Science students' use of inquiry-based learning in science laboratories in Kuwait

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الملخص:

مشاركة الطلاب في عملية التعلم هي من القضايا المهمة والتي دعا لها معظم التربويين والباحثين. في العديد من الدول، تستخدم طريقة الاستقصاء في تعليم مادة العلوم لتعزيز التعلم والاستمتاع به وتوفير التعلم الذي يعتمد على إشراك الطالب في العملية التعليمية. الغرض من الدراسة الحالية التحقق من مدى استخدام طلاب العلوم في الهيئة العامة للتعليم التطبيقي والتدريب لطريقة الاستقصاء في مختبرات العلوم. أيضاً تقوم الدراسة بتعرف العوامل التي تعيق طلاب العلوم من استخدام طريقة الاستقصاء في مختبرات العلوم. قامت الدراسة الحالية بتطبيق البحث المختلط الطرق حيث تم استخدام الاستبانات والمقابلات الشخصية، في المرحلة الأولى تم استخدام الاستبانة لتجميع البيانات من طلاب العلوم (٢٠٢ طالب وطالبة) في كلية التربية الاساسية وفي المرحلة الثانية استخدمت المقابلات الشخصية لتجميع البيانات من طلاب العلوم (١٥ طالب وطالبة). وأظهرت نتائج الدراسة الدراسة الحالية ان طلاب وطالبات العلوم غالباً ما يستخدمون طريقة الاستقصاء لإجراء التحقيقات وجمع البيانات واستخلاص النتائج. إلا أن طلاب وطالبات العلوم نادراً ما يستخدمون طريقة الاستقصاء في تأطير الاسئلة وتصميم التحقيقات. وعلاوة على ذلك، أظهرت النتائج بأن الافتقار الى الخبرة، ونقص المعدات، وعدم توافر تشجيع المدرسين، والالتزام باتباع الخطوات التي يقدمها المدرسين كانت من القيود التي تعيق الطلاب من استخدام طريقة الاستقصاء. في نهاية الدراسة مناقشة التوصيات المتعلقة بتعليم العلوم.

Abstract

Student engagement in the learning process is a vital issue that most of the educators and researchers have advocated for. In many countries, inquiry-based learning is used in science education to enhance students' learning, enjoyment and provide student-centred learning. The purpose of the present study is to investigate the extent to which science students at the Public Authority for Applied Education and Training apply inquiry-based learning in science laboratories. Also, this study identifies the factors that hinder science students from using inquiry-based learning in science laboratory. This study employed a mixed method approach using a survey to collect the data from 202 university students; and a semi-structured interview to collect the data from15 university students. The results of the current study showed that science students often used inquiry-based learning for conducting investigation, collecting data, and drawing conclusions. However, they rarely used inquiry-based learning for framing questions and designing investigations. Moreover, the results showed that lack of experience, lack of equipment, unavailability of instructors' encouragement, and obligation to follow the steps that are given by the instructor were constrains that hinder students from using inquiry-based learning in science laboratory. The recommendations for science learning are discussed at the end of this study.

***Index Terms*— inquiry-based learning, science education, laboratory, science student**

Introduction

Nowadays, a country's advancement and progression are measured by the quality of its education system. The quality of the education system is the main source of innovation and invention. For this to happen, the teaching of science has to be enhanced. The most important aspect of teaching science in higher education is allowing students to learn, explore, investigate, collect data, and understand how to justify conclusions and to reach the best and most accurate conclusion. This is important because as a result, the students will become more knowledgeable, more open to learning, more creative, and have a more interactive learning experience. This type of learning is advocated in most countries; and a lot of money and effort are invested to implement it in their education systems. Also, many researchers demonstrated the positive effect of incorporating students in the learning and giving them the opportunity to seek answers by themselves, which increases the student's academic achievement. However, although it is highly encouraged to use inquiry-based learning in the classroom to reflect a contemporary review of the nature of science, the actual use of it in the classroom is very limited (Capps & Crawford, 2012). For example, some of the factors that hinder the use of inquiry-based instruction are teacher's resistance to change, teacher's lack of inquiry knowledge (Schuster &Cobern, 2011), lack of time (Cheung, 2008), and lack of resources (Zhang et al., 2003).

