

1 Real and Virtual Physics Laboratories in High Schools, 2 Case Study Albania

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4 *Laboratories play a very important role in the teaching modalities, in*
5 *middle and high schools. In physics, they seems to be even more important,*
6 *because help students to better understand what happen, how nature works.*
7 *In the physics curricula of the high schools in Albania, laboratories are part*
8 *of the lessons and using them, teachers derive to what they want to teach*
9 *and explain to the students. But, the question is: It really works like this?*
10 *How laboratories are implemented in the teaching modality? Real of virtual*
11 *experiments are used most? What's their impact to the student performance? In*
12 *this work, we present some results taken in the high schools of some*
13 *principal cities in Albania, regarding the laboratories infrastructure, the*
14 *use of real and virtual laboratories and the role of them in learning and*
15 *understanding physics. We have performed a survey, in 10 different cities,*
16 *in 40 high schools and then analyze the results. The main idea is to expand*
17 *this attempt in more high schools and then make a proposal for the Ministry*
18 *of Education, Sports and Youth for reforms in the actual curricula.*

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20 **Keywords:** *Physics laboratories, high school, Albania, virtual, STEM*

23 Introduction

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25 In the last years, the curricula of middle and high schools in Albania, has
26 changed continuously. The Ministry of Education, Sports and Youth has
27 adapted the British curricula and textbooks in most of the subjects and levels of
28 education (<https://arsimi.gov.al/>), an initiative that had a lot of discussions and
29 objections. Nowadays, the textbooks are chosen by the ministry and translated
30 in Albanian. In most of the important subjects learned in high school, is used
31 the same textbook, a translated version of the British original textbook. This
32 curricula and textbooks aim to develop the competences of the students, putting
33 them in center of the learning process. Also, in most of the STEM subjects,
34 laboratories are considered to be an important tool, because teachers have to
35 guide students to derive conclusions and then explain the topic of the lesson,
36 after performing some experiments in the lab. Laboratories are part of the
37 lessons in the used textbooks and using them, teachers derive to what they want
38 to teach and explain to the students.

39 In different workshops, conferences and meetings with middle and high
40 school physics teachers organized by the Department of Physics and the
41 National Institute of Physics (<https://ikf-akad.al/>), we have faced with a lot of
42 problems. Teachers have to give additional materials to the students and
43 explain only the theory, because most of the schools don't have the proper
44 laboratories infrastructure. In the absence of the laboratories, some of them use
45 virtual laboratories to help students understand. Regarding the use of virtual
46 laboratories we have performed a survey in high schools and published the
47 results in an our previous work (Osmanaj et al, 2021).

1 Taking in consideration the discussions and debates between teachers, we
2 decided to perform a survey and then analyze the results in the high schools of
3 some principal cities in Albania, regarding the laboratories infrastructure, the
4 use of real and virtual laboratories and the role of them in learning and
5 understanding physics. We have performed a survey, in 10 different cities, in
6 40 high schools and then analyze the results. The main idea is to expand this
7 attempt in more high schools and then make a proposal for the Ministry of
8 Education, Sports and Youth for reforms in the actual curricula.

9 10 11 **Literature Review**

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13 Nowadays seems to be very hard teaching science, especially natural
14 sciences, without practical activities in the laboratory. The role and importance
15 of the laboratory in teaching and learning natural sciences has been studied by
16 many authors. (Bates, 1978; Çakiroglu, 2006; Sokołowska & Michelini, 2018).
17 According to them, and not only, laboratories are an important tool for teaching
18 natural sciences as understanding levels are improved when students are
19 involved in learning in science labs in practical experiments.

20 According to the American Association of Physics Teacher (www.aapt.org;
21 Tobin, 1990) physics laboratories should be projected in order to develop
22 ability and self confidence in:

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- 24 ■ Measurement of physical quantities with the proper accuracy
- 25 ■ Understanding the factors which can affect the reliability of the
- 26 measures.
- 27 ■ Understanding how appliances work
- 28 ■ Clear description of measurements and observations
- 29 ■ Presentation of the taken information with exact terms, graphics and
- 30 corresponding math
- 31 ■ Understanding the phenomenology and give conclusions
- 32 ■ Writing labs report in the correct manner
- 33 ■ Collaboration between students and teacher
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35 Also, Sharpe & Abrahams (2019) state that conducting experiments is
36 important in the learning of science subjects and motivates students to study
37 science. Laboratory training is also frequently used to develop skills necessary
38 for more advanced study or research. Therefore, the laboratory plays an
39 essential role in the teaching process. In the absence of laboratories, a lot of
40 teacher use virtual laboratories and numerical simulations in order to explain
41 the topics of the lessons and help students understand better. (Perkins (2006);
42 Paudel (2021); Osmanaj et al (2021))

43 The most of them conclude them virtual laboratories and numerical
44 simulations can't replace the labs, but only can support and expand what
45 laboratories learn.

