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Awareness Regarding the Implication of Artificial Intelligence in Science Education among Pre-Service Science Teachers

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This study aimed to identify pre-service science teachers' awareness of employing artificial intelligence in science education. It sought also to determine the reasons that led to this level of pre-service science teachers' awareness of employing AI in science education. The mixed- method was used with an interpretive sequential design. The researcher prepared a measurement and distributed it to all forty-three pre-service science teachers. In terms of the qualitative method, interviews were conducted with a sample consisting of 15 female pre-service teachers. The quantitative study revealed pre-service science teachers' awareness of employing AI in science education low level. The results of the qualitative interviews used to explain the results of the quantitative study. There are statistically significant differences, at a level of confidence of 0.01, between the hypothetical and actual means of the total score of pre-service science teachers' awareness of employing AI in science education, as well as in the case of dimensions. The differences are in favor of the hypothetical mean.

Keywords: artificial intelligence, pre-service, science teachers, science education, teachers' awareness

INTRODUCTION

Our current era is characterized by the rapid technical progress that has had an impact on all areas of life. The machine has been doing many human actions. A'mar and Eleyan (2022) confirm that technology has changed the way people live. Teaching approaches have changed due to advanced technology such as Artificial Intelligence then is (AI) and the internet. Nainggolan et al (2020) add that as a result of the development of Industrial Revolution (IR 4.0) the landscape of educational system has changed dramatically, where it is controlled by artificial intelligence that results student and internet interface faster than before. Artificial intelligence appeared. Many countries sought to employ AI applications in all areas of life. Interest in AI increased after coronavirus pandemic that swept the entire world. Its applications began to appear in many fields, including education. The World AI Summit was held in 2020, reflecting world countries' interest in AI.

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We use AI applications and as a result Google adjusts search results according to our geographic location or previous searches, generally without our knowledge. Amazon website does the same thing when it suggests purchases in the light of what we bought in the past. So is Siri in Apple devices, which adapt to individual voices, needs, and requests (Karsenti, 2019).

The term AI refers to a group of computer science technologies that enable systems to perform tasks that usually require human intelligence, such as visual perception, speech recognition, decision-making, and language translation (Holder, Khurana, & Watts, 2018). The philosophy of AI is based on the machine simulating the human's mind through computer systems so that it is able to learn, collect data, analyze it, find relationships between them, and make decisions. In this way, the machine can think, learn, decide and act like a human being (Mahmoud, 2020; Zarrouki & Falata, 2020).

Artificial intelligence began in the 1950s with funding from the United States Department of Defense. Applications of expert systems began in earnest in the 1970's. Commercial applications of machine learning technologies first appeared in the 1990s. Recent developments in hardware, such as processing speeds and access to large stores of digital data, generated from various sources, have accelerated applications to build a statistical model that can reliably predict results; most current commercial AI applications use machine learning (Murphy, 2019). In order to achieve a more efficient learning environment and to deliver the best learning process, research on many subjects such as mathematics education is focusing on the area of AI (Chien, 2008).

The International Conference on Artificial Intelligence and Education, organized by UNESCO and China, May 16-18, 2019, recommended encouraging fair and comprehensive use of AI in education. The continuous development of technology has led to more interests in AI (UNESCO,2020). This will change the way we go in life, work and education. Hong Kong has already started teaching AI in schools (Wong, 2019).

Through AI, each student's work can be tracked and guided while highlighting his strengths and weaknesses and providing appropriate support (Mahmoud, 2020). AI can help us with data on the student's performance, correct response to each step, the completed educational tasks, and the time spent on completing the tasks, together with the number of errors. Then it determines how to interact with the student to help improve his/her performance and the feedback or instructions needed by the student. Feedback can be immediate or after completing all educational tasks. A remedial educational activity can also be provided (Murphy, 2019). Feedback is not only individualized, but also faster and more frequent; it helps to determine the student's level, and provides special support and recommendations (Karsenti, 2019).

