Al-Farouk journal of sciences
Volume (2), Issue (3) (JUNE, 2026)
ISSN: 3135-2359

مجلة الفاروق للعلوم
المجلد (2) العدد 3 يونيو 2026
ردمد: 3135-2359

The effectiveness of integrating artificial intelligence in virtual laboratories on achievement and attitudes Physics students at Al-Zawiya University and the challenges of its application

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تاريخ الاستلام: 2026/04/21 تاريخ المراجعة 05/23/ 2026 تاريخ القبول:2026/06/07- تاريخ النشر: 06/30/ 2026

Abstract:
Used in this research Virtual laboratories integrated with artificial intelligenceTo determine their impact on the academic achievement of physics students at Al-Zawiya Universityand recognitionOn their trends towards integrating artificial intelligenceIn virtual laboratories and the challenges they faceand an attempt to present a number of Recommendations and suggestions for overcoming them.The results have proven the effectiveness of integrating artificial intelligence.In virtual laboratoriesIn improving the academic level and the superiority of students in their results compared to students who were taught using the traditional method., andShowedThe research results show that students have positive attitudes towards integrating artificial intelligence.In virtual laboratoriesThe students' positive attitudes were high, with a mean score of (4.32) and a percentage of (86.46%), and showedThe results also showed that the challenges they faced had an arithmetic mean of (2.54) and a percentage of (50.8%). This is a positive sign that proves that these obstacles were not a fundamental impediment to students' use and interaction with the smart laboratory experiment and their strong desire to use it in teaching physics.

Words Key: Artificial intelligence, virtual laboratories, achievement, trends, physics

Introduction :

The integration of artificial intelligence into virtual laboratories represents one of the innovations of modern technology, revolutionizing teaching methods and constituting a qualitative leap in the development of the learning process. It is of paramount importance in improving and developing the learning of physics, a constantly evolving science that permeates all aspects of life and serves as the foundation for scientific and technological advancement. Thanks to the continuous development in physics and its various branches, the pace of scientific progress accelerates, and new discoveries continue to emerge to serve humanity [(1)].The science of physics involves many complex and abstract physical concepts and the relationships between them, requiring interaction to understand them, not just passive reception. It demands the ability to imagine and visualize. Using artificial intelligence in virtual laboratories for scientific experiments transforms them from rigid simulation environments into intelligent, interactive laboratories. Adaptive[(2)] ,It allows students to conduct complex experiments, reveals physical laws and

concepts in a simplified way, and provides immediate guidance without exposure to risks in a safe and low-cost interactive environment.[(3)]It has become necessary to develop physical laboratories to keep pace with rapid technological and informational developments [(4)].

- **The problem of research:**

Through direct experience and observation in teaching physics, a shortage of equipment in actual laboratories was noted, along with low student achievement and a perception among students that physics is difficult, leading to a reluctance to study it.Traditional physics focuses on memorizing material.For studyImposedInstead of students solving the problems they face in their scientific activity and daily lives, the cognitive momentum of scientific concepts in a single subject is not employed in their daily life situations, and the time and effort spent in teaching physical concepts that require the ability to imagine and visualize is wasted.Despite the accelerating trend towards using virtual laboratories in teaching physics, many of these environments still lack adaptive customization. With the emergence of artificial intelligence technologies, an opportunity has arisen to integrate these algorithms to create smart laboratory environments that provide real-time guidance and automated assessment for students.This prompted us to conduct this study and formulate the following questions:

What is the impact of virtual laboratories integrated with artificial intelligence?pTanna'i AlyAcademic achievement of physics department students Faculty of Education, Zawiya, Zawiya University?

What are the trends?Physics Department students, Faculty of Education, Al-Zawiya University, regarding the integration of artificial intelligence into virtual laboratories and the challenges they face?

- **The purpose of the researchTh :**

The research aims to find outThe impact of integrating artificial intelligence into virtual laboratoriesIn the academic achievement of the students of the Physics Department, Faculty of Education, Al-Zawiya University, and to understand their attitudes towards it, the challenges they face, and to reach conclusions and recommendations to develop solutions to the problems mentioned.

