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The Impact of Physics Taught with Simulators and Texts in Brazilian High School: A Study in the Adult and Youth Education

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Abstract**—**The teaching of physics in Brazilian public schools emphasizes strongly the theoretical aspects of this science, showing its philosophical and mathematical basis, but neglecting its experimental character. Perhaps the lack of science laboratories explains this practice. In this work, we present a method of teaching physics using the computer. As alternatives to real experiments, we have the trials through simulators, many of which are free software available on the internet. In order to develop a study on the use of simulators in teaching, knowing the impossibility of simulations on all topics in a given subject, we combined these programs with phenomenological and/or experimental texts in order to mitigate this limitation. This study proposes the use of simulators and the debate using phenomenological/experimental texts on electrostatic theme in groups of the 3rd year of EJA (Adult and Youth Education) in order to verify the advantages of this methodology. Some benefits of the hybridization of the traditional method with the tools used were: Greater motivation of the students in learning, development of experimental notions, proactive socialization to learning, greater easiness to understand some concepts and the creation of collaborative activities that can reduce timidity of part of the students.

Keywords**—**Physics teaching, simulators, youth and adult education, experimentation, electrostatic.

I. Introduction

THE Internet and electronic devices are increasingly common in the daily lives of children and young people and are being used frequently in the classroom. The way to learn has changed: Students have access - with a drag of fingers on the screen - to a world of information that sometimes even the teacher does not know. There is now a sharing of data, stories and curiosities in which the educator needs only to guide. One of the evidences of this is that 82% of the students do their research for school through the web [1], according to the study of the Internet Management Committee in Brazil (CGI.br), which measured the use of technologies in Brazilian schools in 2013. The study shows that 55% of teachers and 51% of pedagogical coordinators of public schools believe that the number of equipment per student limits the use of the computer and the internet in school [1]. Another barrier mentioned by them is the slow speed of the connection with the network. Yet, there is progress in government education institutions: 65% of teachers use technology to teach students how to use machines [2]. Regarding the search for alternatives to traditional teaching and the role of the computer in this new paradigm, we should emphasize the vision of Fiolhais and Trindade: "The difficulties that many students have in understanding physical phenomena are known. Among the reasons for unsuccessful learning in physics, methods of teaching that are out of touch with the latest learning theories, as well as lack of modern pedagogical means are pointed out. The need to diversify methods to combat school failure, which is particularly clear in exact sciences, has led to the increasing and diversified use of the computer in physics teaching. The computer currently offers several possibilities to help solve the problems of failure of sciences in general and of physics, in particular." [3]

The use of simulators is shown as an alternative tool for teaching in schools without a laboratory. In physics, for example, simulators, because they are modelers of phenomena, can instigate discussions and serve as complementary material to the teacher in his classes. In schools where there is lack of laboratories, we note that: "Models can function as a bridge between scientific theory and the world-as-experienced ("reality") in two ways. They may be simplified outlines of reality as observed (example phenomena), produced for specific purposes to which the abstractions of the theory are then applied. They may also be idealizations of a reality-as-imagined, based on the abstractions of theory, produced in such a way that comparisons can be made with reality-as-observed, and thus used to make abstractions visible and to crucially provide basis for predictions about phenomena and their scientific explanations" [4]. Therefore, a good way to discuss modeling processes and simplifications in science with students is to confront (through debate) the model with real situations, and the teacher is the intermediary of this action, as indicated by Filho: "In order to achieve the proposed objectives, applications need to be potentially significant materials, linking the students' previous knowledge with the new knowledge presented, with a view to consolidating, revising and differentiating the previously worked concepts. The methodology of expository classes with emphasis on dialogue and oral discussions, through the use of applications, allows to present and analyze a given phenomenon or physical concept in a perspective of layers of interactivity with multiplicity of languages, with the intention of raising questions to the class through the analysis of the phenomenon in its dynamic and interactive form [5]". Thus, the important thing is not the

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simple manipulation of software, but the involvement committed to the search for solutions or well-articulated answers to the questions posed, in activities that can be purely of thought.

Our interest in this work is to verify the impact of the use of freely available simulators on the Internet and of phenomenological/experimental texts that open debates about laboratory practices in teaching, specifically in the topic of electrostatics due to its high degree of abstraction. This study was applied in the 3rd year of the Youth and Adult Education (EJA) segment of the public school system of the Federal District.

II. Methods

A. Selection of Simulators and Texts

In the study, there was a concern to develop practice support material with simulators in the classroom. This software is an alternative for the teacher and the student to have contact with physics in a way closer to experimentation. The simulators were chosen on the internet and the texts were taken from high school books.

