A STUDY OF KNOWLEDGE, ATTITUDE AND PRACTICE OF SCIENCE TEACHERS REGARDING CHEMICAL SAFETY MEASURES IN LABORATORY

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MS

science study and teaching

Teacher training

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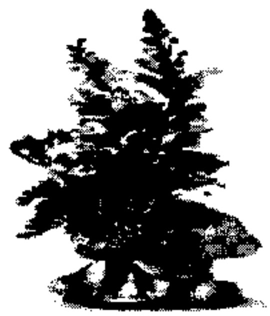
Chemical hazards

بسم الله الرحمن الرحيم

DEDICATION



I dedicate this thesis to my parents, husband, brother and sisters. Without their patience, understanding, support, and most of all love, the completion of this work would not have been possible.

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DECLARATION

I hereby declare that 'A STUDY OF KNOWLEDGE, ATTITUDE AND PRACTICE OF SCIENCE TEACHERS REGARDING CHEMICAL SAFETY MEASURES IN LABORATORY' is my own research work. The sources consulted or referenced are acknowledged properly in-text and out-text. The research is entirely my personal effort done under the sincere guidance of the respectable supervisor. No portion of the work presented herein has been submitted against an application in any degree or qualification of the same or any other university or institute of learning.

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CERTIFICATE

It is certified that NADIA AJAZ Reg # 79- FSS/MSEDU/F09 has completed her thesis titled

A STUDY OF KNOWLEDGE, ATTITUDE AND PRACTICE OF SCIENCE TEACHERS REGARDING CHEMICAL SAFETY MEASURES IN LABORATORY

under my supervision. I am satisfied with the quality of student's research work and allow her to submit her thesis for further process as per IIUI rules and regulation.

Dr. Samina Malik

Research Supervisor

APPROVAL SHEET

"A STUDY OF KNOWLEDGE, ATTITUDE AND PRACTICE OF SCIENCE TEACHERS REGARDING CHEMICAL SAFETY MEASURES IN LABORATORY"

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This thesis has been accepted by the Department of Education, Faculty of Social Sciences, International Islamic University, Islamabad, in partial fulfillment of the degree of MS Education.

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Nadia Ajaz

ABSTRACT

Researcher: Nadia Ajaz

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The aim of the study was to assess the knowledge, attitudes and practices of science teachers regarding the safe use of chemicals in term of proper collection, segregation, handling, transportation and final disposal. Knowledge about the health hazards was also assessed and final disposal of the chemicals. The population of the research was Secondary school science teachers (Males and Females) of Islamabad. The sample size was calculated by formula which was 102 teachers (51 males and 51 females). Mean score on KAP based on gender, age, experience and education was observed regarding the all aspects of the chemical management in schools. Male and Female respondents have got almost equal grades in all three aspects. On the other hand, these points increased with age ($P<0.05$) which shows that knowledge increases with the age. The highest average recorded by the respondents who were at the age of 31-38 years old (21.68 ± 2.74) in the aspect of practice, while respondents with age of 23-30 shows lowest average mean points (14.61 ± 3.10) for the aspect of attitude and statistically there was significant difference ($p<0.05$) between the education and practices. (.037) and (.022). The results also showed that teachers with working experience less than ten (10) years acquired the lowest knowledge score (14.41 ± 3.76) as compared to those working for thirty years (26.50 ± 3.20) and above. The combined result cross tabulation was also observed between the knowledge & attitudes, knowledge & practice and between the attitude & practice. The association between the

two criteria of the classification was observed significant ($p<0.005$) in all cases regarding the knowledge, attitude and practices. The results also showed that there is lack of policies for the safe use and disposal of chemicals.

There is lack of proper knowledge and training of staff about the health impacts of these chemicals. This study recommended adopting policies encouraging proper purchasing, labeling storage and disposal of chemicals, training of faculty and staff on the potential dangers posed by chemicals which needs to disseminate information on reducing the quantity and hazards of chemicals.