- **The importance of researchTh :**

The importance of the research is evident in the fact that it is the first applied study on students of the Physics Department.It links artificial intelligence technology with physics education, an area that lacks sufficient field research.,It provides curriculum designers and learning platform developers with a clear view of the actual student experience.It helps universities accurately identify obstacles (such as infrastructure and network problems), thus directing technical and financial support towards solving the real problems affecting the quality of education. It has proven the feasibility of using AI-integrated laboratories to conduct experiments and obtain results, raising students' academic achievement levels and increasing their motivation to learn physics through simulation programs linked to everyday phenomena. These programs help students understand complex physics models by making scientists' ideas and models visual, leading to cognitive growth, discovery of new ideas, and improved memory. They also enable learners to learn from their mistakes and reduce the effort and time required for learning..

Scope of the research: Human limit: Physics Department students, University of Zawiya; Spatial limit: Faculty of Education, Zawiya; Temporal limit: Academic semester 2026

Research methodologyTh:-The appropriate approach for this research is the descriptive analytical approach and the experimental approach.

Theoretical framework of the research:

The concept of artificial intelligenceIt is the integration of advanced computing capabilities and intelligent algorithms into educational environments to enable systems to simulate human

mental abilities, such as providing adaptive guidance, real-time data analysis, personalized learning, and automated assessment.

FactorsVirtualization: It is an interactive virtual learning environment that aims to conduct and implement experiments in a way that simulates real-life experience [6].

AI-integrated laboratories:-

It is an advanced generation of adaptive digital laboratories that have integrated artificial intelligence tools into their technical structure, transforming them from mere rigid simulation display tools into intelligent interactive environments that shape and change in response to user behavior.learnerand his level of knowledge.

Attitudes: These are the tendencies and acceptance or the degree of emotional intensity that the study sample members show towards e-learning, either by rejection or acceptance [7].

Challenges: These are the obstacles or difficulties that students and faculty members face in using artificial intelligence integration.In virtual laboratories ,These are the factors that negatively affect the implementation of artificial intelligence integration.In virtual laboratories[8].

Benefits and advantages of integrating artificial intelligence and a virtual laboratory: The integrated intelligence system has many benefits and advantages, including:

1. It compensates for the lack of real laboratory facilities and is used as a substitute for them, and provides students with experiences and skills very close to direct experience.
2. The possibility of conducting laboratory experiments that are difficult to conduct in real laboratories because of their danger to the learner, or because they are financially costly, or because conducting them requires a long time in real laboratories.
3. The possibility of covering all the ideas of the course with interactive practical experiments, and this is difficult to achieve through the real laboratory due to the limited capabilities, space and time available for the practical aspect.
4. The possibility of documenting experiment results electronically for the purpose of analyzing, processing, or sharing them with others.[9].
5. Virtual lab software includes tools that help support the experiment, such as graphs, animations, and analysis.
6. Removing the learner's fear factor when conducting experiments and protecting them from the risks of practical training in the early stages of learning, and enabling them to conduct self-assessments during their individual performance of experiments.[10].
7. Virtual experiences are characterized by an element of attraction and excitement, which encourages students to engage in the learning process.
8. Improving the performance of researchers as a result of saving time to travel to the actual laboratories [11].

Obstacles that limit the use of virtual laboratories integrated with artificial intelligence:

Some of the obstacles that limit the use of these laboratories are:

1- The scarcity of virtual laboratories that rely on the Arabic language in dealing with them.

2- Lack of genuine interaction with devices, tools, the teacher, and colleagues.

3- Its design and production require a specialized team of programmers, teachers and curriculum experts [13] [14].

Examples of virtual laboratories integrated with artificial intelligence in physics:

Several universities and research institutions have created virtual physics lab platforms integrated with artificial intelligence, including:

1- PlatformPraxiLabs Smart:-The platform provides three-dimensional physics experiments that simulate real laboratories, and the platform offers integrated physics experiments based on customized learning paths that change according to the student's thinking style.

