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The Degree of Chemistry Teachers' Practice of Artificial Intelligence Applications and its Relationship with their Attitudes toward Teaching

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Abstract

This study aims to investigate the degree of chemistry teachers' practice of artificial intelligence (AI) applications. It also checks the fact that there are statistically significant differences in the degree of practice of AI applications of chemistry teachers and investigates the connection between this practice and the attitudes of teachers. The descriptive correlational design was utilized because this type of research is consistent with the study purpose and objectives. The study questions were answered using two tools: The first was a questionnaire consisting of 20 questions that were based on three domains (planning, implementation, and evaluation) to identify the extent of AI application practice by the chemistry teachers. The second instrument was a questionnaire that was meant to assess the attitude of chemistry teachers towards teaching, and it had 20 indicators. The entire population that was used in the study was all the chemistry teachers who teach in a public school within the Directorate of Education in the Wadi Al-Seer District and there were 49 teachers. A random selection of 34 male and female teachers was the study sample. The findings showed that the level of practice of AI applications among the teachers of chemistry was low with the mean score of 1.65, and their attitudes towards teaching were moderate with the mean score of 2.86. Also, the findings indicate a statistically significant positive linear relationship between the extent of the practice of AI applications by the chemistry teachers and their attitudes towards teaching. Based on the results of the study, the researcher suggests organizing specific training courses on the applicability of AI and introducing it into chemistry teaching to chemistry teachers. These results support empirical evidence that can be used to implement a professional development program among chemistry teachers in the implementation of AI applications in teaching.

Keywords: teaching practices, artificial intelligence applications, chemistry teachers, attitudes toward teaching.

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1-Introduction:

The world, including Jordan, is witnessing tremendous developments in most areas of education. Specifically, in the field of chemistry, it has become necessary for educational institutions to shift their perspectives toward the educational process and work toward improving educational practices in all their aspects. This requires preparing the educational workforce effectively to elevate the educational process and adapt to continuous technological and scientific changes.

The 21st century is characterized by rapid advancements and technical progress, significantly impacting educational processes and teaching practices. These are considered key factors in achieving effective and sustainable competitiveness in the educational process to improve the performance of both teachers and learners. Therefore, the Ministry of Education must engage with and adopt modern methods to keep pace with these changes, develop and prepare teachers at the forefront of the technological age in education, and improve their attitudes toward teaching to prepare future generations.

With the instructions of the directives of His Royal Highness Crown Prince Al Hussein bin Abdullah II, whose goal is to utilize technology to enhance the quality of educational outcomes, the Ministry of Education in 2025-2026 initiated the deployment of the national learning platform with the assistance of artificial intelligence in Jordan, and 60,000 teachers were trained (Siraj). Teaching practices are among the most essential functions of a teacher, encompassing numerous skills and activities that interact to provide a humanitarian and social service, establishing a relationship between teacher and learner (Al-Fattalawi, 2003). These practices include various teaching and learning activities shaped by the teaching system and its core elements. As pointed out by Reinhartz and Beech (1997), the teaching

practice planning is transmitted between generations. Planning is significant because it conserves time and efforts that one needs to learn effectively in the classroom.

Innovative teaching practices are critical in preparing individuals equipped with the tools needed for success in both practical and social life, fostering an individual's awareness of self-management and emotional regulation, and providing opportunities for creativity and innovation that benefit both the individual and the community. This ensures progress and sustainable development (Mukhann & Al-Shayeb, 2015). Given the continuous advancement of technology, innovation in education is central to developing new methods and strategies that deepen knowledge, improve educational outcomes, and enhance the overall educational process to serve students better.

The advancement of science, technology, and e-learning environments has provided information and services that ensure the achievement of the goals of the third millennium. Developments in computing and technology have significantly impacted modern societies and educational fields (Al-Derbashi, 2017; Al-Derbashi & Khadragy, 2018). Amidst these developments, AI applications and programs have emerged and are increasingly utilized in universities and schools due to their importance and positive impact on the teaching process. Hence, teachers must acquire modern technological and learning skills while fostering environments that enable students to interact positively with activities and educational materials.

AI technology has become a major driver of fundamental changes in various fields of life. Education, in particular, holds a special place due to its critical role in building distinguished workforces and sustainable communities. AI first appeared at the Dartmouth Conference in 1956 and has since undergone significant advancements in simulating human cognitive abilities through computer systems capable of

learning and acting like humans (Fernandez, 2019). AI programs stand out from other technological tools due to their exceptional capabilities, such as acquiring expertise, making decisions independently without direct human supervision, and possessing deductive reasoning and adaptability to their environment.

AI applications are closely linked to learning theories that make learning more dynamic and engaging for learners, encouraging interaction between teacher and student to convey information and between peers to activate active learning in the educational process. This calls for the importance of using AI applications. Siemens' theory addressed the concept of AI in 2004 and emphasized the occurrence of education in the electronic educational environment (Abu Khatwa, 2018; Jeon & Kim, 2018).

Countries are constantly seeking to develop their educational programs and curricula. One of the directions of this development is to focus on thinking and the types of thinking required to achieve it among students. Achieving this goal in school requires us to make thinking the center of the curriculum circle and the axis around which the subjects revolve in their activities and teaching methods, to prepare teachers capable of carrying out this responsibility, and to provide the requirements of this process from various means, activities, and learning resources.

