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Effect of Science Laboratory Environment on Cognitive Development of Students

Muti-ur-Rehmaan Khan Niazi[*]
Muhammad Aslam Asghar[**]
Riasat Ali[***]

Abstract

The purpose of the study was to find out the effects of existing physical environment of chemistry lab on cognitive learning of chemistry students in the rural and urban schools of Rawalpindi Division at secondary school level. The population of the study consisted of all science teachers and science students of all male and female schools in Rawalpindi division. Through proportionate sampling technique, 300 science teachers and 400 science students of grade X were taken as sample. For collection of data, an achievement test with respect to cognitive abilities in the subject of chemistry was developed for four hundred students of grade X and a questionnaire with respect to lab facilities was developed for three hundred science teachers. Data were analyzed with the help of descriptive and inferential statistics i.e., percentage, mean and Z-test. Analysis of the study revealed that existing laboratories were substandard, and adequate physical facilities, equipment and consumable items were not available. Due to conduct of practicals, performance of urban students in the achievement test was better than the performance of rural students. The study revealed that laboratory environment had positive impact on cognitive learning.

Keywords: Effect, laboratory environment, cognitive learning, chemistry, rural and urban school

[*] Ph. D Scholar MIU Nerian Sharif AJ &K Email: mutiurrehman497@gmail.com
[**] Registrar MIU Islamabad Campus Email: info@miu.edu.pk
[***] Professor of Education, Abdul Wali Khan University Mardan
Email: riasat@awkum.edu.pk

Introduction

Man is trying to understand the changes that are going around him and is continuously receiving a great impression through his five senses. With the help of senses and communicative ability, he has collected information about his surroundings. This systematic store of knowledge collected after inter-relating different isolated facts is called science. Science is collection of number of empirical observations that result in formation of concepts and theories and these are further modified in the light of empirical observations. Man has always tried to explore the unknown. Keen observation and faculty of reasoning has enabled him to conclude that any event in nature has definite reason behind it (Siddiqui, 2005).

Tanvir (1996) states that, science education serves as a fulcrum of change and brings reform in education system. In science education learners may develop at their own accord a scientific way to solve problems. They do activities and carry out experiments. An effective science education program has direct link with the establishment of well-equipped science laboratories.

According to Baner, Birk and Sawyer (2001) chemistry is a discipline in which scientists inquire about the microscopic worlds around us to understand the chemical nature of our surroundings and environment. The basis for this inquiry is experimentation in which chemists probe for answers to scientific questions, we face in our daily life Chemist mostly design their own experiments, adapting techniques to their own problems, but sometime chemist explore the microscopicworld with well-established experimental techniques. Laboratory experience helps learners to develop important problem-solving skills necessary for success in their competitive, technological society. Some of the ideas the learners confront in laboratory are not examined in lecture because they are issues appropriate only for laboratory. Laboratory experience helps learners develop experimental design skills. These skills are usually not developed in a lecture setting.Experimental skills depend on conceptual knowledge, but differ from the concept students learn in lecture.

Researches on infants show that they can differentiate between highly similar sounds, that they are conscious that a speaker's lips match the speech sounds arriving from the speaker and that they distinguish the connection between tone of voice and facial expression. In the pre-verbal

period of language achievement the young infants coo and older infants babble. When language attainment moves into the verbal phrase the words that children gain are those that name objects. Children demonstrate over expansion and under expansion in their word usage as their notion of word meaning changes from a stress on characteristics features to a stress on defining features. Regardless of the fact that they are telegraphic and exclude words that have an entirely grammatical function, the two words expression common among the children in the next phase of cognitive development have a capability to express a number of complex relationships. This shows that whilst linguist development lags behind cognitive development, valuable communication is already attainable (Sangpanasthada, 2006).

Cognitive conflicts strategy is a component of psychological theories of intangible change. This strategy is helpful in correcting a misunderstanding as well as improving performance. Time and again, students often hold notions that are not compatible with established knowledge. These notions are often regarded as misconceptions. There are two repercussions of misconceptions in the teaching and learning process (Ulthayakumari, 2005). First implication if misconception is not detected and corrected instantly, it will lead to an incorrect understanding of notions and student's achievement will be affected. Second implication is that students gain knowledge in an intangible concept. Under such conditions, students may only memorize the concept due inability to understand. But memorizing a concept is not useful to give students a real understanding and learning will not be useful and meaningful (Noor, 2015).