2-PlatformInteractive PhET:-It is affiliated with the University of Colorado in the United States and includes artificial intelligence. It fully supports the Arabic language and provides more than one interactive experience for various topics in physics in an enjoyable, game-like style.
3- The Virtual Laboratory for Scientific Intelligence (AI.Si-Lab): It integrates artificial intelligence to provide smart assessment tools that allow students to conduct advanced practical experiments across three-dimensional environments, compensating for the shortcomings of real laboratories and without any risks to student safety.
4- PlatformLabster:-It allows students to conduct advanced physics experiments such as quantum mechanics, optics, and others.
5- Digital twinning platforms (Digital Twins:-In engineering physics, it is used to simulate large-scale mechanical physics experiments.
6-PlatformLabXchange:-An affiliated educational platform Harvard University has a diverse library of simulations and experiments in science and physics.
7-Academy-:VRLab Academy provides integrated physics laboratories covering experiments in mechanics, electricity, and magnetism [15] [16].

The generative tools and software helpers are divided completely separately according to each stage of the experiment:

1-Tools for planning and generating theoretical explanationsYThese tools are used to generate scientific texts and hypotheses, and to explain ideas before practical application.

-Lab Generator is a generative AI tool designed to suggest steps. The experiment and writing experiment manuals; you enter the title and immediately formulate the steps, required materials, and safety instructions..

- Curipod:- A generative tool usedTo createInteractive slides and visual content to explain the experiment's concept, clarify concepts, and prepare introductory questions.Based on experience
- MagicSchool AI: - Used to explain related scientific theories in order to prepare an experiment plan and formulate its objectives.
- Diffit is a tool for editing scientific texts and adapting content.yScientific including It is appropriate for the learners' abilities [17].
- -:Education Copilot is a tool for generating lesson plans, mentally preparing the learner for scientific experiments, and preparing preliminary questions and questions.

-2 Digital results processing and extraction tools:-
It is used to collect results, analyze data, and validate findings.To experiment with these tools:

- Julius AI is a tool that converts the numbers resulting from the experiment, analyzes the data, and calculates the averages.
- Wolfram (Alpha): A tool used to calculate, analyze, and graph complex physical equations resulting from experiments.
- Consensus is an intelligent search tool designed to verify results; it matches them with globally published paper research and tells you if they are correct (18).

-3 Graphing and visualization tools: - Used for graphs and charts such as:-
Graphy: An artificial intelligence tool specializing in generating graphs; it takes data and automatically selects the most suitable design and format for you and generates appropriate graphs.

1. Advanced Data Analysis is a software tool that writes (Python) code that converts any data file sent to it into an accurate, editable, and downloadable graph.
2. ChartGPT: A tool that draws charts instantly based on direct text commands

-4. Tools for drafting and generating laboratory reports: - These are used to write scientific reports in an academic manner.
Among them:

- SciSpace (Typeset) is a tool that helps in drafting reports. In an academic way High quality with reference documentation.
- Jenni AI: You write the first sentence of your conclusion, and the tool predicts and completes the scientific paragraphs based on the steps of the input experiment .
- QuillBot:A tool used to summarize a lab report into a concise abstract..

5- Correction and evaluation tools: - Used to correct, evaluate, and examine reports And from theseTools:

- ChatGPT: A tool used to correct scientific reports and provide feedback.
- Gradescope: - Used to evaluate reports and manage grades .

Search procedures:

- Defining the research population: The research population was defined as students of the Physics Department (Faculty of Education, Al-Zawiya), Al-Zawiya University.

- Determining the research sample: The research sample consisted of (70) students from the Physics Department.

- The instructor: The researcher specializing in physics taught, with the assistance of the researcher specializing in computer science, to both groups(19).

First: Preparing and conducting the tests:

- Pre-test procedure: The test was prepared and presented to a group of experts in physics and education to ensure the validity and reliability of the test. The reliability of the test was calculated using the test-retest method. Pearson's correlation coefficient was used to calculate the reliability of the test, and the reliability coefficient was high. After confirming the reliability of the test, the test was conducted.