The texts combined with the programs had the objective of raising broader discussions about electrostatics. All the material was compiled in a CD-ROM attached to the full study.

B. Investigating the Social Profile and Teaching the Computer

Initially, in four classes of the 3rd Year of the EJA modality at CEF 01 Elementary School in CidadeEstrutural - DF, a questionnaire was applied in order to know the social profile of the community. It was noted that the majority of the students were workers between the ages of 18 and 30, they had failed the school year at least once, they reported difficulties in exact sciences, they studied in the classroom only, they had computers at home, they had basic knowledge of internet and they believed that if there were lab activities at school, their interest and learning in those areas could be greater. In order to improve student manipulation with the computer, we did a double student training on the windows system and on the internet.

C. Applying the First Test

Fifteen classes were given following the traditional method of teaching, namely: The teacher verbalizing the information about the electrostatic subject and the students as mere receivers of the same. At the end of this set, a pre-test was applied to the students. In this pre-test there were 4 questions of general knowledge of the subject and 3 questions about experimentation involving electrostatics.

D. Teaching with the Traditional Method Combined with Texts and Simulators

The teacher selected 4 interactive simulators on the internet and developed work scripts for the students with this kind of software. In order to enrich the activity with the simulators, the teacher selected 5 texts in which they had the possibility of emphasizing some physical phenomenon on the subject or about experimental aspects in electrostatics. With the didactic material in hand, another 15 classes were given, combining the traditional method with the practice in simulators in the school's computer lab, as well as debating the phenomenological/experimental texts. Therefore, we applied the post-test (identical to the first one) aiming at quantitatively estimating the students' results in questions of general and experimental notions of electrostatics. When we examined the comparative performances of the students in the pre and post-test we did not notice a considerable evolution of the grades. These results can be seen in Tables I-IV.

TABLE I
PERFORMANCE OF CLASS A IN 2 TESTS

Student	1st test	2nd test	Student	1st test	2nd test
A.S.N	1,2	0,9	L.A.S	0,7	0,8
A.O.S	1,1	1,2	M.R.S	0,4	1,2
B.L.S	1,0	2,0	M.F.B	0,3	1,3
B.G.R	1,4	0,9	N.S.N	0,7	1,8
C.A.R	0,4	0,2	P.B.L	0,9	0,2
C.R.A	1,0	0,9	R.S.G	0,5	0,8
E.S.F	0,1	1,6	R.P.C	1,5	0,8
E.S.V	0,1	0,8	R.A.O	0,3	0,8
E.M.R	0,1	1,5	S.P.C	0,6	0,6
F.C.S	0,3	1,0	V.F.C	0,5	1,2
I.R.F	0,6	0,6	V.O.S	0,9	1,2
K.R.O	1,2	1,5	Z.S.G	0,0	0,9
			N =24	$\bar{x}$= 0,7	$\bar{y}$= 1,0

Note that 66.7% of Class A students have developed their grades (16/24).

TABLE II
PERFORMANCE OF CLASS B IN 2 TESTS

Student	1st test	2nd test	Student	1st test	2nd test
B.A.S	0,4	0,8	O.A.S	1,0	1,6
C.S.R	0,5	0,8	P.R.J	0,5	0,3
D.M.M	1,1	1,2	R.G.B	0,2	1,7
F.P.S	0,2	0,4	R.N.S	0,5	1,3
I.S.G	0,6	1,2	S.H.B	0,7	0,3
I.M.S	0,4	0,3	T.A.A	1,1	1,6
J.E.L	0,8	1,5	N=19	$\bar{x}$= 0,7	$\bar{y}$ = 0,8
L.A.S	0,3	0,3			
L.G.S	1,5	0,7			
L.R.M	1,6	0,8			
M.A.A	0,2	0,2			
M.G.A	0,3	0,3			
N.G.N	0,4	0,8			

Note that 58.7% of Class B students have developed their grades (11/19).

TABLE III
PERFORMANCE OF CLASS C IN 2 TESTS

Student	1st test	2nd test	Student	1st test	1st test
A.N.A	0,9	1,4	M.S.G	1,3	0,9
A.C.P	0,8	0,8	N.M.V	1,2	0,7
C.P.S	0,9	0,5	N.S.L	1,8	0,9
C.A.T	0,3	0,7	P.E.S	0,9	0,8
D.A.N	0,9	0,5	S.P.S	1,0	0,9
D.I.A	1,0	1,4	T.B.P	1,0	1,4
G.P.X	1,7	1,3	Y.L.G	1,4	1,1
K.L.R	0,6	1,5	N=20	$\bar{x}$ = 1,0	$\bar{y}$ = 1,0

K.A.O	0,7	1,3
L.O.F	0,4	0,8
L.L.R	0,4	1,8
L.S.S	0,4	0,1
M.S.F	1,3	2,0

Note that 45% of Class C students have developed their grades (9/20).

