Chapter 5

A Community of Practice Around Online Labs in Iraq: Towards Effective Support for Academics and Higher Educational Systems in the MENA Region

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Additional information is available at the end of the chapter

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Abstract

The growing interest of society in science and engineering disciplines has lead to a quality improvement in curricula; a more careful definition of the educational outcomes; and; an increased concern with the continuous improvement of student learning and the quality of teacher training programmes. Hands-on experiments with innovative instructional technologies (e.g. online labs) built confidence and skills of academics and students by helping them to better understand, especially in those disciplines. A community of practice is a group of people informally bound together by shared expertise or an area of interest in a topic. It focuses on sharing best practices and creating new knowledge to advance a domain of professional practice. In addition, it shares the appropriate activities and instructional technologies that support the higher educational systems. This study aims to examine how teachers and students are interested in using online labs to support hands-on labs for completing their educational tasks and illustrates the potential benefit of a community of practice around online labs. Consequently, in order to facilitate the formation of a new community of practice around instructional technologies in the Middle East and North Africa, several presentations about online labs have been made in different universities in Iraq

Keywords: higher educational systems, Middle East and North Africa region, community of practice, online labs, engineering and science disciplines

1. Introduction

Simply put, an educational system is a set of schools and universities in a given country. Educational systems are crucial because, in the end, they are what empower societies to empower the individual to develop culture, civilization, personality, socio-economic status, informal and formal educational experiences, and a creative mindset [1].

Educational systems are complex entities, and reforming them poses difficult, multifaceted challenges. They may require changes in government policy, adjustments in labor negotiation, and modifications of academic routine [2].

Active learning is an instructional method that strives to engage students in the learning process by encouraging them to perform meaningful learning activities, while always questioning the relevance of what is being achieved. Active learning also creates opportunities for students to collaborate with one another and with teachers, working in small groups toward a common goal [3, 4]. Quoting from the report Active Learning: Creating Excitement in the Classroom [5]:

> *"Students must do more than just listen: They must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in such higher order thinking tasks as analysis, synthesis, and evaluation. Within this context, it is proposed that strategies promoting active learning be defined as instructional activities involving students in doing things and thinking about what they are doing." (pp.5)*

This stronger emphasis on the individual work of the student, as opposed to merely attending classes [6–8], is one key aspect of the Bologna process,[1] a remarkable reform that took place in the last decade, in the countries of the European Union. Although the main goal of the Bologna process was to ensure comparability among higher education qualifications, in terms of standards and quality measures, it also included a reform of the teaching and learning process.

In Latin America, some countries (namely Brazil, Chile, and El Salvador) have also reformed their higher educational systems. In 2012, the first bi-regional University Association Conference in Brazil discussed the innovative strategies for higher educational systems among Latin American and European universities. Among those are collaborative research, research partnerships, and two-way exchanges among universities [6].

An obvious means to enhance educational productivity is using resources more effectively. Another is relying more on technology. A third is to increase the number of courses where the student demand is high, although this one must be considered carefully in those areas where jobs are scarce [9].

[1] "In 1999, Europe started the Bologna Process, named after the university where it was proposed. The aim of this process was, and still is, to create a European Higher Education Area (EHEA) based on international cooperation and academic exchange that is attractive to students and staff from all over the world. It facilitates mobility of students, graduates and higher education staff." (http://www.mastersportal.eu/articles/451/the-european-higher-education-system-the-bologna-process.html)

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Countries in the Middle East and North Africa (MENA) region face a number of common challenges in their higher educational systems. In fact, many of those countries have attempted to improve higher education and mobilized part of their wealth for that. Still, those efforts were not enough to overcome all the challenges that need to be addressed [10, 11].

As a result, higher educational systems in the MENA region are in the low-level scale, when compared to other world regions. We quote from [12]:

> *"Higher education systems in the MENA region have not developed more, so far, because they have failed to focus on 21st century skills. In other terms, the education systems need to change the way they operate, moving from their traditional approach to a more modern one." (pp. 241).*

This is also the opinion expressed in a World Bank report [10]:

> *"Since education is the main source of knowledge creation, the task is clear: the education systems must be changed to deliver the new skills and expertise necessary to excel in a more competitive environment." (pp.84)*

One of the roads for development of higher education is increasing collaboration among researchers, nationally and internationally. In a recent study, which focuses on the area of online labs, we have shown that there are very few connections among MENA researchers in this area [13].

Online labs are an instructional technology which have great potential to enhance higher educational systems in MENA, especially in engineering and science disciplines. One way to foster their adoption is to create a community of practice, gathering researchers and practitioners that share an interest in online labs in a wider area [13–15].

In this context, our research questions are the following:

1. Are academics in MENA interested in using online labs for increasing the collaborative work among researchers?
2. Do academics in MENA believe that a community of practice around online labs can serve teachers, students, and universities?

The argument is that the lack of funding for the MENA researchers is not the only factor impairing more developments but rather it is the lack of cooperation among the researchers. Overall, collaborative and cooperative work is widely recognized as a good way to share resources in the several developed countries. This may be considered a possible direction for the MENA countries to face a lack of resources. Therefore, this chapter addresses the development of a community of practice around online labs in the MENA region and their value. It also discusses the possibility of building a regional and national community network in this region [16]. In addition, it highlights the results of successful collaboration among three universities from Iraq that led to developing specific online experiments for them.

The rest of the chapter is organized as follows. Section 2 introduces the concept of a community of practice. Section 3 presents the methodology and techniques used to collect data that can help to build a community of practice around online labs in the MENA region. Section 4 analyzes data that is collected from the techniques. Section 5 details the results. Section 6 presents some additional remarks. Finally, Section 7 reflects on the conclusions and discusses future work on this subject.

2. A community of practice

The expression "community of practice" has been used to describe a group of people that interact around a topic. More specifically and quoting Etienne Wenger, the educational theorist who invented the concept (together with McDermott and Snyder) [17]:

> *"Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly."*

A more elaborate definition, but essentially equivalent, is the following[2]:

> *"(Communities of practice are) Groups of people who come together to share and learn from one another – either face-to-face or virtually are held together by a common interest in a body of knowledge and are driven by a desire and need to share problems, experiences, insights, templates, tools, and best practices."*

Another interesting definition by John Sharp in 1997 is quoted in [18]:

> *"A Community of Practice (CoP) is a special type of informal network that emerges from a desire to work more effectively or to understand work more deeply among members of a particular specialty or work group."(p. 140)*

Hence, the community of practice concept is focused on enhancing people's skills through interaction around problems, solutions, and insights and building a common store of knowledge [19, 20]. The concept has a number of practical applications in business, organizational design, education, and civic life [19].

On the other hand, Wenger himself has a broader, more philosophical view [21]:

> *"In our communities of practice, we come together not only to engage in pursuing some enterprise but also to figure out how our engagement fits in the broader scheme of things" (p. 162).*

In general, a community of practice is described along three important dimensions [22]: domain, community, and practice. See **Figure 1**.

1. ***Domain***: It is the definition of the area of enquiry. It aims to organize the members so that they can use and share the knowledge that gives them a sense of joint enterprise, brings them together, and follows a common interest.
2. ***Community:*** It is a group of people who interact and learn together for building relationships. The relationships among members are a sense of belonging, interact regularly, and engage in joint activities.

[2]http://www.csuchico.edu/swrk/mh/communityofpractice.shtml

3. ***Practice***: It is sharing the common resources (i.e. documents, cases, and tools) that can build the capability of the community.

Based on Refs. [23, 24], a topology of 21 structuring characteristics has been identified on which a community of practice may be compared. One of them is the geographic dispersion of the participants. Clearly, a community of practice has more chances to succeed if all members are nearby. On the other hand, use of modern technology may greatly diminish the overhead caused by distance.