Although all systems provide automatic feedback and support to students and try to adapt content to meet individual student needs, the level of automated support provided by the systems may not be sufficient to support learning of all students. Teachers should review students' progress within smart systems regularly, using system reports on student performance to identify low-achievers at school and who are at risk of dropping

out. They should intervene to help these students before they become frustrated so that they can receive appropriate support before things deteriorate (Karsenti, 2019). Hence, AI applications will not replace the teacher, but rather do some of his/her tasks and help him/her to find enough time for the work that the machine cannot do.

Artificial intelligence provides adaptive learning, whereby AI is used to guide students to learning paths appropriate to their needs, learning style and characteristics. Algorithms adapt in real time to every student interaction. Therefore, the content can be added or removed and the level of difficulty can be changed to suit the student (Karsenti, 2019). Artificial intelligence can decide the teaching strategy that suits the students, changing the teaching strategy according to the students' responses. It is like an expert teacher (Mahmoud, 2020). Expert systems can handle a large amount of information, and provide conclusions; hence, decisions are made (Al-Mutairi, 2019).

Digital learning platforms also allow teachers to personalize and enrich courses, according to the learner's performance, needs, skills, level of interest, etc. Personalized learning is one of the educational benefits of AI that leads to increased achievement and further learning, because AI can provide appropriate exercises for the student to make learning meaningful and enjoyable. Students can perform personal homework assignments that suit their academic skills and challenges that best suit their abilities (Karsenti, 2019). Artificial intelligence can contribute to the development of curricula, as the information's explosion leads to continuously updating lessons and presenting them to students in a manner commensurate with their needs and abilities through AI (Mahmoud, 2020).

Machine learning can be used to determine relationships between student characteristics, from their early school years, for example, school attendance and results, and many early tests. As a result, it is possible to predict when to graduate from high school, or for a student to drop out in the future. Then teachers can intervene to prevent low achievement (Murphy, 2019). Murphy (2019) argues that one the most promising applications of machine learning in education is early warning detection systems for identifying low-achievers and students who are likely to drop out.

Artificial intelligence enables continuous students assessment as learners' experiences are tracked along the learning path in real time to accurately measure their skill acquisition over time. It tells teachers when too many students answer a question incorrectly or do inappropriate work. Teachers can then modify their courses accordingly (Karsenti, 2019). It can also prepare and rate tests, together with making teaching decisions such as the appropriate teaching strategy, learning time, and the next teaching step (Mahmoud, 2020).

Artificial intelligence can be used to auto-rate specific types of schoolwork, saving teachers time for other tasks (unfortunately auto-rating software is often available in English); machine auto-rating is badly needed. Despite the impressive progress made in auto-rating, the human touch remains essential (Karsenti, 2019). A promising application of machine learning in education is the time-consuming essay test auto-rating systems for teachers. As a result, it became possible for many teachers to give

students more essay tests and student writing assignments that will be automatically rated and provide students with timely feedback (Murphy, 2019).

Murphy's study (2019) showed three types of AI-based applications, namely, smart teaching systems that provide adaptive and personalized learning for students; automatic rating of essay tests; and early warning systems for low-achievers. The study recommended that is necessary to focus on applications that benefit from the capabilities of AI to solve important problems in teaching, and to focus on AI applications that are best suited to carry out the repeated tasks of the teacher. In such a way the teacher is devoted to tasks that cannot be automated. Teachers must be able to deal with everyday non-academic issues and problems that originate in the classroom as more advanced AI systems cannot handle (Murphy, 2019).

The use of smart learning platforms for distance learning is a trend that opens exciting opportunities for students and educators alike. They make distance learning more accessible and attractive. People can learn anywhere, and at any time. The interactive three-dimensional virtual reality provided by AI encourages students to integrate with academic subjects. This interactivity has direct positive effects on learning (Karsenti, 2019).

Artificial intelligence programs, such as *leafsnap*, are used to visually identify tree species from smart mobile photos. It also provides detailed information about trees. As schools continue to employ IA, enormous cognitive potential appear, far exceeding its benefits in urging students to learn (Karsenti, 2019). The design of early programs to evaluate writing features has improved rapidly since the mid-1990s thanks to the contribution of artificial intelligence technology which has served positively in the process of natural language and the tutoring of intelligent language system (Chen & Cheng, 2008).