- Distribution of the research sample: After determining the overall average of the students and conducting a pre-test to measure their existing knowledge and skills, they were divided into two groups, a control group and an experimental group. Each group consisted of 35 students. The first group (the control group) studied using the traditional method, and the real (traditional) laboratory was used to conduct experiments and obtain results. The second group (the experimental group) studied using computer simulation for the theoretical aspect, and used the virtual laboratory integrated with artificial intelligence to conduct experiments and obtain results. The educational material presented to the two groups was reviewed by experts in physics and education, and topics from the physics subjects (mechanics, electricity, electronics, optics, atomic) were studied.

- Conducting the test immediately: The test was prepared, and after ensuring the validity and reliability of the test, the test was conducted immediately after the teaching was completed.

- Conducting the final (concluding) test: After ensuring the validity and reliability of the test, the test was conducted after the teaching was completed.

- Monitoring and statistically processing the scores, making the necessary comparisons, and reaching conclusions and recommendations.

secondly:- Preparing the questionnaire and ensuring its validity and reliabilityThe questionnaire was prepared and its items were drafted., He presented it to a group of expert physics judges.,Education,The computer was used to verify its accuracy, and the reliability of the questionnaire was confirmed.

- Distributing the paper questionnaire,An electronic questionnaire to be filled out byResearch sample.

Data collection,The number of completed questionnaires(70) Student questionnaires

- Analyzing data statistically, interpreting results, and providing recommendations and suggestions.

Search results:

First: Results of the tests conducted on the students:

1- The results of the test that was conducted for the students before starting to teach them (the pre-test) as shown in Table (1) the number of students, averages and standard deviations for both groups.

Table (1) Pre-exam results for both groups

standard deviation	arithmetic mean	Number of students	The group
11.87	13.34	35	Group One (Officer)
12.42	13.02	35	Group Two (empiricism)

2- The results of the practical test after both groups carried out the experiments directly, as shown in Table (2), the number of students, averages and standard deviations for both groups.

Table (2) Direct Results of the Practical Test

standard deviation	arithmetic mean	Number of students	The group
12.86	80.91	35	Group One (Officer)
14.9	81.37	35	Group Two (empiricism)

3- The results of the final practical test after both groups carried out the experiments as shown in Table (3) Number of students, averages and standard deviations for both groups.

Table (3) Final Practical Test Results

standard deviation	arithmetic mean	Number of students	The group
13.37	79.68	35	Group One (Officer)
12.97	92.12	35	Group Two (empiricism)

Tanya: The results of the survey for physics students who used the integration of artificial intelligence and virtual laboratories in their teaching to determine their attitudes and the challenges they face:

- The results of the questionnaire items are shown in Table (4), wherePositive paragraphs (paragraphs 1 to 14, and paragraph 20). And the negative paragraphs related to challenges (paragraphs 15 to 19).