In fact, the major factor to the success of a community of practice is the use of information and communication technologies or, more broadly, of the Internet. The Internet enables us to create online communities that are characterized by strong social relationships among participants, even if the members are physically far apart. It can even foster stronger commitment to the community goals in spite of the distance [25]. Several conversational technologies, such as discussion forums, weblogs, and wikis, can be used to support communities as well [26]. These are the characteristics and the ingredients of instructional technologies. Hence, instructional technologies are certainly a topic around which successful communities of practice can be created. When doing so, the first task should be deciding the kinds of activities that can be important for such a community.

Our ultimate goal is to create a community of practice around online labs in the MENA region. A precondition for this is the existence of a regional network capable of providing the necessary resources to teachers and students and capable of supporting collaborative work.

Building a community of practice can contribute significantly to the success of any educational system and emphasize social and economic aspects as well. Some software in the Internet might be the first step for supporting a community of practice (i.e., chatting). Several new instructional technologies have been at the inception of several communities of practices, like those around online labs [25].

Figure 1. Dimensions of a community of practice.

Creating a network can bring benefits, especially in higher educational sectors; this is what has been proved in the past and today. Furthermore, Internet technology has been expanding the range of networks widely, as mentioned in [16]:

To create a community of practice around online labs in the MENA region, a regional and national community network must be built for providing the resources to teachers and students. Moreover, this community network can increase the collaborative work among researchers.

3. Methodology

In general, this section identifies the factors that can help build a community of practice around online labs in the MENA region by using the 4 Ws idea [27]: "where, why, which, and what", as illustrated in **Figure 2**. The answer to each specific question allows a better understanding of the general aspects associated with such a community. In particular, and for addressing the "what" dimension, a mixed methodology targeting both qualitative and quantitative data was used, allowing for a better observation of the beliefs and expectations of MENA researchers.

3.1. Where do we want to create a community of practice?

MENA countries have taken great steps in developing education: almost complete gender parity has been achieved, the average level of schooling has quadrupled, and since 1980, illiteracy

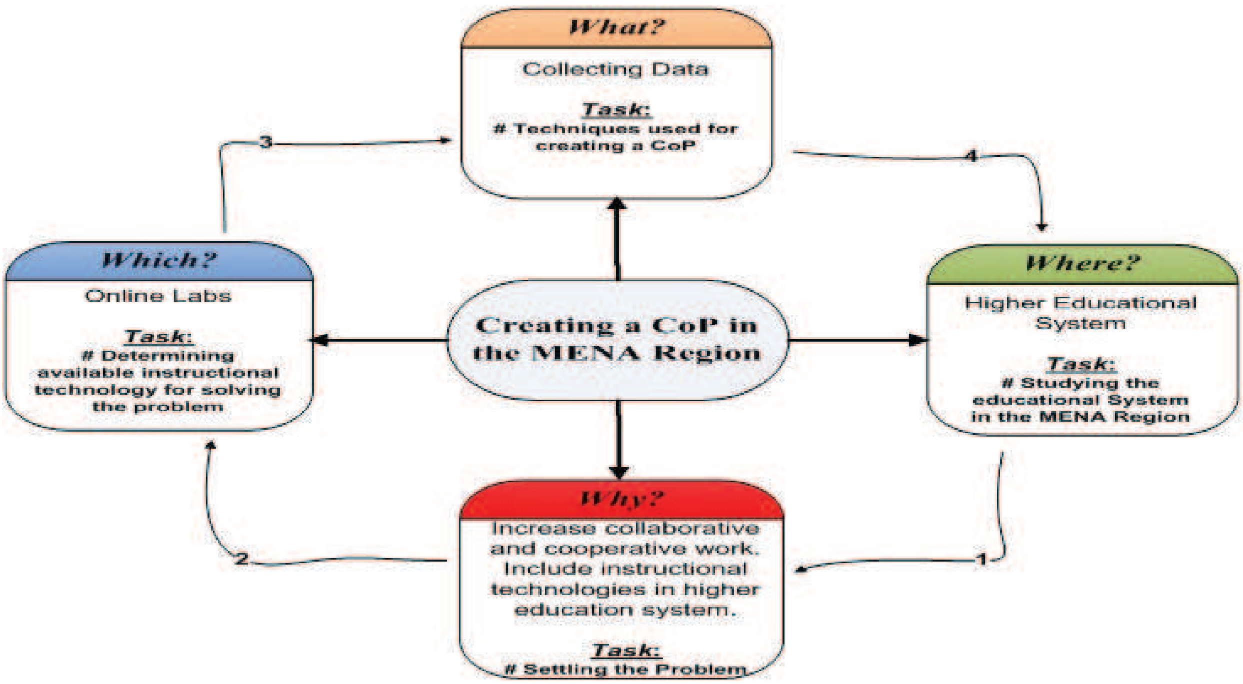

Figure 2. Methodology for creating a community of practice.

has been halved, and so on [28]. However, MENA countries still face many challenges in their higher educational systems. In particular, these countries need to enhance their higher educational systems, which are of "low quality"; to use the qualification used in the World Bank Group report [28]:

> *"Evidence demonstrates that school systems in MENA are generally of low quality. Basic skills are not being learnt, a fact most clearly captured by international standardized tests, whose results reveal that the Region is still below the level expected given MENA countries' per capita income".*

3.2. Why is it important to create a community of practice?

A community of practice will help increase the collaborative and cooperative work among the MENA researchers and will help improve the higher educational systems by promoting instructional technologies in this region. There is a potential interest in instructional technologies that could be help build a community of practice around online labs in this region [14]:

3.3. Which available instructional technology can be used to facilitate a community of practice?

We focus on online labs technology. This shall also be the instructional technology around which we will create a community of practice.

Depending on the topology of the online community, a community of practice can be based on different Internet platforms.

To build a new community of practice, one should consider the paradigm related to the emergence of new instructional technologies. Online labs are characterized by strong social relationships between participants. They support the participants by providing a permanent line of communication and a common online meeting space. This creates an environment where long-lasting relationships between researchers can flourish.

Furthermore, online labs are a special type of online learning community. Hence, the same kind of strong relationships can also be created between teachers and students and among students themselves [25].

Nevertheless, one must not forget that technology alone does not create a community. It may greatly assist, of course, but what is important is the social architecture of the community [29].

3.4. What are the techniques used to analyze the community predisposition toward a community of practice?

Questionnaires, interviews, and online meeting techniques have been used to assist building a community of practice around online labs.

For collecting quantitative and qualitative data, we used three techniques [30, 31]: questionnaires, interviews, and online meetings; see **Figure 3**. The questionnaire technique was applied