Science educators typically place great importance on laboratory work, arguing that scientific knowledge cannot be learned effectively from books. They believe that when students involve themselves in practical work, they not only acquire knowledge but develop technical skills also. Laboratory work promotes cognitive development psychomotor skills of students. It enhance their scientific attitude give them enjoyment of science laboratory as well (Vincent &Lunetta, 2003). NABT (2004) describes a laboratory learning environment as a place where students work individually or in groups. Students make use of scientific process and material to develop their own explanation of scientific process or phenomena. They make use of science process skills such as manipulation, investigation, experimentation, observation

collection and integration of data. The distinction between laboratory learning and traditional classroom learning according to NABT (2004) is that in laboratory learning activities are learner centered with students actively engaged in hands-on and mind- on activities using laboratory material, equipment and chemicals, tools and techniques and approaches and strategies even.

Majority of chemistry educators agree that laboratory work has a vital role in Chemistry education. Laboratory work is used widely to build up students' conceptual learning and understanding of science. Time and again these activities are used to initiate, demonstrate or corroborate information related to course work and to provide real experience of chemical phenomena. Nearly all chemistry courses at senior secondary and tertiary stage include objectives which know the importance of practical skills and methods. Nonetheless as Hegarty &Hazal (1990) expose, given them vocational bearing the development of these skills repeated receives less emphasis than might be appropriate. In the milieu of laboratory work, investigation skills consist of planning an investigation, the capability to perform the investigation, processing and deducing data and evaluating findings. Investigations skills consist of consist of cognitive and affective elements as well as the methods and manipulative skills required to conduct the investigation (Garnett, 1995). Lunetta and Hofstein (1991) found that an instructional simulation can give advantage to students to understand a real system or process or phenomenon. However, they further claimed that within school setting, practical activities and instructional simulation can motivate students to tackle and problems and make decisions. Laboratory activities are structured to help students with material and equipment. Simulation are designed to give meaningful representation of inquiry experience, which are not possible with real material and equipment in most of the science laboratories

Critical thinking and problem solving come under the domain of cognitive learning. Usually goal of critical thinking is to understand the nature of problems. Purpose of critical thinking is to assess the information in a way that permits us to make accurate decisions. Furthermore problem solving is considered as a cognitive process that contains four steps. The first step is to locate the problem, the next step is to define it and build up good solution strategies, it should then be assessed on the basis of primary objectives and finally the problem

should be thought and defined over and again. In this way, the inquiry-based learning put emphasis on the declaration of authentic problems of our everyday life (Arias, 2014).

Objectives of the Study

The study was intended to achieve the following objectives;

1. To find out the existing chemistry laboratories environment in rural and urban schools at secondary school level.
2. To investigate the effect of science laboratory environment on cognitive learning of chemistry students in rural and urban schools at secondary school level.
3. To find out the integration of laboratory activities with theory at secondary school level.

Research Hypothesis

There is no significant difference between mean scores of rural and urban students in the achievement test with respect to cognitive abilities.

Methodology

The study was descriptive in nature. Survey method was considered appropriate for collecting data. Quantitative method was adopted for collection of data. Quantitative data were collected from questionnaires and achievement tests. The study was delimited to Rawalpindi division only.

Population

Population of the study included all 71000 science students and 1396 science teachers working in (1006) boys and girls schools of Rawalpindi division.

Sample

400 science students and 300 science teachers were selected as sample of the study by proportionate sampling method.

Research Instruments

1. Questionnaire for science teachers
2. An achievement test for chemistry students of grade 10

Data Collection

Questionnaires were distributed to science teachers through registered post for collecting data. Stamped self-addressed envelope was put inside each registered post to facilitate science teachers in returning questionnaire.

Achievement test of science students of grade X was taken from sample schools with the help of friends. However, in some accessible schools the achievement test was taken by the researcher.

Data Analysis

Data were analyzed in the light of objectives of the study. Percentage was used for analysis of availability of science laboratories while percentage and mean were used for analysis of achievement test. Comparison of performance of rural and urban schools was found by applying t- test

Table 1

Science Labs

S.No	Science Lab	Rural			Urban			Grand Total
		Boys	Girls	Total	Boys	Girls	Total	
1.	Nil	21 27.6%	28 43.0%	49 34.8%	08 9.5%	18 24.0%	26 16.9%	75 25.0%
2.	Combined	50 65.8%	37 57.0%	87 61.7%	58 69.0%	46 61.7%	104 65.4%	191 63.7%
3.	Separate for chemistry	05 6.6%	00	05 3.5%	18 21.5%	11 14.7%	29 18.2%	34 11.3%
	Total	76 100%	65 100%	141 100%	74 100%	75 100%	149 100%	300 100%

Table 1 reveals that 34.8 percent schools in rural areas had no science laboratory, while 16.9 percent schools in urban areas had no laboratory. 61.7 percent of schools in rural areas had combined laboratories, while 65.4 percent of schools in urban areas had combined laboratories. 63.7 percent of total schools had combined laboratories. Only 3.5 percent of total schools in rural areas had separate laboratories for chemistry, while 18.2 percent of schools in urban areas had separate laboratories for chemistry. Urban schools had comparatively better ratio of separate chemistry laboratories.

