PSYCHOLOGY AND EDUCATION (2020) 57(5): 295-301
An Interdisciplinary Journal

Review Article

An Investigation of Factors Influencing Physics Teachers' Intention to Use Virtual Laboratory at the International Schools in Amman

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Abstract

The study investigates the factors that affect the intention of using the virtual labs in teaching physics, including the TPACK and teacher self-efficacy, for physics teachers who need to be able to teach physics using the virtual labs in the Jordanian context, a descriptive-survey research methodology was conducted with 101 physics teachers who teach physics in the international schools.

The findings of the study analysis demonstrated in four main results. (1)Physics teachers' TPACK will have a positive effect on teacher self-efficacy, (2) Physics teachers' TPACK will have a positive influenced perceived ease of using virtual labs,(3) Physics Teachers' TPACK and perceived ease of use (PEOU) will have a positive effect on the perceived usefulness of technology (PU) and (4) The researcher found that Physics teachers' TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness of technology will affect intention to use technology.

Keywords: TAM, Virtual labs, TPACK, Teacher Self-Efficacy, Perceived Ease of Use and Perceived Usefulness.

Introduction

In today's world, education and technology cannot be considered independent of each other and the integration of technology into education has become highly vital and effective in the process of learning. The integration of technology as a tool is used for improving students' learning, a better understanding of the lesson content, and developing a higher thinking skill for students.

During the last decades, information, and communication technology (ICT) has witnessed rapid development in all educational fields (Pelgrum, 2001). The course of science is being noticed and it relates to technology and many educational experts are taking into consideration the importance of integrating information and communication technology with science (Babateen, 2011).

Physics can be considered as one of the subjects in science that is less preferred by students, they tend to consider physics as a difficult subject since it deals with problems and calculations and it is considered as experimental evidence, criticism, and rational discussion (Kustusch, 2016). Many researchers in Physics educations have shown the ineffectiveness of traditional instructional methods and shed the light on the lack of understanding science and content and processes when students were subjected to conventional teaching (McDermotti, 2001; Onyesolu, 2009). The laboratory experiments are one of the main efficient means to make difficult theories simpler and clearer (McDermott, 2001). Some experiments conducted in a real laboratory can consider an obstacle for its less effective in cost and equipment preparations by lab staff, from these points, we need alternative laboratory equipment where teachers and students can conduct different experiments at any time in safe conditions. One of the solutions that may help to fix the problem is to use a virtual laboratory which is considered one of the power-efficient tools that offer alternative learning environments that attract student's attention and interests (Onyesolu, 2009).

The technique of using virtual labs has been applied in various schools that teach physics in Jordan, and many studies have investigated the effect of using virtual labs in teaching physics on students' achievements (Naser, 2018; Mahmoud, 2017). However, there is a lack of studies that investigate the teachers' behaviors and attitudes toward using virtual labs in teaching physics. Understanding users' behaviors are a very important issue and must be investigated when applying new technology (Venkatesh & Davis, 2003; Huang & Liaw, 2005).

Recently, Jordanian internationals schools start building virtual labs to teach physics. However, there is a paucity of research that studied teachers' behavior toward using virtual labs. For this reason, the researcher observes that there is a gap in previous studies which concerned about investigating the effect of using virtual labs in Jordan while ignoring teachers' behavior. It is imperative to expose teachers' behavior and attitudes due to their effective impact in achieving the desired benefit of that technique (Clark, 2000).

In this study, the researcher focused on investigating the factors that affect the intention of using the virtual labs in teaching physics, including the technological pedagogical content knowledge (TPACK) and teacher self-efficacy, for physics teachers who need to be able to teach physics using the virtual labs in the International schools in the Jordanian context. Many researchers focused on investigating the relationships between these factors, this study emphasized that TPACK and teacher self-efficacy is the most important factors for increasing intention to use technology (JuJoo, Park & Eugene, 2017; Joo, Park & Lim, 2018). The current study helps the school administrators to know what to consider before building the virtual labs. Moreover, this study implies that improving TPACK will play a critical role in helping physics teachers to use virtual labs in their educational context.

Literature review

Virtual labs

Physics can be considered one of the subjects that are less preferred for students because it deals with calculations and problems. Many researchers in physics educations have shown the ineffectuality of traditional methods and shed the light on the misunderstanding of physics concepts and processes when students were subjected to conventional teaching and demonstrations (Kurniawati, Wartono & Diantoro, 2014; Kustusch, 2016).

