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The Necessity of Micro-scale Chemistry Laboratory

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Abstract A large amount of chemistry findings is obtained through observations and experiments whose validity criterion is their concordance with experimental observations. The relationship between goals and activities of teachers and students is the most important educational phase. The interaction is teachers and student's experience each of which occurs collaboratively in an active atmosphere. Therefore, the best way for the efficient learning of chemistry at college-level is conducting experiments and observing scientific phenomena directly. In this area, teaching micro-scale chemistry as a new and efficient method can be a practical solution in the practical education of natural sciences.

Keywords Laboratory, Micro-scale, Chemistry education, Skill

1. Introduction

The educational system curriculum used in Iran is arranged in three areas: attitude, knowledge and skill. Skill building is among the most important goals of the chemistry teaching program which is designed to guide students toward creative thinking, discussion, and conclusion.

The most important educational phase is the relationship between goals and activities of teachers and students. Interaction is the experience of both teachers and student which occurs collaboratively in an active atmosphere. Learning summary and concept construction are the results of activities in this phase of work and the teacher should present essential and important strategies in the classroom so that the students could move towards the goals actively. In the era when utilization of educational technologies increases the effectiveness and efficiency of education and upbringing, unavailability of an equipped laboratory should not impede conducting practical experiments. Moreover, attention to the environment and effort in order to prevent it from pollution by chemical substances, the expenses of substances and equipment, and the possible risk of working with chemical substances cannot act as excuse for excluding this kind of education.

The students are practically gaining experience about a specific concept with the application of specific tools, equipment, and substances in the process of various laboratory methods.

Experimental method can enhance learning quality and be a powerful motivator in educational activities. This method is appropriate for satisfying curiosity, strengthening energy for discovery and invention, and nurturing critical thinking in the learners.

The students can conduct research with laboratory tasks for comprehension of theoretical materials in practical subjects, and thereby, they will grow an interest in the natural sciences in addition to an increase in thinking ability; and as a result of knowledge transfer to others, they will develop and strengthen the sense of cooperation in themselves. Although, chemistry laboratory section has been added to the course books of the new system to achieve this goal, practical activities are still ignored. This decreases not only the quality of natural sciences, but also practical skills of students. The best ways for efficient learning of chemistry is to conduct experiments and observe scientific phenomena directly [2].

A learner will be exposed to various kinds of risks such as burning, explosion, fire, and poisoning if not familiar with the tools and substances he is working with in an experiment. Inaccuracy, impatience, insufficient experience, and safety rules ignorance in a laboratory are among the main reasons for the risks.

To conduct an experiment, first, the required equipment and substances should be supplied and the required device should be prepared. Then, the students' initiative skills are strengthened by performing and repeating the experiment. Therefore, regarding lack of instruction time and working principles and the expenses of the equipment, knowledge of safety rules and its principles is necessities for the instructors and technicians in a chemistry laboratory. The researcher investigated the presentation of micro-scale experiments which can be very useful as a modern educational method.

Teaching micro-scale chemistry is an interesting method which enables the students to get familiar with various concepts experimentally in addition to learning theoretically in the classroom. In this method, the student gets familiar

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with the fundamental concepts in chemistry practically in a real laboratory. The only difference is that in this laboratory, experiment equipment is small and there was little amount of chemical substances used.

The close relationship between chemistry and innovation has made this scientific field interesting, and innovation is realized by conducting experiments in the laboratory. So, students will have opportunities to observe the phenomena and inevitably think about them, and if necessary do other experiments to justify them. This method leads to the flourishing of talents, deeper theoretical discussions, innovation, and discovery of rules at higher levels.

Today, the idea of using realia, media, computers, laboratory equipment and tools is a worldwide issue and most of the countries have invested in this area. Since in practical activities risks are always threatening the health and safety of the experimenters, and most of the chemical substances are toxic and flammable, using methods in which there is less contact with these substances guarantees safety more. In this way, the volume of waste would also decrease, and consequently contamination in the environment will decrease. This method seems appropriate with regard to the population of students and limited facilities. The design and production of chemistry laboratory micro-scale instruction kit have been attended to in many countries since several years ago. This laboratory with low expenses and high safety coefficient is effective in modifying consumption patterns and chemistry experiments for everybody in distant and deprived areas. Gained learning experiences in an effective and goal-oriented laboratory activity are so deep and extensive that the university students can use their findings for solving similar problems in various settings in the best way possible [1].

The university students' behavior in the laboratory is significantly affected by the kinds of laboratory activities which are mentioned to in the laboratory instructions. The analysis of the handbook of laboratory activities and activities undertaken in the typical chemistry laboratory shows that there is a big gap between laboratory learning objectives and the kind of university students' activities [3].

2. Micro-scale Instruction Kit

This kit is a collection of micro-pipe, micro-beaker, dropper, micro-syringe for injection, and micro-alcohol burner which are used respectively instead of pipe, beaker, pipette, burette, and Bunsen burner in a typical laboratory. The design of the experiments are in a way in which substances are used in very little volume, and this leads to an increase in safety, a decrease in substance consumption, and the prevention of air pollution.

As a result of the small size of this kit, students can follow the lesson discussions at their desks practically with the teacher. Therefore, in addition to providing background for innovation and strengthening it in students, necessary instruction time also decreases. This kit is a simple collection which helps students in the discovery of theories and can be used to design and conduct other experiments in addition to the presented one. For example, micro-pipe, balloon, syringe, small silicon pipe, and experiment pipe are used in conducting the Hydrogen Peroxide decomposition experiment. At first, 10 drops of Hydrogen Peroxide are poured in a micro-pipe. The lid of the micro-pipe in which two small holes has been created is put on it and the balloon is attached to it with a syringe containing half-molar Iron Sulphate. A high volume of Oxygen is released with the entrance of a drop of Iron Sulphate, as a catalyst, to the micro-pipe which causes the balloon to get bigger.

The design and operation of this experiment enable the teacher to teach the concepts mole (measuring the balloon volume) and catalyst empirically in addition to teaching the decomposition reaction. The ability to conduct and repeat 50 experiments with this kit shows the usefulness of this method in chemistry teaching. The skills aspect, which is one of the important goals of curriculum, is divided into mental and practical so that various aspects are considered in flourishing learners' talents. This way, aside from using physical abilities, the students also uses their minds. Incorporating laboratory section in chemistry course books was supposed to achieve these goals, but it has caused practical tasks to be ignored.

Experiments can make students think, discuss, conclude, and finally learn. Thus, it is about two decades that movements on more attention to practical tasks have been started and been in progress. One of the new methods is the micro-scale presentation of practical tasks. In the present study, effort was made to conduct the chemistry course book experiments with the micro-scale method for the first time in Iran to compensate for the lack of laboratories for students. The students can do the related experiments with the teacher in the classroom and enjoy learning chemistry with the help of this modern instructional method.

3. Conclusions

Students have success to various resources in areas of descriptive and theoretical chemistry, but they often cannot relate this access to the theoretical and practical chemistry or laboratory. Using micro-scale chemistry laboratory kit stimulates the sense of innovation to design simple experiments and accelerates teaching and learning. Risks are always threatening the health and safety of the experimenters in practical activities. Many of the chemical substances are toxic and flammable, and can have undesirable effects on contact and respiration. However, the use of methods in which there is less contact with chemical substances guarantees safety more and because little amounts of substances are used, the volume of waste would also decrease, and consequently contamination will decrease in the environment. Furthermore, it would be an effective step towards teaching science at schools and has a great role in decreasing necessary expenses in doing

experiments, and it also increases the quality of instruction.

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