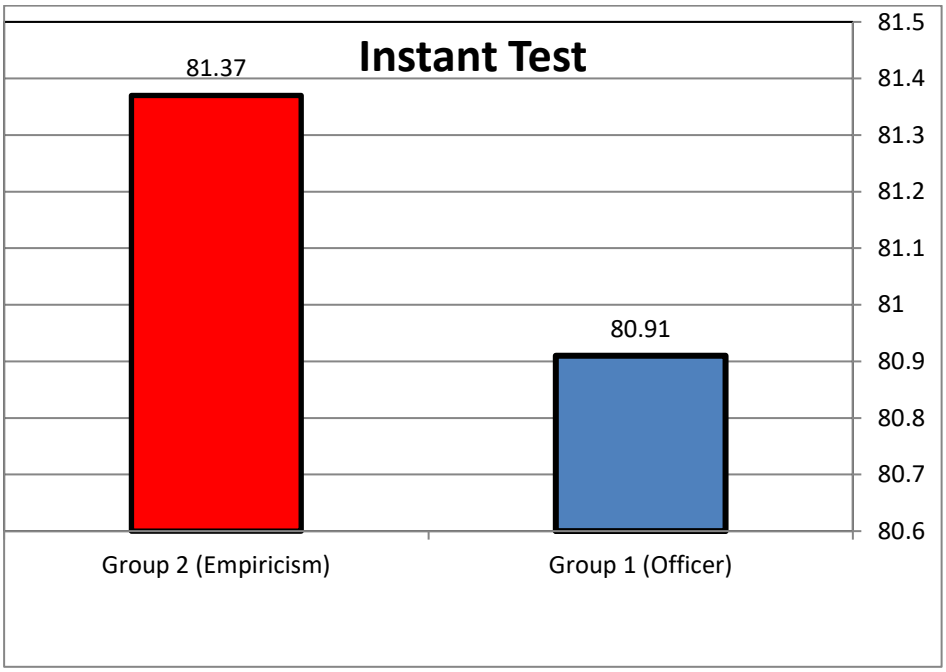
Order	relative color	standard deviation	arithmetic mean	Paragraph/Phrase	
6	87	0.58	4.35	AI-integrated labs help me understand, apply, and implement complex physical laws in a simplified way.	1
4	89	0.65	4.45	The smart assistant guides me through the correct experimental steps to avoid common manual measurement errors in physics.	2
5	88	0.61	4.40	Artificial intelligence tools allow for linking theories and laws to phenomena. Visual process And made it more realistic and accurate.	3
3	90	0.50	4.52	The smart lab provides me with a learning environment that suits my own learning pace and speed.	4
7	84	0.72	4.20	Intelligent assessment immediately helps identify the reasons for the deviation of experimental	5

				results from true values.And my guidance on methods for solving experimental problems.	
2	92	0.52	4.60	The smart environment offers me the opportunity to conduct experiments with complete safety and at the lowest cost.	6
9	82	0.81	4.10	Artificial intelligence saves time and effort in preparing the experiment and collecting and analyzing the results accurately and quickly.	7
11	78	0.71	3.90	Smart data analysis helps me and saves Graphs are useful in quickly understanding the mathematical relationships between physical variables..	8
8	83	0.76	4.15	The smart assistant instantly detects my errors in the experiment and allows me to correct them before making mistakes that could damage the measuring devices..	9
5	88	0.61	4.40	The AI-powered physics lab enhances scientific thinking skills, boosts enthusiasm, and reduces feelings of fear and hesitation..	10
10	79	0.88	3.95	Using correction tools Artificial intelligence gives me an objective assessment and provides feedback..	11
4	89	0.65	4.45	The smart lab allows me to understand the steps of the experiment and link theoretical physics concepts to concrete practical applications..	12
3	90	0.50	4.52	The smart virtual lab provides an engaging and interactive environment that increases passion and desire to study physics..	13
8	83	0.76	4.15	Artificial intelligence helps me deduce physical laws and enhances my ability to formulate correct scientific hypotheses..	14
13	38	0.85	1.90	I am experiencing technical difficulties when using the AI-integrated virtual lab interface..	15
14	37	0.92	1.85	Operating smart experiments requires high technical skills..	16
13	38	0.85	1.90	The university lacks infrastructure, including equipment, internet access, and other services..	17
12	63	0.80	3.15	I fear that the smart virtual laboratory will rely on idealistic assumptions that may not correspond to actual physical reality..	18
11	78	0.71	3.90	It reduces direct scientific interaction and discussion with the professor and colleagues..	19
1	95	0.40	4.75	I see a need to integrate artificial intelligence and virtual laboratories into physics teaching..	20
-	77.55	0.53	3.88	The overall average of the survey as a whole	