Inquiry-based learning has to be understood by the teachers and students clearly, in order to have a successful application of it in the classroom. There are many types of student-based learning, which many researchers have applied in their studies to prove their effectiveness in enhancing student academic achievement and engage them in the learning process. One of these types of learning is

inquiry-based learning, which has gained a vast popularity in science education due to its role in giving the students a chance to be creative, observer, and decision makers (Pedaste et. al, 2015). Pedaste, Mäeots, Leijen, and Sarapuu (2012, p. 82) defined inquiry-based learning as "a process of discovering new relations, with the learner formulating hypotheses and then testing them by conducting experiments and/or making observations." To extend on this, inquiry-based learning relies on allowing students to investigate information that is new to them until they reach the conclusion, without the explanation given to them by the teacher (de Jong & van Joolingen, 1998).

To better understand inquiry-based learning, we must shed light on the process that the students use to lead them to the conclusion. This process consists of four stages (Rezba, Auldridge, & Rhea, 1999), the first stage is confirmation; in this stage the students are given a set of information in advance and confirm it through an activity. The second stage is structured inquiry; in this stage the students are presented with a question and a procedure which they have to follow to reach the final answer. The third stage is guided inquiry, in which the students are presented with a question that they have to solve using procedures chosen by the students. The fourth stage is open inquiry, where students are given a topic and have to formulate their own questions, and then investigate the answers to these questions.

Education in university requires the learning system to pay attention to the tools that are used in teaching undergraduate science students. The more student-centered learning is implemented, the higher the performance of the student; which leads to the development of the country, its industry, science, technology, and inventions. "However, many indicators inform us that students are not achieving

scientific literacy" (Duran, 2004, p. 155). The reason for this is that instructors are not using inquiry-based learning in their class (Gengarelly& Abrahams, 2009).It is crucial to understand science students' concerns about inquiry-based learning to better use it in the classroom. However, few studies in the literature focused on the science students' perceptions regarding inquiry-based learning. Therefore, the current study is initiated to investigate science students' perceptions towards using inquiry-based learning in laboratories. This study contributes to the body of knowledge, because it offers a good opportunity for researchers to expand their knowledge in relation to inquiry-based learning. Particularly, studying students concerns about inquiry-based learning in laboratories is important to improve the education system at Kuwaiti universities specially that there are few studies in Kuwait that investigated the concerns of students in higher education about IBL.

The objectives of the current study are to:

1- Evaluate undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for framing questions.
2- Explore undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to design investigations.
3- Investigate undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to conduct investigations.
4- Evaluate undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to draw conclusions.
5- Identify the factors that affect science students' use of inquiry-based learning in science laboratories.

The current research paper seeks to investigate the perceptions of science students regarding the use of inquiry-based learning in laboratories. The study applied a mixed method approach using a survey questionnaire and semi-structured interviews to collect the data from bachelor science students studying at the college of basic education.

Literature Review

Impact of inquiry-based learning on science education

Inquiry based learning has a high importance in the learning of science. Many research studies have demonstrated the effectiveness of Inquiry-based learning on students' academic achievement. For example, Peffer et al. (2015) conducted a study in the USA, where high school science students were tasked with several scientific simulation problems which they must solve through investigation and hypothesis testing. They found that 67% of the students viewed scientific practices differently i.e. learning a scientist's approach of solving problems, while 80% of the students indicated that science classroom inquiry simulations strengthened their understanding further.

Wolf and Fraser (2008) applied a study where they compared inquiry-based classrooms to traditional based classrooms, and then surveyed the students' attitudes and achievements through inquiry learning. Wolf and Fraser used a Test of Science-Related Attitudes (TOSRA) to assess the student attitudes towards science. They found through comparison between inquiry and traditional learning that inquiry-based laboratories seemed to promote more cohesiveness in the classroom.