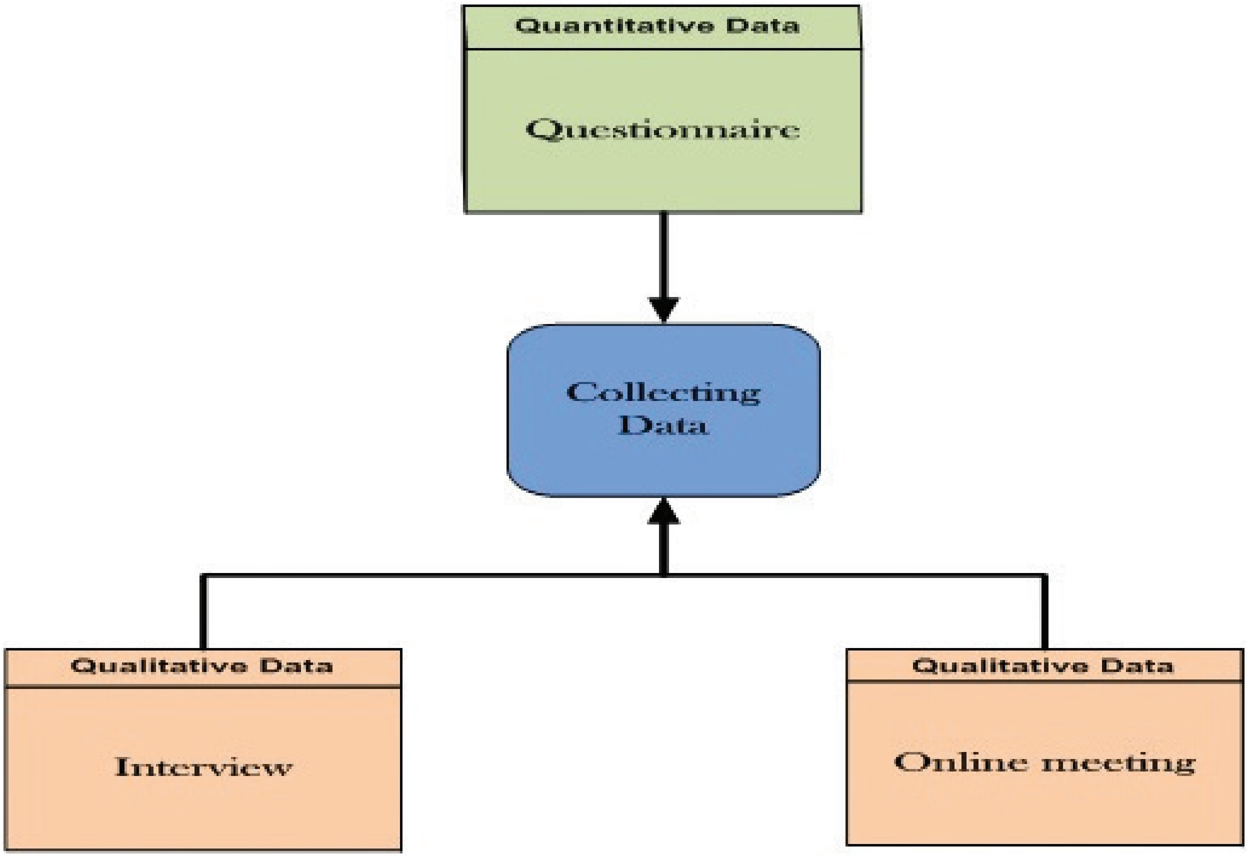

Figure 3. Techniques used for collecting quantitative and qualitative data.

during seminars that we presented in three institutions in the Kurdistan region of Iraq: the University of Duhok, the University of Zakho, and Duhok Polytechnic University. After those seminars, we interviewed some of the participants, who were academics from those universities. Finally, we conducted an online meeting between a selected group of academics from the Kurdistan region of Iraq and an outside expert, using video conference.

3.4.1. Quantitative data

Quantitative data were collected via the questionnaire. A series of presentations were made in three universities in the Kurdistan region, Iraq, according to the following schedule:

1. December 14, 2015, the University of Zakho, Faculty of Engineering and Science.
2. December 23, 2015, the University of Duhok, Faculty of Engineering.
3. January 6, 2016, the University of Duhok, Faculty of Science.
4. January 12, 2016, Duhok Polytechnic University, Faculty of Engineering and Science.

After each presentation, the questionnaire forms, which were validated through peer review, were handed out to the participants. Most of the participants agreed to respond.

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3.4.2. Qualitative data

Qualitative data were collected in the interviews and in the online meetings. The interviewees were academics from the three universities, with an interest in instructional technologies and who have more than 15 years of work experience at the university. The interview included a set of open-ended questions [31] that were used to draw new insights from the interviewees and discover new ideas [32].

The online meeting used the Skype conference tool.[3] During the meeting, participants in the Kurdistan region of Iraq met with Professor Gustavo R. Alves (who is one of the authors of the present study). Professor Alves[4] has vast experience using online labs and is one of the most active researchers in the area [33]. During the meeting, details of the operation of online labs were discussed and how online labs can be the focus of a new community of practice in the MENA countries.

4. Data analysis

This section analyzes the quantitative and qualitative data collected from the questionnaires, interviews, and the online meetings. Quantitative data provides a great value to study by providing meaningful results from a large data set [34]. Qualitative data focused on meanings rather than on quantifiable phenomena. It includes rich descriptions of the data rather than measurements of specific variables [35]. Furthermore, it involves the identification, examination, and interpretation of patterns and themes in textual data and determines how these patterns and themes help to answer the research questions [34].

4.1. Questionnaire

The questionnaire aimed to evaluate how online labs can assist teachers and students and highlights how a community of practice around online labs can increase collaborative and cooperative work among researchers,[5] especially in engineering and science disciplines. In general, the data are classified into two kinds: nominal data and interval data [34].

4.1.1. Characterizing the sample

In order to understand the demographical background of participants (i.e. occupation, gender, language, age, program taken, Internet use experience, and internet use frequency), a descriptive analysis of the data was performed, as shown in **Figure 4**. From this analysis, the sample can be characterized as being primarily teaching staff (from electronics and computer engineering to physics), male, Kurdish, above 30 years old, and regarding the Internet usage, 89% have used it for more than 3 years on a regular basis.

[3]http://uoz.edu.krd/news.php?NID=ODY=4DXtDr2x
[4]https://scholar.google.com/citations?user=vAonlVMAAAAJ&hl=en
[5]https://drive.google.com/file/d/0BykHovfSV4CCSk9peGw5X0ZOWDQ/view