Education is witnessing fundamental transformations in teaching methods and learning styles as universities and educational institutions seek to adopt modern technologies to improve the quality of education and provide effective and fruitful educational experiences. Hence, employing AI applications emerges as an innovative means to improve the educational experience and enhance students' skills.

One of the most developed and diffused technologies is AI, which is a form of machine learning technology capable of generating new data, including images,

texts, and audio clips, depending on how human beings train on these technologies. It is also possible to use AI to develop conversations and customer services online or music and art content as a marketing or creative tool, etc. AI can contribute to providing self-learning for students and can provide personalized learning experiences that match the needs and skills of each student (Al-Khalifa, 2023).

Measurement and evaluation activities can also be conducted with a high degree of accuracy and efficiency to assist in academic excellence and help in the presentation of questions in manner that exposes the weaknesses and mental preparedness of the various learners. AI can also be used to monitor and investigate the learning styles of individuals (Faggella, 2019; Zawacki-Richter et al., 2019). Among the applications of AI are programs used for smart teaching, which work to provide students with instant lessons, track students' work, and identify the strengths and weaknesses of each student. There are AI applications and programs that teachers can use to summarize long texts accurately and easily and programs that teachers can employ in the classroom to employ smart educational games that aim to meet the needs of students (Al-Subhi, 2020).

AI is transforming the idea of education, by developing intelligent content based on the digital instructions of textbooks to self-made digital learning platforms at any level (primary to post-secondary) as well as automating basic activities in education, such as grading and classifying assignments, tracking learners' progress, and alerting teachers if there is a problem with learners' performance.

The AI-based learning environment is easy to set up and can provide active-interactive learning over the web, which achieves the goals of interactive learning to develop thinking skills, participation, problem-solving, and the ability to anticipate the future through problem-solving. Many studies have shown the importance of

diversity in educational methods and the necessity of an AI-based learning environment to keep pace with global developments and innovations in the educational and technological process to stimulate and activate the educational process.

One of the main objectives of teaching chemistry is to train students to adapt to rapid progress and developments and to benefit from the latest technological innovations, as they play an effective and influential role in enhancing and improving the interaction between students and engagement in educational learning smoothly and comfortably. E-learning has become an influential tool in enriching the cognitive structure of students and enhancing their collaborative and cooperative skills, in addition to providing an interactive educational environment that helps students express their ideas freely and independently and learn better from real-life experiences.

Simulation tools provided by e-learning represent one of the most essential characteristics of e-learning since they allow students to address real-life scenarios without fear of failure, promote a sensible grasp of complex theories, and improve the learning experience of students by introducing them to practical activities through the application of those activities in specialized science laboratories (Campos et al., 2020). Numerous studies have highlighted the role of AI-based learning and the impact of AI applications on developing various aspects of students' learning, particularly in the sciences. AI technology is increasingly regarded as a central axis for learning, innovation, and achieving lifelong learning. This contributes to preparing generations equipped with the technological skills necessary for the future.

The researcher also believes that chemistry teachers demonstrate a positive orientation toward the teaching profession through collaboration with school administration and educational supervision bodies, as well as fostering respectful and friendly relationships with their students. Such relationships, built on mutual respect, warmth, and camaraderie, significantly enhance the teaching-learning process.

The teachers bring their attitudes, inclinations and experiences to the interactions with the students, and the attitude significantly influences the process of education. As a key figure in influencing students, the teacher is instrumental in driving renewal and change. Therefore, the teacher's attitudes and approaches are of utmost importance in ensuring the success and effectiveness of the educational process.

Therefore, the use of e-learning and technological innovations, as well as the use of AI applications, are among the main topics that should be focused on, as the development of education accelerates with the pace of technological updates, and the fate of any country is tied to the creativity of its teachers and students, the generations of the future, and their ability to face the challenges of change. Also, the skills of students and the outcomes of education in the digital age rely primarily on teachers, and the role of teachers and their skills significantly contribute to achieving the quality of learning and education that affects the future of students, their families, and their communities, which is a critical factor in human development as a whole. AI applications work to empower teachers, improve their performance level, process large amounts of data, and enable them to analyze problems according to the educational situation. (Al-Farani & Al-Hujaili, 2020)

The research conducted by Haseski (2019) was conducted to determine the views of pre-service teachers regarding AI. The qualitative approach was followed, and the

study sample comprised of 94 pre-service teachers in the Faculty of Education in Manisa Celal Bayar University in Turkey. A semi-structured interview form and a questionnaire were used as study tools. The findings reported that pre-service educators use varied definitions of AI and have predominantly negative attitudes towards AI. Moreover, pre-service teachers believe that AI can possess numerous benefits and risks along with positive and negative impacts on education (Bachnik, 2020). Al-Asimi (2022) undertook the research to determine the attitude of teachers towards teaching profession among the teachers of government schools in the Sultanate of Oman. The researcher has employed descriptive approach and developed a questionnaire that was sent to a sample of (200) male and female teachers. The research ended in a number of findings. Among these, the most significant ones are such negative attitudes of some teachers to the teaching profession, inclination of some teachers to the development of their teaching skills, the agreement that the teaching profession and teachers were not valued in the right way, and a necessity to lessen academic loads.