Pedaste et al. (2012) conducted a study in Estonia to explore the effect of a web-based learning environmentin science classroom on students and tested their inquiry skills through reflection and self-regulation. They pointed high

importance towards reflective activities and self-regulation, as they enhance students' inquiry skills. Pedaste et al. "designed a learning environment that enables students to pass through all inquiry-learning stages and provides them with multiple tools and scaffolds" (2012, p.83). Their results showed the students' skills in forming questions and collecting answers and forming conclusions improved; and that when either of those skills improves then the other skills are more than likely to improve as well. It was also shown that students working in pairs achieved a higher quality of regulative skills and were able to evaluate the outcomes of some inquiry stages effectively. It was also shown that regulation of the learning process has a positive influence in the overall learning process. Similarly, Hulshof and de Jong (2006) found that transformative processes help the students discover more information during the learning process. Aleven and Koedinger (2002) found that students acquire higher declarative knowledge through reflective based classroom activities.

An important aspect of inquiry-based learning is the inclusion of social interactions between students. Ellwood and Abrams (2018) conducted a study in the USA that considered two cases, on-campus and off-campus. The study's participants consisted of eighth grade girls, and the data was collected through formal and informal techniques. They found that students are highly motivated during inquiry-based science classroom activities. These findings were similar to many research studies where students' interactions found to be high during inquiry-based lessons, in which students would cooperate while investigating the set problems (Brewer &Daane 2002; Colburn 1998;Krajcik et al., 1998). Marx et al. (2004) have also found that inquiry-based lessons increased student awareness and

achievement in science classrooms, by conducting a study on almost 8000 students of grades six, seven, and eight.

Students' use of Inquiry based learning in science laboratories

It's important to understand the effectiveness of inquiry-based learning for science education, but the most important is to make sure that inquiry base learning is used by students. Although many researchers have discussed and conducted research on the effectiveness of inquiry learning, they rarely looked at the student perspectives towards inquiry-based learning. The experience of the students and their attitudes towards inquiry-based learning is of high importance, as they are the ones applying inquiry and achieve through it; whereas the teachers only supervise their learning.

Chatterjee, Williamson, McCann, and Peck (2009) conducted a study in the USA to explore students' perceptions regarding the actual use of guided and open-inquiry laboratories. Chatterjee et.al (2009) used a survey to collect the data from 703 university students. The results of the study showed that the majority of the students like to use guided-inquiry laboratories more than open-inquiry laboratories. The researchers attributed the reason for students' preference towards guided inquiry over open inquiry to the way instructor assess students. The students don't get bonus points while attempting open inquiry, although they need to put in extra effort to accomplish the experiment's tasks. Therefore, they prefer to use less effort with the help of their instructor, which would still lead to the same grade.

Sabah, Basheer, Barham, and Fayez (2011) conducted a research study in Jordan to investigate 244 college students' perceptions regarding the actual use of inquiry-based learning in science laboratories.The researchers used

a questionnaire survey to collect the data from the students. The results of the study demonstrated that the students used inquiry-based learning for collecting data and conducting investigations. In contrast, the results found that the students did not practice inquiry-based learning for framing questions and designing investigations. These results indicate the low use of inquiry-based learning in science laboratories which could be attributed to the modest preparations of teachers for inquiry. Therefore, the researchers at the end of the study suggested that the students and teachers should attend workshops to understand how to properly use inquiry-based learning in the classroom.