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1 **Methodology**

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3 This survey based research was motivated by the meetings of physics
4 teachers in different workshops/conferences, and the level of physics
5 knowledge of high students, who come in universities. The new curricula and
6 textbooks used in middle and high schools have created a lot of discussions.
7 Educational experts, teachers, university professors wonder if this British copy
8 curricula is the most appropriate in the context of Albania laboratories
9 infrastructure and background. The main idea was to see how laboratories are
10 implemented in the teaching modality, real or virtual experiments are used
11 most and what's their impact to the student performance. Also we wanted to see
12 if the new curricula and the translated book (*12 grade: Original: Sang D.,*
13 *Jones G., Chadha G. and Woodside R., Cambridge International AS and A*
14 *level Physics Coursebook, second edition, 2014*) with 19/24 chapters with
15 practical activities, is suitable for being used with the current laboratories
16 infrastructure.

17 The research samples taken are teachers of natural sciences and students in
18 high schools. The study was conducted in 10 different cities in Albania, at 40
19 high schools, with 35 teachers and 4800 students of the 12th grade. A survey
20 was performed to evaluate the current situation of the natural sciences
21 laboratory and teaching activities of natural sciences in the laboratory in high
22 schools.

23 We prepared an online survey in Google forms for the teachers, shared in
24 LinkedIn, in a public group on Facebook, "The platform "Mesuesi i fizikes
25 online"(Online Physics teachers)", and directly to schools. The teachers shared
26 the students' survey in all the 12th grade classes.

27 We collected data from March 2023 to June 2023 and then analyzed the
28 results. The collected data were analyzed, discussed qualitatively and
29 quantitatively, as indicated in the charts and reports.

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31 **Results**

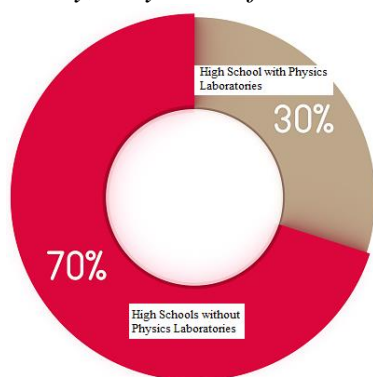
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33 The results of our survey were analyzed and the most important parts of
34 these results are presented in the figures below.

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- 1 **Figure 1.** *Laboratories infrastructure in Albania. From 40 Schools Part of the*
 2 *Survey, only 30% of them have Physics Laboratories*



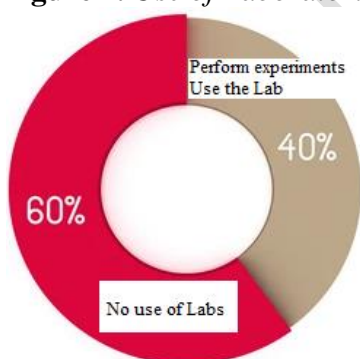
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5 As can be seen by figure 1, 70% of the 40 schools taken as sample in 10
 6 cities in Albania, don't have physics laboratories. The next question was if
 7 these 30% of schools with the proper laboratories infrastructure, use
 8 laboratories during the lessons and perform experiments?

9 The results taken were surprising..ascan be seen in figure 2. Only 40% of
 10 these high schools use the physics laboratory and perform some experiments.
 11 60% of them don't use labs, even just for demostring simple experiments. This
 12 happened, because teachers don't have enough time to explain the lessons and
 13 perform experiments, because the topics to be explained are a lot. Let's
 14 remember that the physics textbook used in the 12th grade and the topics there,
 15 are explained in two years in the United Kingdom.

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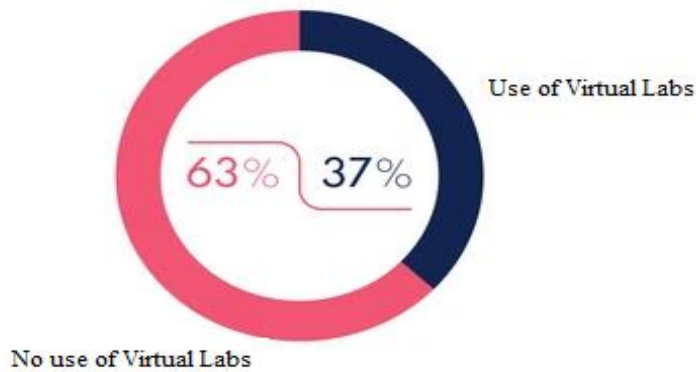
Figure 2. *Use of Laboratories in High Schools*