The laboratory experiments are one of the most important means to make any theory simpler and clearer (Aqel, 2019). Learning physics has been restrained by the deficiency of laboratory equipment in schools. Some experiments that have been conducted in a real laboratory can consider an obstacle for its less effective in cost and equipment preparations by lab staff (Oidov, Tortogtokh & Purevdagva, 2012). From these points came the idea of using virtual laboratories and according to Galan, et al. (2016), virtual labs can be defined as a computer-based simulation that provides ways of work similar to hands-on labs.

There are many characteristics of using virtual labs in education and according to many researchers such as Harry and Edward (2005) using virtual labs will encourage the students to do different kinds of experiments, performing different kinds of experiments that are difficult to be done in a traditional laboratory, producing new intellectual model in education better than the real, and minimizing the learning time spent in the traditional lab as well. Moreover, Tatlıand Ayas (2010) stated that using virtual labs will increase academic success for the students and could enhance and emphasize the use of educational strategies which are based on constructivist and collaborative teaching method. Also according to Ranjan (2017) using virtual laboratories will provide the students with significant virtual experiences to present the concepts, processes, and principles that they have learned, and that will help the students to understand any concepts readily.

The technique of using a virtual laboratory has been applied in various schools that teach physics in Jordan (Naser, 2018; Mahmoud, 2017). Although, there was a lack of studies that indicate teachers accepting it.

Therefore, It is important that before schools start building these virtual labs, they need to understand how well teachers accept the use of virtual laboratory in teaching physics since teachers can be considered as one of the most important components of classroom managements and important responsibilities in this process, one of these responsibilities is having a positive attitude towards technology which enables them to use technology in learning environments (Adiguzel & Berk, 2009; Naser, 2018).

Technological Pedagogical Content (TPACK)

There is various way to define TPACK, one of these definitions is a theoretical framework for representing the interaction of technology, pedagogy, and content knowledge that is needed to integrate technology in the learning process (Schmidt, et al. 2009).

The Term of TPACK, although it can consider being a new term, the idea of TPACK has been around for a long time. It was first mentioned in Mishra (1998) through the context of educational Design. Pierson (1999), Keating, and Evans (2001) all of them describe the relationships between pedagogy, technology, and content.

TPACK is a framework that introduces the relationships between all three strains of knowledge (pedagogy, technology, and content) (Mishra & Koehler, 2006), and this term has been adopted by many researchers for describing the knowledge and skills that are needed to integrate technology into education (Graham, 2011; Koh, Chai, & Tsai, 2010). Moreover, TPACK consider being a useful frame for thinking about what kind of knowledge teachers should have to merge technology into learning and how they can develop their knowledge (Schmidt, et al. 2009)

Teacher self-efficacy: -

Teacher self-efficacy is defined as the teachers' beliefs about their skills and their ability as a teacher. It contains both their abilities and their beliefs to outline instructional objectives (Gavora, 2010) and their confidence in their ability to support student teaching (Hoy, 2000).

Many studies have investigated and concluded that teacher self-efficacy has a good influence on the students' achievement (Cox, 2010; Young, Park & Eugene, 2017). These studies have concluded that teachers with high self- efficacy will ask their students open-ended questions, do inquiry methods, and prefer small-group teaching activities more than the teachers with low self-efficacy. Moreover, Teachers with high self-efficacy are more willing to do creative learning methods, more open to new ideas, and more willing to adopt better teaching methods do (Brouwers & Tomic, 2003; Isaac, et al., 2017) teacher can importantly motivate to integrate technology in the classroom.

Many researchers have proved the relationship between the intention to use technology and self-efficacy (Baker-Eveleth & Stone, 2008; Anderson, Groulx, & Maninger, 2011; Valtonen, et al., 2015; Isaac, et al. 2017). Teachers believe the integration of technology in the classroom is a very important predictor of their intention to use technology in the classroom (Anderson, 2011).

Perceived ease of use and perceived usefulness:

There is various way of defining Perceived ease of use; one of these definitions is the degree to which users believe they will use new technology without difficulty (Davis, 1989). While Perceived usefulness is defined as how much the individual users can know that the new technology will improve their performance (Davis, 1989).