Previous research studies focused on investigating the impact of inquiry-based learning on students' academic achievements, and the perceptions of students toward the use of inquiry-based learning in laboratories. Research has shown that the use of inquiry-based learning atuniversity level is still limited, this could be attributed to the faculty members' conflict between teaching and conducting research (Beck, Butler, & Burke da Silva, 2014). In Kuwait there are few research studies that focused on exploring the extent to which higher education science students apply inquiry-based learning in science. Also, few studiesfocused on understanding the reasons ofscience students' perceptions toward using inquiry-based learning in science laboratories (Hofestein & Lunettam 2004). Therefore, the current study investigates undergraduate science students' perceptions regarding the actual use of inquiry-based learning in science laboratories and takes a deeper look into the factors that may hinder students from using inquiry-based learning in science laboratories.

3. Methodology

3.1 Research design

A mixed method approach was employed in the present study to find information about the research study (Johnson & Christensen, 2008; Creswell, 2009). Questionnaires and interviews were used to collect the data from undergraduate science students at the Public Authority for Applied Education and Training.

Survey instrument

This study adapted the questionnaire that was developed in 2010 by Campbell, Abu-Hamid, and Chapman. Beck et al. (2014) stated that it is highly recommended for researchers to apply validated inquiry-based learning instruments in different institutions. This provides a clear assessment of science students' perceptions in order to enable better comparisons of the results from different universities. Two bilingual Kuwaiti experts translated the English survey into Arabic, which in turn was translated back to English by one expert. A comparison was then made between the different survey versions to then create a final optimal survey. A pilot study was conducted to make sure that there were no ambiguous statements, and to run a Cronbach's alpha test (reliability test). The Cronbach's alpha for the survey was 0.769 which demonstrates the consistency of the measuring results of the survey (Hair et al., 2006).

The survey instrument consisted of five categories: 1) framing questions, 2) designing investigations, 3) conducting investigations, 4) collecting data, and 5) drawing conclusions.

Interview instrument

The interview question emerged from the survey. The question that was addressed during the interviews was:

What are science students' views of the factors that affect their use of inquiry-based learning in science laboratories?

3.2 Participants

The participants of the survey, N=202 (66 males and 136 females), were randomly selected from science students who were in year four and who were taking science laboratory courses. While, the participants of the interviews, N= 15(5 males and 10 females) were selected from among the science students who had answered the survey.

4. Data analysis

4.1 descriptive statistics of survey data

This study employed SPSS 22 software to analyze the data. Firstly, the normality of the data distribution was tested using the indicators (skewness and kurtosis). Secondly, descriptive statistics (mean and standard deviation) were used to answer the following research questions:

1- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for framing questions?
2- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to design investigations?
3- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to conduct investigations?
4- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to draw conclusions?

Normality tests

The criteria that were used in the present study to examine the normality of the data distribution were +3 – 3 (Peat & Barton, 2005). skewness and kurtosis of each item

of the survey are presented in Table1. According to Table1, it can be demonstrated that the data were distributed normally.

Table 1. Normality test (skewness and kurtosis)

	Skewness		Kurtosis	
	Statistic	**Std. Error**	**Statistic**	**Std. Error**
I formulate questions which can be answered by investigations	1.280	.171	.997	.341
My research questions are used to determine the direction and focus of the lab	.754	.171	-1.009-	.341
Framing my own research questions is important	1.302	.171	.906	.341
Time is devoted to refining my questions so that they can be answered by investigations	1.725	.171	2.048	.341
I am given step-by-step procedures before I conduct investigations	-1.696-	.171	2.402	.341
I design my own procedures for investigations	.539	.171	-.447-	.341
I engage in the critical assessment of the procedures that are employed when conducting investigations	1.043	.171	.127	.341
I justify the appropriateness of the procedures that are employed when I conduct investigations	.921	.171	-.522-	.341
I conduct the procedures for my investigation	-1.198-	.171	-.021-	.341
The investigation is conducted by my teacher in front of the class	-1.153-	.171	.264	.341
I am actively participating in investigations as they are conducted	-1.060-	.171	.196	.341
I have a role as investigations are conducted	-1.292-	.171	.932	.341
I determine which data to collect	-.476-	.171	-1.231-	.341
I take detailed notes during each investigation along with other data I collect	-.255-	.171	-1.397-	.341
I understand why the data I am collecting is important	-.661-	.171	-.964-	.341
I decide when data should be	-.509-	.171	-1.064-	.341