Artificial intelligence is used in deep learning. It is useful for making predictions. So instead of manual coding, the device is given a set of training data and then tasked with sorting massive amounts of data on its own. For example, Facebook and Apple Photos build training datasets from millions of accessed photos, in which they 'learn' to get to know people (Karsenti, 2019).

Deep learning uses interconnected artificial neural networks in terms of layers of algorithms to simulate the capabilities of the human's mind and recognize complex patterns in large multivariate data sets. The deep neural network learns from its errors, by comparing the expected result with the known actual results, and making adjustments to reduce the prediction error (Murphy, 2019).

Artificial intelligence is used for voice recognition, and then used to teach language and provide customized assistance in pronunciation skills. It also helps in better classroom management by integrating students with virtual reality. It can detect, to some extent, learners' moods, which is useful for modifying teaching practices (Karsenti, 2019).

Artificial intelligence cloud technology enables data to be collected, stored, and secured, to capture, organize, analyze, and produce knowledge from vast amounts of data, while

keeping it secure. This addresses both ethical and educational issues. In addition to employing gamification, students with special needs may particularly benefit from AI (Karsenti, 2019).

Artificial intelligence helps to do administrative tasks more efficiently, such as sending newsletters, counting student absences, and so on, which are dealt with quickly and easily. It can do a lot of automated tasks and save a lot of time that is usually spent on important teaching tasks by AI systems (Karsenti, 2019). Sangapu' study results (2018) reveal that teachers and students strongly recommend the use of AI in the classroom.

There is a need to prepare and train teachers in employing AI as it will have a great impact on individuals and societies. Training teachers in the use of AI will help make a real contribution to academic success (Karsenti, 2019). Jannah, Prasojo and Jerusalem's study results (2020) indicated that the main factor in the success of digital learning is teachers' skills, and not the availability of digital equipment. Robots will not replace the teacher, but for all students, the role of the teacher remains central, perhaps more than ever. Smart robots will change schools and we must start preparing for the new reality early (Karsenti, 2019). Humanoid robots play a greater role in the classroom, and act like teacher's assistants by performing complex and time-consuming tasks, which, in turn, is reflected in providing better teaching (Karsenti, 2019).

Similarly, robots have been employed in STEM education: the integration among science, mathematics, engineering, and technology. Countries, including Saudi Arabia, have begun to adopt this education, which includes some applications of AI and robotics. This shows the need to employ AI in science education, as it contained the educational units prepared by the Robotics Teaching Development Company and its employment in learning scientific concepts. This requires teachers' awareness of employing it in science education.

Khanlari's study results (2014) aimed to recognize teachers' perceptions of the importance of robots as a tool for science, technology, engineering and mathematics (STEM) education. It revealed that teachers are aware that robots have the potency to facilitate learning of basic science. Robots have positive effects on students' lifelong learning skills. Almost all teachers agreed that robots can develop interpersonal skills with students. Serholt, and Barendregt's study results (2014) revealed that students were positively oriented towards using humanoid robots in the classroom.

Careful planning of the uses of AI by educational institutions requires starting with science teachers; it is high time to prepare our teachers for that. We cannot ask all teachers to become experts in AI, but they must at least be prepared to work in the schools of the future, to have awareness of employing AI at the same time. We should equip teachers with the tools they will need to build tomorrow's society (Karsenti, 2019). Mahmoud's study (2020) recommended the necessity of employing AI in educational institutions, raising awareness of the positive effects of AI, and training teachers in it. Razrouki and Fallata (2020) recommended the necessity of preparing teachers who are capable of employing AI.

Some studies recommend studying teachers' perceptions towards AI, such as Khanlari (2014) Sangapu (2018), and studying their interest in AI, such as Incerti (2020). Khanlari aimed to recognize teachers' perceptions of the importance of robots as a tool for science, technology, engineering and mathematics (STEM) education, while Sangapu explored the perception of teachers and students on the usage and effectiveness of AI in the classroom. Aldosari (2020) believes that transferring smart products to countries will not work without awareness of many great roles played AI, in terms of its advantages or disadvantages in academic processes, whether administrative procedures or teaching and learning methods. It is recommended to increase the awareness of specialists of the requirements of applying AI in education.

