

## Stakeholders Perspective on the Efficiency of the Virtual Laboratory in the Development of Students Scientific Research Skills in Science

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### Abstract

*This paper is study aimed at knowing the efficiency of the virtual laboratory (VLs) in the development of students scientific research skills in science from the perspectives of 15 teachers and 75 fourth grade students as stakeholders in the departments of Chemistry, Physics, and Biology at East China Normal University (ECNU), who are exposed to the well equipped virtual laboratory in the experiments of sciences. It also aimed at knowing its impact on the educational process, and the integrative roles of both real laboratory and VLs in teaching, so as to make students able to carry out scientific research in the affairs of their environment. The most important findings of the study are, that the VLs is very effective in science experiments, especially when we integrate it with the real laboratory, and it provide the students with scientific research skills, but these skills are not enough for students to apply in the real environments, and real laboratory is very important for science, because students need real experiments to improve and explore their real environments.*

**Key Words:** Virtual Laboratory (VLs), Real Laboratory, stakeholder, Science Experiments, ECNU.

### 1. Introduction

Educational systems around the world are under increasing pressure to use the new information and communication technologies (ICTs) to teach students the knowledge and skills they need in the 21st century (UNESCO. 1998). ICTs in education creates a powerful learning environment and it transforms the learning and teaching process in which students deal with knowledge in an active, self directed and constructive way (Volman & VanEck, 2001). And it is increasingly makes an impact in the society and our daily lives, both in terms of the values, attitudes and conventions it engenders and how it underpins commercial, economic and industrial structures and practices. ICT can provide access to a huge range of resources that are of high quality and relevant to scientific research. In some cases the resources fill gaps where there are no good conventional alternatives; in other cases they complement existing resources.

The specific criteria for a science learning environment will depend on many factors such as the needs of the students and the characteristics of the science program (Report, 1996). ICT is seen as an important instrument to support new ways of teaching and learning. It should be used to develop student's skills for cooperation, communication, problem solving and lifelong learning (Plomp et al., 1996; Voogt, 2003). And good use of ICT in education allows for a more flexible use of information, because students can build experiences as they use copious amounts of information, it is necessary to help students develop and improve their overall ICT-related abilities.

The laboratory becomes a safer environment for learning, and expensive supplies are less likely to be wasted. Besides, the interactive simulations allow learners to change all possible parameters of the experiment and let them study the phenomena in all details. When a practical lab is not feasible due to hazards, budget constraints, or time limitations, a virtual laboratory can provide a convenient substitute (Blamush, Dumbraveanu 2005). The virtual laboratories are a virtual reality environment that simulates the real world for the purpose of discovery learning (Muhamed, 2010). Juan and Lely (2010) mentioned that, the VLs provide students with the accessibility, observability, ability to simulate realistic scenarios, realistic, separability of virtual network, remote configurability, and ability to share resources efficiently.

With accessibility it is understood that a student can easily access the virtual laboratory and its elements, the characteristic of observability is about the possibility of students to observe the effects of their actions within the virtual laboratory, as it would be in reality. The ability to simulate realistic scenarios, where realistic, mean that the virtual laboratory should have an environment that gives a real sensation of the practice. The separability of virtual network, remote configurability and ability to share resources efficiently are referred to the capability of the virtual laboratory to allow interacting with it by many students at the same time, without generating problems in the virtual environment also the virtual laboratory should permit to be modified at any time by the laboratory's administrator.

Virtual laboratory permission must be eligible for the development of research skills for students, because it relies upon the development of the educational process, to support the labor market with qualified individuals who are able to apply scientific knowledge in the development of their environment.

The virtual laboratories are new ideas that to make teaching practice well in digital area, but many problems are difficult to be solved in this system, and many challenges facing those who are working in it. Giuseppe and Giorgio (2003) mentioned that, the real laboratory experience offers the student the possibility to know the actual behavior of a system, including non linearity and noisy data, and the virtual laboratory environment does not preclude a student to face these problems. In teaching science students need to develop the scientific research skills, and the virtual laboratory should give students sense of the practice in their learning, help them to understand theories very well to apply it in the real life, develop their innovation skills, and improve their individual productivities.

The study problem is to know the efficiency of the virtual laboratory in the development of student's research skills in science from the points of stakeholders. This study aims to answer these two questions; first: to what extent that the virtual laboratory is functional in sciences experiments at university? And second: to what extent that the virtual laboratory helps to develop the scientific research skills of students?