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20 While in the schools that don't have physics laboratories, we asked if
 21 teachers use virtual laboratories, and what kind of virtual labs. From the 70%
 22 of the 40 high schools that didn't have laboratories, only 37% of them use
 23 virtual labs during the lessons (Figure 3) and 85% of them used PheT Simulations
 24 (Figure 4)

1 **Figure 3.** *Use of Virtual Laboratories in the Schools that don't have Physics*
2 *Laboratories*



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4 **Figure 4.** *Types of Virtual Labs used*

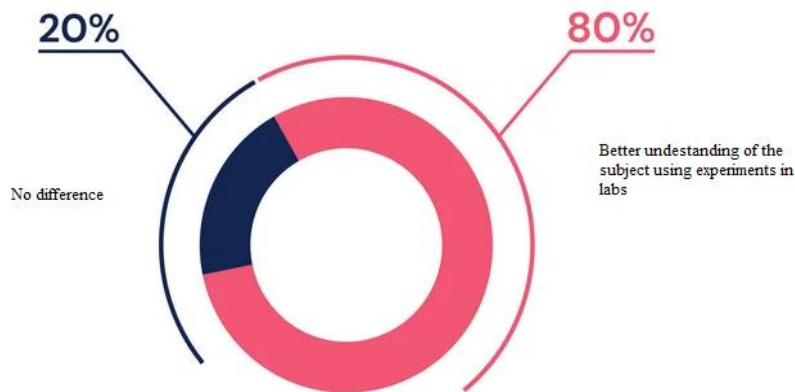


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7 The use of PheT simulations in high schools in Albania has been
8 published in another previous work of us (Osmanaj, 2021) but in a different
9 point of view.

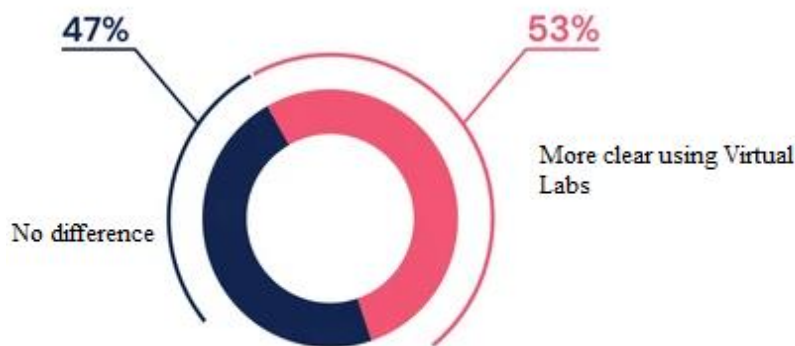
10 During this survey, we also asked about the level of understanding of the
11 subject and student performance when laboratories (real or virtual) are used
12 and when not. The results taken are presented in the graphics in figure 5 and 6.

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1 **Figure 5.** *Understanding/Student Performance. 12 School with Physics Laboratories*
2 *in Different Cities/ 1700 Students of the 12th Grade*



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5 **Figure 6.** *Understanding/Student Performance 15 School using Virtual Laboratories*
6 *in Different Cities/ 1850 Students of the 12th Grade*



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9 As can be seen by the results presented in figure 5, the student
10 performance and level of understanding is much more better when experiments
11 and labs are used during the lessons. 80% of the students studying in high
12 schools with the proper laboratories infrastructure, had a better understanding
13 of the topics when labs are used.

14 While in the high schools which don't have laboratories, but teachers use
15 virtual labs, 47% of the students said there was no difference if virtual labs
16 were used or not.

17 Let's remember that the main idea of the work is to expand this attempt in
18 more high schools and after taking and analyzing the results, make a proposal
19 for the Ministry of Education, Sports and Youth for reforms in the actual
20 curricula.

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1 Conclusions

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3 From this survey based research, some of the conclusions would be as
4 follow: Real Laboratories are very important and play a key role in the actual
5 curricula and with the actual textbooks used in the high schools. Unfortunately,
6 more than 70% of the high school in Albania don't have physics laboratories
7 with modern and suitable appliances for experiments. Even those schools that
8 have labs, use them not to often. The virtual laboratories are just a support for
9 teachers, but they don't substitute real labs. Most of them, just realize the
10 theoretical part, without considering other elements, which make students think
11 and analyze. With the actual textbooks and curricula, the teachers have to add
12 materials for the students, in order to achieve a better performance, if they
13 don't have labs. (Fact that makes unusable the textbooks) The performance of
14 the students increase when laboratories are used and the books would be
15 suitable for that level. The Ministry of Education should perform reforms:
16 Improve the laboratories infrastructure in all cities, or change the actual
17 textbooks

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