



Research Article

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A Proposal for Virtual Laboratories in Learning Biology for Secondary School Curriculum

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Abstract

The study aimed to identify the extent of biology teachers' awareness regarding the importance of virtual laboratories in teaching biology for secondary school. It also intended to develop a proposal to enable biology teachers to use virtual laboratories in teaching secondary level. To achieve these aims, the descriptive-analytical approach was used. The research sample consisted of fifty female biology teachers at the secondary level in the city of Al-Kharj. The study applied the questionnaire as its main tool to gather data. The study concluded that the degree of awareness among female biology teachers regarding the importance of virtual laboratories in teaching biology for the secondary level was found at a moderate level. Besides, the ability of female biology teachers to use virtual laboratories in teaching biology for the secondary stage was low. Considering these results, a proposal was developed to enable female biology teachers to use virtual laboratories in teaching biology for secondary school.

Keywords: Female biology teachers, Virtual laboratories, Secondary school level

1. Introduction

The current age is witnessing rapid progress in the field of educational technology. This has made it easier for many students to receive their education anywhere and anytime. It has made it possible for students to attend lectures and implement experiments in places far from the lecturing place. Moreover, they can carry out scientific experiments that they have missed through virtual laboratories. In this approach, the technology in education offers a field that gives all students the scientific and technical knowledge to be able to keep pace with contemporary developments and acquire various skills that expand their intellectual perceptions and expand their knowledge. The use of educational technology in implementing virtual experiments has become one of the important concerns. Educational institutions need to pay attention because it provides an excellent alternative to known laboratories. It is providing students with experiences and skills. Furthermore, educational technologies offer students a great ability to visualize many concepts that are challenging to imagine realistically. It provides the students with an interesting interactive climate that allows them to practice scientific experiments gradually.

The virtual laboratories are considered as interactive e-learning and teaching environment,

through which scientific experiments may conduct virtually or remotely (Keller and Keller, 2005). It simulates the real application of the experiment. The researcher procedurally defines those laboratories as a virtual learning environment. It implements the applied experiments related to biology, which may not be available. It allows the students to use their skills and develop their cognitive abilities by participating in experiments step by step and repeating these by any number of times as per their requirements. The use of the virtual laboratory allows synchronization between the process of explaining theoretical ideas and the scientific application. The actual scientific experiments are linked to a separate laboratory schedule from the theoretical lectures. So the experiment can be repeated in any number according to the students' comprehension ability without having a watchdog offering the possibility to interact with others in conducting the experiments. This encourages students' integration into the learning process. Its importance has been proven by many studies that dealt with the use of virtual laboratories (Al-Bawi and Salem, 2017; Al-Dulaimi, 2018; Al-Da'ajah, 2018; Nael, 2018; Hussain and Aady, 2019; Babateen, 2011; Tatli and Ayas, 2013; Herga et al., 2014; Nikoonezhad et al., 2015; Sari and Yilmaz, 2015).

Based on the above-mentioned discussions, the importance of using virtual laboratories in teaching scientific materials is presented. It contributes to achieving ideal academic performance and educational outcomes from students through actual and virtual practice. Otherwise, in most cases, it requires expensive equipment or an increase in the number of classes to enable science teachers to explain and implement it. Therefore, it is important to shed light on the awareness of female biology teachers regarding the importance of this technique in teaching biology. It is one of the important scientific materials that broaden the student's knowledge and connect this knowledge with real-life experience because of the importance of the topics it contains. Considering this, a proposal is suggested to enable female biology teachers to use virtual laboratories in teaching biology at the secondary school level.

It has been experienced and noticed by the researchers that there is a deficiency in using virtual laboratories in teaching biology and carrying out scientific experiments related to such laboratories. This may be due to the low level of their application skills among female biology teachers or their lack of awareness regarding the importance of using them in teaching biology and its impact on the development of many skills and abilities among female students. Besides, the researcher has found that many high schools have not dedicated equipped laboratories to use as virtual laboratories. The female students do not have any skills or knowledge to use these classes. This was also confirmed by the study of Alian and Al-Ghatim (2017) in the case of Saudi Arabia. It was concluded that there was a deficiency in the application of virtual laboratories in teaching scientific subjects such as biology, physics, and chemistry. It emphasized the necessity of providing training needs for the use of virtual laboratories for science teachers in general. This exploratory study aimed to identify the reality of the extent to which female biology teachers were using the virtual laboratories in teaching biology to the secondary school level. The study distributed a pilot questionnaire of 15 female biology teachers. The results of the study are summarized in Table 1.