Preparing for the future requires that science teachers are aware of employing AI in science education. Hence, attention should be paid to teachers' awareness of AI and its applications in education. With reference to studies on AI (Khanlari, 2014; Serholt & Barendregt, 2014; Han & SeonKwan, 2018; Sangapu, 2018; Holder, Khurana, & Watts, 2018; Aldosari, 2020; Jannah, Prasojo & Jerusalem, 2020; Incerti, 2020; and Al-Ghamdi & Al-Frani, 2020), it turns out that more studies have to be conducted concerning pre-service science teachers' awareness of employing AI in science education. So, this research aims to study pre-service science teachers' awareness of employing AI in science education.

Research Problem

This research tried to answer the following question:

Q1: What is the level of pre-service science teachers' awareness of employing AI in science education?

Q2: What are the reasons that led to this level of pre-service science teachers' awareness of employing AI in science education?

Research Significance

The significance of this research stems from the following:

1. It deals with an important field of research: use of AI in science education. This research may contribute to shedding light on how AI is used in education.
2. It may help decision-makers and those in charge of science curriculum to make decisions based on scientific study that help to employ AI in science curriculum.
3. It may assist those in charge of professional development programs for teachers in identifying the topics related to AI that pre-service science teachers need.
4. It is considered a response to what educators are calling for regarding the necessity to continuously develop science education in the light of scientific and technical progress.
5. The results of this research may help the leaders of higher education institutions in planning a science teacher preparation program, including the applications of AI in education.

6. The results of this research may lead to presenting opinions and suggestions that could help researchers to conduct research in the field of employing AI in science education.
7. This research may contribute to enriching the library with research related to this field.

Research Limitations

This research was limited to:

1. Time limitations: The research was applied in the first semester of 2020/2021 academic year.
2. Place limitations: The research was applied to pre-service science teachers enrolled in the Department of Basic Education, majoring in science, College of Education, Qassim University.

Research Terms

Artificial intelligence

Murphy (2019, p. 2) defined AI as "the applications of software algorithms and techniques that allow computers and machines to simulate human perception and decision-making processes to successfully complete tasks." Pokrivcakova (2019, pp. 136-137) adopted the following definition of AI as "computer systems that have been designed to interact with the world through capabilities (for example, visual perception and speech recognition) and intelligent behaviours, for example, assessing the available information and then taking the most sensible action to achieve a stated goal.

Awareness

Al-Laqani and Al-Jamal (1996, p. 204) defined awareness as "a strong emotional feeling that directs many aspects of the behavior of the individual. Awareness is formed through the educational work stages in the various stages of education. The more mature and steady awareness is, the more amenable it is to support and direct rational behavior in the desired direction."

The awareness of employing AI can be defined operationally as "the awareness of science teachers and their knowledge of the importance of AI in science education, and the characteristics AI, together with how to employ AI in science education; and the obstacles to employing it. It measured by the scale prepared for this purpose."

METHOD

Research Method

Qualitative data were read five times, carefully and thoroughly, understanding content, and extracting ideas and concepts included in the interview. The qualitative data were coded and the ideas and reasons included in the interviews were monitored more than once to ensure the clarity of the ideas and the meaning of the sentences. The data were written, classified and arranged, and similar reasons were listed. In order to ensure

mutual truthfulness indicators, conclusions were discarded from describing what the study participants said upon the interview. Some clarifications were made about some ideas that were put forward to unify their understanding and clarify their formulation.

In the current research, a mixed approach and an explanatory sequential mixed design were used. A mixed approach collects quantitative and qualitative data and combines them using different research designs in order to gain a deep understanding of the research problem. Furthermore, the mixed approach combines the strengths of both quantitative and qualitative research, avoiding shortcomings in both. It helps in a deeper understanding of quantitative results. Interpretive sequential design is intended as a mixed design that includes two stages: the researcher collects quantitative data, analyzes it and uses it in planning to collect qualitative data and analyze it accordingly (Creswell, 2014, 2019). Quantitative data are collected using the descriptive survey approach, which aims to describe the reality of the studied phenomenon in terms of its nature and degree of presence (Al-Assaf, 2016), using the awareness scale for employing AI applications in science education. This was followed by a wide interpretation of the data through the collection of more detailed qualitative data with the intention of interpreting the results of the quantitative survey. The results of the quantitative data were used in designing the qualitative study and in determining the intended qualitative study sample and determining the interview questions, which are general open questions. The qualitative study sample was chosen from within the quantitative study sample. The quantitative study sample included all the research population in order to avoid the challenges facing this sequential design to achieve a good mixed explanatory study. Ethical considerations were taken into account when collecting the qualitative study data, as the purpose of the study was clarified. The names of the study sample would not be mentioned. Recoding the interview was clarified (Creswell, 2014/ 2019).