In his study, Al-Ma'ani (2023) attempted to determine the truth of using AI in the educational process in the eyes of government school principals in Bani Obaid District. The sample size of the study included (44) male and female principals out of the total number of principals in government school at the Bani Obaid District in Irbid Governorate. The selection was done in a simple random way. The descriptive survey method was used in the study. One of the tools of collecting and analyzing data was a questionnaire. The findings revealed that there is an average reality of the use of AI in the learning process according to the perspective of government school principals in the Bani Obaid District. It did not also indicate statistically significant differences in the reality of using AI to the educational process according to the role

of government school principals in the Bani Obaid District. Based on this, the research proposed a list of recommendations, the introduction of AI and its use in education being the most obvious one among the courses included in the training programs of new teachers or during their university education. Al-Ayyar and Al-Balushi's (2024) study aimed to know the extent to which secondary school teachers in the State of Kuwait employ AI applications in the teaching process. The analytical method was descriptive analytical; a questionnaire was adopted and the research sample comprised of (430 male and female secondary school teachers in the State of Kuwait). The findings indicated that the levels of using AI applications in teaching process by teachers are average. Also, the degree of employment of these applications in remote tests and following up on students' assignments is average. In addition, the degree of employment of these applications to analyze students' answers and build digital assessment tools is average. Moreover, the degree of employment of these applications to identify content that is difficult for students to understand is average, and the degree of employment of these applications to develop a treatment plan for students with poor performance and to provide reports on students' weaknesses is average.

The purpose of the study by al-Jamil (2024) was to investigate the degree of usage of AI applications in the Sultanate of Oman schools in terms of perspective of the teachers as defined by the Oman Vision 2040. The descriptive methodology and the questionnaire were adopted by the researcher to gather information about (121) male and female teachers in the Sultanate of Oman. It was found that the degree of use of AI applications in the schools of the Sultanate of Oman is very high. Additionally, the degree of teachers' use of these applications to prepare lessons is high, and the degree of their use of smart games to develop higher-order thinking

skills among students is high. Also, the degree of teachers' use of these applications to prepare test questions is high, and the degree of use of these applications to automate administrative tasks and analyze the educational needs of each student individually is very high. The study also indicated that these applications were highly effective in designing exceptional educational programs for students and played an important role in assisting teachers in decision-making.

The current study is similar to previous studies in that it follows a descriptive approach and examines the extent of AI application usage. However, it differs from past studies in that they did not address the use of AI applications in teaching practices and teachers' attitudes toward teaching. No study has addressed this topic specifically for science and chemistry teachers in Jordan to the researcher's best knowledge. Therefore, this study is distinguished by its research sample and variables, specifically AI applications in teaching practices and the attitudes of chemistry teachers toward teaching in Jordan.

The above analysis of the past research points to an agreement on the relevance of using artificial intelligence (AI) tools in the overall teaching process. Nevertheless, the range and character of the studies on this subject is varied. Other studies are aimed at perception of teachers about AI in teaching like the study by Al-Ayyar and Al-Balushi (2024) or the study by Al-Ma'ani (2023) is aimed at perceptions of school principals. Because, to the researcher's knowledge, no studies link AI and its use by chemistry teachers to their teaching attitudes, it was deemed necessary to conduct a study exploring the relationship between these two variables. Therefore, the significance of the current research is that it will unveil the degree of the use of AI applications by chemistry teachers and its connection with the teacher attitude.

The educational reality indicates that AI applications contribute to developing various skills among students if properly integrated into the educational curriculum, especially when the necessary modern technology is available. This highlights that teachers should integrate AI applications into the educational process effectively, placing on them the responsibility to stay updated with new developments in educational and teaching technologies. Consequently, it is necessary to explore the degree to which chemistry teachers practice AI applications and its relationship with their attitudes toward teaching.

Taking into consideration the quick digital changes in the educational field, especially the AI applications. It is clearly observed that there is a gap between the availability of such applications and the ability of features to implement them effectively in the classroom. Furthermore, the current study comes to reveal the relationship between the chemistry teacher's practices of such applications with their attitudes toward teaching.

2-Statement of the Problem:

Due to the current situation, the world is going through and the changes in learning and teaching, as well as the ongoing development of chemistry curricula in the Hashemite Kingdom of Jordan to keep up with the digital and technological advancements globally, the teacher is considered a key figure in these educational developments. Every educational reform starts with the teachers and their teaching practices. The teacher is the one who uses technology to deliver knowledge to students, encourages them to be creative, develops their thinking skills, and creates a learning environment that stimulates and motivates their future perspectives. Most studies, such as Hwang et al. (2020) and Al-Jamil (2024), emphasize the importance of using AI in learning processes due to its effectiveness in managing and solving

problems and making the right decisions. AI systems are considered expert systems that outperform traditional systems by helping learners with low academic levels complete the learning process successfully. Through the researcher's experience in the educational field, it was observed that there is a decline in some teachers' level of practice of technological applications, especially AI applications, and that their teaching practices do not align with the developed chemistry curricula. Science subjects require varied teaching strategies due to the nature of scientific content and its increasing volume. Therefore, the best strategies for teaching science are those centered on the learner and building knowledge independently. AI-compatible technological applications are among these strategies. Today's students are digital citizens who use the web and technology primarily for entertainment, but most students do not know how to use them effectively. The researcher also noticed that the COVID-19 pandemic forced many educational communities to use various technological applications, which have become an essential part of our educational lives. Accordingly, the study problem emerged, aligning with the current era, the age of technology, in which students are described as digital citizens. The research will examine the level of applying AI within the teaching practices of chemistry teaching professionals and how it is associated with the teaching attitude of these professionals.

