & Nicholas, J. (2022). AI adoption for teaching and learning of physics. International Journal for Infonomics, 15(1), 2121–2131. https://doi.org/10.20533/iji.1742.4712.2022.0222

Mahligawati, F., Allanas, E., Butarbutar, M. H., & Nordin, N. A. (2023). Artificial Intelligence in physics education: A comprehensive literature review. Journal of Physics: Conference Series, 2596 (1), 012080. https://doi.org/10.1088/1742 6596/2596/1/012080

Nachman, B., & Shimmin, C. (2019). AI safety for high energy physics. arXiv.org. https://arxiv.org/abs/1910.08606