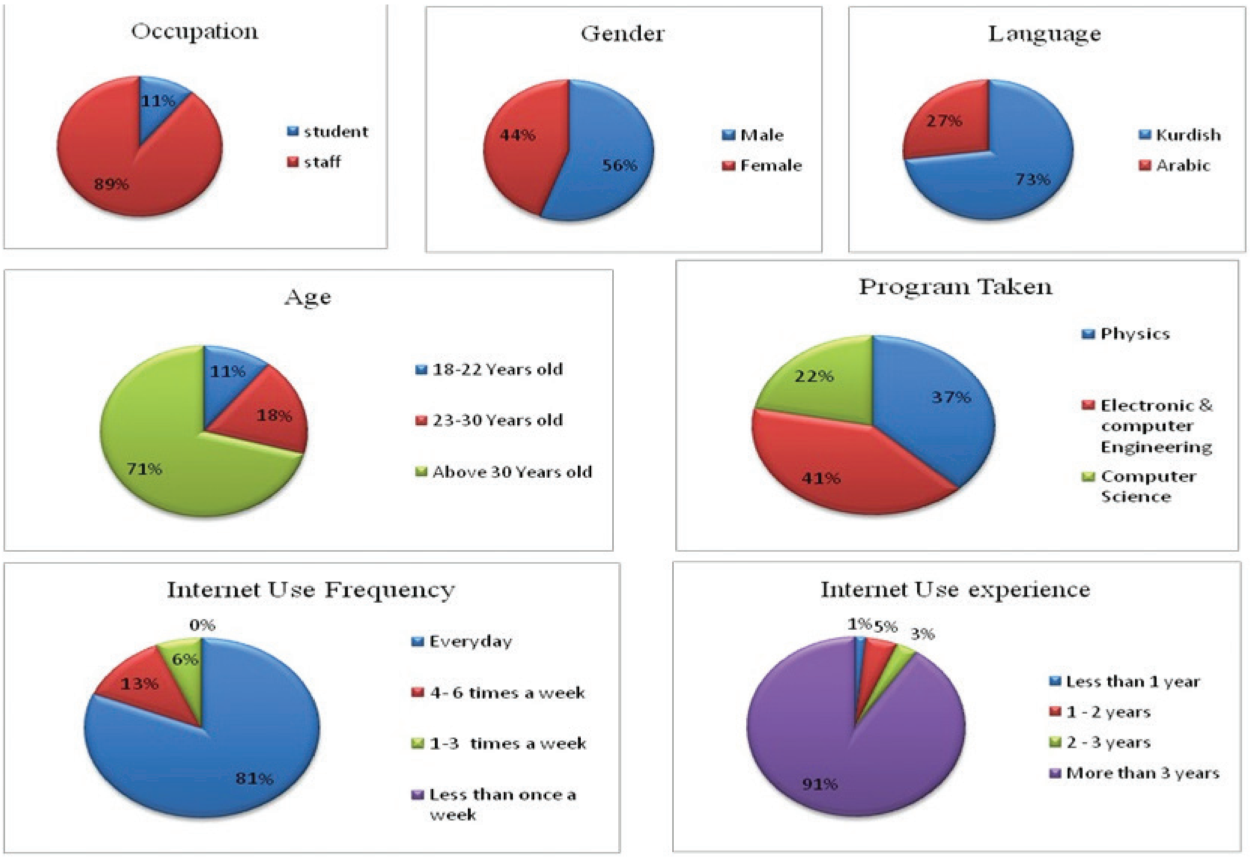

Figure 4. Analyzing the nominal data.

4.1.2. Analyzing interval data

To classify the continuous data, the questionnaire showed standardized differences between values. We transferred the questionnaires into a spreadsheet by putting each question number as a column heading and one row for each person's answers, as shown in **Table 1**. The scale was strongly agree (4), agree (3), disagree (2), and strong disagree (1) [36, 37]. This four-point scale (i.e. an even scale) forces people to choose a side, without a middle point [36, 38]. It gives a certain tendency of answer, hence increasing the reliability [39]. In addition, within using four points, the result can reasonably perceive the tendency [40].

4.2. Interview

Regarding the academics' questions, these had already been discussed and had been replied to in their office about online labs. Interestingly, the academics agreed that online labs can be useful to science, technology, engineering, and mathematics (STEM) fields for supporting hands-on labs. In their comments, they indicated online labs technology can be very interesting to use in higher educational and curricula. In addition, they pointed out that online labs should become available resources for engineering and science disciplines. The academics answers are shown in the results section.

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Question number	Scaling				Total questionnaires	Percentage (%)			
	(4)	(3)	(2)	(1)		(4)	(3)	(2)	(1)
Q1	6	40	12	5	63	10	63	19	8
Q2	14	42	6	1	63	22	67	10	2
Q3	14	37	10	2	63	22	59	16	3
Q4	20	32	11	0	63	32	51	17	0
Q5	11	46	6	0	63	17	73	10	0
Q6	19	37	6	1	63	30	59	10	2
Q7	19	38	6	0	63	30	60	10	0
Q8	17	37	6	3	63	27	59	10	5
Q9	15	39	7	2	63	24	62	11	3
Q10	20	33	10	0	63	32	52	16	0
Q11	27	28	8	0	63	43	44	13	0
Q12	13	39	11	0	63	21	62	17	0
Q13	6	34	22	1	63	10	54	35	2
Q14	3	18	28	14	63	5	29	44	22
Q15	10	45	6	2	63	16	71	10	3

Table 1. Analyzing the interval data.

4.3. Online meeting discussion

During the presentation, the participants wrote questions related to online labs technology and a community of practice to the respondent. Several questions were passed and answered by Professor Alves. These questions were related to online labs, collaborative, and cooperative work among researchers, a community of practice, cost of online labs use, and so on. These questions and answers are also shown in the results section.

5. Results

In this section, we describe the results collected from both quantitative and qualitative data analysis. Afterward, we highlight some important points.

5.1. Quantitative data results

To examine the questionnaire data, we used the terms of a p value, under a null hypothesis, for quantifying the strength of the evidence against the null hypothesis and measuring the size of an effect or the importance of a result [41]. Therefore, for moderating the evidence as statistically significant, a p value ≤ 0.05 [42] is commonly used in research [41–44]. It is used as a confidence for analyzing the data to find if there are independencies and correlations in the nominal and interval data.

5.1.1. Correlations among nominal and interval data

Regarding the quantitative data, several correlations were detected inside nominal and interval data and between nominal and interval data, as illustrated in **Figure 5**. These correlations are described below.

Using a confidence level of 95%, several statistical significant correlations were found between different items in analysis as shown in **Table 2**.

Occupation: The number of respondents was 63 with 88.9% responding as teachers and 11.1% responding as masters students. Regarding occupation, we found a correlation ($p \leq 0.05$) with nominal (i.e. age, program taken, Internet use experience, and internet use frequency) and interval (i.e. Q2, Q7, and Q8) data; see **Figure 6**.

Gender: Regarding gender, there was 63.5% male and 36.5% female. During the analysis, we found a correlation of gender with two nominal data: age and scientific area of program taken, as illustrated in **Figure 7**.

Age: In age, the percentage was 28.7% in the 23–30-years-old age group and 71.3% were above 30 years old. We found that age has a correlation with Internet use experience nominal data, as illustrated in **Figure 8**.

Program taken: Program taken is correlated with Q14 interval data, as illustrated in **Figure 9**.

Internet use experience: Long use time of the Internet is correlated with Internet use frequency nominal data and Q2, and Q7 interval data, as illustrated in **Figure 10**.

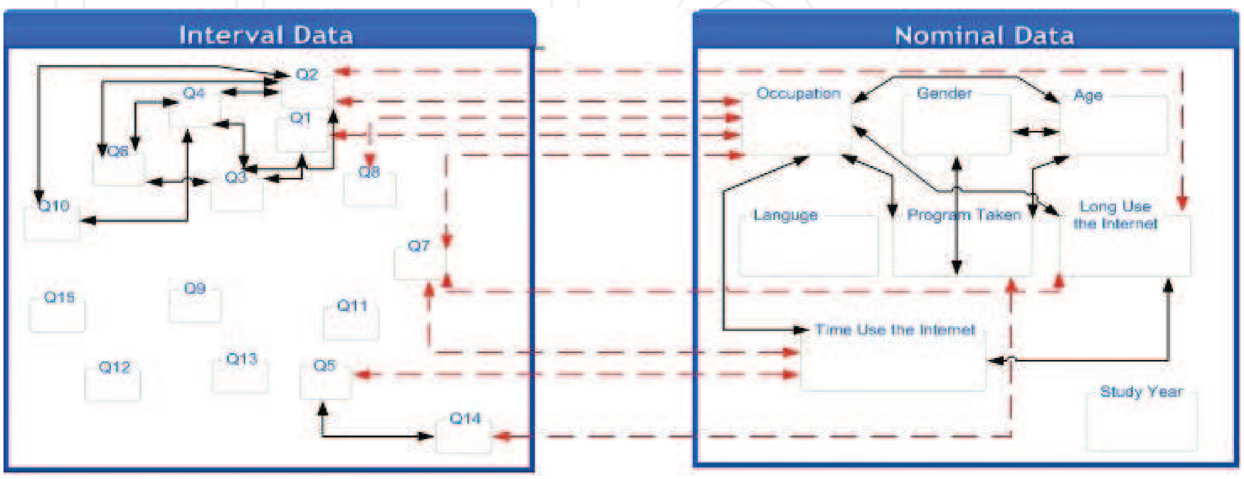

Figure 5. Correlations inside nominal and interval data and between nominal and interval data.