3-Research Questions:

The study problem is identified with the help of the following questions:

1. What is the degree of chemistry teachers' use of artificial intelligence applications?
2. What are the teaching attitudes of chemistry teachers?
3. Is there a statistically significant correlation ($\alpha = 0.05$) between chemistry teachers' practice of artificial intelligence applications and their attitudes toward teaching?

4-Research Objectives:

1. To identify the degree of chemistry teachers' use of AI applications in their teaching.
2. To investigate the teaching attitudes of chemistry teachers.
3. To determine if there is a statistically significant correlation ($\alpha = 0.05$) between the degree of chemistry teachers' use of AI applications and their teaching attitudes.

5-Study Significance:

-Theoretical Significance:

1. This research contributes to the theoretical literature, on the application of AI to the educational process, in this case, science and chemistry education under the conditions of e-learning and e-learning applications.
2. It provides a theoretical framework related to teaching practices of AI applications for chemistry teachers and chemistry teachers' attitudes toward teaching.
3. It provides instruments involving instructional activities that may be of value to the researchers. This is the first research, to the best knowledge of the researcher,

that examines the issue of teaching practices and the application of AI application by chemistry teachers and attitudes that they have towards teaching.

4. The study contributes to informing officials in the Ministry of Education about the importance of artificial intelligence and its use by chemistry teachers, and to strengthening their attitudes towards teaching.

-Practical Significance:

The results of the study benefit:

1. Science and chemistry teachers by helping them better understand their teaching practices and the requirements of these practices considering AI applications and supporting the development of these practices.
2. Science supervisors to guide teachers in improving their teaching practices in light of AI applications.
3. Developing training courses to use and apply artificial intelligence tools, training chemistry teachers on how to utilize them in the teaching process, and how to utilize them in evaluation.
4. Future studies exploring the teaching practices of chemistry teachers in different educational environments.

6-Delimitations of the study:

Population: The sample consists of chemistry teachers from grades 10 to 12 in public schools in Wadi Al-Seer District.

Time: This study has been carried out during the first semester of the 2024-2025 academic year.

Place: The research was performed in public schools which were under the authority of the Wadi Al-Seer Education Directorate.



Topic: This study is limited to examining the degree of chemistry teachers' practice of artificial intelligence applications in the domains of planning, implementation, and assessment, and its relationship with their attitudes toward teaching.

7-Key Terms of the Study:

Teaching Practices: According to Tay and Saleh (2019, p. 125), teaching practices are teachers' characteristics and behaviors through which they manage classrooms consistently. In this research, on an operational definition, teaching practices can be considered as the degree of performance of the chemistry teacher within and without the classroom, which coincides with the application of AI programs.

AI Applications: Applications capable of simulating human intelligence, human capabilities, and cognitive processes, such as instant messaging programs and robots (Al-Ghamdi & Al-Farani, 2020, p. 59).

Teaching Practices for AI applications: In the present study, the operational definition of teaching practices is the level of using artificial intelligence application to teach chemistry in terms of planning, implementation, and assessment, as determined by the questionnaire designed by a researcher.

Attitude toward Teaching: Pickens (2013) defined attitude as an individual's response to a topic, which can be either positive or negative depending on the individual's previous experiences.

Operationally, in this study, it is defined as the responses of science teachers toward using AI applications in teaching, whether positive or negative. These are measured using the questionnaire designed for this purpose.

Chemistry Teachers: Individuals holding an academic qualification that qualifies them to teach chemistry at the elementary and secondary levels in public schools

affiliated with the Education Directorate in Wadi Al-Seer District for the 2024/2025 academic year.

8-Methodology:

The required approach of the study was a correlational descriptive approach because this study type is appropriate to the nature and the purpose of the research to determine the extent of using AI applications by the chemistry teachers and its connection to attitudes towards teaching. The correlational descriptive approach, examines the interrelationships between variables rather than focusing on individual traits. It aims to understand relationships and allows for the examination of natural relationships between variables without interfering with conditions or controlling the variables.

9-Population and Sample of the Study:

The study population for this research was selected from all chemistry teachers in the public schools of the Wadi Al-Seer Education Directorate, with 49 male and female teachers. The sample consisted of 33 male and female chemistry teachers working in the Wadi Al-Seer District Education Directorate after five incomplete samples were excluded. The sample was selected randomly based on the size of the study population.

10-Study Tools:

Two tools were used to answer the study questions:

Tool 1: Questionnaire on the Use of AI Applications in Teaching

The researcher reviewed several previous studies, such as those by Al-Jamil (2024) and Qurqaji (2023), to design a questionnaire to determine the extent to which chemistry teachers in the Wadi Al-Seer Education Directorate practice AI applications in their teaching.