According to TAM, researchers have discovered the effect of perceived ease of use on perceived usefulness (Chow, et al., 2012; Joo, Lee, & Ham, 2014; Lee & Lehto, 2013). Moreover, they have confirmed that the perceived ease of use and perceived usefulness importantly affect teachers' intention to use technology (Jeung, 2014; Davis, Bagozzi & Warshaw, 1989; Teo, 2011; Wangpipatwong, Chutimaskul, & Papasratorn, 2008).

Theoretical framework: Technology Acceptance Model (TAM)

The TAM is one of the most important theories for predicting technology acceptance, and it has been adopted by many theoretical studies (Bazelais, Doleck & Lemay, 2018) and it has been appeared in 1998 (Davis, 1988). Moreover, it considers being one of the most popular research models that predict the acceptance of technology by individuals' users. TAM has been verified by various studies that studied the technology acceptance behavior in various information system constructs (Joo, Park, & Lim 2018).

Two parts affect the TAM model: the perceived usefulness (PU) and the perceived ease of use (PEOU), Davis defines the perceived ease of use as the degree to which users believe that they will use new technology without difficulty and perceived usefulness defines it as how much individual users recognize that new technology will help improve performance.

According to TAM, the two parts are the most important determinants to the actual use; the two parts are affected by external variables. The main external factors are usually considered Cultural factors, Social factors, and Political factors. Social factors include skills and languages whereas political factors are mainly the effect of using technology in politics (Mai & Liu, 2007).

TAM has been widely used in the model to understand and explain user's behavior toward the information technology system, there have been several studies conducted by researchers to modify the TAM by adding new variables to it (Joo, Park, & Lim, 2018).

In this study, the researcher added new variables to the TAM model which are the TPACK and self-efficacy and although these variable are important, there are not many studies that pay attention to the significant influence of TPACK and self- efficacy on physics teachers' intention to use technology (Joo, Park & Lim, 2018).

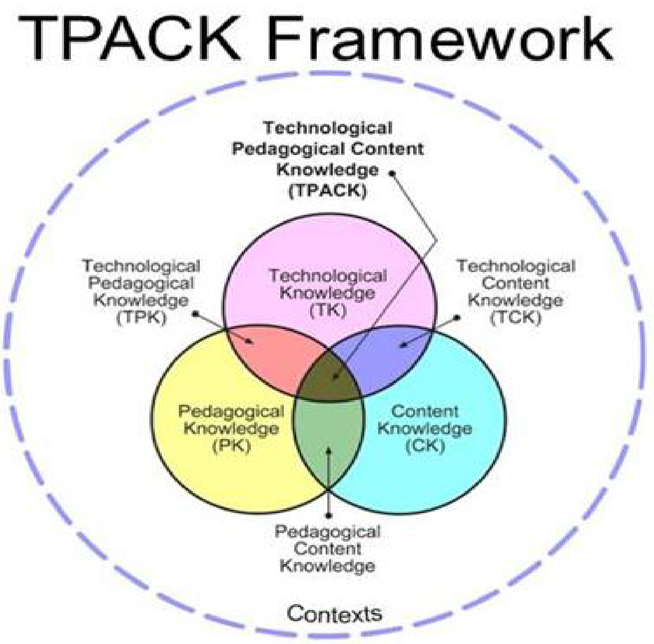
Based on the theoretical framework and the lecture review, this study investigated the relationships between factors that influence physics teachers' TPACK, self-efficacy, perceived usefulness, perceived ease of use, and their intention to use virtual labs in teaching physics. TPACK is considered to be a critical factor that influences other variables in this study.

Figure shows the research hypotheses for this study.

Hypothesis 1: Physics teachers' TPACK will positively affect teacher self-efficacy.

Hypothesis 2: Physics teachers' TPACK will positively affect the perceived ease of using virtual labs.

Hypothesis 3: Physics Teachers' TPACK and perceived ease of use will positively affect the perceived usefulness of using the virtual labs



.**Figure 1.** TPACK Framework (Schmidit, Baran, Thompson, Mishra, Koehler&Shin, 2009).