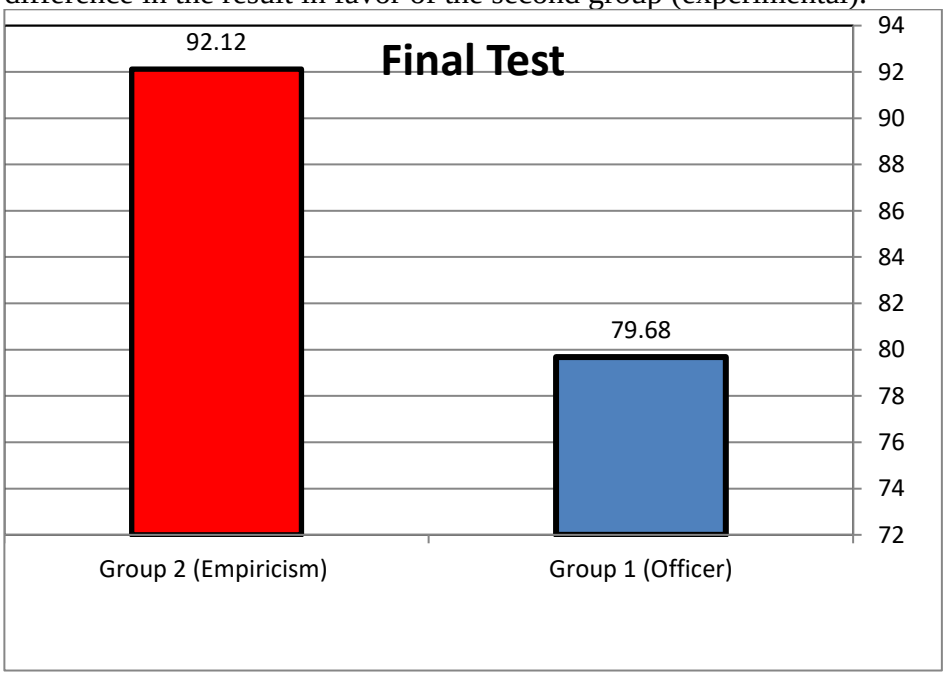
Comparison and discussion of the results:

First: By comparing the results of the pre-test for both groups, we observe that both groups are equal in terms of their prior knowledge and skills.

Second: By directly comparing the results of the practical test for both groups, Figure (1) shows a comparison of the arithmetic means of both tests for the two groups. We note the similarity in the test result for both laboratories.



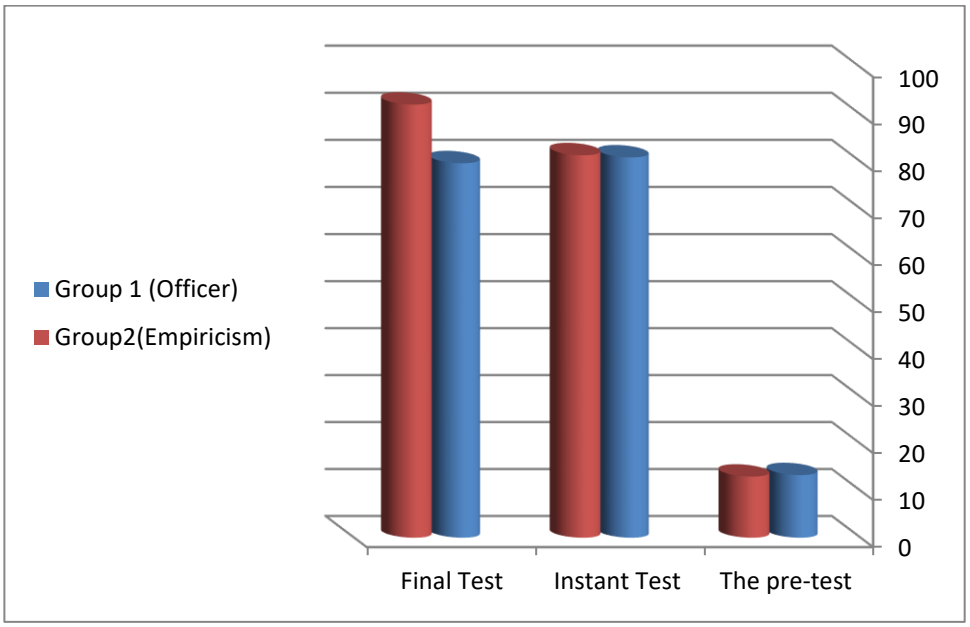
Thirdly - By comparing the results of the final practical test for both groups, and Figure (2) shows a comparison of the arithmetic means of both tests for the two groups, we notice a difference in the result in favor of the second group (experimental).