A three-point Likert scale was used to score the study tools, with each item being assigned a score of one of the following three levels: (1) High, (2) Medium, (3) Low. These numerically are expressed as (3, 2, 1) respectively. The scale was created to analyze the data in the following ranges:

- From 1.00 to 1.66 = Low
- From 1.67 to 2.33 = Medium
- From 2.34 to 3.00 = High

The scale was computed as shown in the equation below: Upper limit of the scale (3)-Lower limit (1) = 2. Then this difference (2) was divided by the necessary number of categories (3) then we had: $2/3=0.66$. To the end of each range of categories, the value of 0.66 was included.

Tool 2: Attitudes Scale

An attitude scale for chemistry teachers towards teaching was developed based on previous studies and research, such as Al-Awawdeh (2020). The items of the attitude scale were formulated in clear procedural terms with short phrases addressing teachers in the present tense. The items were designed to be understandable and unambiguous. They covered the emotional aspect of the respondents using simple, non-complex sentences, each measuring a single objective and straightforward with a subjective nature.

Answering the items of the attitude scale was accomplished using the Likert five-point scale, in the following way: (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree). The scale gives numerical value (5, 4, 3, 2, 1), respectively. The result analysis scale used was the following one:

- From 1.00 to 2.33 = Low
- From 2.34 to 3.67 = Medium

- From 3.68 to 5.00 = High

The scale was computed in the following equation:

Upper limit of the scale (5)-Lower limit (1) =4. This value was then divided by the number of required categories (3) to get: $4/3=1.33$. Each category range was increased by the value of 1.33.

Validity of Tools: Teaching Practices Questionnaire

- The Teaching Practices Questionnaire content was validated by the submission of the questionnaire in its original form to a sample population (9) of specialized judges such as university professors teaching science curriculum, technology, educational supervisors teaching science, technology specialists in measurement and evaluation, and science teachers.

Based on the views and recommendations made by the arbitrators, 4 test items were eliminated and substituted with 4 other items.

In order to derive the construct validity indicators of the scale, the researcher computed the correlation coefficients of every item with the total score, which was the correlation between every item with its respective domain and the correlation between the domains and total score. This was conducted on a pilot sample outside the study sample, consisting of 20 male and female teachers, from the public schools of the Wadi Al-Seer Education Directorate. The correlation coefficients for the items with the overall tool ranged between (0.45–0.76), with domain correlations ranging from (0.45–0.85). The table below illustrates these findings.

Table 1. Correlation Coefficients between Each Item, the Total Score, and Its Domain

Item Number	Correlation with Domain	Correlation with the Tool	Item Number	Correlation with Domain	Correlation with the Tool	Item Number	Correlation with Domain	Correlation with the Tool
1	0.66**	0.55*	8	0.85**	0.49*	15	0.66**	0.76**
2	0.67**	0.47*	9	0.66**	0.45*	16	0.62**	0.50*
3	0.64**	0.49*	10	0.85**	0.48*	17	0.82**	0.46*
4	0.75**	0.53*	11	0.79**	0.53*	18	0.62**	0.74**
5	0.82**	0.48*	12	0.66**	0.46*	19	0.67**	0.57**
6	0.52*	0.46*	13	0.75**	0.57**	20	0.45*	0.55*
7	0.79**	0.50*	14	0.82**	0.47*			

Significant at the 0.05 level. Significant at the 0.01 level.

It is also important to mention that all the correlation coefficients were reasonable and significant, thus no item was dropped. The correlation between the domain and the total score and the correlation of the domains, were also extracted as shown in the following table.

Table 2. Correlation Coefficients between the Domains and the Total Score

	Planning	Implementation	Evaluation	Overall Practices
Planning	1			
Implementation	0.505*	1		
Evaluation	0.525**	0.577**	1	
Overall Practices	0.691**	0.781**	0.750**	1

Significant at the 0.05 level. Significant at the 0.01 level.

Table 2 shows that all correlation coefficients were acceptable and statistically significant, indicating an appropriate level of construct validity.

-Reliability of the Teaching Practices Questionnaire:

The reliability of the study tool was ensured using the test-retest technique. The scale has been administered and re-administered after 2 weeks (14 days) to a sample not included in the study, comprising of 20 teachers. Pearson correlation coefficient was then obtained comparing their scores at both their instances.

Also, Cronbachs Alpha formula was used to calculate the internal consistency coefficient. Table 3 indicates the internal consistency coefficient based on the test-retest reliability according to Cronbach Alpha on domains and the total score. These were the values that were deemed to be suitable for this study.

Table 3. Cronbach's Alpha Internal Consistency Coefficient and Test-Retest Reliability for the Domains and Total Score

Domain	Test-Retest Reliability	Internal Consistency (Cronbach's Alpha)
Planning	0.85	0.79
Implementation	0.84	0.77
Evaluation	0.80	0.80
Overall Practices	0.91	0.85

-Validity of Tools: Attitude Scale towards Teaching:

In order to make the items of scale understandable and the correlate to the objectives of study and the item each is correlated to the field, (7) academic staff members are working at university and (5) teachers' specialists in computer science and chemistry reviewed the scale. Some refinements that they advised to make included cutting one of the items and paraphrasing the other items.