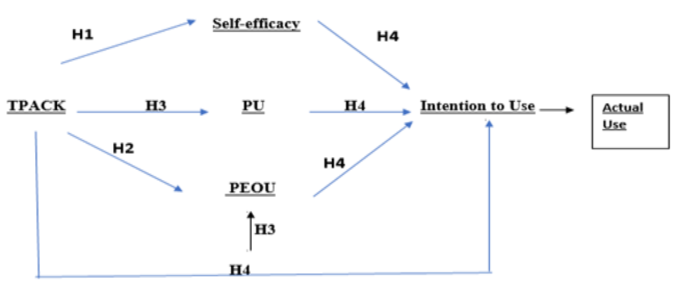


Figure 2. Hypothesized research model

Hypothesis 4: Physics teachers' TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness of technology will affect intention to use virtual labs.

Methods

Participants and procedures

The researcher has used the descriptive-survey research methodology to investigate peoples' perceptions and beliefs of their thoughts, feelings, and actions (Lodico, Spaulding,& Voegtle, 2006). By distributing electronic surveys throughout various international schools in Amman to investigate the factors, influencing physics teachers' intention to use virtual labs: TPACK, self-efficacy, and technology acceptance model,Data were collected from 101 physics teachers.

Table 1 shows the distribution of the individuals in the study according to their demographic information.

Instruments

Demographic information

Demographic information includes age, year of experts, gender, and degree level. The researcher can easily and effectively collect these kinds of information with an electronic survey.

Attitude questionnaire

To test the structural relationships between the various variables, the researcher has used one measurement instrument. The content was done for the use of Jordanian physics teachers, by doing the appropriate methods. The Survey used the 5-point Likert Scale ranging from 1 to 5 to have a fixed scale. The Survey had 30 questions for entrants, excluding the demographic variables.

To measure TPACK, the scale was developed by (Schmidt, Baran, Thompson, Koehler, Mishra& Shin, 2009) among the 57 items, the researcher selected17 items from TPACK Scale, and the instrument was originally progressed for preserves teachers in elementary teaching. Since the participants in this study are physics teachers that teach physics in international schools, the researcher removed any expression identifying any subject that is not related to physics.

To measure teacher self-efficacy, the scale was developed by (Schwarzer & Colleagues, 1999) among the 30 items the researcher

Table 1. Demographic Information

Variables	Levels	Frequency	Percentage %
Age	23-37	45	44.6
	38-52	36	35.6
	Above 52	20	19.8
Total		101	100.0
Gender	Male	52	51.5
	Female	49	48.5
Total		101	100.0
Year of experts	Less than five years	29	28.7
	5-10 years	33	32.7
	Above ten years	39	38.6
Total		101	100.0
Qualifications	Bachelor's Degree	50	49.5
	Master's Degree	31	30.7
	PhD	20	19.8
Total		101	100.0

selected 5 items that focused on physics teachers' feelings and their faith in their capability to use virtual labs to teach physics.

To measure perceived usefulness and perceived ease of use, 12 items have been used and the instruments were developed by Davis (1989).

Finally, the intention to use technology has been measured by using 3 items and developed by Todd and Taylor (1995).

Validity and reliability

First, the researcher checks the validity of the instrument by distributing a survey in its initial form to ten specialists to express their opinion and check the paragraph affiliation and language accuracy Also, the researcher calculated the correlation coefficient between the items and the dimensions using the SPSS program. Second, the researcher checks the reliability of the instrument by calculating Cronbach's alpha coefficients. After checking the validity and the reliability of the instrument a descriptive analysis has been done using the SPSS program. Finally, multiple and linear regression have been conducted to examine the structural relationships between the variables and to check the hypothesis of the study.

Table 2 shows the results of the Cronbach's Alpha coefficients and compares them with the original study.

It is noted from the table 2 that there are high-Reliability coefficients in each dimension of the survey and there are higher than the original studies, Also the overall Cronbach's alpha coefficient of the survey is equal to (0.973) and it is higher than (0.60) and that indicates that the overall survey has a high-reliability coefficient which enhances the accuracy of the study tool, and its suitability for application to achieve the study objectives.

Results

Answer the study hypotheses

Hypothesis 1: Physics teachers' TPACK will positively affect teacher self-efficacy.

A simple linear regression was calculated to predict teacher self-efficacy based on physics teachers' TPACK, b=0.84,t(99)=-1.99,p<0.001. A significant regression equation was found (F(1,99)=245.452, p<0.001),with an R^2 of 0.713.