Correlations	**Occupation**	**Gender**	**Age**	**Program taken**	**Internet use experience**	**Internet use frequency**	**Q1**	**Q2**	**Q5**	**Q7**	**Q8**	**Q14**
Occupation			p-Value <0.001	p-Value =0.002	p-Value <0.001	p-Value =0.003	p-Value =0.057	p-Value =0.005		p-Value =0.001	p-Value <0.001	
Gender			p-Value =0.047	p-Value =0.047								
Age	p-Value <0.001	p-Value =0.047			p-Value =0.028							
Program taken	p-Value =0.002	p-Value =0.047										p-Value =0.043
Internet use experience	p-Value <0.001		p-Value =0.028			p-Value =0.015		p-Value =0.034		p-Value =0.001		
Internet use frequency	p-Value =0.003				p-Value =0.015				p-Value <0.001	p-Value =0.002		
Q1	p-Value =0.057											
Q2	p-Value =0.005				p-Value =0.034							
Q5						p-Value <0.001						
Q7	p-Value =0.001				p-Value =0.001	p-Value =0.002						
Q8	p-Value <0.001											
Q14				p-Value =0.043								

Table 2. Significant correlations between items.

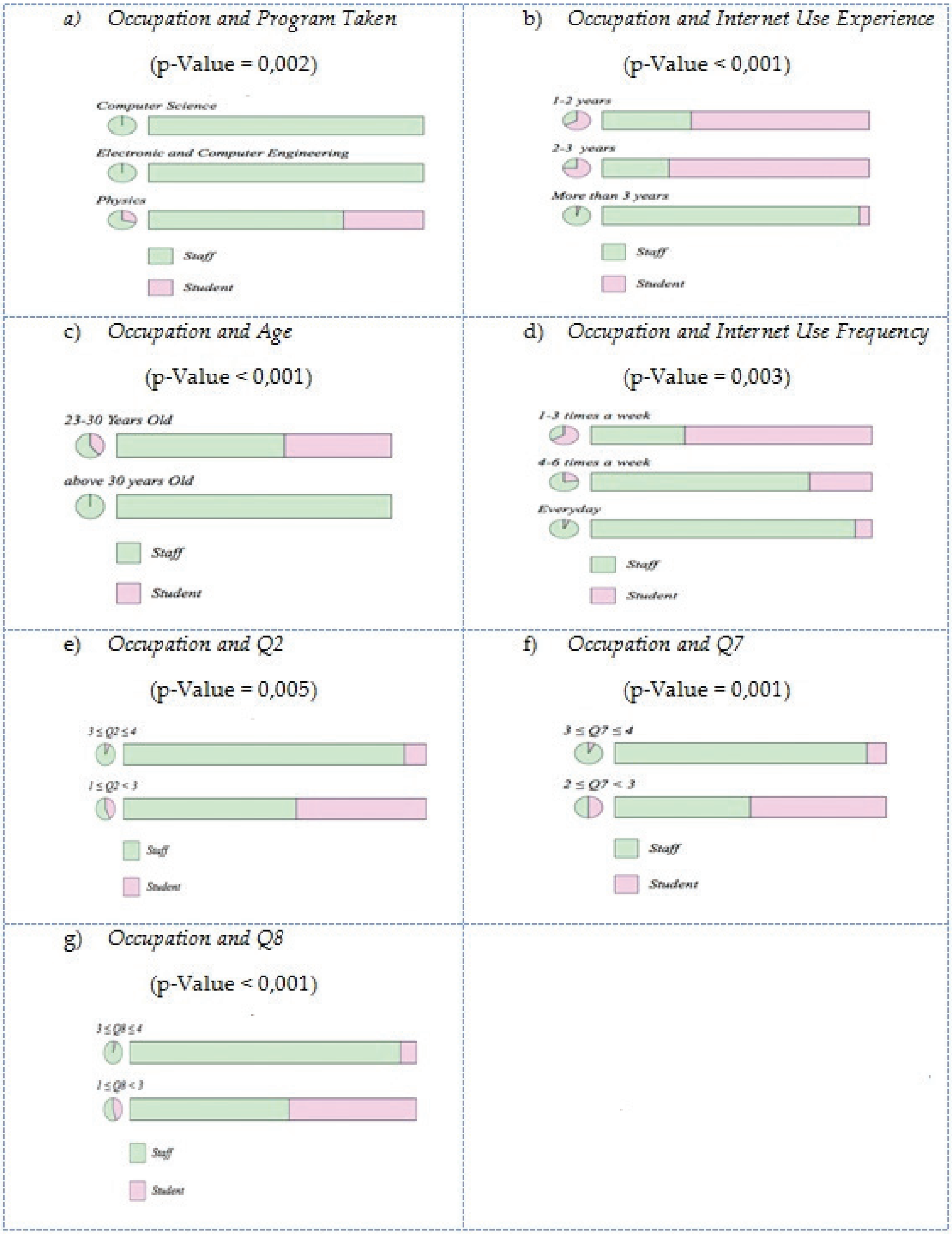

Figure 6. Occupation correlation with age, program taken, Internet use experience, Internet use frequency of the use of the internet, Q2, Q7, and Q8.

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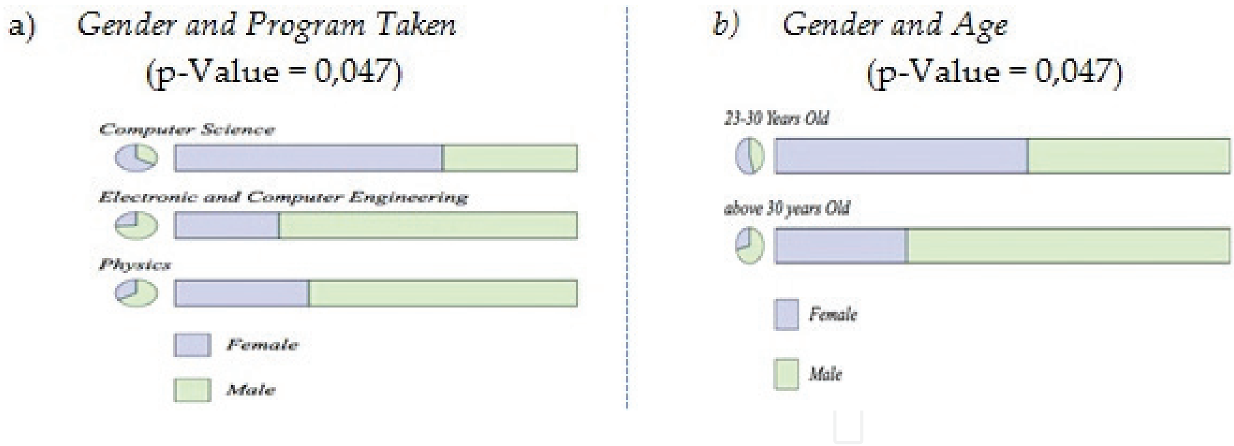

Figure 7. Gender correlation with age and program taken.

Internet Use Frequency: Finally, Internet use frequency is correlated with Q5 and Q7, as illustrated in **Figure 11**.