## 2. Methods

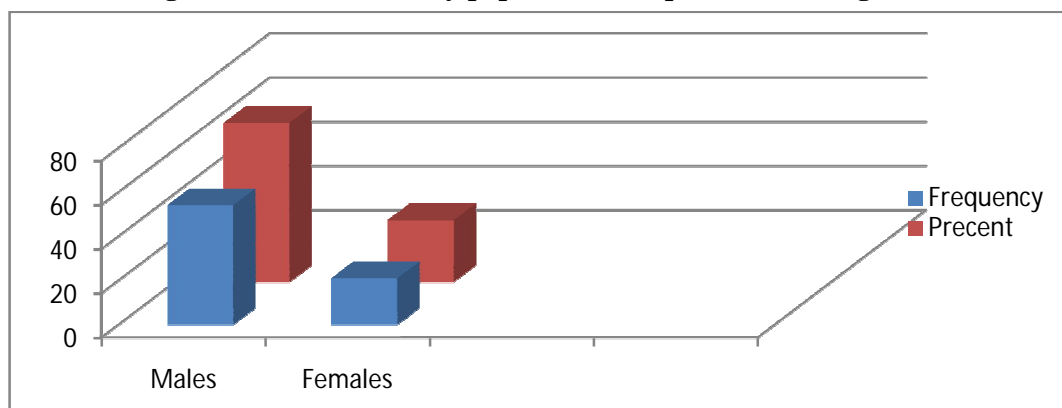
The method used in this study is the descriptive analytical method to describe the efficiency of the virtual laboratory, through analysis of its role in the development of students scientific research skills in science, the extent to what it is equipped for teaching science, its advantages and disadvantages, and the complementary role with the real laboratory, using the tools of the data collection which is interview for teachers and a questionnaire for students.

### 2.1- The Study Sample

Stratified random sample of teachers has been interviewed and (75) fourth grade students have responded to the questionnaires, (25%) of the whole population of the study in the department of science (Chemistry, Physics, and Biology) in East China Normal University, Minhang campus.

#### 2.1.1-Gender

**Fig. 1 distribute the study population and percent for the gender**



From the above Fig It is clear that the percentage of males' students (72.0) is higher than the percentage of females (28.0) in the study sample.

2.1.2- Major

**Table 1 Distribution of the study sample for the majors**

	Frequency	Percent
Chemistry	24	32.0
Physics	25	33.3
Biology	26	34.7
Total	75	100.0

From the above table it is clear that there is no big difference among the three departments in terms of percentage.

2.1.3- last score

**Table 2 Distribution of the study sample according to the score**

	Frequency	Percent
Less than3.0	19	25.3
(3.0-3.3)	26	34.7
(3.3-3.7)	15	20.0
(3.7-4.0)	15	20.0
Total	75	100.0

Table 2 indicate that, the percentage of students those whose score are between (3.3-3.0) is the highest, which is (34.7%).

3. Findings

In this part the researcher will present the results of data gathered, it includes two parts, the first part has two tables, one represents the response of the study sample for the first question: To what extent that the virtual laboratory effective in science experiments at university? Second table represents the response of the study sample to the second question: Does the virtual laboratory helps to develop the scientific research skills of research to students? In the second part the researcher has analyzed and discussed teachers' responses to the interview.

3.1- The Questionnaire Findings

Table number (3) to answer the questions: To what extent that the virtual laboratory effective in sciences experiments at university?

NO	Items		Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean	SD
1	Helps students to do some experiments need the equipment that is often not available	N	31	36	8	0	0	4.31	.657
		P	41.3%	48.0%	10.7%	0	0		
2	It enables students to perform experiments safely.	N	31	34	8	1	1	4.24	.803
		P	41.3%	45.3%	10.7%	1.3%	1.3%		
3	Gives students integrated information	N	22	38	14	1	0	4.08	.731
		P	29.3%	50.7%	18.7%	1.3%	0		
4	Less laboratory time would be wasted looking for items of apparatus	N	27	31	14	2	1	4.08	.882
		P	36.0%	41.3%	18.7%	2.7%	1.3%		
5	Helps students in information recalling.	N	18	46	9	2	0	4.07	.684
		P	24.0%	61.3%	12.0%	2.7%	0		
6	It helps in understanding the concepts of sciences	N	20	41	12	2	0	4.05	.733
		P	26.7%	54.7%	16.0%	2.7%	0		
7	Helps the students to understand accurate interpretation	N	13	47	13	2	0	3.95	.676
		P	17.3%	62.7%	17.3%	2.7%	0		
8	It helps in understanding theories of science	N	16	41	12	6	0	3.89	.831
		P	21.3%	54.7%	16.0%	8.0%	0		
9	Gives chance for students to record accessed experiment	N	15	41	15	3	1	3.88	.821
		P	20.0%	54.7%	20.0%	4.0%	1.3%		
10	Virtual laboratory give students sense of the practice.	N	10	48	14	3	0	3.87	.684
		P	13.3%	64.0%	18.0%	4.0%	0		
11	It develops students' innovative skills.	N	16	30	28	1	0	3.81	.783
		P	21.3%	40.0%	37.3%	1.3%	0		
12	Improves individual productivity	N	10	37	22	5	1	3.67	.844
		P	13.3%	49.3%	29.3%	6.7%	1.3%		

