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Diagnosing the barriers for integrating Educational Technology in Physics courses in Lebanese secondary schools

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Abstract

This paper investigates the barriers affecting the success implementation of ICT in the Lebanese secondary physics classes. It is realistic based study adopted the descriptive quantitative method to collect data by attitude test survey from 94 Lebanese secondary schools from different Lebanese districts. The results indicated that the ICT implementation in physics courses was not attained. Physics teachers must improve their ICT skills. Moreover, the low technology periods per week and revealing curriculum content, inflexibility of the curriculum to ICT implementation, insufficient existence of computer labs, lack financial support, insufficient training, inadequate technical support, unavailability of internet connectivity and the crowded class rooms were main barriers that prevent the implementation of ICT.

Key words: Educational Technology, Physics courses, ICT implementation, Educational technology barriers, Lebanese secondary physics teachers.

Introduction

"Technology literacy is increasingly becoming mandated in K-12 curriculum which puts more stress on curriculum administrators to integrate technology into lesson plan requirements" (Accuosti,2014).

Nowadays, ICT educational technology has become an influential value in drawing the future of learning (Baytak, Tarman & Ayas, 2011; Salas-Pilco & Law, 2018; Shan-Fu, 2013; Tarman, 2017; Tarman & Dev, 2018; Tarman & Chigisheva, 2017; Yücel et al. 2010) and has become an important part in Lebanese society. It is the lens through which we experience much of our world and the need in every classroom. Per the Report of the International Conference on ICT and Post (UNSECO,2015), education technology constitutes a transformative tool that facilitates future lifelong learning by allowing people to learn anytime, anywhere, anyway and with any content they may need.

Recent research designed and administered by Hanover Research on behalf of McGraw-Hill Education (2016) with the goal of assessing college students' digital study habits and experiences (sample of 3311) revealed that (81%) of students agree that educational technology is beneficial (Corrado,2016). Educational technology helps learners across variety of activities, including doing homework, preparing for exams, doing research and improving grades. Physics, as an essential subject in secondary curricula, also benefited from the ICT revolution. Several studies argue that ICT implementation in physics offers many means of improving teaching and learning in the class room. ICT educational technologies have the potential to support physics education across the curriculum, motivate learners, provide visual education to concertize abstract notions, support for effective communication between learners, and develop critical thinking skills and other competencies needed to work in an ICT-rich environment (Salas-Pilco, & Law, 2018; Siddiqa Siddiqa, Schererb, & Tondeu, 2016; Hursen & Asiksoy, 2015; Sharma, 2015; Kamei, 2015; Shan-Fu, 2013; Aina, 2013). Thus, the limitations of ICT technology tools in physics courses can limited physics teaching and learning (Makki, O'Neal, Cotten, & Rikard ; 2018) and the impact of ICT can't be investigated in the absence of investigating the main barriers that prohibit its use from the teachers' perspective (Mndzebele, 2013; Hassler et al., 2016).

Consequently, identifying the possible barriers to the integrating of educational technology in physics classroom would be an important step in assisting educators to overcome these barriers and improving the future and the quality of physics teaching and learning with technology.

Educational technology barriers, in the paper at hand, refer to the factors that frustrate teachers who are teaching Physics courses from using ICT and retarded its implementation in their secondary classes unless overcoming blockades. Many researchers examined specified barriers that prevent ICT implementation in their countries. According to Al Mulhim (2014), the barriers that prevent teachers from frequently and appropriately using ICT for their teaching in Saudi Arabia are: a) lack of access to technology, b) lack of effective training, and c) lack of time and same barriers in Sudan Secondary schools (Elemam, 2016). According to Doumi and Al-Shanak (2008) and to Al-Haresh, Mfleh, & Al-Dahon (2010) the main obstacles in carrying educational technology on physics in Jordan secondary schools are the lack of computer labs for science classes, not having enough computers for all students, lack of technician and the internet services. According to Laaria (2013) and to Kipsoi, Changach, & Sang (2012) the key barriers that prevent teachers from using ICT effectively in Kenya are lack of periods for ICT training, poor models of practice, and poor schools' administration.

Osta (2005) related ICT using barriers in the developing countries to policy making and national planning that didn't create a clear time plan with clear outcomes. These countries limit their efforts and missions in creating computer curricula, teaching computer sciences and computer skills, and supply schools with computers and equipment. These efforts are not accompanied with the infrastructure and concrete time plan to prepare teachers to integrate these computers in teaching and learning.

The existing literature has reported different categories of barriers that obstruct teachers from implementing ICT in education. Becta (2004) grouped barriers whether they are related to individual (teacher- level) such as time, lack of confidence, and resistance to change or to institutions (school-level) such as lack of effective training in solving technical problems, and lack of access to resources. Similarly, Ether (1999) and Chen, Tan & Lim (2012) classified barriers that teachers face in using ICTs into two main categories: 1) extrinsic barriers and 2) intrinsic barriers. Extrinsic barriers are school level barriers related to organization and institutional context. They result from insufficient and/or inappropriate configuration of ICT infrastructures, insufficiency of funding, the high cost of hardware and software, lack of effective teachers' training and technical support, lack of access to resources, lack of internet connectivity and lack of time. Correspondingly, Gomes (2005) and Pandolfini (2016) concluded that lack of training in Digital literacy, lack of pedagogic and didactic training in how to use educational technology in class room and in specific areas in science are main ICT implementation barriers. While intrinsic barriers are related to teachers' personal experiences and awareness, teachers' beliefs and attitudes towards technology, teachers' lack of confidence in using technology, teachers' lack of knowledge and skills in using technology practices, and their resistance to change towards ICT.