In order to establish the construct validity of the scale, correlation coefficients between each item and the overall scale score were computed using a pilot sample that was not part of the study sample, and of which included 20 teachers. The r

values between the items and the total score were 0.45 to 0.86. These values are indicated in the following table.

Table 4. Correlation Coefficients between Items and the Total Score of the Scale

Item Number	Correlation Coefficient	Item Number	Correlation Coefficient	Item Number	Correlation Coefficient
1	0.75**	7	0.45*	13	0.83**
2	0.62**	8	0.85**	14	0.86**
3	0.71**	9	0.73**	15	0.73**
4	0.82**	10	0.61**	16	0.71**
5	0.55*	11	0.75**		
6	0.77**	12	0.47*		

**Correlation is statistically significant at the 0.05 level. **Correlation is statistically significant at the 0.01 level.*

It should be noted that all correlation coefficients were acceptable and statistically significant, therefore no items were removed.

-Reliability of the Attitude Scale towards Teaching:

The test-retest method was used to verify the reliability of the study tool. The scale was administered initially, then re-applied two weeks later to 20 participants outside the main study sample. The Pearson correlation coefficient between the scores from both administrations was 0.86. Additionally, the internal consistency reliability was calculated using Cronbach's Alpha, which yielded a value of 0.81. These values are considered acceptable for this study.

-Study Results:**Question 1: What is the degree of chemistry teachers' use of AI applications in teaching?**

The means and standard deviations were calculated to determine chemistry teachers' use of AI applications in teaching to answer this question. The table below illustrates the results.

Table 5. Means and Standard Deviations of Chemistry Teachers' Use of AI Applications in Teaching, Ordered in Descending Order by Means

Rank	Number	Area	Mean	Standard Deviation	Degree
1	1	Planning	1.79	0.36	Medium
2	2	Implementation	1.60	0.34	Low
3	3	Evaluation	1.56	0.46	Low
		Overall Practices	1.65	0.29	Low

As shown in Table 5, the means ranged from 1.56 to 1.79. The "Planning" domain ranked first with the highest mean of 1.79, while the "Evaluation" domain ranked last with a mean of 1.56. The overall mean for chemistry teachers' use of AI applications in teaching was 1.65, considered "Low."

This result suggests that chemistry teachers were not exposed to training programs to plan lessons using AI applications. AI applications in teaching require specific technical planning and preparation skills. This finding aligns with studies such as Al-Masaad and Al-Farani (2023), which indicated that the availability of AI application usage skills in teaching was moderate in planning, implementation, and evaluation, as perceived by secondary school teachers. The outcome is also justified by the fact that the application of artificial intelligence is wanted by the chemistry teachers, and therefore, the teachers attempt to apply it during lesson planning, thus planning skills entered rank 1. However, they do not have suitable tools and skills that enable

them to use it while carrying out lessons in front of students. In addition, training programs are not usually followed by supervisors to ensure that the impact of teacher training is transferred to the classroom. This was evident through the fact that lesson delivery skills came in rank 2 and assessment skills in rank 3. Similarly, Al-Khaybari (2020) found that secondary school teachers in Al-Kharj lacked skills in using AI applications for lesson planning, implementation, and evaluation, with many barriers to using these applications.

This result is consistent with Al-Ma'ani (2023) and highlights the need to provide chemistry teachers with intensive training to plan and prepare chemistry lessons using AI applications.

Question 2: What are the chemistry teachers' attitudes towards teaching?

This question was addressed by calculating the means and standard deviations of the attitudes of the chemistry teachers toward teaching. The results are shown on the table below.

Table 6. Means and Standard Deviations of Chemistry Teachers' Attitudes towards Teaching, Ordered in Descending Order by Means

Rank	Number	Item	Mean	Standard Deviation	Level
1	3	I tend to distribute educational tasks to students during teaching and assist with AI applications.	3.39	1.22	Medium
2	1	I believe it is necessary to provide motivating guidance to direct students' thinking using AI applications.	3.24	0.97	Medium
3	11	I believe it is important to give students the opportunity to interact with each other to develop their thinking skills using online chat.	3.24	0.97	Medium
4	8	I encourage students to apply acquired knowledge in different life situations and use AI	3.15	1.06	Medium

		applications.			
5	16	I believe that using AI applications encourages students to learn independently.	3.12	1.11	Medium
6	6	I tend to use materials, tools, and devices in the teaching process and employ AI applications.	3.00	1.00	Medium
7	13	I expect that using AI applications in teaching will make the class more engaging.	3.00	1.20	Medium
8	7	I see that AI applications in teaching will help me monitor students' performance.	2.85	1.37	Medium
9	5	I encourage students to use diverse knowledge sources for AI tools.	2.79	1.43	Medium
10	9	I tend to provide feedback to students using AI applications.	2.79	1.14	Medium
11	4	I believe it is necessary to design diverse enrichment activities to improve students' creativity using AI applications.	2.70	0.98	Medium
12	12	I consider that cooperation among students to perform educational tasks may lead to effective learning may lead to effective learning.	2.70	1.45	Medium
13	10	I agree that the AI tools could help create different assessment methods.	2.61	1.39	Medium
14	2	I tend to diversify enrichment strategies using AI applications.	2.55	1.33	Medium
15	14	I agree that designing chemistry textbooks based on AI applications could motivate students' enthusiasm and help them learn effectively.	2.42	0.94	Medium
16	15	I tend to believe that AI applications increase the enjoyment of learning chemistry among students.	2.27	1.04	Low
		Overall Attitudes	2.86	0.81	Medium

As shown in Table 6, the means ranged from 2.27 to 3.39. Item 3, "I tend to distribute educational tasks to students during teaching and assist with AI applications," ranked first with the highest mean of 3.39. On the other hand, item 15, which says "I tend to believe that AI applications increase the enjoyment of learning chemistry among students," ranked last with a mean of 2.27. The overall mean for chemistry teachers' attitudes towards teaching was 2.86, indicating a "Medium" level.