TABLE IV
PERFORMANCE OF CLASS D IN 2 TESTS

Student	1sttest	2nd test	Student	1sttest	2nd test
A.S.C	0,8	0,8	F.S.S	0,2	0,0
A.D.S	0,6	0,8	J.M.A	0,7	0,7
A.R.P	0,8	0,8	J.D.P	1,9	0,9
A.G.B	0,2	0,3	K.C.L	0,5	0,5
C.L.E	0,9	1,0	L.E.L	0,9	1,4
D.D.A	0,9	0,8	M.R.B	0,0	1,5
D.S.S	1,0	0,8	M.F.S	1,4	0,9
D.F.A	0,2	0,8	M.C.S	0,4	0,9
D.S.D	1,0	2,0	P.X.R	1,3	1,1
D.S.S	0,3	0,0	R.P.S	1,0	1,5
D.B.V	0,4	0,5	V.G.F	0,3	1,0
E.J.M	0,2	1,0	W.F.S	0,8	0,7
E.S.O	0,9	0,8	N= 25	$\bar{x}$ = 0,7	$\bar{y}$ = 0,9

Note that, 48% of Class D students have developed their grades (12/25).

E. Asking the Student´s Opinion about the Class with Simulators and Texts

We applied a questionnaire of opinion with 16 subjective questions about the hybrid methodology of teaching with simulators and discussion of texts. In this questionnaire, the main items evaluated were: Quality of the material, development of notions of experimentation, student´s motivation towards hybrid methodology, socialization focused on learning, content understanding and behavioral change in physics classes.

III. RESULTS AND DISCUSSION

In this work, we preferred to reserve ourselves to the qualitative sphere of analysis, although we believe it is possible to triangulate between the quantitative and qualitative approach. Figs. 1-4 show some important results of this study. We could observe that 70% of the students felt more motivated with this teaching methodology, as shown in Fig. 1. Fig. 2 shows that 72% believed they had evolved in their experimental notions. Regarding understanding, 82% said they had a better understanding when in contact with the method tested (see Fig. 3). Finally, 62% reported having a greater learning synergy (see Fig. 4).

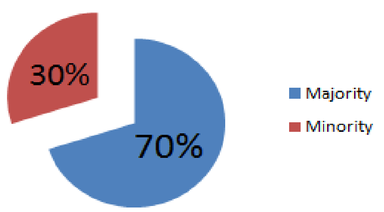

Fig. 1 Student´s response to the Motivation criterion

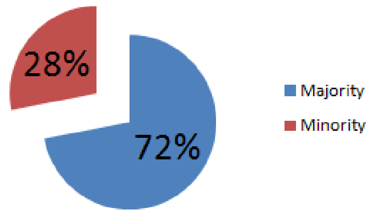

Fig. 2 Student´s response to the Experimental Notions criterion

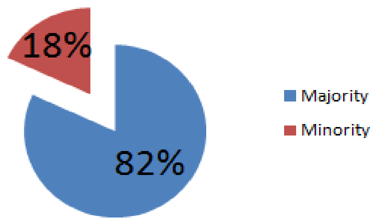

Fig. 3 Student´s response to the Understanding criterion

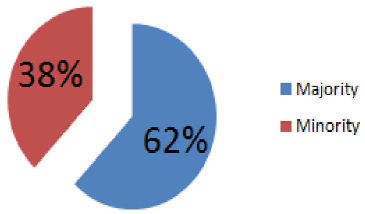

Fig. 4 Student´s response to the Learning Synergy criterion

IV. FINAL REMARKS

Brazilian students have low performances in the areas of reading, mathematics and science. This can be observed from the performances in international exams such as PISA-Programme for International Student Assessment.