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
collected in an investigation				
I develop my own conclusions for investigations	-.353-	.171	-1.002-	.341
I consider a variety of ways of interpreting evidence when making conclusions	.965	.171	-.048-	.341
I connect conclusions to scientific knowledge	-.546-	.171	-.655-	.341
I justify my conclusions	-.519-	.171	-.746-	.341

Descriptive statistics

Descriptive statistic is used to answer research questions regarding science students' perceptions toward using inquiry-based learning in science laboratories.

1- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for framing questions?
2- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to design investigations?
3- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to conduct investigations?
4- What are undergraduate science students' perceptions toward using inquiry-based learning in science laboratories to draw conclusions?

There were five categorize in the survey: 1) framing questions, 2) designing investigations, 3) conducting investigations, 4) collecting data, and 5) drawing conclusions. A 5-point Likert scale was used to measure the perceptions of the science students: 1= "almost never", 2= "seldom", 3= "sometimes", 4= "often", and 5 = "Almost always". The following paragraphs describe the results in detail.

1. Undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for framing questions

The dimension *framing questions* was measured using four items. The descriptive statistics indicators are shown in table 2. Items from the highest to the lowest mean among the first topic of the survey were as follows:

- Item 2 (my research questions are used to determine the direction and focus of the lab), the total mean of this item was 2.04 and the Std. Deviation was 1.32. Thus, item 2 ranked the highest among the items of the first topic. This indicates that the majority of science students rarely used their own research questions to focus of the lab.
- Item 3 (framing my own research questions is important), the total mean of this item was 1.80 and the Std. Deviation was 1.07. Thus, item3 ranked the second highest among the items of the first topic. This shows that most of the science students hardly find that framing questions as an important issue.
- Item 4(the time advocated to refining my questions so that they can be answered by investigations), the total mean of this item was 1.75and the Std. Deviation was 1.19.This indicates that item 4 ranked penultimate among the items of the first topic of the survey. This demonstrates that many of the science students were infrequently given time to refine their questions.
- Item 1 (I formulate questions which can be answered by investigations), the mean of this item was 1.74 and the Std. Deviation was 1.03. This indicates that item 1 ranked the lowest among the items of the first topic of the survey. This indicates that many of the science students rarely formulate questions to be answered by investigations.

Table 2. Descriptive statistics of students' response to the items of framing questions

Framing questions	Mean	Std. Deviation
1-I formulate questions which can be answered by investigations	1.74	1.034
2-My research questions are used to determine the direction and focus of the lab	2.04	1.328
3-Framing my own research questions is important	1.80	1.075
4-Time is devoted to refining my questions so that they can be answered by investigations	1.75	1.193

2. Undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for designing investigations

The dimension *designing investigations* was measured using four items. The descriptive statistics indicators are shown in table 3. Items from the highest to the lowest mean among the second topic of the survey were as follows:

- Item 1, the total mean of this item was 4.62 and the Std. Deviation was 0.65.This shows that the majority of science students were almost always given step-by-step procedures before they conduct their research.
- Item 2, the total mean of this item was 2.37 and the Std. Deviation was 1.18.This indicates that most of the science students rarely design their own procedures for the investigations.
- Item 4, the total mean of this item was 2.06and the Std. Deviation was 1.33.This demonstrates that many of the science students seldomjustify the appropriateness of the procedures that are employed when they conduct their investigations.
- Item 3, the mean of this item was 1.71 and the Std. Deviation was 0.88. This shows that many of the science students hardlyengage in the critical assessment of the

procedures that are employed when conducting investigations.