Accuosti (2014) classifies four factors affecting ICT implementation and leading to the absence in its systematic use: 1- the visions of ICT role either as marginal activities for teaching where computers are used from time to time to motivate, train students, or fill time or as a magic solution for learning difficulties; 2- teachers as an element of facilitation based on their impact on how technology is implemented, their attitude and resourcefulness; 3- social environments that can either enable or restrict the implementation based on students behaviour, social and historical circumstances of the environment, the cooperation for the sociocultural, the background and scientific longevity and durability of the education community and economic influences that are related to costs, available funds, technical support , the availability and the access (Prasad, Lalitha, & Srikar, 2015) ; 4- teachers' requirements and their personal developments.

Evidently, ICT implementation barriers at all the levels (teacher, school, and ministry of education level), either classified in different categories or discussed separately are imbedded and interfered together. Each barrier to ICT use could impact several other barriers (Jones, 2004) and cannot be neglected for better education.

Thus, identifying these barriers encourages the desired improvement in the future of educational technology in the national educational plans for various subjects, and may lead to overcome them in the investor sectors and governments improvement policies.

Aim of the study:

Since 2000, the Lebanese Ministry of Education and Higher Education (MEHE) has been taking the decision of the implementation of ICT in education and equipping schools with computers. In 2003, the Lebanese Government, through the United Nations Development Programs (UNDP), and the Office of the Minister of State for Administrative Reform (OMSAR) completed the development of the "National e-strategy" to move Lebanon towards knowledge e-based society. Also, the World Bank provided Lebanese public schools with 5000 computers in 2003, and with 2500 personal computers in 2005 to computer labs in different public schools (Burns, 2011). After 2006, several US-based companies (Microsoft, Occidental Petroleum, Intel, and Cisco) launched several initiatives that initiate different technology-related projects in several Lebanese schools. However, it was not until July 2013 that the Ministry of Education and Higher Education (MEHE) started to organize workshops and conferences aimed to adopt an appropriate ICT framework to access teachers' ICT knowledge, skills and readiness, and to move a step forward on the way of ICT implementation in the Lebanese schools (Center for Educational Research and development [CERD], personal communication, 2017). It can be clearly seen that ICT educational technology in Lebanon is not implemented in education since all the potentials has focused on hardware, software and did not address teachers' training and curriculum development. This was also mentioned by Alameh (2013) "it is not clear if this initiative will include training teachers on integrating technology in their classrooms".

The delay in the educational technology progress at the Lebanese official level does not mean that there are no initiatives at teachers' level or schools' level to implement educational technology in their subjects and classes. There may be more technology-based initiatives in Lebanon than those found in official documents and reports (Alameh, 2013). These initiatives face many barriers where very few research studies have been identified these barriers (Mo'dad, 2012) for that, this study came to highlight some barriers that prevent the implementation of educational technology particularly in physics courses as a part of education status in Lebanon in general.

Although there are reasonable research studies on the barriers that challenge teachers in using ICTs from a general perspective over the world, there are few studies that identify the barriers which exist in the integration of ICT in education in Lebanon and in physics Lebanese classes from Lebanese physics teachers' perspectives. In response to this lack, the study aimed to:

1- Identify the current barriers of implementation of ICT in Lebanese secondary physics classes that may be common to all the educational fields.

2- Recognize Lebanese secondary physics teachers' perspective for the success of ICT implementation in physics courses

3- Provide proposals and recommendations that may enhance effective technology integration in Lebanese secondary schools.

Thus, to fill the knowledge gap about the barriers of educational technology implementation in physics courses in Lebanese schools and help policymakers and schools' administrators to achieve their goals for better ICT visions the following questions are addressed:

1- What is the level of the ICT educational technology implementation by Lebanese secondary physics teachers in their courses?

2- What are the barriers tackled by physics secondary teachers for the implementation of educational technology in Lebanese secondary physics courses?

3- What are Secondary physics teachers' suggestions for more effective educational technology implementation?

Method

Research Design

The study adopted the quantitative descriptive method as an appropriate research method to answer the study questions and examine the indicated barriers for appropriate implementation of ICT. In this study, structured survey, with different types of questions such as closed ended and open ended, has been prepared and used as research instrument to obtain data relevant to the study's objectives and research questions. The survey was reviewed and modified many times by other researchers and pretested among a small subset of target respondents to check if it serves to collect appropriate comparable data and to determine its feasibility and usefulness as a research instrument. The measure of central tendency (mean M), and the measure of dispersion (standard deviation SD) of the descriptive statistics were used to interpret data to generate descriptive information and to lead to important recommendations.

Population and Sample/ Study Group/Participants

The population that was considered in this endeavor was all the English Lebanese secondary schools that form a population of 443 schools (126 public and 317 private) and their physics teachers who teach the scientific sections without gender discrimination. It must be mentioned that the chosen secondary schools for the sampling process are the English section schools because the difference between the languages in determining the ICT barriers, if there is any difference, is beyond the aim of this investigation. Moreover, the concentration on physics teachers for scientific sections is to ensure enough number of periods per week since scientific sections have dedicated more hours per week and that may encourage teachers' initiatives, if any exist, and give better opportunities to use educational technology in physics classes.