In 2009, students scored 412 in this category, in which the maximum score registered was around 554. This performance gives Brazil the 53rd position in a total of 65 countries that took the exam and level 2 of learning, on a scale ranging from 1 to 6. This means that students can understand only a limited part of the text and are only able to make low level inferences [6]. Some data from this program can be analyzed in Fig. 5. Thus, in the hope of improving reading proficiency, it is the responsibility of teachers in all subjects to implement activities that exercise the interpretation of texts with possible debate about them. In a study related to the use of scientific dissemination texts -CDT-, many teachers report the following advantages in working with texts in the classroom: Encouraging reading habits in the school context, promoting understanding about aspects of the production of scientific knowledge, promoting the interest of students in the classroom, stimulating students' critical thinking, encouraging discussion and debate in the classroom, encouraging learning of concepts and developing students' oral and written communication skills [7].

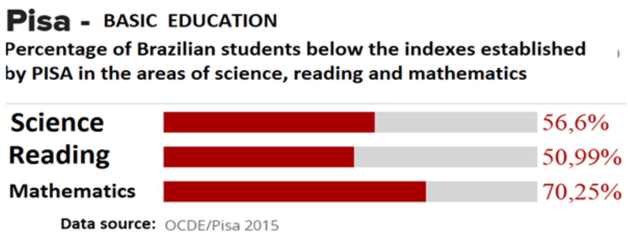

Fig. 5 Performance of Brazilian students in PISA

In physics, after explaining the content, the teacher directs his classes to exercises [8]. Often, when students are faced with problem situations, the difficulties of interpretation related to the information given by the exercise appear, a fact that greatly compromises their resolution. Thus, developing the scientific vocabulary and the ability to interpret exercises becomes a pressing need for those who teach this subject. In this work, we propose the reading of phenomenological/ experimental texts, aiming to promote a more complete formation in physics, where the theoretical framework and some experimental situations is discussed in the classroom, as well as the students' questioning is motivated and the student breaks his passivity before the knowledge transmitted by the teacher, giving the school environment a more critical vision on the part of its involved ones, besides the necessary interpretive evolution of the numerous situations in focus are being practiced.

V. Conclusion

In the practice with simulators and texts in teaching, the meanings shared between what the student experiences and what the teacher shows are perceived in a few moments, since in an attempt to interpret the simulated phenomenon or the text in debate, the apprentice often faces unexpected results, distant from his previous conceptions. Thus, through the communication between the classmates and the teacher of their ideas, the formation of an extremely participative and collaborative environment takes place in the classroom, enabling conditions for the consolidation of meaningful learning.

From the assessment of the student´s responses, we noticed that motivation, understanding, disinhibition, socialization, pleasure in learning and the notions of experimentation, in relation to conventional classes, evolved using the method. However, a more detailed study is necessary in order to offer such indications as it is a pioneering work.

References

[1] Brazil. TIC Governo Eletrônico 2013. Comitê Gestor de Internet no Brasil. Pesquisa sobre o uso das Tecnologias da Informação e Comunicação no Setor Público Brasileiro. Available at: <http://cgi.br/media/docs/publicacoes/2/TIC_eGOV_2013_LIVRO_ELETRONICO.pdf> Accessed in: 20 de Ago. 2014.

[2] Machado, V. "Na era do Tecnoaprendizado". Correio Braziliense, Brasília: Caderno Especial Volta àsaulas, 13 de janeiro 2013, p. 2-3.

[3] Fiolhais, C.; Trindade, J. Física no computador: o computadorcomoumaferramenta no ensino e naaprendizagem das ciênciasfisicas. Revista Brasileira de Ensino de Física, v. 25, n. 3, p. 259-272, set. 2003.

[4] Gilbert, J. K. Visualization: A metacognitive Skill in Science and Science Education, in Gilbert, J.K. (ed), Visualization Inscienceeducation, Netherlands: Springer, 09-27, 2005.

[5] Filho, Geraldo Felipe. "Simuladores computacionais para o ensino de Física básica: uma discussão sobre produção e uso". MSC Thesis, Federal University of Rio de Janeiro, Institute of Physics, Rio de Janeiro: December, 2010.

[6] Pisa, Relatório Nacional dos-resultados brasileiros-2012. Available at: <http://download.inep.gov.br/acoes_internacionais/pisa/resultados/2014/relatorio_nacional_pisa_2012_resultados_brasileiros.pdf>. Accessed on: 15 ago 2014.

[7] Ferreira, L.N.A, Queiroz, S.L. "Scientific Divulgation Text" in Taught Physics: one review". Revista de Educaçãoem Ciência e Tecnologia, São Paulo, 1(5): 3-31, 2012.

[8] Peruzzo, J. Experimentos de Física Básica. Eletromagnetismo, Física Moderna & Ciências Espaciais. São Paulo: Livraria da Física, 2013.