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"HOME EXPERIMENTS", THE BEST WAY TO COMPLETE LACK OF MATERIALS IN HIGH SCHOOL LABORATORIES, ALBANIA

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Abstract: This paper presents some technical suggestions for biology and chemistry teachers, who lack the means at the school labs. In Albania, several high school education labs are either partially equipped or have a complete lack of chemicals and other aids needed to reach the goal. Laboratory sessions are suggested in biology, chemistry, physics and informatics Albanian curricula. Laboratories are the most attractive part of science subjects. They serve as motivation for students of all levels to participate actively in the classes, in sessions of these subjects. Note that these subjects seem to be very difficult to understand for students. The laboratory sessions makes easier learning of the topics planned for these subjects. Students look closely at theoretical explanations of the lessons, which are often memorized but not understood very well. Completion of lack of materials can be easily done by materials, which are part of our daily products or using of technology. Realization of these laboratory sessions makes learning of subjects that students find hard to theoretically understand easier. Materials that can be used to complete these sessions can be easily provided by the teacher. Many of these we can found in market, pharmacy or daily materials. We suggest our colleagues to complete the lack of materials in their labs and to realize these labs sessions, because their satisfaction and achievement will be greater.

INTRODUCTION

This paper highlights one of the most common problems for students of pre-university education in chemistry, biology, physics, etc. In very few schools there are appropriate classes to carry out the experiments of these subjects. Most of them lack the tools, reagents and conditions, needed to fully complete the

experimental topics and in many others experiments are not carried out. The subjects of Chemistry, Biology and Physics courses in pre-university education that are realized in the academic years 10, 11 and 12 have predicted and described experimental parts (Gallagher and Ingram 2015; Pople 2015; Pashko 2015; Andoni *et al* 2000). Experiments in these subjects are important part because firstly they visually describe the theory and secondly the experiment is a part of the curriculum that brings the student closer to these subjects (Musai 1999). To fully cover the lack of laboratory and reactive tools requires relatively large investments. On the other hand, the realization of the experiment is indispensable, so the use of daily products (Home Experiments) is a solution to fill these deficiencies (Pashko et al 2012). Also the use of on-line experiments obtained from the internet is another tool that at least fulfills the realization of an experiment in visual mode. Some of the most visited web pages are: lifetech-select.com; LSFB.org.uk/Marketing-school; ymc.de; 1000sciencefairprojects.com and chemistry.about.com.

During its classroom activity, the teacher intends to give the pupils a logical connection to the subject, knowledge, skills, experience and stable value. During this process teachers should perform several roles; to be a teacher's expert, to be motivating for the student, to manage the class very well, to explore the student's personal problems, to be a model for the students. Considering activity, teaching has several features: communication, which includes not only speech and writing, but also gestures, intonation, use of space, eyesight, eye tracking, description of different phenomena from everyday life or by means of circumstances, etc. Perception goes beyond the classroom look. By the precept, the teacher can reflect the sensitivity and adoption skills in relation to the needs and interests of students. Work with students is more effective when there is a cooperative spirit between teachers and students. Another feature of teaching and experienced teachers is the care of evaluation. Evaluation regards the review of information on the validity and usefulness of an action. Many of the teachers use scientific methods in their work. Identifying the problem, which is carried out by the teachers and they are the ones who decide what they require from the students. Formulate a series of logical steps to achieve the goal, so how to tackle topics to master learner learning (Musai 1999). Collect appropriate data for the needs, skills and interests of the classroom. Interpretation of data, which makes the teacher judge whether student behavior is consistent with his objectives. Teaching is a planned action aimed at helping one or more people to learn. Teaching is both art and science because art requires inspiration, intuition, talent, and creativity, and few are taught, while science knows the knowledge that can really be taught (Pashko *et al* 2012).