In the context of this study, the sample is formed of 141 physics teachers of 94 secondary schools (51 private schools and 43 official schools), designated by random sampling process from the population of the Lebanese secondary schools that teach physics in English in the academic year 2016/2017 using a table of random numbers. Although some teachers in the chosen sample are common instructors in more than one secondary school, they submitted different surveys expressing the ICT status of each school separately.

The level of precision in the existing representative sample for the considered population, using the Sample Size Calculator, indicated that the sample size reflects the target population at

95% confidence level and 9% confidence interval. Moreover, this sample can be considered as a representative sample since the 94 chosen schools represented 22% of the Lebanese secondary schools that instruct physics in English from different socioeconomic backgrounds and geographical locations without any gender discrimination.

Data Collection Tools

A survey developed by the researcher based on the review of literature for previous researches dealt with the Barriers of ICT implementation in education in different countries. It was used to realize the barriers that prevent the appropriate implementation of educational technology in Lebanese physics classes and investigate the changes needed within schools and education policy makers to better adoption of learning technologies.

The survey besides its first section about teachers' demographic variables gender, age, teaching experience, level of qualification, and type of training contained sections dealt with ICT availability and administrative support. The survey also contained a section pivoted around the school vision for ICT use and the barriers that faces physics teachers in the use of educational technology in their learning/ teaching process. The validity of the survey sections and statements were checked and reviewed by Ph.D. educators and physics instructors and modifications were done based on their instructions and feedback. Also, draft copies from this survey were tested with different teachers to check their clearness and their comments were taken into consideration. Moreover, the reliability of the questions that deal with the ICT barriers was measured by Cronbach's alpha. The measure of the internal consistency between survey's questions is 0.686.

Data Collection

The survey was distributed after the approval of the Ministry of Education and Higher Education (MEHE) at the beginning of the academic year 2016-2017.

Data Analysis

Data was managed using Statistical Package for Social Sciences (SPSS v19). The descriptive statistics was used in summing the data including percentage, frequency, mean and standard deviations.

Findings

The following section revealed separately the results in the context on the three questions of this endeavor to come up finally with a discussion that diagnosed the barriers in ICT implementation in Lebanese secondary physics classes.

1- The Results of the First Questions:

Physics Lebanese secondary teachers N= 141 responded to the level of the ICT technology implementation question "What is the level of the ICT educational technology implementation by Lebanese secondary physics teachers?" in the different sections of the used survey. The survey was designed to collect evidences about the level of the ICT implementation by using: (1) yes/ no question about the existence of ICT vision in their institutions; (2) Description of ICT technology resources that are abundant in their schools and that are important in the process of integration of technology in physics education; (3) Set of 8 statements about how often the use of different ICT tools by physics teachers for teaching in class with a Likert scale format consisting of 5 points: 1= never, 2= few times/year, 3= at least once per month, 4 = at least once a week, 5 = daily.

The collected results shed light on many factors that reflect the level of ICT implementation in Lebanese physics classes and can affect this implementation. These interacting factors were described in the three following levels: 1- schools' vision and the administrations' role, 2- availability of ICT resources and 3- the physics teachers' utilization for educational technology tools.

Schools' vision and the administrations' role:

The results related to the Lebanese secondary schools' vision and the role of the schools' administrations in ICT implementation are displayed in table 1:

Table 1

ICT Lebanese secondary schools' vision and coordinators' supportiveness

Statements	Percentages		
	Yes	No	No Answer
Is ICT vision integrated in the whole school plan	43.28%	55.32%	1.41%
Is the coordinator or the head of the department in your organisation supportive for using technology in teaching, learning and assessment?	71.6%	28.4%	0 %

Unfortunately, schools seem to be not motivated in implementing ICT. The collected data shown in figure 1 revealed that 55.32% (19.15% private and 36.17% official) of physics teachers claimed in the (yes/ no) question that there is no ICT vision in their schools. It seems that many of these schools in both sectors (private and official) do not feel the need of ICT educational technology, or they do not understand what changes are needed. They are tied to traditional teaching and learning tools, satisfied with their tried and tested ways in providing knowledge. Thus, the level of awareness among schools' administrations of the local ICT was found to be quite low and there is a little opportunity to adapt to technologies.

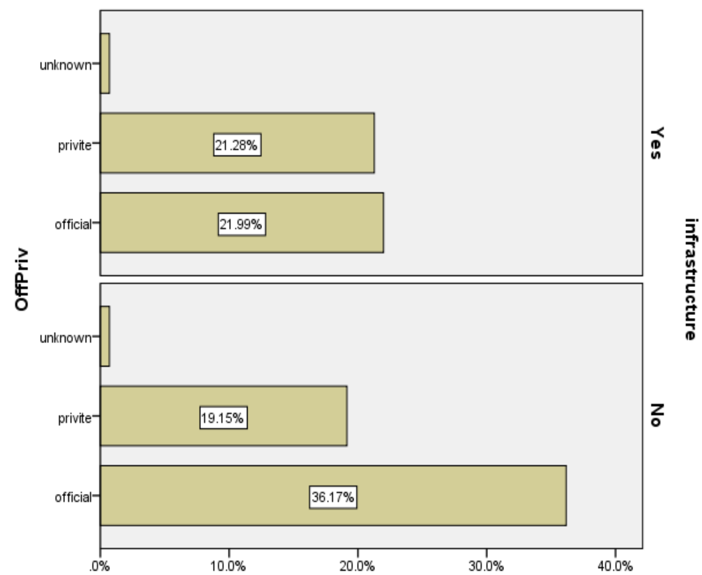

Figure 1: ICT vision in Lebanese secondary schools

Footnote

On the positive side, 72% of physics teachers in the sample showed that principals, head of physics departments or/ and the physics coordinators encourage and support technology implementation in their physics courses for teaching, learning and assessment. This result, from one side, revealed the coordinators' and teachers' ICT awareness for the need of ICT in learning and reflect teachers' initiatives for ICT implementations. However, this positive encouragement and supportiveness for ICT implementation in physics classes seem insufficient in the absence of real proactive actions in providing ICT tools. ICT encouragement and supportiveness need at least the availability of ICT appropriate resources (Makki et al., 2018).