Research Instrument

The researcher prepared a pre-service science teachers' awareness scale by employing AI in science education. After reviewing many studies that dealt with employing AI in science education (Al Saud, 2017; Karsenti, 2019; Murphy, 2019); studies that dealt with measuring awareness (Al-Sharif, 2018; Abdul-Samad, 2006; Alyan, 2017; Abdel-Qader, 2008; Abdul-Razzaq & Hammoudi, 2015; Yahya & Hamdi, 2011); studies that dealt with teachers' perceptions such as (Khanlari, 2014; Han, & SeonKwan, 2018; Serholt & Barendregt, 2014; Holder, Khurana, & Watts, 2018; Sangapu, 2018). The scale was formed as consisting of four axes: awareness of the importance of AI in science education, awareness of the characteristics AI, awareness of how to employ AI in science education, and awareness of the obstacles to employing AI in science education. The scale's questions were formulated from the type of multiple choice, taking into account their suitability for the target group. The initial form of the scale was prepared and presented to a group of jurors to ensure the apparent validity of the scale. The wording of some statements was modified, according to the opinions of the jury.

The scale was applied to a sample of 43 female teachers in order to measure the reliability and validity of the scale. The internal consistency of the scale questions in each of its dimensions was verified to ensure the homogeneity and coherence of the

scale questions in each dimension with each other, by using the Pearson Correlation Coefficient in measuring the correlation coefficients between the score of the question and the total score of the concerned dimension. The correlation coefficients were as shown in Table 1:

Table 1
Correlation coefficients between the scores of the scale questions and the total score of the concerned dimension

Awareness of the importance of AI in science education		Awareness of the characteristics AI		Awareness of how to employ AI in science education		Awareness of the obstacles to employing AI in science education	
No.	Correlation	No.	Correlation	No	Correlation	No	Correlation
1	0.471**	1	0.594**	1	0.505**	1	0.444**
2	0.527**	2	0.756**	2	0.618**	2	0.608**
3	0.578**	3	0.536**	3	0.335*	3	0.566**
4	0.426**	4	0.511**	4	0.635**	4	0.349*
5	0.537**			5	0.395**	5	0.573**
6	0.390**	5	0.546**	6	0.375**	6	0.418**
7	0.474**			7	0.347*		
8	0.593**	* Significant at 0.05 confidence level, ** significant at 0.01 confidence level					

Table 1 shows that the correlation coefficients between the scores of the scale questions and the total score of the dimension to which the question belongs are positive correlation coefficients and statistically significant at the level of 0.01 or 0.05. This confirms the homogeneity and coherence of the scale questions in each dimension of the scale. The homogeneity of the sub-dimensions of the scale was also confirmed by measuring the correlation coefficients between the scores of each dimension and the overall score of the scale, so the correlation coefficients are shown in Table 2:

Table 2
Correlation coefficients between the scores of the scale dimensions and the total score of the scale

Awareness of the importance of AI in science education	Awareness of the characteristics AI	Awareness of how to employ AI in science education	Awareness of the obstacles to employing AI in science education
0.834**	0.590**	0.568**	0.595**

Table 2 shows that the correlation coefficients between the scores of the sub-dimensions of the scale and the total score are positive correlation coefficients and statistically significant at the level of 0.01. This confirms the homogeneity and coherence of the scale dimensions.