Table 1: Results of the pilot study to identify the extent of reality of using virtual laboratories by female biology teachers in teaching biology at the secondary school level.

S.N.	Main Axes	Yes		No	
		numbers	%	numbers	%
1	I conduct experiments with virtual labs.	2	13	13	87
2	I have the skills to use virtual laboratories.	4	27	11	73
3	The school has technical tools and equipment that facilitate the use of virtual classrooms.	7	47	8	53
4	There are not enough classes for neighborhoods to apply experiments with virtual classes.	15	100	-	-

Table (1) shows that there was a deficiency in using virtual laboratories in teaching biology. To cope with the situation, this research was designed to find “how aware are the female biology teachers regarding the importance of using virtual laboratories for biology teaching in the secondary school level?” and “what is the proposed perception for using virtual laboratories in teaching biology at the secondary school level?”. To investigate these questions, the research is aimed to identify the awareness of female biology teachers regarding the importance of using virtual laboratories in biology teaching for secondary school. Moreover, this research is intended to develop a proposal to enable female biology teachers to use virtual laboratories in biology teaching for secondary school level.

This research plays an important role in drawing the attention of educational leadership to the need for virtual laboratories in scientific experiments included in biology curricula for secondary school level. It is a vital aspect of the improvement of students' academic performance and outcomes. It highlights the importance of virtual laboratories in teaching biology. This helps in spreading awareness among biology teachers for the need of these laboratories to carry out scientific experiments in biology for the secondary school level. Besides, it helps students implementing many biological experiments that cannot be applied in real-life settings. This contributes to improving their cognitive skills by experimenting step by step and repeating it with any number of times. Moreover, it provides scientific grounds for other research that sheds light on the use of virtual laboratories in teaching scientific subjects in which many experiments are applied.

The literature is limited to study the female teacher's extent of awareness regarding the importance of virtual laboratories in biology teaching at the secondary school level. Considering this, a proposal was developed to enable only female biology teachers to use virtual laboratories in teaching biology. And, we applied it to a sample of biology female teachers in Al-Kharj city in Saudi Arabia. It was carried out in the academic year 2019-2020. There is a dire need to expand the research for both genders in the future. Moreover, it should be carried out over more cities of the Kingdom to achieve more reliability of the results.

2. Research Procedures and Methodology

The research has used the descriptive-analytical approach. It represents a perception of the current situation by collecting data from the original population or the selected curriculum. The data is analyzed and classified neutrally. It proposes the hypotheses and outcomes that can be applied to the community in which the research was conducted. Therefore, this approach is suitable for the research topic that aims to present a proposal for using virtual laboratories in teaching biology at the secondary school level. The research community consists of all female biology teachers in the secondary school stage in Al-Kharj city for the year 2019-2020. The research sample was randomly selected from the biology teachers of the secondary school stage in Al-Kharj city. It has consisted of fifty female teachers.

Based on the nature of data and the approach used in the research, the researcher found that the most suitable tool to achieve the objectives of this research was a questionnaire. It was designed by analyzing literature and previous studies related to the research topic. The procedure for preparing the questionnaire consists of two aspects. The first aspect deals with the primary data of the research sample. The second aspect consists of 23 paragraphs explaining the awareness of female biology teachers regarding the importance of using virtual laboratories in biology teaching for the secondary school stage. The researcher has used the five-point Likert scale i.e. very high (5), high (4), average (3), low (4), and very low (5) for all paragraphs.

The search tool was set to calculate its validity. A questionnaire's validity means to make sure that it is suitable to measure the targeted objects. It implies that the research tool includes all the elements that the research should contain on the one hand. Moreover, the clarity of its paragraphs and vocabulary should be ensured on the other hand, so that, it is understandable for users. The researcher confirmed the questionnaire's validity through the questionnaire's virtual validity (experts' validity). The researcher presented the questionnaire to 10 experts in biology as faculty members in a university comprising of associate professor, assistant professor, supervisors, and lecturers to express their

opinions according to the suitability and comprehensiveness of the primary data variables, the importance, and clarity of the paragraphs' formulation. They asked their agreement to the extent of its ability to measure the hypothesized objects and their scale. Considering the resulting amendments, suggestions, and observations from the experts, the necessary adjustments have been made to ensure that the questionnaire becomes clear and appropriate for measurement. Moreover, the questionnaire's internal consistency was calculated by using the Pearson Correlation Coefficient between the score of each paragraph, and the total score of the questionnaire in Table 2.