Availability of ICT resources

Lebanese secondary physics teachers indicated the presence of ICT tools in their schools from a list of tools listed in the survey. Moreover, they could indicate the existence of other tools if any were found and not listed in the survey. The percentage of the availability of the ICT educational technology resources are represented in the graph of figure 2.

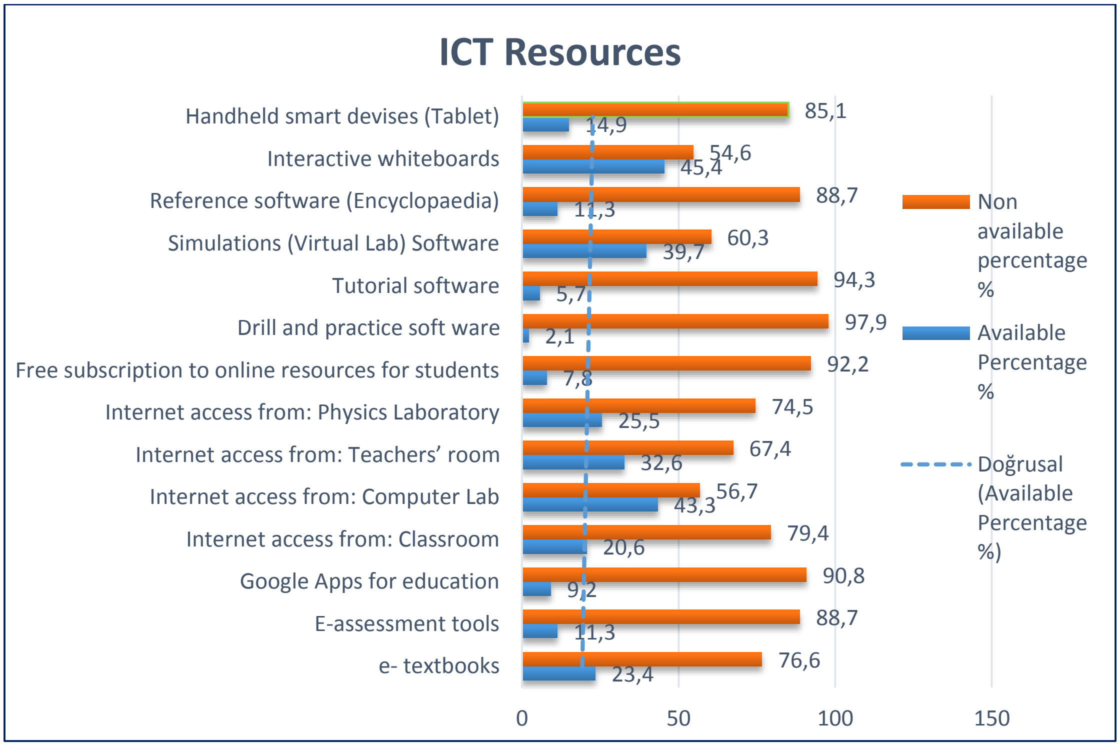

Figure 2: Percentage of available and non-available resources in the Lebanese secondary schools

The graph showed that Internet access was found to be most widely used in computer laboratories (43.3% available) but not in the physics class rooms (20.6% available). This reflected a permeation of computers occurred in specialist rooms (computer labs) where no free subscription to online resources for students in physics classrooms (7.8% only available). Simulations were the next most widely used in Lebanese secondary physics classes (39.7% available). In general, most of ICT educational technology tools are not available in Lebanese schools and are rarely used for teaching in class as Google Apps for education (9.2% available), E-assessment tools (11.3% available), Reference software (11.3 % available). Drill and practice software and tutorial software were generally uncommon in Lebanese secondary physics classes (2.1% available). Thus, the Lebanese secondary schools did not provide physics teachers with educational technology resources and didn't give them enough time to manage and familiarise with ICT. This again, clearly confirms that administrations' ICT supportiveness is only theoretical and away from real actions in the classrooms.

Physics teachers' utilization for educational technology tools.

"Technology is just a tool. In terms of getting the kids working together and motivating them, the teacher is most important." - Bill Gates

The existence of the educational resources in schools and physics classrooms is without any doubt important but what is more important is how and how frequency of implementation in the learning process.