MATERIALS AND METHODS

Laboratory experiments using alternative materials from daily life "Home Experiments"

Materials that can be used to carry out the experiment in the absence of chemical tools and reagents are usually tools and materials that are used in everyday life at home. They can be easily found and have the same reactive content as that required for experiment. Tools and reagents that can be used in the lab include: vinegar found in market, baking soda, food coloring, salt, alcohol, vodka used as ethanol, sugar, flour, potatoes, wire, dishwashing detergent, cooking oil, red cabbage, vitamin C in the form of pharmacy tablets, hydrogen peroxide (purchased at the pharmacy), pure starch (bought in markets), etc. Unable to carry out a laboratory experiment, the teacher can use the technology. He can offer his students videos, sketches, photos, etc. that clarify the experiment from the visual point of view. Some of the experiments that can be done by chemistry teachers for high school students are as follows:

Investigation of acid-base properties using red cabbage

The first step of this experiment is to prepare a red cabbage extract that will be used as an acid-base indicator. Five hundred grams of red cabbage is cut into small pieces and put into a laboratory container, and then 250 ml of water is added continuously stirring until the liquid gets the color of red cabbage, which can be reached for one time interval of about 15-30 min. After this, the juice is separated from the mix and the red cabbage extract will be used to explore the basic and acidic properties of various substances. It can be used in solvent form or can be imprinted on a filter paper. The wet filters are left to dry before using them. Let's look an example of acid-base properties determination that the teacher can accomplish during the lesson. To achieve this goal, white vinegar can be used. Its bottle label describes that vinegar contains acetic acid. This indicates that vinegar is an acid and has properties similar to acids. To see its acidity, mix an amount of white vinegar with the cabbage extract and notice the color changes.

In a transparent glass consecutively add 125 ml of white vinegar and 5 ml of cabbage extract and then stir the mixture and notice its color change. Mixture of this glass is retained for use as a reference in the rest of the experiment development. Meanwhile, the effect of baking soda is mixed with the red cabbage extract. A volume of 125 ml solution of baking soda is put into another glass. Then add 5 ml of red cabbage extract, its color change is noticed. This glass is preserved as a reference to the basic properties. The red cabbage tracer shows whether a substance is an acid (like vinegar), or a base (such as soda). In the same way we can prove a large number of materials we use at home such as: tap water, aerated water, carbonated drinks, detergents, tile hygiene solutions, etc. The colors that will take the solvents will classify them as acids or as bases. The student records this information in his lab sheet.

Classification of acids and bases

The experiment can go further. We know there are many compounds which are acids or bases. Some of them are strong acids and some weak acids. We can say that for bases as well. The chemists use pH scale to find acidity or alkalinity of a solution. The red cabbage extract has different colors for different pH values so it can be used to evaluate the relative strength of acids and bases. The experiment is carried out in a similar manner to the above experiment and the student notes the colors that each of the solvents takes. These colors he compares with the following colors by determining the pH of the solutions and at the same time classifying them as strong or weak acids.

Determination of pH by using red cabbage impregnated paper

The experiment can be accomplished in a similar way using indicator papers treated with red cabbage solution. Some white papers are cut in strips and dive on a plate in which the red cabbage is poured and left to repose for about 30 minutes and then dried in the air. Once dried, they are used to investigate the acids and bases as well as their strength, based on the color that the strips develop.

Red cabbage impregnated paper can be used to determine different solvents whether they are acids or bases. Lemon juice can be used in this experiment. Students must observe cabbage paper, where the paper color becomes pink this mean an acid solution. So the pH is less than 7.

Once placed red cabbage impregnated paper within the solution of sodium it is seen that the paper gets blue-green. This means that the solution is basic and the pH value is greater than 7. This experiment can be repeated and with other solvents. If we want these strips to be used for a long time they should be stored in the fridge.

Titration process in the presence of indicators

Titration is the technique by which concentrations of unknown solutions can be found using acid-base reactions, oxidation-reduction, etc. These reactions are accomplished by adding a solution with known concentration to a solution with unknown concentration in the presence of an appropriate indicator. The indicators are organic molecules whose conformationdepends on the pH or the reaction they take have different shape structures and hence different easily recognizable color. To find the concentration, the solvent is added using a scaled matrix (for measuring volume, spent during titration) filled with a well-known concentrate solution according to an acid-base reaction, oxidation-reduction, etc. The reaction continues to change the color of the solution. For the calculation of unknown concentrations, the following equation is used:

$$N_1V_1 = N_2V_2$$

On one side stand the normal concentration (N1) and the volume of the known solution and on the other hand the normality and the volume of unknown solutions remain. For determining the concentrations of acids and bases phenolphthalein, methylorange etc. can be used as indicators, and in their absence solution of red cabbage or other natural indicators such as solution of strawberry, blackberry, etc. can be used.