Table 2: Pearson correlation coefficient between the result of each paragraph and the overall questionnaire's score

Item No.	Correlation Coefficient	Item No.	Correlation Coefficient	Item No.	Correlation Coefficient	Item No.	Correlation Coefficient
1	**0.54	7	**0.49	13	**0.58	19	**0.84
2	*0.30	8	**0.50	14	**0.70	20	**0.80
3	*0.31	9	**0.47	15	**0.75	21	**0.65
4	**0.47	10	*0.32	16	**0.73	22	**0.75
5	**0.49	11	**0.45	17	**0.79	23	**0.80
6	*0.33	12	**0.72	18	**0.77		

* Statistically significant at (< 0.05).

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Table 2 shows that the correlation coefficient between the score of each paragraph and the overall score of the questionnaire is statistically significant. It indicates the consistency of the questionnaire's axes and its validity for application to the research sample. The questionnaire reliability was calculated using Cronbach's alpha coefficient. It was found that the overall reliability coefficient for all paragraphs was high reaching 0.88, which is statistically acceptable. After ensuring the internal consistency's validity and reliability of the questionnaire, the questionnaire was distributed to the sample to collect data from their responses to the questionnaire's paragraphs. Then the questionnaires were collected back, and responses were analyzed statistically. To achieve the research objectives and to analyze the collected data, the data were processed statistically using the Statistical Package for Social Sciences (SPSS) program.

After that, the researcher collected data and entered it into the computer to determine the scale's length i.e. the lower and upper limits. The range ($5-1= 4$) was calculated, then divided by the number of the five scales to obtain the item's length ($4/5=0.8$). Then this value was added to the lowest value in the scale (1) to determine the scale's upper limit and so on. Here, a level (1-1.80) represents a very low score for each statement depending on the axis to be measured, (1.81 - 2.60) represents a low score for each statement depending on the axis to be measured, (2.61-3.40) represents an average score for each statement depending on the axis to be measured, (3.41 to 4.20) represents a high score for each statement depending on the axis to be measured and (4.21-5.00) represents a very high score for each statement depending on the axis to be measured. After that, the following statistical procedures were calculated: Cronbach's Alpha to measure the questionnaire's reliability, repetitions, percentages, arithmetic means, and standard deviations of the questionnaire statements and Pearson correlation coefficient to verify the validity of the questionnaire's internal consistency. The results were concluded, and a proposal was developed in light of the results obtained for using virtual laboratories in teaching biology for the secondary school stage. Moreover, future recommendations were made in light of the results.

3. Data Analysis

The first research question was "How aware are female biology teachers regarding the importance of

using virtual laboratories for biology teaching in secondary school?". The researcher calculated the frequencies, arithmetic means, standard deviations, and percentages for the responses of the sample to this question. Table 3 presents the results.

Table 3: Arithmetic means, standard deviations, and percentages of the female biology teachers' awareness regarding the importance of using virtual laboratories for biology teaching in secondary school