The validity of the scale was ascertained by using discrimination factors and the ability of each question to distinguish between highs and lows in the awareness of employing AI in science education; The difficulty factor refers to the ratio of the number of wrong

answers to the number of correct and wrong answers in each question. The best questions have difficulty coefficients range between 0.1 and 0.9. As for discrimination coefficients, the value of discrimination coefficients ranges between (-1, +1). The discrimination of the question is considered low if it is less than 0.2. When the discrimination coefficient is zero, it indicates the lack of ability of the item to distinguish. When discrimination coefficient is one, the item is completely discriminant. The difficulty and discrimination factors for each of the test questions are shown in Table 3.

Table No. 3
Difficulty and discrimination coefficients for the scale questions

Awareness of the importance of AI in science education			Awareness of the characteristics AI			Awareness of how to employ AI in science education			Awareness of the obstacles to employing AI in science education		
No.	Difficulty coefficient	Discrimination coefficient	No.	Difficulty coefficient	Discrimination coefficient	No.	Difficulty coefficient	Discrimination coefficient	No.	Difficulty coefficient	Discrimination coefficient
1	0.744	0.455	1	0.419	0.545	1	0.395	0.455	1	0.698	0.727
2	0.395	0.636	2	0.512	0.455	2	0.721	0.818	2	0.558	0.545
3	0.628	0.545	3	0.512	0.727	3	0.791	0.818	3	0.349	0.818
4	0.605	0.545				4	0.395	0.636	4	0.674	0.545
5	0.535	0.909	4	0.651	0.545	5	0.767	0.545	5	0.558	0.636
6	0.419	0.545				6	0.767	0.636			
7	0.558	0.545	5	0.674	0.636	7	0.698	0.636	6	0.767	0.727
8	0.698	0.727									

Table 3 shows that the scale questions have acceptable difficulty coefficients, where the difficulty coefficients for the scale questions ranged between 0.349 and 0.767. Moreover, Table 3 shows that the scale's questions clearly and significantly distinguish between highs and lows in awareness of employing AI in science education. The discrimination coefficients for the scale's questions ranged between 0.455 and 0.909. This confirms the validity of the scale in terms of the ability to distinguish.

The reliability of the scale was confirmed by the method of Kuder-Richardson (KR-20), and the reliability coefficients are shown Table 4:

Table 4
Reliability coefficients for scale scores and its sub-dimensions

Scale	Awareness of the importance of AI in science education	Awareness of the characteristics AI	Awareness of how to employ AI in science education	Awareness of the obstacles to employing AI in science education	Scale as a whole
Kuder-Richardson	0.801	0.822	0.830	0.789	0.855

Table 4 shows that the scores of the current scale and its sub-dimensions are good and statistically acceptable reliability coefficients. It is confirmed that the awareness scale of employing AI in science education has reliable statistical indicators, which confirms the validity of its use in the current research.

3- The original population and the research sample:

The research population consisted of pre-service science teachers, No. 43, from the Division of Basic Education, majoring in Science, College of Education, author's University. The pre-service science teachers' awareness scale was applied by employing AI in science education for all the research population. A targeted sample was selected for the qualitative study consisting of 15 pre-service female teachers from the study quantitative study.

FINDINGS

Quantitative Study Results

It was evident from the demographic data in the scale that all pre-service science teachers did not attend AI training courses. To answer the research question, the One Sample t-test was used to compare the mean scores of a sample with a hypothetical mean in order to identify the pre-service science teachers' awareness of employing AI in science education. The hypothetical mean for each dimension of the scale was determined as (0.5 × the number of questions in each dimension). The scores for answering the scale questions are (0, 1). Based on that, the results are shown in Table 5:

Table 5
The significance of the differences between the hypothetical and actual means of the pre-service science teachers' awareness of employing AI in science education (degree of freedom = 42)

Awareness	Hypothetical mean	Actual mean	Std. Deviation	"T" value and its significance	Availability ratio	Awareness level	rank
Awareness of the importance of AI in science education	4	3.366	1.997	-2.033**	42.075%	Low	1
Awareness of the characteristics AI	2.5	1.951	1.203	-2.921**	39.020%	Low	2
Awareness of how to employ AI in science education	3.5	1.463	1.076	-12.135**	20.900%	Very Low	4
Awareness of the obstacles to employing AI in science education	3	2.073	1.367	-4.340**	34.550%	Low	3
Total score of awareness	13	8.854	3.870	-6.860**	34.054%	Low	

Table 5 shows that there are statistically significant differences, at a level of confidence of 0.01, between the hypothetical and actual means of the total score of pre-service science teachers' awareness of employing AI in science education, as well as in the case of dimensions. The differences are in favor of the hypothetical mean. This confirms that the percentage of awareness among students does not reach 50%. This confirms that the pre-service science teachers' awareness of employing AI in science education is low, with a marked decrease in awareness of how to employ AI in science education.