Determination of concentration of acids and bases by titration

For the realization of this experiment, various solutions with known concentrations can be prepared in the laboratory, such as baking soda solutions with known concentration (Na_2CO_3).

Fifty ml of vinegar are put into a glass, and then several drops of red cabbage solution are added. Using a 50 ml burette, the amount of a basic solution (e.g. backing soda) of known concentration are added until the color of the vinegar solution is changed.

This is the moment when the titration process should be stopped. The added volume of base solution is noted and it is used to calculate the concentration of the vinegar using the equation mentioned above. Acetic acid (vinegar) neutralization reaction with sodium hydrogen carbonate solution (base solution) is given below.

$$\mathbf{CH_3COOH + NaHCO_3 = CH_3COONa + CO_2 + H_2O}$$

Other natural indicators that can easily be obtained are strawberry juice, grape juice, fruit juice, etc.

Redox reactions. Determination of ascorbic acid by titration with iodine

Vitamin C or ascorbic acid is an essential antioxidant for humans. Its absence can lead to bone and tooth abnormalities. Many fruits and vegetables contain vitamin C, but during cooking with heat it is destroyed. One way to determine the amount of vitamin C in foods is the use of redox reactions. The main reaction is the oxidation of ascorbic acid with iodine (iodine solution can be obtained from the pharmacy). Iodine oxidizes ascorbic acid to dehydroascorbic acid:

$$\mathbf{C_6H_8O_6 + I^{3-} + H_2O = C_6H_6O_6 + 3I^- + 2H^+}$$

If vitamin C is present in the iodine solution, it reacts very quickly. When all of the vitamin C is oxidized, iodine exhibits a complex of blue-black in the presence of amidon (starch). The appearance of this color indicates the end of the titration. This titration procedure is suitable for testing the amount of vitamin C found in vitamin C tablets, juices and fresh, frozen or packed vegetables.

The effect of the catalyst on the speed of chemical reaction

In this experiment it will be noticed how a transparent liquid turns into a dark blue glittering liquid. The experiment should be carried out in the presence of a teacher or an adult. Iodine will stain all that touches. Hydrogen peroxide can cause irritation in the eyes and in the skin. Protective glasses and gloves are needed throughout the experiment.

Safety glasses are laid out. Vitamin C is put into a glass and cocooned with a spoon until powder is made. After the tablet has been dissected, 60 ml of warm water is added. The solution is mixed for 30 seconds and during this time it becomes turbulent. Let's mark this solution with the symbol A. In another glass, add 5 ml of the above solution and then add 60 ml of warm water and 5 ml of iodine. Solution will remain clear even though iodine is brown. Let's mark this solution with the symbol B.

In the third glass we put 15 ml of hydrogen peroxide (in the role of the catalyst) and 3 ml of starch solution and we put it all into a glass with the same solvent as the glass B, which we mark as Gota C. We continually stir the solutes of glasses B and C until the blue color develops. We notice which tincture will change the color faster by estimating the impact of the catalyst.

Isolation of aspirin from bark and leaves of white willow

For this experiment white leaves or white willow can be used. In the case of leaves, they can easily be collected either wet or dry. If bark is to be used, it should be handled with care using a 10 cm x 10 cm metal knife. Lice are cut in smaller pieces. A cloth or filter paper is used to wrap the leaves or husks of white willow.

These are placed in a container where 300 ml of water is added and left for 15 minutes to boil. The obtained texture has a dark, purple color. It is filtered with a filter paper to separate the salicylic acid. After the complete crystallization of salicylic acid, it is separated by filtration. The white dust remaining on the filter paper is salicylic acid. In a glass add 1 gram of salicylic acid and 12 ml of vinegar, and its contents are put in a boiling water bath for 15 minutes and then left to crystallize the obtained product which is aspirin. It is again separated by a filter paper. Aspirin is rinsed with 20 ml of cold water.