5.1.2. Correlation among interval data (Q1–Q15)

While analyzing the interval data from the questionnaire, several variable relations have been detected among questions. In general, these variable relations, namely correlation and two-way ANOVA, show a mutual relation of two or more pairs of variables and how strongly they are

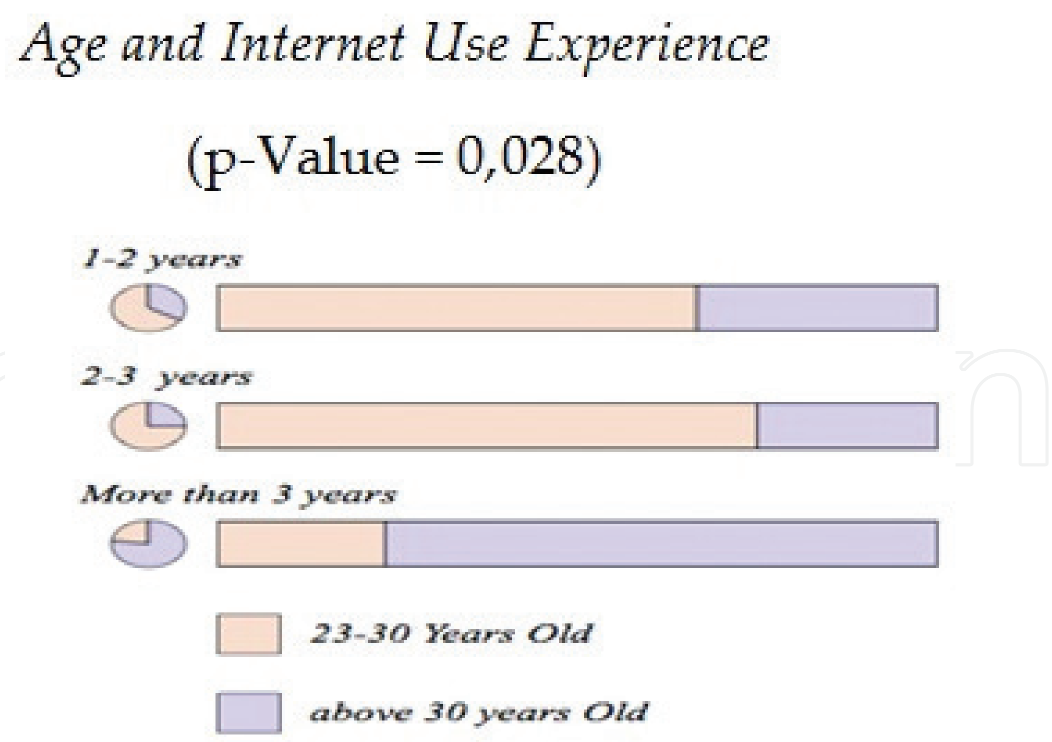

Figure 8. Age correlation with internet use experience.

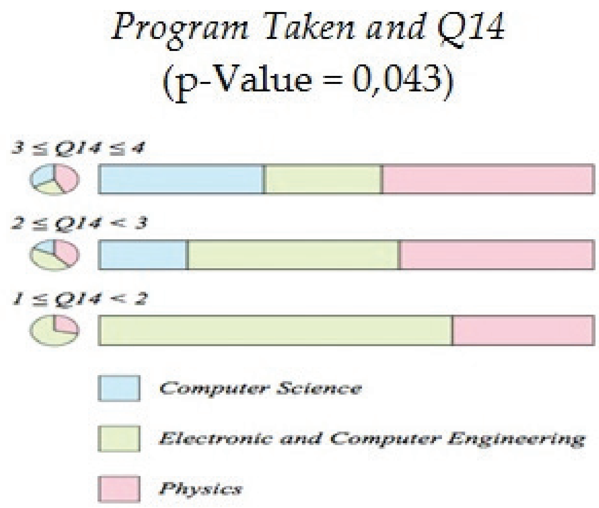

Figure 9. Program taken correlation with Q14.

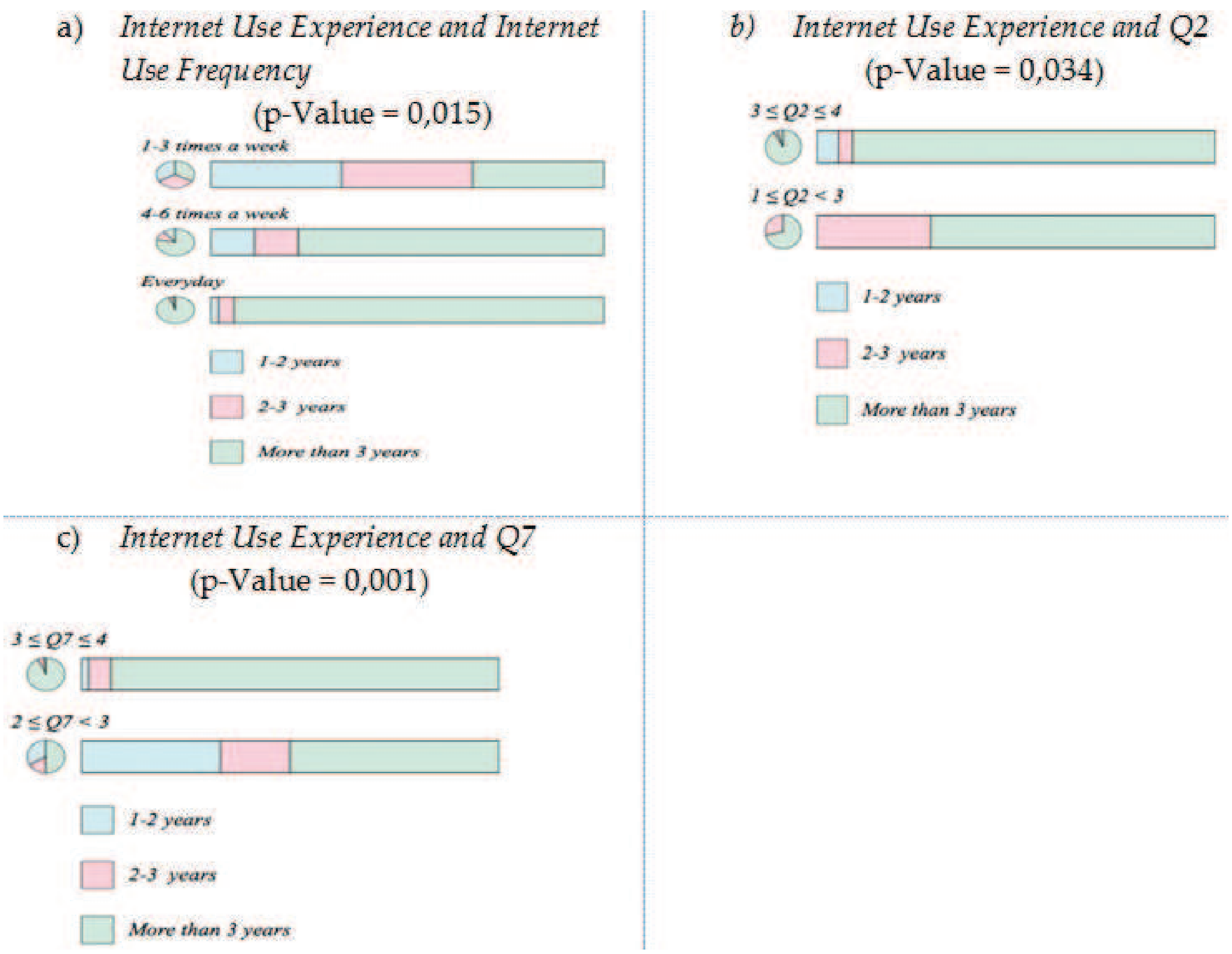

Figure 10. Internet use experience correlation with Internet use frequency, Q2, and Q7.