Discussion and Interpretation of Quantitative Study Results

The results confirmed the low level of pre-service science teachers' awareness of employing AI in science education, with a marked decrease in awareness of how to employ AI in science education. This result is similar with Aldosari (2020) and Holder, Khurana, and Watts (2018), as well as Incerti (2020), indicating that using AI in the classroom is limited. Moreover, Al-Ghamdi and Al-Frani (2020) showed that the knowledge and skill in using educational applications of AI techniques is limited. Al-Mutairi (2019) concluded that practitioners are less aware of the importance of AI, together with poor training in AI.

These results may be due to the failure to address the employment of AI applications in the program of preparing science teachers in basic education. In reference to the study plan of the program and the educational techniques course, it was found that they do not include topics on AI and its use in education in general or its use in science education in

particular. These results may also be attributed to the non-enrollment of pre-service science teachers in training courses on AI, as it became clear that the attendance rate for training courses on AI was 0%.

Data Collection

In order to explain the quantitative research results and answer the second question of the research, qualitative interviews were conducted with a targeted sample consisting of 15 female pre-service teachers in order to explain the reasons for the low level of pre-service science teachers' awareness of employing AI applications in science education. The purpose of the interviews was determined; the questions were formulated; the intended study sample was chosen; and ethical considerations were adhered to when conducting the interview. The sample consent was taken; the date of the interview was set. The interviews were done individually. The interviewees were informed of the aim of the study and the importance of their responses. They were told that their answers would be treated confidentially and used for research purposes only. The interview began by thanking interviewees for accepting to be interviewed, providing a suitable environment for the interview. The interview provided a relationship based on respect and familiarity between the researcher and the interviewees, informing them that their answers to the interview questions will be recorded. The accuracy of the recording has contributed to good documentation, and the possibility of taking direct quotes from the interviews. Their responses were written down clearly and without bias. Clarification is only made when they do not understand what is asked. Their answers were presented to them after completing the interview to check their answers. At the end of each interview, the interviewees were given an opportunity to delete or add.

After reviewing the qualitative data five times, coding them, and then arranging the reasons in terms of the most frequent for the qualitative study sample. To ensure validity and reliability, four criteria of validity were used: verifying the answers during the interviews; presenting other reasons that the researcher did not address when interpreting the results of the quantitative study; making use of peers as the data was coded by an Associate Professor in Curriculum and Science Education, Princess Noura Bint Abdulrahman University. The agreement rate in coding was 85% and this percentage is more than 80% which Creswell (2014/2019) believes is an acceptable percentage; the research has been submitted to an external juror (Professor in Curriculum and Science Education). The reliability of the results was ensured by comparing the results and codes, verifying the raw data, and making sure that there was no disagreement in the coding system. Table 6 shows the results:

Table 6
Reasons for the low awareness of AI that were deduced from the qualitative interviews

Reasons	Frequency	Examples of quotations
Not studying AI and its applications in public education and university	10	I studied in college for four years and we did not study it, even in intermediate school and high school, we did not have any practice related to it.
Lack of training in AI based on training courses	6	We did not have training in it No one gave us any information in terms of any courses or related material
Lack of motivation and passion in learning it	5	Some people have information about it because they have love and passion that make them enrich their information and research AI. Lack of motivation to develop, rather they resort to the usual means. Low motivation to learn something new.
Not researching and reading about it in terms of self-learning	3	We do not try to find and explore new methods
Unaware of its importance	3	Because they do not realize its importance; therefore, they are not eager to learn about it
Faculty are not interested in it	1	Faculty did not give it attention. They did not teach us about AI. There is a unit in the book about AI. They bypassed this unit.
Lectures are not enriched with AI	1	A lack of enrichment given by the teachers; therefore, the students were not affected by it
It may be attributed to financial reasons and its cost is unavailable.	1	Cause of low awareness can be attributed to budget
One teacher stated that she did not actually see it employed in reality.	1	No one applied it to us. We did not see it on the ground
Another teacher said that it is due to not practicing teaching	1	I did not practice teaching nor have explored new things
Another teacher mentioned the lack of applications of AI in education.	1	There are things that serve us with AI
For the modernity of AI	1	It is a new and not widespread science