On the level of utilizing ICT technology tools, the results about how often the use of different ICT tools by physics teachers for teaching in class with a Likert scale format consisting of 5 points: 1= never, 2= few times/year, 3= at least once per month, 4 = at least once a week, 5 = daily were presented in Table 2

Table 2
Level of ICT usage by Lebanese physics teachers

	Percentage %					M	SD
Educational Technology Tools	Daily	at least once a week	at least once a month	a few times per year	Never		
Internet access	16.3	24.8	14.2	18.4	26.2	2.87	1.460

Free subscription to online resources for students	4.3	4.3	7.1	7.8	76.6	1.52	1.080
Drill and practice Software	2.1	3.5	5.7	2.1	86.5	1.33	0.898
Tutorial Software	0	6.4	10.6	2.8	80.1	1.43	0.920
Simulations (Virtual Lab)	2.8	22.7	29.8	17.7	26.2	1.36	0.847
Reference software	0.7	4.3	7.1	6.4	81.6	2.56	1.203
E-assessment tools	1.4	7.1	8.5	14.9	68.1	1.59	1.008
Hand holdup smart devises(Tablet)	2.8	5	11.3	16.3	64.5	1.65	1.049
Interactive whiteboards	5	6.4	9.2	19.1	60.3	1.77	1.163
e- textbooks	9.2	14.9	8.5	11.3	56	2.1	1.441
Google Apps for education	2.8	5.7	7.1	12.8	71.6	1.55	1.038
Total	**4.30**	**9.55**	**10.82**	**11.78**	**63.4**	**1.793**	**1.017**

On the up side 41.1% of Lebanese physics teachers, who teach the scientific sections, indicated that they use Internet daily and or at least once a week and 25.5% stated that they use simulation daily or at least once per week. However, the other use of ICT tools is at low percentage. Also, the results indicated that 63.4% of the total number of physics teachers never use ICT tools in their learning process and 11.78% rarely use ICT (few times per year) that reflects a miserable implementation status.

Moreover, the mean for the most used technology resource is (M= 2.87, SD =1.86) for internet access and (M= 2.56, SD= 1.20) for computer software and M< 2.5 for all the others technology resources. Moreover, the total average of the mean of the use of ICT tools in physics courses was (M= 1.79) with a standard deviation SD = 1.01 which is very low. Thus, this low mean in the use of educational technology resources can be an evidence that Lebanese secondary physics' teachers don't appreciate the role of appropriate ICT tools in motivating students and making lessons more interesting in spite their positive awareness towards ICT. This situation delays ICT implementation and make teachers resist its use (Makki et al., 2018 ; Khan, Hossain, Hasan, & Clement, 2012), firmly grounded to their traditional teaching ways, and lose opportunities to adapt to technologies.

To conclude without any doubt, per the vision status of Lebanese schools to the use of ICT, the shortage of ICT tools and resources, in addition to the low mean in the level of the ICT usage (M=1.79) that the level of ICT educational technology implementation by Lebanese secondary physics teachers in physics courses was very low.

2- *The Results of the Second Question*:

The second question “What are the barriers tackled by physics secondary teachers for the implementation of educational technology in Lebanese secondary physics courses?” allowed physics teachers to reveal the obstacles that they have faced in their attempts to implement ICT and to construct on the results of the first question.

Physics teachers N= 141 replied on the survey’s section that deals with ICT barrier. The survey was formed of 9 statements about the barriers of ICT implementation in their physics courses with a Likert scale format consisting of 4 points distributed as following: (5= Strongly agree; 4= agree; 2= disagree; 1= strongly disagree). There is no choice (3= neither agree or disagree) to produce a forced choice measure and collect actionable data where no uncaring option was available. Unanswered statements are indicated with 3 and considered as neither agree or disagree.

The mean “M” and the standard deviation “SD” for each barrier were calculated and accordingly the results were arranged in descending order as presented in Table3.

The analyses of the results were based on the following criteria:

1-The obstacle of mean less than 2.5 ($M<2.5$) is considered as a weak barrier

2- The obstacle of mean $2.5 < M< 3.5$ is considered as medium barrier

3- The obstacle of mean less than $3.5 <M< 4$ is considered as big barrier

4- The obstacle of mean greater than 4 ($M>4$) is considered as a very big barrier

Table 3

The mean and the Standard deviation for the obstacles in decreasing order

Statements	N	Mean	SD
6- The number of physics periods is not enough for using technology and revealing all the curriculum content	141	4.29	.990
5-The lack of technicians for computer labs	141	3.78	1.166
7- There is no internet services in physics classes	141	3.78	1.243
3-The number of Computers is not sufficient for students	141	3.63	1.174
1-Computer labs are unavailable for physics subject	141	3.53	1.257
4-Physics classes are too crowded	141	3.53	1.290
9- Physics official curriculum is not appropriate for technology resources use	141	3.50	1.313
2-Computer lab is away from the physics classroom	141	3.43	1.289
8- The download and use of the computer physics programs are difficult.	141	2.82	1.280

The results for the obstacles in ICT implementation in the Lebanese secondary physics classes revealed that there are no weak barriers per the study mentioned scale.

The raised barrier “6- The number of physics periods is not enough for using technology and revealing all the curriculum content” of mean M= 4.29 can be considered as a very big barrier for ICT integration in physics courses.

Also, the following raised barriers: “5-The lack of technicians for computer labs; 7-There is no internet services in physics classes; 3-The number of computers is not sufficient for students; 1-Computer labs are unavailable for physics subject; 4-Physics classes are too crowded; and 9- Physics official curriculum is not appropriate for technology resources use” of mean ranged between 3.5 and 4 ($3.5 < M < 4$) can be considered as big barriers for ICT integration in physics courses.

Furthermore, the two barriers raised in the table “2-Computer lab location is not conveniently located near the physics classroom” and “8-The download and use of the computer physics programs are difficult” of mean $2.5 < M < 3.5$ are considered as medium barriers.