From table 4, we notice that high percentage of the respondents agree to a very high degree that the virtual laboratory helps students to do some experiments need the equipments that is often not available, enables them to perform experiments safely, gives them integrated information, less laboratory time would be wasted looking for items of apparatus, helps them in information recalling, and helps them in understanding the concepts of sciences, the means for the above mentioned statements are as the following (4.31, 4.24, 4.08, 4.08, 4.07, 4.05) respectively.

High percentage of the respondents agree to a high degree that the virtual laboratory helps the students to understand accurate interpretation, it helps in understanding theories of science, gives chance for them to record accessed experiment, give them sense of the practice, it develops students' innovative skills, and improves individual productivity, the means for the above mentioned statements are as the following (3.95, 3.89, 3.88, 3.87, 3.81, 3.67) respectively. The standard deviation was between (0.882 – 0.657), and this is an indication for the consistency of the study sample.

From above the study view the virtual laboratories is very effective and useful in teaching science at university, it helps students to do some experiments that need equipments which are often not available. It also gives them integrated information and enables them to recall it, and also it helps them to understand concept of science.

**Table number (4) to answer the questions: Does the virtual laboratory helps to develop the scientific skills of research to students?**

NO	Items		Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean	SD
13	Helps students to understand how to analysis data.	N	22	42	8	2	1	4.09	.791
		P	29.3	56.0%	10.7	2.7%	1.3%		
14	It helps the students to understand experiments designed for research.	N	20	44	7	3	1	4.05	.804
		P	26.7%	58.7%	9.3%	4.0%	1.3%		
15	It helps the students to judge data accuracy.	N	18	39	17	1	0	3.99	.726
		P	24.0%	52.0%	22.7%	1.3%	0		
16	Helps students to understand how to collect data.	N	18	36	18	2	1	3.91	.841
		P	24.0%	48.0%	24.0%	2.7%	1.3%		
17	It improves students' deduction skill.	N	14	40	18	1	2	3.84	.839
		P	18.7%	53.3%	24.0%	1.3%	2.7%		
18	Enables students to understand how scientists are able to explain what they observe.	N	17	35	18	4	1	3.84	.839
		P	22.7%	46.7%	24.0%	5.3%	1.3%		
19	It helps students to apply knowledge in real life.	N	20	44	7	3	1	3.52	.811
		P	26.7%	58.7%	9.3%	4.0%	1.3%		

From table 5, we notice that high percentage of the respondents agree to a very high degree that the virtual laboratory helps students to understand how to analysis data, and it helps them to understand experiments designed for research, the means for the above mentioned statements are as the following (4.09, 4.05) respectively. High percentage of the respondents agree to a high degree that the virtual laboratory helps the students to judge data accuracy, helps them to understand how to collect data, it improves their deduction skill, enables them to understand how scientists are able to explain what they observe, and it helps them to apply knowledge in real life, the means for the above mentioned statements are as the following (3.99, 3.91, 3.84, 3.84, 3.52) respectively.

The standard deviation was between (0.841 - 0.726), and this is an indication for the consistency of the study sample. From the above view we conclude that the virtual laboratory is very useful to develop scientific research skills for students, because it helps the students to understand experiments designed for research, helps them to understand how to collect and analysis data, and enable students to understand how scientists are able to explain what they observe.

### 3.2- The Interview Findings

From the teachers answers for the interview questions there are different views on the efficiency of the virtual laboratory in the development of student's research skills in science. For the integration between the virtual laboratory and real laboratory there is a big number of teacher said, that virtual laboratory plays necessary roles in science experiments, which is used to illustrate principle of experiment before real laboratory, and it emphasizes theory, and also used for some experiments needs money or high energy, and the same number of teachers agree that the real laboratory should be used as the main part in teaching science.

For the alternative virtual laboratory with real laboratory, high number of teacher agree that the virtual laboratory can used as guide in the real laboratory, which demonstrates the key point in teaching theory and teaching content thoroughly. And also to locate items in science courses between those two kinds of laboratories, (13) teachers agree when the virtual laboratory and real laboratory working together they can cover almost all items for science courses. For the role of the virtual laboratory to help teachers to teach the course contents with the real laboratory, there are ten teachers agree with that virtual laboratory can help them very well for teaching, but those teachers also see that there is a need for real laboratory because research needs real experiments and virtual laboratory cannot improve research skills in real environments.