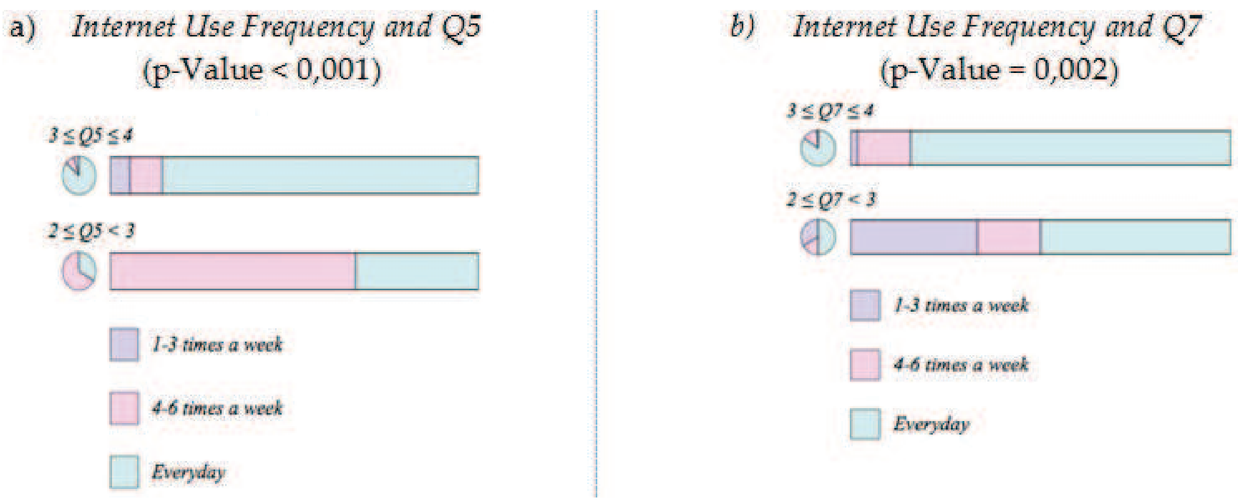

Figure 11. Internet use frequency correlation with Q5 and Q7.

related [45, 46]. As shown in **Table 3** and **Figure 12**, these categories are used to form groupings of observations.

5.2. Qualitative data results

Qualitative data results were collected from using interviews and online meeting techniques, as shown below.

5.2.1. Interview results

Table 4 shows some of the researchers' answers collected from the interviews, which included six questions:

Group	Questions	Detected	Variable relation	p value
Usefulness	2, 4, and 6	Interaction	Two-way ANOVA	0.033
Sustainability	5 and 14	Positive	Correlation	0.013
Learnability	1 and 3	Positive	Correlation	<0.001
	2 and 3	Positive	Correlation	0.008
	2 and 4	Positive	Correlation	0.002
	2 and 10	Positive	Correlation	0.012
	3, 4, and 6	Interaction	Two-way ANOVA	0.012
	4 and 10	Positive	Correlation	<0.001

Table 3. Correlations among interval data.

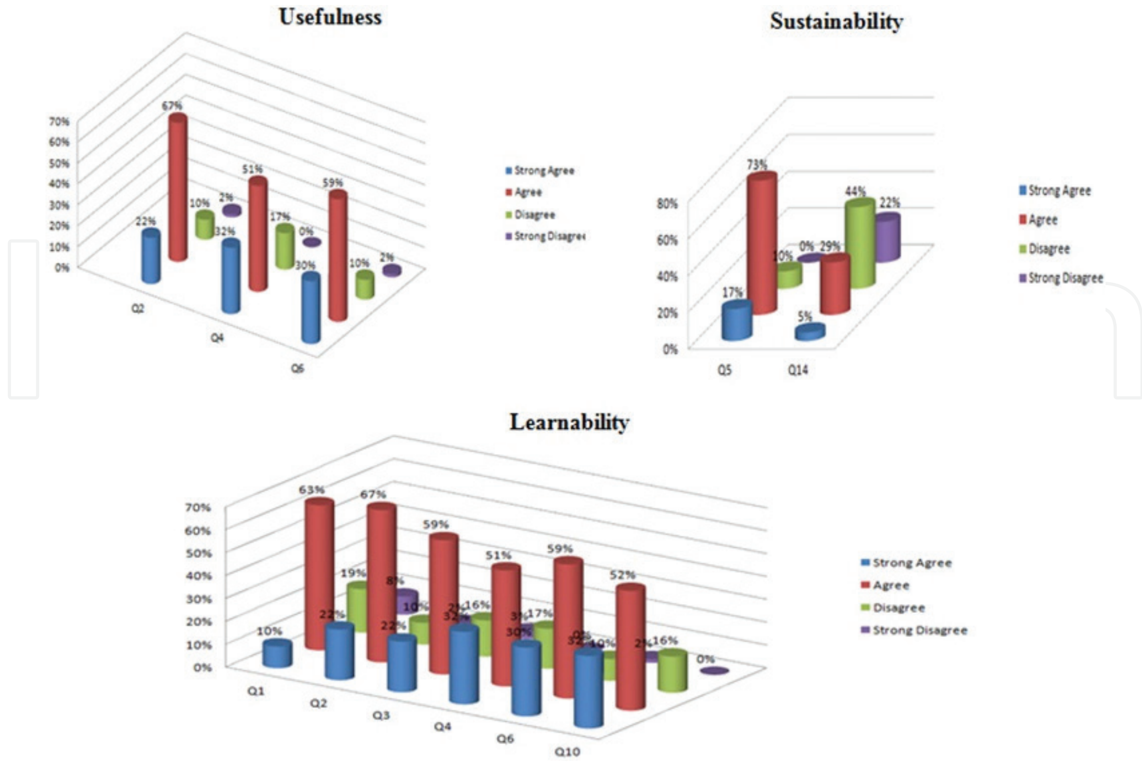

Figure 12. Interval data results (usefulness, sustainability, and learnability).

5.2.2. Online meeting results

Here are the main questions and answers that were collected from the online meeting.

Q1: Why are most online labs free?

Answer: *The purpose of online labs is educational. They are used for assisting and supporting hands-on labs, not for replacing them.*

Q2: How can online labs increase the collaboration and cooperation work among researchers?

Answer: *Online labs have the ability to increase collaboration and cooperation works by sharing the resources, experiments, and so on, among universities and researchers.*

Q3: Do online labs have facilities to serve a community of practice?

Answer: *Yes; today, there are communities around online labs, for example, virtual instrument systems in reality (VISIR). This community is called a special interesting group (SIG)*[6] *and includes many researchers from different countries.*

Q4: Is it possible to consider that online labs can be one useful option, in higher educational government, in the case of unavailability of equipment or the high cost of instruments?

Answer: *In general, it can be said that online labs save time and money. Therefore, yes, online labs can be used, in case of unavailability of equipment or costly equipment, for assisting hands-on labs. Additionally, it can help develop the students' technical skills and contribute to the quality of higher education and so on.*

[6]http://www.online-engineering.org/SIG_visir.php

Q1	**Can online labs technology provide useful information for teachers and students of higher education?**
Answers	*It is very useful because it would provide experiments that cannot be available at the university using modern techniques (vice president, the University of Zakho).* *It could if we consider that teachers can have an overview into the already existed and ready experiments in its subject at the online lab system. For students, sure it would provide experiment information and can work on it from anytime and from anywhere (teacher in the Electrical and Computer Engineering Department, the University of Duhok).* *Yes both of them can get benefit from it. The teacher by using the new methods to develop his teaching and the students by connecting what is he going to study with the technology (teacher in the Physics Department, the University of Duhok).*
Q2	**Do you think online labs technology can assist and support the work of the teachers in the hands-on lab and, at the same time, offer students an easier way to complete their tasks?**
Answers	*I can feel the sense to which level the teachers and students can improve their skills and knowledge (vice president, the University of Zakho).* *Yes of course because some time you need more perceptible tools to understand the difficulties in the lectures (teacher in the Physics Department, the University of Duhok).* *Yes, if the relevant teachers and/or instructors received some basic training on the use of the system. The system will need good documentation (with regular updates) for users and some model experiments to encourage potential users enrolling it within their courses (the Head of Refrigeration And Air Conditioning Department, the Duhok Polytechnic University).*
Q3	**Do you think students can benefit from online labs technology applications, especially in STEM fields?**
Answers	*It can be benefitted, especially for physics department. Because, in same case, Our Hands-on labs cannot include all components for students, which are required to complete the experiments (the Head of the Physics Department, the University of Duhok).* *Yes, especially now where our province is in a financial crises (teacher in the Electrical and Computer Engineering Department, the University of Duhok).* *Yes. It can do so by sharing experiments from worldwide universities and this would undoubtedly improve the quality and improve the curriculum in some cases (teacher in the Electrical and Computer Engineering Department, the University of Duhok).*
Q4	**Do you think online labs technology can improve the curriculum in higher educational system?**
Answers	*Sure, because higher education system required several equipment and tools that might not be available. Therefore, such a technology will compensate such lack of availability (vice president, the University of Zakho).* *It depends what facilities are available? Can we use this technology to conduct our laboratories keeping in mind that number of students is high? (teacher in the Electrical and Computer Engineering Department, the University of Duhok).* *Yes I believe so if the service provider of the On-Line laboratories support a large domain of theories and implementations (the Head of Refrigeration and Air Conditioning Department, Duhok Polytechnic University).*
Q5	**Do you think online labs technology can increase collaboration and cooperation works among researchers?**