This Finding propose that chemistry teachers are able to use AI applications in teaching, but they do not have the necessary skills for effective integration. The item about AI applications increasing the enjoyment of learning chemistry, which received the lowest score, suggests that chemistry teachers do not feel confident that AI can promote students' enjoyment of learning science.

Upon reviewing the means and standard deviations for all items on the attitudes scale, it could be observed that most scores were in the "Medium" range. This can be attributed to several factors: (1) Teachers have not participated in many specialized training courses that equip them with AI skills and applications, especially for new teachers. (2) The workshops organized by the Ministry of Education to enhance teachers' skills in using modern teaching strategies do not adequately address AI applications in teaching chemistry. (3) Teachers' academic backgrounds, which focus on using chemical laboratory materials, devices, and tools during their university studies, do not cover AI tools or applications in the curriculum.

Question 3: Is there a statistically significant correlation at the ($\alpha \leq 0.05$) level between the degree of chemistry teachers' practice of AI applications and their attitudes toward teaching?

Pearson correlation coefficients were calculated between the degree of chemistry teachers' practice of AI applications and their attitudes toward teaching. Table 7 presents the results.

Table 7. Pearson correlation coefficients for the relationship between chemistry teachers' practice of AI applications and their attitudes toward teaching

Dimension	Correlation Coefficient (r)	Statistical Significance	Sample Size
Planning	0.620**	0.000	33
Implementation	0.405*	0.019	33
Evaluation	0.689**	0.000	33
Overall Practices	0.803**	0.000	33

**Significant at the (0.05) level. **Significant at the (0.01) level.*

From Table 7, there is a statistically significant positive correlation between the degree of chemistry teachers' practice of AI applications and their attitudes toward teaching.

This can be attributed to the fact that teaching using AI applications requires chemistry teachers to have various technological knowledge and skills to implement electronic applications for learning and teaching effectively.

The given table contains a clear statistically significant positive correlation between the assessments of the study sample; the total correlation coefficient is (0.803) and proves the effect of artificial intelligence on such attitudes to teaching. The findings can be explained by the critical role played by AI-based tools. Given the unique

nature of chemistry, which includes explanations and interpretations of chemical symbols, chemistry teachers can utilize AI techniques to approximate the spatial dimensions of chemical orbitals of elements. This enables teachers to design educational activities, thereby improving their attitudes towards teaching and enhancing their awareness of the importance of employing AI tools.

This is especially true in light of the Jordanian Ministry of Education's emphasis on enhancing teachers' competencies, equipping them with diverse skills, and employing the best modern and constructive strategies in teaching, with the student as the central focus of the learning process. This means that the less teachers practice AI applications, the more their attitudes toward teaching may diminish.

This aligns with some recent studies that have emphasized the need for teachers to possess technological tools, especially artificial intelligence confirmed the effectiveness of delivering lessons to students through the (TRACK) application in all aspects of the content and the necessity of training teachers on this model. (Santos et al, 2021)

As far as the researcher is concerned, the findings of this study were not contrasted with the previous research results since there are no prior studies that have specifically dealt with the practice of AI applications and its correlation with teaching attitudes.

To summarize, the current research paper shows that the introduction of artificial intelligence (AI) instruments into the teaching process is one of the key solutions to enhancing and advancing the educational process. The application of these tools largely helps to boost student interaction with the curriculum and offer them personalized learning experiences that fulfill their personal needs. The AI also provides educators with the possibility to process data and make evidence-based

educational choices. The research should also go forward to investigate how AI will affect different elements of the learning process. Using AI in teaching can be a highly effective means of triggering innovation, but only if it is combined with conventional teaching strategies and reinforced by the role of a teacher in the successful organization of the educational process. It consists of opportunities to offer teachers to attend special training workshops with the use of AI applications in the educational sphere and to conduct such workshops at schools, as well as compile a constantly updated list of applications that can improve the teaching of science and chemistry at schools. A team of professionals within the Ministry of Education should be in charge of this list. Moreover, the Ministry must build specific departments in Jordan to oversee the use of AI plans, programs, and applications in education and offer training opportunities to teachers to use different applications.

11-Recommendations and Suggestions:

According to the results of the research, the researcher suggests the following:

- Promoting science and chemistry educators in learning and gaining expertise regarding AI and its use in teaching.
- Recommending the need to incorporate AI applications in many facets of the educational process to decision-makers and educational planners.

On a larger scale, the training of science and chemistry teachers should be conducted to introduce them to the applications of AI and provide the required skills to effectively use them in the educational process.

- Creating special training courses in the use of artificial intelligence and its implementation in the process of teaching chemistry.