No.	Para.	Very High		High		Average		Low		Very Low		Average	Standard D.	Prevailing opinion	Rank
		Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage				
1	I Use simulation software for a virtual lab.	11	22	4	8	10	20	9	18	16	32	2.70	1.54	Very Low	15
2	I have a background on the components and tools of virtual labs.	6	12	5	10	16	32	13	26	10	20	2.68	1.25	Average	16
3	I have a background in how to work in a virtual lab.	6	12	3	6	11	22	13	26	17	34	2.36	1.33	Very Low	22
4	I can manage virtual labs.	14	28	3	6	7	14	19	38	7	14	2.96	1.47	Low	12
5	I Use the graphing software of a virtual lab in teaching biology.	11	22	5	10	10	20	11	22	13	26	2.88	1.51	Very Low	13
No.	Para.	Very High		High		Average		Low		Very Low		Average	Standard D.	Prevailing opinion	Rank
		Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage				
6	Students have skills that help them use virtual classrooms to study biology.	9	18	2	4	10	20	22	44	7	14	2.68	1.30	Low	17
7	I notice the performance of each student in the virtual lab while teaching biology.	8	16	2	4	12	24	19	38	9	18	2.62	1.29	Low	19
8	I have teaching skills suitable for virtual classrooms.	8	16	3	6	15	30	17	34	7	14	2.76	1.25	Low	14
9	There are tools and educational materials suitable for teaching biology in virtual classrooms.	13	26	5	10	15	30	7	14	10	20	3.12	1.48	Average	10
10	The school environment encourages the use of virtual labs.	11	22	8	16	16	32	7	14	8	16	3.14	1.36	Average	6
11	Virtual laboratories in biology teaching require a technical supervisor to facilitate the communication process between teachers and students.	14	28	5	10	11	22	13	26	7	14	3.12	1.44	Very High	8
12	Virtual labs provide an opportunity for a student who has been unable to attend the lab classes used for scientific.	17	34	9	18	8	16	11	22	5	10	3.44	1.42	Very High	3
13	Virtual classes help students accomplish some laboratory assignments in their homes.	23	46	11	22	4	8	8	16	4	8	3.82	1.38	Very High	1
14	I use the virtual lab to conduct some experiments in biology with tools that are not available in the school.	9	18	2	4	11	22	14	28	16	32	2.58	1.40	Very Low	20
15	I can explain more than one experiment in one class using virtual classes.	14	28	5	10	6	12	18	36	7	14	3.02	1.48	Very Low	11
16	I use virtual classes to apply some of the skills learned in situations that a student may not have the opportunity to apply in a real environment.	7	14	2	4	11	22	14	28	16	32	2.42	1.34	Very Low	21
No.	Para.	Very High		High		Average		Low		Very Low		Average	Standard D.	Prevailing opinion	Rank
		Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage	Repetition	Percentage				
17	Virtual classes help solve overcrowding while conducting some experiments.	17	34	2	4	10	20	13	26	8	16	3.14	1.53	Very High	7
18	Virtual classes give a significant ability to visualize many concepts that are difficult to realistically imagine, such as germination and photosynthesis.	14	28	5	10	11	22	13	26	7	14	3.12	1.44	Very High	8
19	Students can study various biological phenomena that are very difficult to observe and experiment with, such as malaria's life cycle and the fungus reproduction on bread mold.	14	28	9	18	8	16	11	22	8	16	3.20	1.47	Very High	5
20	With this technology, it is possible to replace some equipment that is difficult to provide in laboratories, such as an electron microscope, so that the student can study the composition and reproduction of bacteria and viruses.	16	32	11	22	6	12	10	20	7	14	3.38	1.47	Very High	4
21	Virtual classes provide an interesting and interactive science atmosphere.	16	32	9	18	21	42	3	6	1	2	3.72	1.05	Average	2
22	Virtual classes help to overcome the shortage of time in biology class to conduct many types of experiments.	15	30	3	6	13	26	11	22	8	16	3.12	1.47	Very High	9
23	There is a clear plan by the Ministry of Education to use virtual classrooms in biology teaching.	9	18	2	4	11	22	18	36	10	20	2.64	1.35	Low	18
Overall Average												2.98	1.39	Average	

Table 3 shows that the arithmetic averages of the paragraph of this axis ranged from 2.36-3.82. It falls between two categories i.e. low and high. The overall mean was 2.98. These results show the awareness among female biology teachers regarding the importance of using virtual laboratories in teaching biology for the secondary school level with an average degree. The results of the responses on most of the questionnaire's paragraphs showed the awareness of female biology teachers regarding the importance of using virtual laboratories in teaching biology to a significant extent. The highest five paragraphs in the questionnaire according to the responses came in the order of the highest arithmetic mean and lowest standard deviation.