Clearly, one of the most important reasons for pre-service science teachers' low awareness is that they did not study AI and its applications. It became clear that 67% of the qualitative study sample mentioned this reason. One of the most important reasons for pre-service science teachers' low awareness is that they are not trained in it in terms of training courses. This is confirmed by the results of the quantitative study. It is obvious that all the research population did not enrol in training courses on AI. The qualitative study sample indicated that one of the reasons for the low awareness is that they do not research nor read about it. It is also due to their lack of awareness of its importance; the lack of interest of the faculty members in it; and the lack of enrichment of the lectures on AI. It may be attributed to financial reasons and the unavailability of funds. One teacher stated that she did not actually realize it in reality. One teacher mentioned that she did not practice the teaching profession. Another teacher mentioned that there are no applications for AI in education; another reason is the modernity of AI. The teachers indicated that they were researching for information about AI after responding to the scale. They expressed their desire to identify it. Another teacher

mentioned she thought that AI is only used in games. Another wondered if her concept of AI was correct.

Mixed Methods Integration

The quantitative results revealed a decrease in pre-service science teachers' awareness of AI. The results were interpreted. Qualitative interviews agree on two reasons, namely the lack of study of AI and the lack of enrolment in training courses. However, they revealed other reasons for the decline in awareness that the researcher did not address, which was previously referred to as a lack of research by teachers about new technologies. It is noted that teachers are responsible for learning new technologies based on their belief in their ability to learn technology. Among the reasons for the low awareness is the lack of motivation and passion for AI, which will direct their behavior towards research and learning about AI.

DISCUSSION

Planning for education requires identifying science teachers' awareness of AI to open the way for employing it in science education. Artificial intelligence provides us with a lot of capabilities that we need to employ with the digital generation that does not do without technology. The quantitative study revealed a decrease in the awareness of science teachers about AI. When explaining the reason for the decrease in awareness, the researcher attributed it to two reasons, namely the lack of study of AI and the lack of enrollment in training courses. However, the qualitative study revealed other reasons for the decline in awareness that the researcher did not address, which was previously referred to. Perhaps this sheds light on the importance of collecting qualitative data that may help to identify the causes of low awareness of AI and then address it.

CONCLUSION

The increasing acceleration and steady progress in the applications of AI in education is observed, as its applications in education are increasing day by day. This urges us to educate science teachers about this technology and how to employ it so that they are ready to benefit from it. It was evident from the results of the research that the awareness of pre-service science teachers is low. This urges people responsible for science education, to pay attention to educating science teachers about employing AI in education, and updating them on the most recent information about AI. Identifying the reasons for the low awareness of teachers helps us to try to overcome them, and then spread awareness of employing AI in science education. This may urge science teachers to research for everything new in the field of employing AI in science education.

RECOMMENDATIONS

Based on the previous results, the researcher recommends the following:

1. Spreading awareness among teachers about employing AI through forums, lectures and seminars.
2. Training teachers in employing AI applications in science education.

3. Inclusion of AI and its use in science education in the preparation of science teachers program.
4. Directing specialists and AI experts to provide attention to AI applications in teaching science in Arabic.
5. Providing teachers with guides for using AI applications in teaching.

In the light of the results of the current research and based on the fact that the value of scientific research depends on the research problems it raises, the researcher proposes the following future studies to complement and continue the current research:

1. Conducting a study on textbook analysis to uncover issues related to AI and its applications.
2. Conducting a study on the effectiveness of a proposed training program for developing the competencies of employing AI in science education.
3. Conducting quasi-experimental studies on the effectiveness of employing AI in science education.

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