- Creating online support platforms for chemistry teachers to utilize artificial intelligence in lesson plans, prepare and conduct chemical experiments, and implement a system for continuous teacher evaluation and motivation.
- Chemistry supervisors follow up with teachers by attending classes that demonstrate the extent to which teachers possess the skills to employ and benefit from artificial intelligence applications.

The researcher also suggests:

- Conducting similar research on teachers across all disciplines.
- Conducting survey-based experimental studies to highlight the effectiveness of AI applications in all dimensions of the educational system.

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Appendix (1)

Means and Standard Deviations for Chemistry Teachers' Practice of Using AI Applications in Teaching

No.	Statement	Mean	Standard Deviation
1	I set clear objectives for using AI when planning lessons.	1.85	0.619
2	I formulate lesson objectives using AI applications.	1.18	0.392
3	I design activities compatible with AI, considering their impact on student engagement.	1.85	0.795
4	I choose teaching tools using AI applications (e.g., stories).	2.06	0.747
5	I prepare presentations using AI applications.	1.73	0.674
6	I collaborate with colleagues to share ideas when planning lessons that use AI tools.	1.97	0.918
7	I analyze the lesson sections for using AI for topics before integrating them into lessons.	1.88	0.927
8	I identify students' prior knowledge to test activities compatible with AI.	1.51	0.781
9	I analyze student interaction with activities and chemistry experiments that employ AI and choose accordingly based on their characteristics and preferences.	1.69	0.728
10	I use AI applications to present real-life chemical examples to introduce the lesson.	1.36	0.728
11	I ask students to collaborate when conducting chemistry experiments and activities using AI tools.	1.91	0.508
12	I implement teaching tasks compatible with AI to enhance students' higher-order thinking skills in learning chemistry.	1.51	0.781
13	I regularly apply the skill of closing chemistry lessons using AI applications such as chatbots to meet students' needs.	1.60	0.650
14	I use procedures to evaluate student learning during chemistry explanations with the use of AI applications.	1.88	0.727
15	I use AI applications to prepare good questions for chemistry lessons.	1.85	0.870
16	I use AI applications to provide detailed reports on chemistry topics that	1.09	0.747

	are difficult for students to understand.		
17	I employ AI activities to assess student understanding in order to achieve learning objectives.	1.88	0.727
18	I use AI applications to develop remedial plans to improve student performance.	1.82	0.857
19	I analyze students' answers using AI applications.	0.94	0.561
20	I use AI applications to help identify students' strengths and weaknesses.	1.46	0.708

درجة ممارسة معلمي الكيمياء لتطبيقات الذكاء الاصطناعي وعلاقتها باتجاهاتهم نحو التدريس

الملخص

تهدف هذه الدراسة إلى بحث مستوى ممارسة معلمي الكيمياء لتطبيقات الذكاء الاصطناعي، والتحقق مما إذا كانت هناك فروق ذات دلالة إحصائية في هذا المستوى من الممارسة، فضلاً عن استكشاف العلاقة بين هذه الممارسة واتجاهات المعلمين. وقد تم اعتماد المنهج الوصفي الارتباطي لكونه يتناسب مع غرض الدراسة وأهدافها. وللإجابة عن أسئلة الدراسة، استُخدمت أداتان: تمثلت الأداة الأولى في استبانة مكونة من 20 سؤالاً تغطي ثلاثة مجالات (التخطيط، والتنفيذ، والتقويم) لتحديد مدى ممارسة معلمي الكيمياء لتطبيقات الذكاء الاصطناعي؛ بينما كانت الأداة الثانية استبانة تهدف إلى قياس اتجاهات معلمي الكيمياء نحو التدريس، وتضمنت 20 مؤشراً. وشمل مجتمع الدراسة جميع معلمي الكيمياء العاملين في المدارس الحكومية التابعة لمديرية التربية والتعليم في منطقة وادي السير، والبالغ عددهم 49 معلماً. تمثلت عينة الدراسة في مجموعة مختارة عشوائياً مكونة من 34 معلماً ومعلمة. وأظهرت النتائج أن مستوى ممارسة تطبيقات الذكاء الاصطناعي لدى معلمي الكيمياء كان منخفضاً، بمتوسط حسابي بلغ 1.65، في حين كانت اتجاهاتهم نحو التدريس متوسطة، بمتوسط حسابي بلغ 2.86. كما أشارت النتائج إلى وجود علاقة خطية طردية ذات دلالة إحصائية بين مدى ممارسة معلمي الكيمياء لتطبيقات الذكاء الاصطناعي واتجاهاتهم نحو التدريس. واستناداً إلى هذه النتائج، يقترح الباحث تنظيم دورات تدريبية متخصصة لمعلمي الكيمياء حول إمكانية تطبيق الذكاء الاصطناعي ودمجه في تدريس الكيمياء. وتدعم هذه النتائج الأدلة التجريبية التي يمكن الاستفادة منها في تنفيذ برنامج للتطوير المهني لمعلمي الكيمياء يركز على توظيف تطبيقات الذكاء الاصطناعي في العملية التدريسية.

الكلمات المفتاحية: ممارسات التدريس، تطبيقات الذكاء الاصطناعي، معلمو الكيمياء،