Table 3. Descriptive statistics of students' response to the items of designing investigations

Designing investigations	Mean	Std. Deviation
1-I am given step-by-step procedures before I conduct investigations	4.62	.653
2-I design my own procedures for investigations	2.37	1.186
3-I engage in the critical assessment of the procedures that are employed when conducting investigations	1.71	.886
4-I justify the appropriateness of the procedures that are employed when I conduct investigations	2.06	1.333

3. Undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for conducting investigations

The dimension *conducting investigations* was measured using four items. The descriptive statistics indicators are shown in table 4. Items from the highest to the lowest mean among the third topic of the survey were as follows:

- Item 4, the total mean of this item was 4.11 and the Std. Deviation was 1.15.This demonstrates that the majority of science students almost always have a role as investigations are conducted.
- Item 1, the total mean of this item was 4.02 and the Std. Deviation was 1.40.This indicates that most of the science students almost always conduct the procedures for their investigation.
- Item 2, the total mean of this item was 3.97 and the Std. Deviation was 1.27. This shows that many of the

students indicate that the teacher almost always conducts the investigation in front the class.

- Item 3, the mean of this item was 3.94 and the Std. Deviation was 1.24. This demonstrates that many of the science students almost always actively participate in the investigations as they are conducted.

Table 4. Descriptive statistics of students' response to the items of conducting investigations

Conducting investigations	Mean	St. Deviation
1-I conduct the procedures for my investigation	4.02	1.409
2-The investigation is conducted by my teacher in front of the class	3.97	1.271
3-I am actively participating in investigations as they are conducted	3.94	1.244
4-I have a role as investigations are conducted	4.11	1.151

4. Undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for collecting data

The dimension *collecting data* was measured using four items. The descriptive statistics indicators are shown in table 5. Items from the highest to the lowest mean among the fourth topic of the survey were as follows:

- Item 3, the total mean of this item was 3.74 and the Std. Deviation was 1.40.This indicates that the majority of science students almost always understand why the data they collect is important.
- Item 1, the total mean of this item was 3.52 and the Std. Deviation was 1.49. This shows that most of the science students almost always which data to collect.
- Item 4, the total mean of this item was 3.45 and the Std. Deviation was 1.42. This indicates that many of the students decide when data should be collected in an investigation.

- Item 2, the mean of this item was 3.35 and the Std. Deviation was 1.51. This demonstrates that many of the science students sometimes take detailed nots during each investigation along with other data they collect.

Table 5. Descriptive statistics of students' response to the items of collecting data

Collecting data	Mean	St. Deviation
1-I determine which data to collect	3.52	1.490
2-I take detailed notes during each investigation along with other data I collect	3.35	1.510
3-I understand why the data I am collecting is important	3.74	1.402
4-I decide when data should be collected in an investigation	3.45	1.421

5. Undergraduate science students' perceptions toward using inquiry-based learning in science laboratories for drawing conclusions

The dimension *drawing conclusions* was measured using four items. The descriptive statistics indicators are shown in table 6. Items from the highest to the lowest mean among the fifth topic of the survey were as follows:

- Item 3, the total mean of this item was 3.55 and the Std. Deviation was 1.273.This shows that the majority of science students almost always connect conclusions to scientific knowledge.
- Item 4, the total mean of this item was 3.53 and the Std. Deviation was 1.27.This demonstrates that most of the science students almost always connect conclusions to scientific knowledge.
- Item 1, the total mean of this item was 3.41 and the Std. Deviation was 1.35. This indicates that many of the studentssometimes develop their own conclusions for investigations.
- Item 2, the mean of this item was 2.08 and the Std. Deviation was 1.22. This shows that many of the

science students rarely use a variety of ways of interpreting evidence when making conclusions.

Table 6. Descriptive statistics of students' response to the items of drawing conclusions

Drawing conclusions	Mean	St. Deviation
1-I develop my own conclusions for investigations	3.41	1.351
2-I consider a variety of ways of interpreting evidence when making conclusions	2.08	1.221
3-I connect conclusions to scientific knowledge	3.55	1.273
4-I justify my conclusions	3.53	1.274

4.2Analyses of interview data

The interview question emerged from the survey. The question that was addressed during the interviews was: What are science students' views on the inhibiting factors that affect science students' use of inquiry-based learning in science laboratories?