Also (70%) of teachers agree that some theories are difficult to teach in the virtual laboratory, and they mentioned many reasons for that, such as, the virtual laboratory is limited, not good for practice skills, some experiments can master only in the real laboratory. Other teachers (30%) have different opinions on the virtual laboratory can enable the students to do all experiments as its software environment.

About the effectiveness of the virtual laboratory in science experiments (90%) of teachers agree the virtual laboratory is very effective, but it is not more effective than real laboratory.

In developing students innovative skills by the virtual laboratory (70%) of teachers said it is great in helping their innovative skills, because the students will combine virtual laboratory by themselves, helps imagination ability to help them to open their mind. But (30%) of teachers do not agree with that, because the virtual laboratory is just automatically experiments and it is hard to get innovative skills for real environments as they see.

Also teachers mentioned many different advantages for the virtual laboratory in teaching science which are, low cost and convenient, quick, it can be conducted in the distance education via internet, free of contamination, it can reproduce, improve the exiting experiments, it can carry out experiment, saving energy, safe, helping to improve imagination, convenient for observation, high rate of successes to ensure, not limited by time and place, good for learning theory, help students to understand abstract concepts, and save teacher time.

Also there are disadvantages for the virtual laboratory mentioned by teachers, like the virtual laboratory is a kind of abstract, it does not offer a lot of opportunities for students to do real experiments that may be come understood in the real situation, the result of experiments needs to be conducted in the real laboratory, students ability to do practical work is hard to be improved, it's not true and will influence the students understanding for the real experiments, high depending on computer, not helpful to develop students imagination and innovation, not good for practical skills, and it is not enough for developing students operational ability.

There is much kind of skills are difficult to be improved for students in the virtual laboratory mentioned by teachers, which are the ability to do practical work, the ability to observe experiment and analyze problem, also students operational skills, understanding of function of each part of equipment, lack understanding of the real environment, doing real experiments skills, and the ability to meet emergency.

The findings of this study according to the highest means for the students respondents and teacher views, that the virtual laboratory is very effective in teaching science at university, especially when we integrate it with the real laboratory, and also it is useful to give students scientific research skills, but these skills are not enough for students to apply in the real environments, and real laboratory is very important for science experiments, because students need real experiments to improve and explore their real environments.

#### **4. Discussion**

this study aimed at knowing the efficiency of the virtual laboratory in the development of student's research skills in science, from perspective of those who are using this kind of technology, teachers and students, and the findings of this study have shown that the virtual laboratory is very effective in the process of teaching science and developing research skills for students, because it has many different roles for student, teachers and educational institutions, which helps students to understand science, helps them to do some experiments which cannot be done in the real laboratory. Teachers can teach some experiments that are dangerous or expensive or need equipments not available in the real laboratory; and helps students to understand theories and abstract concepts. These roles for the virtual laboratory in science make it very useful for students to improve their innovative skills and ability of imagination. For educational institutions' virtual laboratory can be used in distance education via internet, because it is not limited by time and place, teachers can create it online or in hard disk as DVD or USB or other media, and students can get it every time and they can repeat the experiments many times.

Also when we integrate the virtual laboratory with the real laboratory they will play a great role for teaching contents of science courses, and virtual laboratory can be used as guide for real laboratory to illustrate principle of theories before the practical work in the real laboratory or in the lecture in the classroom, and that makes students understand experiments very well and help them to open their mind for practical work, so, the integration between those two kind of laboratories is very useful for developing students scientific research skills in science.

For developing students research skills, the virtual laboratory is useful for students, because it helps them to understand the way how to design experiments for research because using computer systems can give good simulation for what should happen in the reality, and help them to collect data and analyze it, and enable students to understand how scientists are able to explain what they observe. These roles make it useful for research, but the completed skills for research needs the real laboratory, because some skills are difficult to be improved in the virtual laboratory. For example, in chemistry students need to develop sensory and taste skills as well as in Physics and Biology, also students skills including operational skills and understanding the function for each part of equipments need to be developed with real experiments in real environment, and improve students skills in software environments may not help them to transfer it into real environment.

## 5. Conclusion

The development of the student's scientific research skills in science become very important and critical issue, especially when we use the virtual laboratory, because of that the traditional or real laboratory can give students skills which are difficult to get with the virtual laboratory. This study concluded that the virtual laboratory is efficient in teaching science, and it helps to develop the student's research skills, because it can provide good helps for the process of doing experiments. Moreover, the virtual laboratory should be integrated with real laboratory to illustrate the principal of theories, and that will play great role in solving real environments problems. Also the real laboratory should be used as main part in science experiments to improve the students' research skills to be applied in the real environment, and using only virtual laboratory may not be enough to improve and develop the students' scientific research skills in reality.

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