Q1	**Can online labs technology provide useful information for teachers and students of higher education?**
Answers	*Yes sure. The systems would let researchers and people from the academia share their knowledge and experience so this would be a great opportunity to collaborate and share information and work together (teacher in the Electrical and Computer Engineering Department, the University of Duhok).* *It will help to increase the collaboration and cooperation work by using online labs. This technology can help to create a bridge for researchers to share information and knowledge (the Head of the Physics Department, the University of Duhok).* *I don't think that On-Line labs will have big impact on the research side, because research usually needs specialized equipment that may not necessarily be shared with other researchers. Moreover, if there isn't wide domain of users for certain experiments set of equipment then it won't be economically viable for the service provider of On-Line Labs people (or company) themselves. The economical issue here will prevail in this case (the Head of Refrigeration and Air Conditioning Department, Duhok Polytechnic University).*
Q6	**Finally, do you have special advice about use online labs technology in STEM fields?**
Answers	*Online labs can provide good alternative for some educational establishments (probably in third world countries). From my own experience, the issue of labs is quite complicated. In most cases labs and their equipment needs logistic support. By this I mean a range of things, starts with fund for the initial cost, right personnel to run and maintain the equipment, suitable premises and last but not least (the legitimate use of these lab equipment (in some cases). These could be burdensome responsibilities for some educational establishments. In the On-Line labs case most of these issues are resolved. As a computer laboratory can play a dual functionality in these cases, besides being a computer lab it could be used as Electrical Technology (for instance) using On-Line labs via internet connection (the Head of Refrigeration and Air Conditioning Department, Duhok Polytechnic University).* *It needs encouragement and motivation to get knows this technology and gets closed to this technology (vice president, the University of Zakho).* *I suggest the following to use the online lab. First step is to encourage the staff members and postgraduate students to use this technology. It is very essential to introduce them to the facilities and devices available. Second step is to use this technology to implement final year projects. Third step is to encourage all undergraduate students to use this technology (teacher in the Electrical and Computer Engineering Department, the University of Duhok).*

Table 4. Interview results.

6. Remarks

In general, it is important to remark the results collected from the quantitative and qualitative data analysis. These remarks are:

1. **Providing resources:** Quantitative and qualitative data results show that online labs can assist the higher educational systems by sharing materials and online experiments among teachers and students. As shown in **Table 1**, Q2, Q7, and Q11 have the highest scale of "agree" and "strong agree". Likewise, the academics' answers, during interviews, indicated that online labs can provide a new method of teaching, that is, online experiments, for both teachers and students.

2. **Assisting and supporting work:** The results of quantitative data, presented by Q3, Q5, Q7, Q9, and Q11, show online labs can help teachers and students complete their task

24/7. As shown in **Table 1**, Q14 has the highest scale of "disagree" and "strong disagree" and that means most respondents also agree that online labs are aimed to support hands-on labs, not replace them, by offering online experiments to students and teachers. Likewise, most academics' answers collected from the interviews mentioned that online labs can provide more tools, and they encouraged their use to improve their students' skills.

3. **Benefiting from online labs:** Students can benefit from online labs, especially in fields that face the limitation of equipment and components. This point appeared in some academics' answers to Q2, Q4, Q6, Q9, Q10, and Q11 of the questionnaire.

4. **Improving curricula:** In general, academics agreed the curriculum can be improved by including instructional technologies, particularly online labs. These technologies can support a large domain of theories and implementations. This is shown in the Q2, Q3, Q6, and Q7 results, as well.

5. **Increasing the collaboration and cooperation among researchers:** Most researchers agreed that online labs can help increase collaborative and cooperative work among them by sharing knowledge and experience. In addition, one of the two main questions received from the respondents during the online meeting was "*how can online labs increase the collaborative and cooperative work among researchers and how can online labs have the ability to create a community of practice, especially around the VISIR Open Lab Platform*". From the quantitative data result, it can be noticed that Q4, Q5, and Q15, which are related to collaborative and cooperative work and to a community of practice, evidenced to a high level of agreement.

6. **Advising: several advices have been gathered in this study**. For example:

a. Online labs can be a good alternative, for some countries, which is related to the increase of student numbers, financial crises, and quality of educational systems.

b. Online labs need encouragement and motivation for people who have never used technologies in education.

c. Online labs can be implemented as final projects for students in the last year of their study.

7. **Outcomes and impact:** Two things can be highlighted:

a. *First work done (VISIR)*: After completing the series of presentations, the University of Duhok and the University of Zakho are using VISIR system by including several online experiments (e.g. Ohm's and Kirchhoff's laws) for the 2016–2017 academic year.

b. *Second work done (REXNet Project*[7]*)*: Researchers from the University of Duhok, the University of Zakho, and Duhok Polytechnic University have collaborated in creating a group of researchers and afterward they submitted a proposal to the IREX organization,[8] named *Building a Remote Experimentation Network for serving higher education teachers and students*

[7]https://tinyurl.com/jtf96m3 (Use Internet Explorer or Mozilla browsers to open the REXNet project)
[8]https://www.irex.org/

in Iraq (REXNet) project. The project idea is to create a remote experimentation network to use online experiments, which are developed and located in the United States universities for serving teachers and students in the Kurdistan region of Iraq. In conclusion, it has been accepted for implementation in collaboration with Oklahoma State University (OSU). In general, REXNet project aims to develop a virtual lab, which is based on virtual environment "virtual reality (VR)", for serving engineering and science students from the University of Duhok, the University of Zakho, and Duhok Polytechnic University. It introduces fundamentals of robotics to students by including several experiment modules that allow students to run experiments via the Internet.

7. Conclusion and future direction

This chapter outlines some indicators related to the higher educational systems in the MENA region, such as the support given by instructional technologies to academics working in this region. The research instrument consisted of a series of questions for collecting data from the respondents by using three techniques: questionnaires, online meetings, and interviews.

Overall, the major goals of this chapter are:

1. Providing materials and instructional technologies (i.e. online labs) to researchers, teachers, and students in the MENA region.
2. Building a community of practice around online labs in the MENA region.
3. Increasing collaborative and cooperative work among the MENA researchers by sharing resources and online experiments.

A community of practice can be task and goal oriented to satisfy the need for cooperative achievements of goals and provide support for online learning [47].

This research provides a feasible idea for more achievements in higher educational sectors in the MENA region by including instructional technologies that facilitate the students' skills acquisition and assist higher educational systems.

It is also hoped that by setting the online labs indicator, this chapter may be useful to guide the development of higher educational systems in other regions. Similarly, it may find other indicators or activities related to learning that can develop and assist the higher educational systems in the MENA region and increase collaborative and cooperative work among their researchers.

Hopefully, for the middle/long term, involving other universities, in Iraq and other MENA countries in general, to become a part of this online labs community, either using the VISIR system or through the REXNet project, for sharing resources and knowledge among them and increasing collaborative and cooperative work among their researchers.

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