Tables 3,4 and 5 show the results of the analysis.

Table 2. Summary of the internal consistency of the TPACK, Teacher self-efficacy, Perceived ease of use, Perceived usefulness, and the Intention to use technology variables.

Dimensions	Source	Cronbach Alpha	
		Original study	The current study (Pilot study)
TPACK	Schmidt, Baran, Thompson, Koehler, Mishra& Shin (2009)	0.89	0.929
Teacher self-efficacy	Schwarzer&colleagues (1999)	0.86	0.929
Perceived ease of use	Davis (1999)	0.87	0.923
Perceived usefulness	Davis (1999)	0.90	0.926
Intention to use technology	Taylor&Todd (1955)	0.90	0.959
Overall	-	-	0.973

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.844	.713	.710	.50372

a. Dependent Variable: Self-efficacy
b. Predictors: (Constant), TPACK

Table 4. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	62.279	1	62.279	245.452	.000
	Residual	25.119	99	.254		
	Total	87.398	100			

a. Dependent Variable: Self-efficacy

Table 5. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.607	.305		-1.989	0.049
	TPACK	-1.160	.074	.844	-15.667	0.000

a. Dependent Variable: Self-efficacy
b. Predictors: (Constant), TPACK

It is noted from the tables 3,4, and 5 that there is a statistically positive effect, with a value of F (245.452) with a significance level (0.00), and this value is statistically significant at (0.05 = α). Also, the tables showed that the value of the correlation coefficient between them is high and equal to (0.844).

Hypothesis 2: Physics teachers' TPACK will positively affect the perceived ease of using technology (PEOU).

A simple linear regression was calculated to predict (PEOU) based on physics teachers' TPACK,b=0.77,t(99)=-0.12,p<0.001.A significant regression equation was found (F(1,99)=143.229,p<0.001),with an R^2 of 0.0.591.

Tables 6, 7, and 8 show the results of the analysis.

It is noted from the tables 6,7, and 8 that there is a statistically positive effect, where the value of F (143.229) reached the level of significance (0.00), and this value is statistically significant at (0.05 = α). Also, the tables showed that the value of the correlation coefficient between them is high and equal to (0.769)

Hypothesis 3: Physics Teachers' TPACK and perceived ease of use (PEOU) will positively affect the perceived usefulness of technology (PU).

A multiple linear regression was calculated to predict (PU) based on their (TPACK and PEOU), a significant regression equation was found (F (2, 98) =81.733, p<0.000), with an R^2 of 0.625.

Tables 9,10, and 11 show the results of the analysis.

It is noted from the tables((9), (10), and (11)) that there is a positive statistically significant effect of (TPACK and PEOU) on (PU), where the value of F is equal to (81.733) reached the significance level (0.00), and this value is statistically significant at (0.05 = α). Also, the tables showed that the value of the correlation coefficient between them is high and equal to (0.791).

Hypothesis 4: Physics teachers' TPACK, teacher self-efficacy, perceived ease of use (PEOU), and perceived usefulness of technology (PU) will affect intention to use technology (Behavioral Intention (BI) to Use VL).

Table 6. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.769	.591	.587	.58623

a. Predictors: (Constant), TPACK
b. Dependent Variable: PEOU

Table 7. ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	49.223	1	49.223	143.229	0.000
Residual	34.023	99	0.344		
Total	83.246	100			

a. Dependent Variable: PEOU
b. Predictors: (Constant), TPACK

Table 8. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.041-	.355		-.116-	.908
	TPACK	1.031	.086	.769	11.968	.000

a. Dependent Variable: PEOU
b. Predictors: (Constant), TPACK

Table 9. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.791[a]	0.625	0.618	0.53668

a. Predictors (Constant): PEOU, TPACK
b. Dependent Variable: PU

Table 10. ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	47.083	2	23.541	81.733	0.000[b]
Residual	28.227	98	.288		
Total	75.309	100			

a. Dependent Variable: PU
b. Predictors (Constant): PEOU, TPACK

Table 11. Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.113	.332		3.355	.001
TPACK	.006	.147	.004	.038	.970
PEOU	.731	.107	.787	6.823	.000

a. Dependent Variable: PU
b. Predictors (Constant): PEOU, TPACK

Table 12. Model Summary

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate
1	0.909[a]	0.826	0.819	0.36387

a. pendent Variable: BI
b. Predictors: (Constant), PU, TPACK, Self-efficacy, PEOU

