USE OF VIRTUAL LABS FOR ENHANCE STUDENT'S PROCEDIMENTAL ABILITY

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Abstract - This article presents some results of a study investigating the use of the simulator VLAB, developed by Carnegie Mellon University, to increase the capacity of graduate students in Chemistry in the preparation of experimental procedures. The activity was conducted in two stages, first the students were asked a manuscript describing in detail the procedure and equipment used in the technique of dissolution and delivering it to the teacher. Later in the computer lab, each student performed the same procedure using the simulator. The activity has been proposed to determine if there could be accuracy gains of the description of the process when performed by the simulator. One of the main positive aspects obtained using the simulator students was the recognition of error, important in that the great majority recognized omitted or confused any process step. This reflection showed the students that in addition to testing a procedure using the simulator facilitates the organization of thought and helps arrange it

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logically. With the use of simulators, students are encouraged to take risks, to explore, to experience a new way, and a real lab usually offers much less room for risk, exploitation and failure.

Keywords **- Chemical Education, Dissolution, Simulation, Virtual Lab**

I. INTRODUCTION

Focking [1], considers educational simulations as representation or modeling of a real world object, a system or event, that is a symbolic and representative model of reality which must be used to characterize essentials aspects of any phenomenon. Changing simulation values and parameters, the results can be checked instantly and this is a very important aspect of the learning process, often called feedback. Thus, a simulation can be used after learning of basic concepts and principles of the curriculum subject matter to increase the theoretical knowledge or training skills practice.

According to Alessi & Trollip [2], educational simulations have a number of advantages over other teaching resources. The main advantage is the interaction with the phenomenon or object to be studied. This feature encourages student participation, turning the learning more interesting, intrinsically motivating and closer to a real experience. The simulations allow students to experience phenomena that can be dangerous, expensive or even impossible to observe in the real world. A clear example of the advantage of a simulation is the control over the speed of an event where we can appreciate with such detail events that occur a fraction of seconds or accelerating phenomena that would take hours or days to occur (Wilson & Cole, 1996) [3].

Since adequate and planned simulations use can offer many educational benefits, that include arouse and improve students interest about a subject matter, facilitate it develop and test hypotheses, analyze results and refine concepts. Another beneficial aspect of the simulations is to allow the student get involved more actively in the construction of knowledge, since in a simulation situation there is no problem or danger in the wrong. In addition, the students can repeat the simulation many times as desired. Good [4], suggest that access to good simulations contributes to the improvement of science teaching in general.

In chemistry there is a wide range of possibilities for simulations exploration, ranging from the representation of physical models of atoms, molecules and chemical reactions, until more complex systems such as titrations, stills, spectrophotometers, and others.

The main function of an educational simulation is experimentation and prediction. Changes in the input variables allows instantaneous evaluation of the results and consequences in the phenomenon being studied, this simulation characteristic putting the student in a more active stance to explore knowledge, encouraging logical rationality and promote abilities to make predictions. Levy [5] argues that, use of interactive simulation techniques are not a guarantee of human inferences, but improve the imagination and capacity for thinking, especially when compared to the passive resources as videos or animations without any interaction

It is important to understand that computer simulations can be a great tool for direct contact with natural phenomena and experimental work, but cannot fully replace practical activities, for it makes no sense to simulate a process that can be easily observed or experienced (BOYLE, 1997) [6].

But the simulations also have limitations, it is necessary consider that the use of this tool does not guarantee learning gains, and the knowledge obtained by simulations cannot be always applied to real life. Another limitation to be considered is the possibility of the students developing distorted view of events and phenomena, believing that the real world can be simplified and controlled in the same way as in simulation systems.

This paper presents some results of a study that investigates the use of simulator VLAB to increase the ability of graduate students in chemistry in the preparation of experimental procedures.

The VLAB is a "Virtual Laboratory", developed by Carnegie Mellon University that allows students to plan and carry out chemical reactions as they would in a real lab. The simulator presents a high degree of fidelity to the different types of laboratory practice, such as the preparation of solutions, balancing quantitative and qualitative analysis, thermochemical, stoichiometry, among others.

II. METODOLOGY

In order to verify the benefits of using the simulator VLAB in learning operating procedures, we propose an activity of dissolution of sugar for 30 students of the Universidade Estadual Paulista (Brazil). The activity was conducted in two stages, initially requested students to describe in detail in a paper the procedure and equipment used in the dissolution and deliver it to the teacher. So in the computer lab, individual students performed the same procedure using the simulator. The proposed activity was to determine whether there would be gains in accuracy of the description of the procedure when conducted with the simulator.