The results from the interviews indicated that the science students face some inhibiting factors that may affect students' use of inquiry-based learning in science laboratory. These factors are explained below with examples of relevant statements from respondents.

1. **Obligation to follow the steps that are given by the instructor**

The results of the interviews demonstrated that the students do not have the freedom to frame questions or design the investigations by using their own techniques; instead they have to follow the rule of the instructors. As science students remarked:

...I don't frame questions because they are prepared by the instructor and we have to follow it to do the investigation (S2).

...I have never designed investigations (S5, S15).

...we always commit to the design that is given to us (S11, S4).

2. Lack of experience

Another factor that shows inadequate ability to use inquiry-based learning in science laboratory is lack of experience. As science students stated:

...I don't know how to design the investigation by myself (S2, S10).

...No one taught me how to use different ways to do the investigation (S15).

3. Lack of instruments

The lack of the instruments in the science laboratory limits students' use of inquiry-based learning. As students remarked:

...the battery was not working while I was doing the experiment (S9).

...there is not enough equipment in the lab and we share the equipment together to do the experiment (S6).

...the instructor distributes the class into two groups, so if group one attend then group two is dismissed for the day and the next time group two will attend.This is to make sure that the equipment is enough for the number of the students (S1, S14, S11).

...the equipment is very old (S3, S8).

4. Unavailability of instructors' encouragement

Unavailability of encouragement from instructors to use inquiry-based learning in science laboratory is an important factor that leads to decrease the motivation of the students to use inquiry in lab. As students remarked:

...there are no instructors that encourage us to do the investigation without following the steps given by them (S12).

…in the exam we have to use the same steps that were give to us during the lessons, we can't write different steps (S13).

It appears from theinhibiting factors mentioned above by science students that these obstacles have agreat impact on the students' use of inquiry-based learning in science laboratory.

Discussion

The results of the quantitative data demonstrated that the science students offered inquiry-based learning in some processes of investigation. The science students have been given the opportunity to use inquiry-based learning for conducting investigations, collecting data, and drawing conclusions. However, they have not been given the opportunity to use inquiry-based learning for framing questions and designing investigations. The result of the current study is consistent with Sabah, Basheer, Barham, and Fayez (2011) who found that science studentspracticed inquiry-based learning in laboratories to conduct investigations and collect data, but they did not have the chance to use inquiry-based learning to frame questions and design investigations. The researchers indicated that the reason for not using inquiry-based learning properly was that the instructors are not prepared to use inquiry-based learning in their teaching in science laboratories. Not giving students the opportunity to use some of the essential features of inquiry-based learning in science laboratory is not accepted. Science students should engage with all the processes of investigating and inquiry to reach uniqueness in laboratory (Hofstein & Lunetta, 2004).

The result of the current study also demonstrated that the science students were given step-by-step procedures before they conduct investigations. This result is consistent with Sabah et al. (2011), who showed that the science

students were taught traditionally. The instructors used a step-by-step approach in the laboratory andconducted the investigations in front of the class. This could be attributed to the lack of time and resources that cause the instructors to use traditional approaches in science classroom (Peffer et al., 2015).

Moreover, evidence found in the current study showed that the students used simple inquiry practices to draw conclusions. However, they did not use variety of ways of interpreting evidence. Chinn and Malhotra (2002) demonstrated that the simple inquiry practices are not targeted to achieve authentic scientific processes. Therefore, students should be exposed to an authentic science experiences to allow a meaningful inquiry-based learning in science laboratory (Hofstein & Lunetta, 2004).