Table 13. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	60.464	4	15.116	114.165	.000
	Residual	12.711	96	.132		
	Total	73.175	100			

a. Dependent Variable: BI
b. Predictors: (Constant), PU, TPACK, Self-efficacy, PEOU

Table 14. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.661	.238		2.779	.007
	TPACK	-.112-	.100	-.089-	-1.112-	.269
	Self-efficacy	.006	.100	.007	.064	.949
	PEOU	.397	.111	.423	3.578	.001
	PU	.564	.089	.572	6.327	.000

A. Dependent Variable: BI
B. Predictors: (Constant), PU, TPACK, Self-efficacy, PEOU

Multiple linear regression was calculated to predict (BI) based on their TPACK, Self-efficacy, PEOU and PU a significant regression equation were found ($F (4, 96) = 114.165$, $p<0.000$), with an R^2 of 0.909.

Tables 12, 13, and 14 show the results of the analysis.

It is noted from the tables 12, 13, and 14 that there is a positive statistically significant effect of (TPACK, Self Eff., PEOU, and PU) on (BI), where the value of F equal to (114.165) reached the significance level (0.00), and this value is statistically significant at ($0.05 = \alpha$). Also, the tables showed that the value of the correlation coefficient between them is high and equal to (0.909).

Discussions

This study investigated the structural relationships between teacher self-efficacy, perceived ease of use, perceived usefulness, TPACK, and the intention to use virtual labs for physics teachers. The results supported the following hypothesis. First, the researcher founds that Physics teachers' TPACK positively affected teacher self-efficacy, this result is in accord with the results of previous studies (Cox, 2010; Lee &Tsai, 2010; Akturk & Ozturk, 2019). Physics teachers would benefit from doing workshops and training programs about the virtual labs to improve the level of TPACK.

Moreover, Physics teachers' TPACK positively influenced perceived ease of using virtual labs, which supports the previous studies (Alsofyani 2012; Horzum & Gungoren, 2012), the researcher founds that physics teacher who have a high level of TPACK will find that using the virtual labs will consider being an easy technology to teach physics, so a virtual labs training should be provided to physics teachers to learn more about using the virtual labs to overcome the unwillingness to learn virtual labs and enable them to know how virtual labs is a very easy technique to teach physics.

The current study also has proven that Physics Teachers' TPACK and perceived ease of use (PEOU) had a positive effect on the perceived usefulness of technology (PU), This finding is in accord with the findings of previous studies (Alsofyani 2012; Horzum & Gungoren, 2012). So physics teachers need to have more time, possibilities, and opportunities to practice on how to use virtual labs until they feel comfortable enough to use virtual labs in their physics lessons and perceive that virtual labs are useful in teaching physics.

Finally, the researcher found that that Physics teachers' TPACK, teacher self-efficacy, perceived ease of use, and perceived usefulness of technology had a positive effect on their intention to use virtual labs. This finding is in accord with the findings of previous studies (Young, Sunyoung, & Eugene, 2017; Isaac, Abdullah, Ramayah & Mutahar, 2017) the study emphasized that TPACK and teacher self-efficacy are the most important factors to increase the intention of using any new technology (Young, Park & Eugene, 2017). Moreover, this study implied that improving TPACK will play a critical role in helping physics teachers to use virtual labs into their educational context and to have an effective learning environment.

Limitations and recommendations

This study was limited by the amount of time, the difficulty in generalizing the results of the study and the adequacy and stability of the tool used.

Depending on the results of the study, the researcher presented several recommendations that she reached through her study. First, workshops and training programs about the virtual labs should be done to improve the level of TPACK. Also, virtual labs training should be provided to physics teachers to learn more about using the virtual labs to overcome the unwillingness to learn virtual labs. Decision-makers should use this survey to find out how well the teachers accept the use of virtual laboratories before building virtual laboratories. Moreover, more studies should be done in the future to study how well the teachers accept the use of any technology in different fields.

Acknowledgement

The Authors are grateful to the Middle East University, Amman, Jordan for the full financial support granted to this research project.

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