Moreover, “difficulty to download and use of the computer physics programs” even it is not of high mean M=2.88 compared to the other barriers’ mean, but it is an indicator to the teacher-level barriers reflecting lack of teachers’ ICT skills; lack of teachers’ confidence; lack of pedagogical training; lack of follow-up and lack of differentiated training. In addition to that, it reflects the need for the Lebanese secondary physics teacher for professional development.

3- The Results of the Third Question:

The third question in this endeavor, “What are Secondary physics teachers’ suggestions for more effective educational technology implementation?”, is a complementary question to the second question. This question aimed to let teachers based on their experiences in ICT implementation to highlight more barriers, if any and not mentioned in the survey, since any submitted suggestion is an image of a barrier that may delay the establishment of ICT in their classes.

Most responses proposed many suggestions directed towards those who are responsible for the integration of technology in physics education and can be generalized for the whole educational process in other subjects. They can be summarized by the following:

- Provide schools with computers for physics classes.
- Increase the finance support for schools especially for public schools to invest in technology.
- Increase the number of physics teaching periods per week.
- Train teachers to use ICT in their classes effectively.
- Modify the Lebanese physics curriculum to give teachers a clear sense of what to teach and foster teachers on-the job training.
- Enrich the physics Lebanese curriculum with software simulations and provide it freely for all learners.
- Train students to use educational technology starting from their elementary level.

Thus, the revealed suggestions yield and confirm that the barriers are pivoted around schools’ resources and teachers’ skills and support the results of the previous questions. Also, these suggestions insured that schools’ visions and their slow attempts to ICT implementation are real barriers at this level. In summary, the revealed suggestions were aligned with the results of the previous questions in this study and support them.

Discussion, Conclusion and Implications

ICT is not only the future of our learners' education, it is the present investment. The study highlighted, based on the literature review and physics teachers' perspective, many indicators and factors that diagnosis the ICT status in Lebanese secondary school and hinder the successful implementation of ICT for physics learning and for whole curricula in general. Effective implementation of ICT largely depends on the school administration's vision and the teachers' effort to insert ICT (Khanet al.,2012; Mndzebele, 2013; Hassler et al., 2016). Lebanese secondary schools' visions did not reduce the pressures by offering training, financial assistance for teachers, timetabling time for any ICT implementation to comfortably progress towards technology rich environment. Also, they did not prepare the needed infrastructure and provide teachers with enough ICT resources. Per Makki (2018), Ghavifekr, Kunjappan, Ramasamy & Anthony (2016), Accuosti (2014) and Ampirica's (2006) limited resources within the schools can seriously delay and limit the teachers' initiatives to implement ICT in classes. A strategic vision is required to implement ICT; teachers need to be provided with suitable facilities, software and training to be able to implement them in technology learning -teaching process (Tiwari & Singh, 2018; Salehi & Salehi ,2012).

Consequently, the study proved that efficient ICT implementation in Physics courses at the Lebanese secondary schools was not attained and was weak in the absence of clear ICT vision in schools, real support and the limitation of ICT appropriate tools. This aligned with what mentioned in the Lebanese literature about the fuzzy status of ICT in Lebanese school (Alameh, 2013; Mo'dad, 2012).

Physics teachers indicated many related barriers that interact to hinder ICT effective implementation. Most of show up ICT barriers in this endeavor are aligned with the barriers revealed in the literature review concerning this topic.

Loaded curriculum and the lack of time appeared as very high extrinsic barriers that negatively impact the integration of technology in physics education. This is aligned with what was mentioned by Bingimlas (2009) and Chen et al. (2012) and argued that enough time in using technology can be effective to improve ICT usage (Accuosti, 2014; Goktas, Yildirim, & Yildirim. 2009).

Also, the lack of ICT support, lack of access and appropriate resources, are mentioned as an effective barrier that cannot be ignored for better ICT implementation in the Lebanese physics secondary courses. ICT support helps teachers to use ICT in teaching without losing time through fixing software and hardware problems. The absence of technical support and maintenance is a major impediment to the development of ICT in schools. Without the good technical support in the classroom and the whole school resources, teachers cannot be expected to overcome the barriers preventing them from using ICT (Bingimlas, 2009; Salehi and Salehi; 2012). In the same context, Ampirica (2006), Khan et al. (2012), Prasad et al. (2015) and Ghavifekr (2016) found that lack of access, lack of computers and software are the large barriers to ICT implementation. Moreover, the limitation on access to hardware and software resources influences teachers' motivation to use ICT in the classroom. In addition to that, availability of computer outside physics classrooms is mentioned as an effective barrier in ICT implantation in the Lebanese physics secondary courses. The existence of computers in the class is motivational to ICT integration (Dotong, De Castro, Dolot, & Prenda,, 2016). The existence of lab computers defines computers as non-integrated devises in learning and make teachers suffer from lab reservations and tabulated the movements of students between class and computer labs. Accuosti (2014) claims that "computer's physical presence changes the atmosphere and structure in the class due to its very nature". Thus, Computers in educational setting should be part of student environment that promotes academic achievement, interaction and the positive attitude in the class. Besides this, the raised barrier concerning the physics curriculum and its unsuitability for ICT implementation is important to be highlighted. Inflexibility of the curriculum to adapt and adopt new technologies are main barriers at the resources level (Goktas et al., 2009; Rabah, 2015; Dotong et al., 2016) and this was confirmed by physic teachers' suggestion, since ICT cannot be a simple added value to the traditional curriculum without renew the curricula and make it flexible to contain the educational technology (Accuosti, 2014; Stoilescu, 2014).