The qualitative data confirm the results of the quantitative data and provide in-depth information regarding the inhibiting factors that have an impact on science students' use of inquiry-based learning in laboratory. The factors that inhibit students from using inquiry-based learning in laboratory were as follows:

The first factor that impacts students' use of inquiry in science laboratories is the obligation to follow the steps given by the instructor. This result was in line with Sabah et al. (2011) who found that teachers provide the students with the steps required for the task, and the students have to follow these steps to do the investigation. Hofstein and Lunetta (2004) stated that the students perceive that to do the work correctly in laboratory they have to follow the instructions of the instructor. Students perceive that they have to follow the steps provided by the instructor to achieve a better grade, rather than to extend their knowledge and use unique ways to do the investigations.

The second factor that inhibit science students from using inquiry-based learning in laboratory is the students' lack of experience. Pedaste et al. (2012) demonstrated that training students to use inquiry-based learning and giving them firsthand experience improves their overall skills and further leads them to apply inquiry-based learning by themselves. Vishnumolakala et al. (2017) also demonstrated that providing workshop learning experience to science students helps the students in understanding the difficult concepts and the relationships between the data and the result. This is due to the fact that students are more comfortable and skilled in inquiry-based learning after having practiced it, which makes them automatically use inquiry to formulate questions, collect data, and draw conclusions.

The third factor that has a great impact on science students' use of inquiry-based learning in laboratory is the lack of instruments. Peffer et al. (2015) stated that the shortage of resources and equipment in laboratories hinders students from applying authentic inquiry-based learning. The lack of equipment will have to enforce more than one student to work on the same piece of equipment as the number of students is much more than that of the equipment. This will make the students have insufficient time to apply inquiry skills in their experiment and they will need to finish it as fast as possible using preset steps, rather than take their time and apply inquiry, to allow the next students to work as well.

The fourth factor that affects students' use of inquiry-based learning is the absence of encouragement from the instructors to apply inquiry in laboratory. This is consistent with Tobin and Gallagher (1987) who found that science teachers do not encourage students to use meaningful scientific inquiry in science laboratories. Gardiner and

Farrangher (1999) also demonstrated that science teachers do not help students in using inquiry-based learning in laboratories, but instead use traditional teaching and learning methods, even though they understand the importance of inquiry-based learning processes. Encouraging students is important because the positive influence of the teacher will be directed onto the students and their learning, which will motivate the students to apply these processes to have a meaningful use of inquiry.

Conclusion

This study investigated the extent to which science students at the Public Authority for Applied Education and Training apply inquiry-based learning in science laboratories. The study focused on examining science students' use of the five features of inquiry-based learning: 1) framing questions, 2) designing investigations, 3) conducting investigations, 4)collecting data, and 5) drawing conclusions. The results lead to the conclusion that despite that the science students practiced some of the inquiry-based learning in science laboratory, this use is not authentic. Science students appear to use inquiry-based learning for conducting investigations, collecting data, and drawing conclusions. However, this use of inquiry is simple and does not lead to high levels of thinking.There are many factors that affect the use of inquiry and promote a meaningful use of inquiry-based learning, these factors are: obligation to follow the steps given by the instructor, students' lack of experience, lack of instruments, lack of encouragement from the instructors to apply inquiry. Thus, to improve the learning in science laboratory and to make sure that inquiry-based learning is used successfully in the classroom; universities should encourage students and instructors to use inquiry-based learning in the classroom. Also, a real endeavor should be considered to transform the

learning in science classroom by providing all the resources and facilities that are needed to enable the use of authentic inquiry-based learning.

At the end of the study the following recommendations should be taken into account to have a meaningful application of scientific inquiry:

- Arrangement of workshops for teachers and students that show the real application of inquiry-based learning, with assisted practical inquiry-based activities; so that the teachers and students can learn how to really apply inquiry in laboratories.
- Provide a shared vision between different government sectors and universities to overcome the barriers that prevent the successful use of inquiry-based learning in science laboratories.
- Provide a shared vision between educators, teachers, students, and policy makers to allow a useful implementation of inquiry-based learning in science laboratories.
- Assign professional experts in inquiry to observe the learning process in science laboratories to ensure that inquiry-based learning is used properly.

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