The paragraph "virtual classes help students accomplish some laboratory assignments in their homes" came in the first rank with an average of (3.82) and a standard deviation of (1.38). The paragraph "virtual classes provide an interesting, interactive science atmosphere" came in the second rank with an average of (3.72) and a standard deviation of (1.05). The paragraph "virtual labs provide an opportunity for a student who has been unable to attend the lab classes used for scientific" came in the third rank with an average of (3.44) and a standard deviation of (1.42). The paragraph "with this technology, it is possible to replace some equipment that is difficult to provide in laboratories, such as an electron microscope, so that the student can study the composition and reproduction of bacteria and viruses" was in the fourth rank, with an average of (3.38), and a standard deviation of (1.47). Lastly, the paragraph "students can study various biological phenomena that are very difficult to observe and experiment with, such as malaria's life cycle and the fungus reproduction on bread mold" was in the fifth rank with an average of (3.20) and a standard deviation of (1.47).

Although the results showed the low ability of female biology teachers to use virtual laboratories in biology teaching for the secondary school level. The lowest-ranked five paragraphs in the questionnaire according to the response of the research sample came in the order of the highest arithmetic mean and lowest standard deviation. The paragraph "there is a clear plan by the Ministry of Education to use virtual classrooms in biology teaching" ranked eighteenth with an average of (2.64) and a standard deviation of (1.35). The paragraph "I notice the performance of each student in the virtual lab while teaching biology" ranked nineteenth with an average of (2.62) and a standard deviation of (1.29). The paragraph "I use the virtual lab to conduct some experiments in biology with tools that are not available in the school" ranked twentieth with an average of (2.58) and a standard deviation of (1.40). The paragraph "I use virtual classes to apply some of the skills learned in situations that a student may not have the opportunity to apply in a real environment" ranked twenty-first with an average of (2.42) and a standard deviation of (1.34). Lastly, the paragraph "I have a background on how to work in a virtual lab" ranked the twenty-second with an average of (2.26) and a standard deviation of (1.33).

The researcher believes that this is due to the lack of training courses for male and female teachers that support the use of virtual laboratories in teaching scientific subjects including biology. Also, it is due to the shortage of tools and means in the school that contribute to facilitating the process of using virtual labs in teaching biology. Besides, it is because of a lack of sufficient skills in students to use virtual labs. There are no training courses or educational publications that explain teachers and students to work in these classes. Therefore, many teachers do not know the way to perform in a virtual class to teach. Despite a significant percentage of them know the importance of having virtual classes to save effort and time spent in conducting experiments with classes. It also helps in conducting many experiments that cannot be applied in real life. Because, these are not available, require special equipment, or other reasons. These results agree with the findings of the study of Alian and Al-Ghatim (2017). It emphasized the necessity of providing training for the use of virtual laboratories in science teaching.

Al-Bawi and Salem (2017) recommended the need to implement a training program for science teachers in secondary schools to work in virtual laboratories. Al-Dulaimi (2018) confirmed the impact of using virtual laboratories in developing the laboratory skills of biology teachers. Moreover, Al-Da'aja (2018) showed a low level of female science teachers' use of virtual laboratories. It emphasized the need to train them appropriately with the applications of this technology due to its importance in the development of academic outcomes for students in secondary schools. Nael (2018) concluded that there

were many obstacles facing physics teachers limiting their work in virtual laboratories. The obstacles were related to the teachers' abilities, the school environment, and the students. Finally, Hussain and Aady (2019) showed the effect of using virtual classes in improving the academic achievement and performance for students in physics classes.

The second research question is "What is the proposed perception for using virtual laboratories in teaching biology at the secondary school level?". To answer this question, a proposal was developed to enable female biology teachers to use virtual laboratories in teaching biology at the secondary school level. The key objective of the proposal is to enable female biology teachers to work in virtual laboratories for teaching biology at the secondary stage due to its importance in improving students' skills. These skills would help them solve their challenges and confront them with accurate practical methods. That would depend on analysis, interpretation, auditing, and decision-making to achieve their learning goals and improve their academic achievements. To achieve this objective, the proposal seeks to achieve the contribution while developing the capabilities of female biology teachers to help them work in virtual labs for teaching biology at the secondary school level. It addresses the deficiencies in the requirements needed to use virtual laboratories in biology teaching at the secondary school level. It motivates the students to use virtual labs in biology to improve their skills. It would help them solve various challenges while keeping pace with all new developments in the scientific and technical fields.

The philosophy of this proposal relies on the approach of systems analysis through assembling interlinked elements related to the awareness level of female biology teachers and their work in virtual labs for teaching biology at the secondary school level. Dealing with these elements at an integrated level includes details that can help teachers to work in virtual labs for teaching biology at the secondary school level. The proposal consists of the visualization inputs, operations, and outputs. The visualization inputs further comprise of natural input, humanitarian input, and symbolic input. The natural input includes the tools that help in working in virtual labs and the rooms designated for that in a school.