Fourth: Comparing the results of the three tests, as shown in Figure (3), reveals a difference between the three tests.

We observe a difference in the post-test results in favor of the second (experimental) group. This is attributed to the following reasons: the teaching method used in this group effectively captures the student's attention, facilitates comprehension by making things visual, and encourages the student to focus, discover, and deduce ideas, thus improving memory.

The student was able to repeat the experiment multiple times at any time and place.



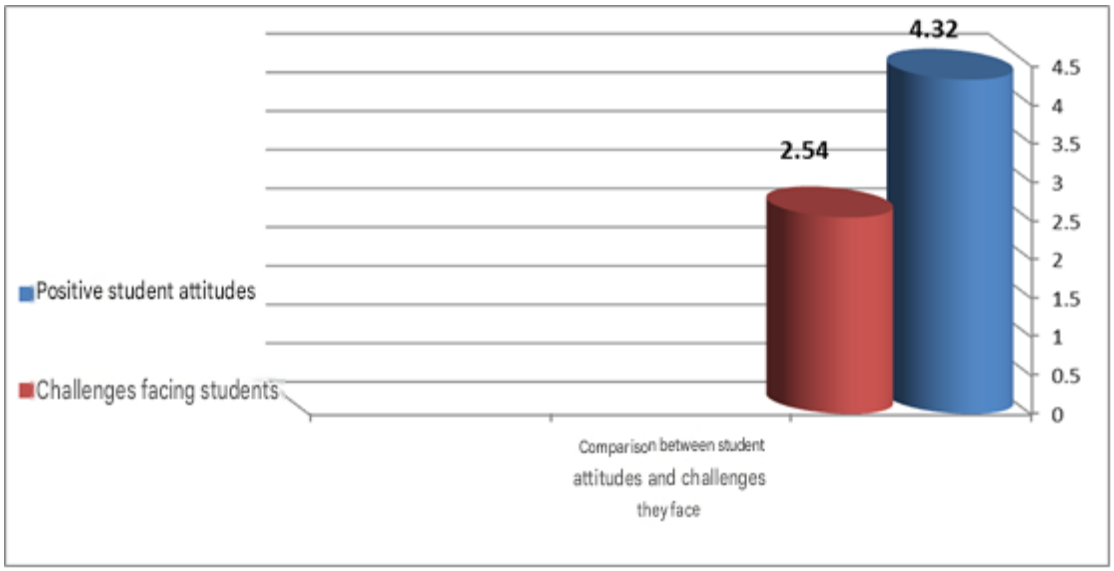
Fifth: It is clear from the survey results table that the overall average of physics students' opinions on integrating artificial intelligence into virtual laboratories has an arithmetic mean of (3.88). And relative weight(77.55%) which indicates a general level of agreement.

The arithmetic mean was found to be (4.32)And by relative weight (%86.46) For paragraphs on positive student attitudes(Paragraphs 1 to 14, and paragraph 20) which indicates a very strong positive general trend (agree to strongly agree).