Furthermore, the lack of physics teachers' skills in dealing with computer software is also a hinder for ICT implementation (Tiwari & Singh, 2018). The insufficient teachers' training sessions to progress in the technology rich context are serious barriers in teachers' skills and attitude level (Mathevula, 2014; Hassler et al., 2016). Teachers who are motivated and commitment to ICT will evidently integrate ICT more easily within the learning teaching process. This was insured by teachers' suggestions and reflected their need for professional development. Training is a key factor for successful integration of computers into classroom teaching (Gomes, 2005; Goktas et al., 2009; Khan et al., 2012). Consequently, ICT related training programs develop teachers' competences in computer use, influencing teachers' attitudes towards computers and assisting teachers to reorganize the task of technology and how new technology programs are significant in student learning (Goktas et al. 2009, Buabeng-Andoh,2012; Prasad et al., 2015).

In summary, the barriers that resist ICT implementation in the Lebanese physics classes are: lack of the number of physics periods per week for using technology and revealing all the curriculum content; the insufficient existence of computer labs for the subject and their positions away from physics class room; the lack of resources to access and unavailability of internet connectivity in physics class room; inadequate technical support; inflexibility of the curriculum to ICT implementation; insufficient training for physics teacher physics teacher; in addition to the lack of financial support and the large number of students in the class room. These barriers are met with the findings of the previous literature review that shed light on same situations (Gomes, 2005; Bingimlas,2009; Buabeng-Andoh ,2012; Tiwari & Singh,2018) and approved that efficient ICT implementation in physics courses at the Lebanese secondary schools was not attained.

Recommendations:

Based on the results of the study, the following recommendations can be formulated for better integration of technology in Lebanese secondary schools for physics education and whole teaching- learning process for different subjects in general at different levels:

1- At the ministry of education's and education policymakers' level:

The ministry of education and the education policymakers should be aware of the positive impact of ICT implementation in developing teaching and learning in general and physics courses in particular. They should increase the finance support for schools especially for public schools to invest in educational technology, technical support and maintenance to ensure the continued operation and development of ICT systems. Also, education policymakers should develop ICT resources in schools and apply efforts to promote awareness within available software to facilitate teaching and learning. Moreover, they should stress on teachers' training programs to implement technology in the learning process as main priority. Added to this, physics curriculum developers should avoid digitizing for old curricula that lead to both time and finance loss. Instead of that, they should renew the physics official curricula and make it flexible to contain the educational technology in order for teachers and students to become partners in the learning process and this can be applied in all curricula subjects.

2- At schools' level:

Schools should integrate ICT vision in their plans and develop their technology resources. Cooperation among administrators, principals and teachers should be encouraged to reduce ICT barriers among schools. School principals and administrators should provide all teaching and learning spaces with ICT facilities and computers in general and particularly in physics classrooms. ICT tools should not be narrowed to specialized rooms like our present and students should be provided with sufficient number of computers and internet services in classes and an access to ICT facilities outside lesson times. Moreover, they should avoid crowded classes in general and particularly physics classes that keep the teachers of physics subject feel irresponsible to ICT integration and only concern about the content.

Furthermore, school principals and administrators should reduce the pressure of curriculum and the number of teaching periods to encourage instructors to invest the allotted time in the development of ICT skills. Also, they should develop strategies for evaluating the impact of ICT at different levels in the school thus ICTs' users can be confident in assessing its impact on teaching/ learning process.

3- At physics teachers' level, and all teachers in general:

Teachers should plan for the integration of ICT in all aspects of their teaching, as appropriate. They should exploit the benefits to be gained from ICT in their lesson planning and preparation and the potential of ICT in developing students' skills including research and investigation skills, writing, communication and presentation skills, teamwork and collaborative skills, and the higher-order skills of problem-solving, analysis, and evaluation.

Furthermore, teachers should provide students with an appropriate and equitable level of experience of ICT at all class levels and explore the appropriate use of resources and applications in facilitate learning.

4- At community level:

Community should be aware of the importance of ICT in their development and cooperate with schools in their regions and support the ICT implementations and raise funds to reach this aim. Also, software designers, educators and instructors in their community should work together to develop appropriate forms of software that are able to support different skills and ways of learning and teaching to use in subject teaching.

Limitation of the study:

The research data collection process was very exhausting and challenging. A delay in answering back the survey questions and sometimes the ignoring for the survey at all were main constraints of this endeavor. This act, despite it was limited, wasted effort and time and reflected the lack of some teachers' awareness and appreciation to the importance of research in education.

Tables and Figures

Table 4

ICT Lebanese secondary schools' vision and coordinators' supportiveness

Statements	Percentages		
	Yes	No	No Answer
Is ICT vision integrated in the whole school plan	43.28%	55.32%	1.41%
Is the coordinator or the head of the department in your organisation supportive for using technology in teaching, learning and assessment?	71.6%	28.4%	0 %

Table 5
Level of ICT usage by Lebanese physics teachers

Educational Technology Tools	Percentage %					M	SD
	Daily	at least once a week	at least once a month	a few times per year	Never		
Internet access	16.3	24.8	14.2	18.4	26.2	2.87	1.460
Free subscription to online resources for students	4.3	4.3	7.1	7.8	76.6	1.52	1.080
Drill and practice Software	2.1	3.5	5.7	2.1	86.5	1.33	0.898
Tutorial Software	0	6.4	10.6	2.8	80.1	1.43	0.920
Simulations (Virtual Lab)	2.8	22.7	29.8	17.7	26.2	1.36	0.847
Reference software	0.7	4.3	7.1	6.4	81.6	2.56	1.203
E-assessment tools	1.4	7.1	8.5	14.9	68.1	1.59	1.008
Hand holdup smart devises(Tablet)	2.8	5	11.3	16.3	64.5	1.65	1.049
Interactive whiteboards	5	6.4	9.2	19.1	60.3	1.77	1.163
e- textbooks	9.2	14.9	8.5	11.3	56	2.1	1.441
Google Apps for education	2.8	5.7	7.1	12.8	71.6	1.55	1.038
Total	**4.30**	**9.55**	**10.82**	**11.78**	**63.4**	**1.793**	**1.017**