Preparation of soap using e vegetable oil and baking soda

In a 1 liter volume container, 250 ml of vegetable oil and 100 ml of ethanol or vodka are added. In one container, 150 ml of water is taken and 100 g of baking powder ($NaHCO_3$) is added. After complete soda dilution, which is carried out in the warm, it is thrown into the container where the vegetable oil is found. The mixture of reaction is set to be heated and stired continuously using a stiring motor. The mixture is heated up to evaporate ethanol and water and obtain a solid amount of soap. The obtained soap is cast into various forms and left to cool.

Preparation of Hydrogen

One tube or a narrow-necked container is fitted with a rubber cork. The rubber cork has a hole in the middle where we can insert a thin glass or metal tube. It is preferred that the tube be longer than 10 cm and have an angle of approximately 90 degrees. In the container several wire or nail pieces (Fe) are inserted and added murratic acid (murratic acid used for the sanitation of the washbasins) and then put the cork and stir the tube tightly.

If we put the end of the tube in a container of water, we will notice that gas is released through it. To understand that gas is hydrogen, we use a firing yarn. Hydrogen burns easily and its ignition is accompanied by a crack. The reaction that enables hydrogen production is:

$$\mathbf{Fe + HCl = FeCl_3 + H_2}$$

Note: These simple tools can also be used for obtaining different gases e.g. acetylene by using carbides and water, carbon dioxide using lime stones and murratic acids, etc.). In addition there are other evidence to investigate these gases.

CONCLUSION

This paper deals with one of the most common problems in chemistry, biology, physics, for students of pre-university education (Gymnasium). Very few schools in Albania have appropriate classes to carry out the laboratory hours of these subjects, and in many of them there are no tools, reagents, conditions suitable for the full realization of the experimental topics planned by the curriculum of these subjects.

Almost all the curricula of natural science courses in pre-university education have scheduled laboratory hours. The experiment is an important part of these subjects because first he visually describes the theory and secondly, the experiment is a part of the subject that brings the student closer to the theoretical knowledge applications in the real world. Complete supply of labs with tools and reactive to fully cover experimental sessions requires relatively large investments. On the other hand, experimentation is indispensable, so using Home Experiment is a practical solution. The realize of the experiment increases the interest and the active participation of the students in the lesson, develops the productivity of the quality of the whole work to ensure the connection of the theory with the practice.

All of the above experiments, discussed in this paper indicate that laboratory time can be accomplished even in the absence of tools and reagents. Similar experiments can be carried out in the biology course to determine proteins, carbohydrates, etc. using eggs, sugar, starch, etc., or in the physics of building the circuit using different cells, small bulbs, switches, wire , etc. The use of

technology (phone, computer to show photo, video, sketch, etc.) is another tool that meets at least visually the laboratory hours. Many websites offering full these experiments for all classes. By carrying out a full-time laboratory lesson, students will be more active, more committed to the subject, and will find it easier to learn the practical uses of the many topics they learn in the book.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests regarding the publication of this article. It was written after the proposal of the first author (A.N.) and all the other authors (A.M. and A.N.) contributed equally to the discussions of the text.

REFERENCES

1. Musai B., (1999) Education psychology.
2. Gallagher R.M., Ingram P., (2015) *Chemistry* 10-11
3. Williams G., Fosbery R., (2015) *Biology* 10-11
4. Pople S., (2015) *Physik* 10-11
5. Pashko L., (2015) *Përparimi frontal i nxenësve në mësimin e kimisë*
6. Pashko L., Zekja Z., Mehqemeja S., (2012) Teknika dhe Metodika e eksperimentit kimik në shkollen e mesme
7. Andoni E., Koci K., Berisha B., Gjongecaj F., Hamza M., Ccakmaccian X.. (2000) *Chemistry* 10
8. www.lifetech-select.com, Life Science Research Quickly and Easily Keep up with your field of Research.
9. www.LSBF.org.uk/Marketing-School, MSc Marketing London Study MSc in Strategic Marketing, Enhance Your Career with LSBF!
10. www.ymc.de, IEX Materials from YMC Develop Cost efficient downstream process with YMC IEX media
11. www.1000sciencefairprojects.com/Chemistry/ChemistryProjects.php
12. www.chemistry.about.com/od/homeexperiments/tp/homeprojects.htm