Subsequently, we compare both descriptions of each student to investigate the differences and show the accuracy of the procedure.

Assuming that the activity before using the simulator is referred to as Lab Description 1 (LB1) and after using the simulator is referred to as Lab Description 2 (LB2).

III. RESULTS

Before use of simulator we asked to students about the utility of simulators in education. As result, we obtained: 58% of students said that the use of simulators make possible test procedures before performing them, 8% believes it is useful for testing theories learned in classroom. For 17% of students, believes that simulations are more accessible and faster than real laboratory, and 25% said not knowing what is the utility of a simulator.

The comparative results of the activities analyzed showed some significant differences in the following aspects:

a) The majority of students described the LB2 more extensive than LB1, averaging 50% higher; b) the majority of students described LB2 more detailed than LB1; c) For most of students, the LB1 contained one or more errors in procedures, mainly related to forgetting any of the steps of the process; d) No student has committed significant error in LB2; e) the majority of students identified their errors in the procedure of LB1, indicating that the simulator allowed to reflect on practice.

Analyzing students' answers on the LB2 activity, we found that 83% of students make use of new glassware or change it. The same percentage made significant changes in the footsteps in the second activity. The glassware changes LB2 activity can be seen in Table 7.

TABLE I - List of glassware used in VLAB

Laboratory Glassware	Changes
Volumetric Pipette	50%
Burette	17%
Flask Beaker	25%
Graduated Cylinder	25%
Volumetric Flask	8%

The data obtained after the use of simulation presented in Fig 1, show that in general, 75% of students considered that the simulator "greatly facilitated" the preparation of SOP - Standard Operating Procedure, indicating that the simulator helps: to remember the steps and sequences of the procedure (42%); viewing of laboratory material on the computer screen makes it easy to practice (25%), the visualization of glassware provides the most appropriate choice of materials (17%) and the simulator allows to materialize about the thought of the practice (8 %). It is interesting to note that the description of the proposed SOP had listed all the glassware that can be used, but students did not perceive the need to use it. However, when using the simulator to perform the same procedure they found the necessity of using them. According student responses, formerly described, the presence of the image of glassware facilitate the choice and the perceived need for it.

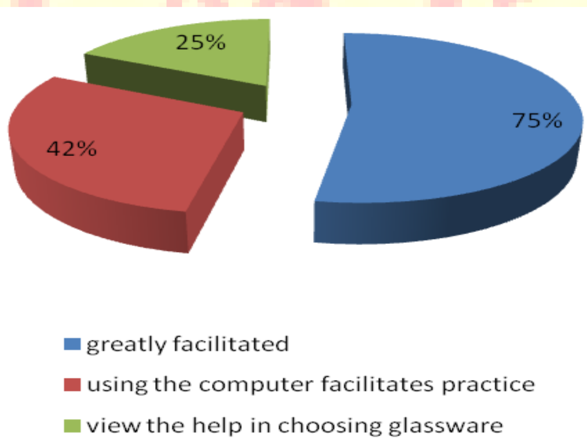

Fig. 1 Information reported by the students after using the simulator

IV. CONCLUSIONS

We believe that one of the main positive aspects obtained using the simulator by the students, was the recognition of error, important in that the great majority recognized omitted or confused any process step. This reflection showed the students that in addition to testing a procedure using the simulator facilitates the organization of thought and helps arrange it logically. The educational simulators, in general, reduce the harmful consequences of failures, because when a student make mistakes automatically receives a feedback; noticing the error, the student can go back and redo the procedure properly. Thus, students are encouraged to take risks, to explore, to try a new way. In fact, failure in the simulator can be good for learning because it leads to reflection on practice. A real laboratory environment usually offers less freedom at risk, exploitation and failure.

Thus, students are encouraged to take risks, to explore and to try a new way. In fact, failure in the simulator can be good for learning because it leads to reflection about the practice. A real laboratory environment usually offers much less room for risk, exploitation and failure.

Simulators, and especially the VLAB can be used as tools for training and routine standard procedures required of a professional in the area of chemistry. The absence of cost and ability to access the simulator from any computer enables use it extensively as a complementary activity to the real laboratory. Students can be progressively exposed to new problem classes more complex, so learning to use the new knowledge gained earlier. It's called the "Circle of Expertise" (Bereiter, Scardamalia, 2003)[7], in which the concepts are introduced progressively until the time the student becomes an expert in a particular topic or procedure. It is common that during the course, students with greatest difficulties are not enough opportunities to consolidate their learning, so in this sense, the simulator seems to be a useful tool for the student to seek to improve their individual skills.

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