Table 6

The mean and the Standard deviation for the obstacles in decreasing order

Statements	N	Mean	SD
6- The number of physics periods is not enough for using technology and revealing all the curriculum content	141	4.29	.990
5-The lack of technicians for computer labs	141	3.78	1.166
7- There is no internet services in physics classes	141	3.78	1.243
3-The number of Computers is not sufficient for students	141	3.63	1.174
1-Computer labs are unavailable for physics subject	141	3.53	1.257
4-Physics classes are too crowded	141	3.53	1.290
9- Physics official curriculum is not appropriate for technology resources use	141	3.50	1.313
2-Computer lab is away from the physics classroom	141	3.43	1.289
8- The download and use of the computer physics programs are difficult.	141	2.82	1.280

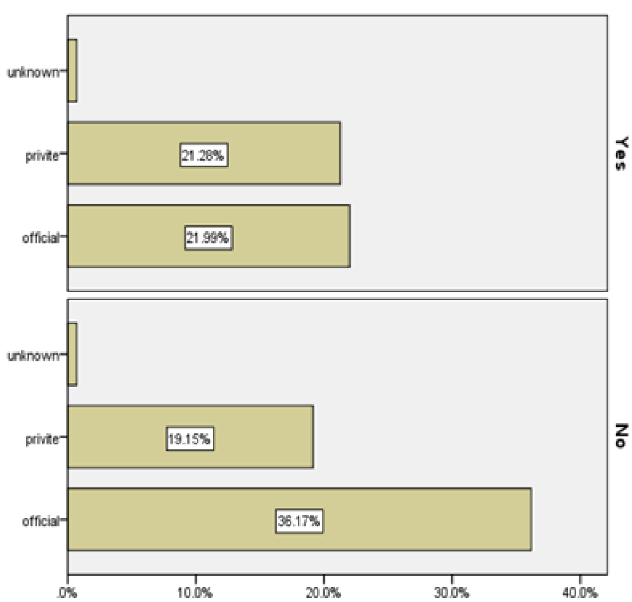

Figure 1: ICT vision in Lebanese secondary schools

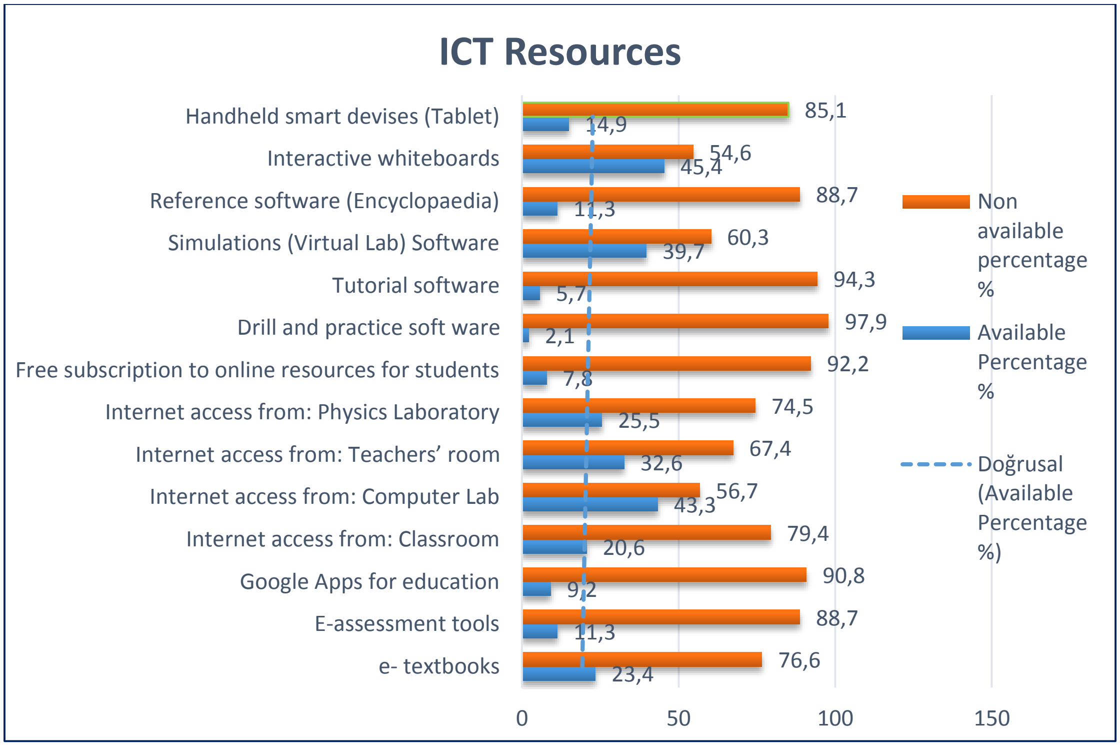

Figure 4: Percentage of available and non-available resources in the Lebanese secondary schools

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