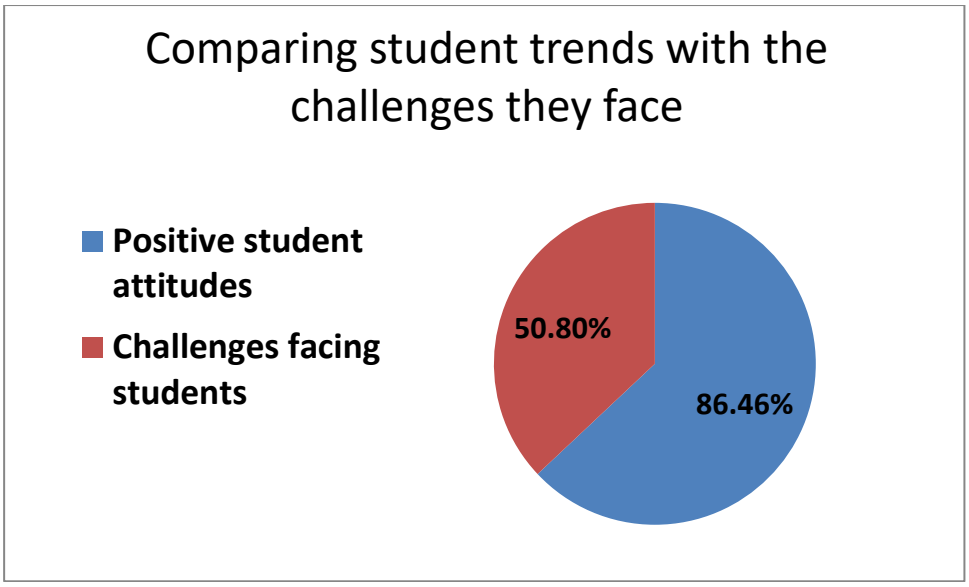
-The final paragraph (p20) shows the highest expected arithmetic mean approaching (4.75), reflecting a serious collective desire of the students to generalize the experience and use it in education.

The arithmetic mean for the challenge items is 2.54 And by relative weight (%50.8) (p15 to p19)

-By comparing the arithmetic means of the students' positive items and the challenging items, as shown in the figure(4)



- Comparing the relative weights of the positive student items and the challenging items as shown in Figure (5)



We observe that the arithmetic mean and relative weight of the items related to positive attitudes are high, while the arithmetic mean and relative weight of the items related to challenges are low. Their values provide a positive indicator, demonstrating that technical and human obstacles did not prevent students from using AI-supported virtual labs in their studies.

- **Conclusion:**

The results demonstrated the superiority of students who used AI-integrated labs to conduct their experiments compared to those who used traditional methods. This provides an opportunity to cover most course concepts with AI-supported virtual experiments, something difficult to achieve in reality due to limited equipment or the inherent risks of the experiment. This, in turn, contributes to raising students' academic achievement.

The results proved thatPhysics students' attitudes were positive towards integrating artificial intelligence into virtual laboratories, and they believe it plays a role in improving and developing the quality of education to keep pace with continuous and rapid scientific and technological developments, and to give them the ability and skill to use modern technology.

And to give themMeaningful learning contributed to their retention of the learned scientific material, which increased their motivation to learn and their attitudes towards learning physics.,However, they see some challenges.However, the technical or human obstacle did not prevent students from showing a strong desire to adopt these smart environments in education. And it must be done by aFor education officialsTo get rid of theseObstaclesOr limit them.

- **Recommendations :**

1- Utilizing virtual laboratories integrated with artificial intelligence to overcome the problems faced by faculty members due to the lack of equipment and tools in real laboratories.

2- Develop a comprehensive and clear planTo adopt and generalize smart virtual laboratoriesWe recommend integrating artificial intelligence technologies into university physics lab plans.YYes, due to its effectiveness in promoting realistic simulation, equipping students with advanced skills such as the ability to analyze, evaluate, discover, and solve problems, and helping students connect theoretical aspects with practical applications..

3- Raising awareness of the importance of applying artificial intelligence and integrating it into virtual laboratories

In education, the goal is to address or minimize negative trends.

4- Holding training courses, workshops and scientific seminars for faculty members and university students on the use of virtual laboratories integrated with artificial intelligence and its applications in the educational process.

5- Providing the necessary infrastructure To implement AI-integrated virtual laboratories at the university.

6- Funding projects to provide AI-integrated virtual laboratories for university students at a lower cost than real laboratories.

7- Conducting a study similar to the current one in other sciences at the higher education level and

Another sample viewpoint.

8-ProcedureA study similar to the current study at the general education level from the perspective of teachers and supervisors.

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