Table 2

Mean Scores and Percentage of Rural and Urban students

S.No	Cognitive Abilities	Max Marks	Rural Students		Urban Students	
			Mean	%	Mean	%
1.	Knowledge	10	6.04	60.40	7.24	72.40
2.	Comprehension	16	7.32	45.75	10.48	65.50
3.	Application	06	2.32	38.66	3.73	62.25
4.	Analysis	06	1.89	31.50	3.42	57
5.	Synthesis	06	1.77	29.50	3.30	55
6.	Evaluation	06	1.86	31	3.56	59.30
	Total	50	21.20	48.40	31.70	63.40

Table 2 indicates mean scores of rural and urban students. Mean scores of rural students in all cognitive abilities were 6.04, 7.32, 2.23, 1.89, 1.77 and 1.86 and their percentages were 60.40, 45.75, 38.66, 31.50, 29.50 and 31 respectively. Whereas mean scores of urban students were 7.24, 10.48, 3.73, 3.42, 3.30 and 3.56 and their percentages were 72.40, 65.50, 62.25, 57, 55 and 59.30 respectively. Mean scores of urban students in all cognitive abilities were greater than mean scores of rural students. Percentages of urban students in the areas of application, analysis, synthesis and evaluation were much better than the percentages of rural students in those areas.

Table 3

Comparison of Calculated and Table Values of t-test of Rural and Urban students

Mean of Rural students	Mean of Urban students	Calculated Value of t-test of Rural and Urban students	Table Values of t-test at 0.05 Significance Level
21.20	31.70	6.28	2.57

Table 3 shows that calculated value of t-test was greater than tabulated value hence the hypothesis that there is no significant difference between mean scores of rural and urban students was rejected. There was a significant difference between mean scores of rural and urban students. The difference was in favor of urban students.

Discussion

On the basis of data analysis a brief discussion is as under. This discussion is related to effect of science laboratory environment on cognitive learning of chemistry students in rural and urban schools of Rawalpindi Division at SSC level. For collection of data two research instruments i.e., an achievement test in the subject of chemistry for students of grade X, questionnaire for science teachers were developed. To find out the significance level between rural and urban groups, a hypothesis was developed and tested by using t test and subsequently hypothesis was rejected.

There was significant difference between the performance of rural and urban students in the achievement test. The performance of urban students was better than the performance of rural students. Performance may be due to the reason that urban schools had comparatively better equipped laboratories than rural schools. Findings of this study support the findings ofKacha and Wushishi (2015) who concluded that Performance of students who were exposed to adequately equipped laboratory was significantly better.

Furthermore analysis of data reflects that laboratories of schools in urban areas were more adequately equipped than laboratories of schools in rural areas. Consumable material was available in sufficient quantities

in majority of urban schools. The findings of the study support the findings of Oblu (2015) who showed that there was a significant relationship between laboratory learning environment and students' performance in chemistry.

Majority of respondents stated that due to shortage of laboratory tables, space and consumable materials students were asked to perform experiments in groups. Doosti (2015) describes that laboratory work has positive influence on science education and it enhances the cognitive skills of science students but shortage of equipment, low quality of laboratory material and overcrowded classes are big hurdles in the way of effective implementation of laboratory work.

To sum up, analysis of the data of the study revealed that chemistry was being taught in most of the schools by lecture method. Laboratories were substandard and appropriate facilities and adequate apparatus and consumable materials were not available. Practical work was given no emphasis. Theory and practical work were not conducted simultaneously. That is why; students were facing difficulty in learning concept of chemistry. Urban group where the laboratories were comparatively better equipped showed better performance in achievement test than rural group. Almost all the previous studies dealing with relationship on cognitive learning and academic achievement revealed that there is a positive relationship between laboratory environment and cognitive learning.

Conclusions

Analysis of data reveal that overcrowded classes, inappropriate method of teaching chemistry, no importance to practical work, no availability of laboratories in many schools, combined science laboratories for all science subjects in most of the schools, miserable condition of laboratories due shortage of physical facilities, lack of necessary apparatus and adequate consumable material are responsible for poor performance of rural schools and average performance of all schools in the achievement test. Analysis of data further depict that in urban schools where science laboratories were comparatively better

equipped and theory and practical work was being done in some schools showed better performance in the achievement test.

Recommendations

- Overcrowding in schools may be avoided by appointing new science teachers and reallocation by the Government.
- Laboratories may be established in all schools that are functioning without science laboratories by the Government.
- Comprehensive laboratories in rural schools may be established.
- All science laboratories need to be adequately equipped with apparatus and consumable material. Head of the institutions may purchase these things from Farough e Taleem Fund and non salary budget.
- Adequate time for practical work may be allocated in weekly time table.

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