The humanitarian input is the teachers and students. The symbolic input is learning purposes, skills for working in virtual labs, and educational outcomes. The operations and activities express interaction. These take place during conducting some experiments in virtual laboratories in biology between teachers, students, materials, tools, and equipment available to achieve the learning objectives. The outputs enable female biology teachers to work in virtual laboratories for teaching biology at the secondary school level to achieve the educational goals and develop many different skills for students. These skills include gaining a positive perspective towards biology, motivating them for learning and scientific achievement, acquiring problem-solving skills, developing higher-order thinking skills, and gaining social and emotional values related to the nature of science. Table 4 shows the implementation mechanism for the proposal to enable female biology teachers to use virtual laboratories in teaching biology at the secondary school level.

Table 4: The implementation mechanism to enable female biology teachers to use virtual laboratories in teaching biology at the secondary level

Requirement	Proposal Requirement
Training	<ul style="list-style-type: none"> • Conducting training courses for biology teachers to equip them with the skills of using and managing virtual laboratories in conducting experiments related to biology for the secondary stage. • Adding practical lessons in the biology curricula to train students in the skills and use of virtual laboratories. • Conducting educational periodicals regarding the suitable technical innovations related to virtual labs necessary for conducting experiments related to biology. • Conducting workshops supervised by the educational supervision office to educate teachers about the importance of using virtual laboratories in teaching biology.

Requirement	Proposal Requirement
Practical Skills	<p>Both teachers and students must acquire the skills of using virtual labs in conducting scientific experiments related to biology. To make it easier for both to use such an environment in learning and teaching biology for the following reasons:</p> <ul style="list-style-type: none"> • For teachers: Teachers must possess these skills to be able to use them while working in virtual laboratories and to teach those skills to students. • For students: Students must acquire these skills because of the importance that this entails in achieving the objectives of the educational journey and provides them with various scientific skills. This also helps them in conducting biological experiments that are not available in schools, such as cell division, photosynthesis, cell fertilization, and others. Besides, these skills contribute to achieving many other learning objectives by improving the students' cognitive structure. It makes them conduct experiments individually at any time and to be able to understand them. It in turn is considered an important method for overcoming individual differences among students.
Virtual Labs Equipment	<ul style="list-style-type: none"> • Equipment must be provided which are suited for the virtual lab use. This equipment includes modern technical devices, computers, the internet, and others. • Educational leadership must not overlook any request from any school regarding the shortage of equipment. It is required for use in virtual labs. As their shortage causes the inability of all students in the school to use the virtual labs in conducting biological experiments. Thus, it is considered a failure to achieve one of the key learning objectives.

4. Conclusions and Recommendations

The research has reached to several results. The most important of which is the result of the awareness level among female biology teachers regarding the importance of using virtual laboratories in teaching biology for the secondary school level. It is found that their awareness level is significant. In spite, they are aware of the importance of using virtual labs in terms of saving time and effort. They are unable to perform well in virtual laboratories. It is because of the reason that the female biology teachers possess the low ability to use virtual laboratories in secondary school for teaching biology. Virtual laboratories help in conducting many experiments that cannot be applied in real life. To benefit from virtual laboratories, it is highly recommended to train the female teachers on the skills of using it in teaching biology at the secondary school level. There is a dire need to provide technical equipment suitable for the use of virtual laboratories in the schools. Besides, it is suggested to review the biology curricula for secondary school level and includes some scientific experiments to conduct through virtual laboratories. Moreover, there is a need to encourage female biology teachers to use virtual laboratories in teaching biology through female school managers and educational supervisors.

We also propose to conduct the studies which emphasize the effectiveness of a proposed training program to develop the skills of female biology teachers on the use of virtual laboratories. It also studies the effect of the program on developing higher-order thinking skills of female students at different educational levels. We advise developing a proposal for biology curricula at the secondary school level in the light of conducting experiments using virtual laboratories. It also studies its impact on improving the skills of female students. We further propose to evaluate the performance of female biology teachers in using virtual laboratories to be acquainted with the reality of their application. It may contribute to expanding the circle of interest in their use in teaching biology.

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