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LIST OF ABBREVIATIONS

AC	Air Conditioner
Al	Aluminum
IOFC	International Offshore Financial Center
K	Potassium
KAP	Knowledge, Attitude and Practice
MDGs	Millennium Development Goals
Mg	Magnesium
MSDS	Material Safety Data Sheets
Na	Sodium
NIOSH	National Institute of Occupational Safety & Health
OSHA	Occupational Safety and Health Administration
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
PSDS	Product Safety Data Sheets
PVC	Poly Vinyl Chloride
RP	Republic of Philippines
SDS	Safety Data Sheets
SOPs	Standard Operating Procedures
SPSS	Statistical Package for Social Sciences
TCDD	Tetra Chloro dibenzodioxin
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs

UP/NPMCC	University of Philippines/ National Poison Management Control Center
US.EPA	United States. Environmental Protection Agency
WHO	World Health Organization

CHAPTER 01

INTRODUCTION

Education, broadly speaking is any act or experience that is responsible to bring any formative effect on the mind, character, or physical ability of an individual. In its technical sense, it is the process of education by which society deliberately transmits its accumulated knowledge, skills, and values from one generation to another. Teachers in educational institutions not only direct the education of students but also make them expert in subjects, like reading, writing, arts, and science subjects including Physics, Biology, Chemistry etc.

Scientists share a familiar way of reaching conclusions that is based not only on proof and logic, but upon truthfulness, creativeness, and openness to new thoughts. The scientific community thus often works together across cultures, and bridges political divides. Such collaborations have mostly led to the discovery of new information about the natural globe. It is the need of the hour that in order to develop the minds of children and to expand their logic and reasoning skill they would have to be exposed to the wonders of the science, and it can be done by having a concise argument on gravity, or taking children to a science museum, answering their questions concerning science is important to their overall maturity. In teaching of Science the practical work is of great importance as it develops the confidence of doing something by one's own self. (B, Leary, Sharp, William, 2004)

Practical work not only enhances the knowledge about a particular phenomenon but also explains the underlying ideas about it. Practical Work/Experimentation is the step in the scientific method that helps people to decide between two or more competing explanations, models -- or hypotheses. These hypotheses suggest reasons to explain a phenomenon, or predict the results of an action (Cooper stock, Fred I. 2009).

Practical lessons are well-liked by both students and teachers. But their popularity with students may lie in the fact that they are less demanding than theory lessons. Practical work which aims to develop students' scientific knowledge is best seen, and judged, as communication rather than as enquiry. Practical work helps to make links between two domains of knowledge: the domain of objects and observables, and the domain of ideas. Practical work provides differentiated activities that widen students of all abilities. Consequential practical work can stretch the most competent students in a class at the same time as being accessible to the entire class. Education in grades-7-12 often has the dispensation of introducing students to the science laboratory, while at secondary level the students are more exposed to many hazardous chemicals during their practical work so they are at great risk (Hodson, 1990).

Chemistry and chemicals have an essential place in science, and safe chemical practices are the most basic and fundamental parts of any tutorial. Having acquired good chemical safety routine early, students are better prepared when they move on to more advance and complex courses. The significance of health and safety can reduce future epidemics of illness and infectious diseases by teaching and giving awareness at the school level and it is also certain that these diseases spread through unawareness and lack of knowledge. All chemicals are hazardous, but they all can be used safely if we know how to control their hazardous characteristics while we use them. The knowledge about the nature of chemicals, their properties and safe disposal is important to ensure the chemical safety and get maximum output without any accident.

Chemical safety is the prevention of the adverse effects (both short- and long-term), to humans and the environment from the production, storage, transportation, use and disposal of chemicals (WHO, 2009). Chemical Safety is achieved by undertaking all activities involving chemicals in such a way as to ensure the safety of human health and the environment. It covers all chemicals, natural and manufactured, and the full range of exposure situations from the natural presence of chemicals in the environment to their extraction or synthesis, industrial production, transport use and disposal. Chemical safety has many scientific and technical components. Among these are toxicology, eco-toxicology and the process of chemical risk assessment which requires a detailed knowledge of exposure and of biological effects. In chemistry, a chemical substance is a form of matter that has constant chemical composition and characteristic properties. It cannot be separated into components by physical separation methods, i.e. without breaking chemical bonds. They can be solids, liquids or gases (Nic, J. Jirat, B. Kosata, 1997).

All chemicals and the manner in which they are intended to be used must be scrutinized by the user to identify potential hazards before acquiring the materials or conducting a procedure. Once, the hazards have been identified, commensurate hazard controls and emergency equipment must be planned and acquired or developed to effectively control the hazards to a negligible menace and to necessary goals. So for this purpose it is the need of the time that teachers must be educated and trained to use the chemicals in a safe way to protect the student's health and school environment (Hill, Petrucci, 2005).

1.1 Statement of the Problem

Developed countries are continuously struggling to provide the laboratory manual guidelines to the school administration and training the teachers to minimize the accidents in school laboratories, they are not only trained about the nature, properties, transport and storage of chemicals but are also equipped with first aid training so that they could provide the immediate help to the injured one.

However in Pakistan the situation is worse because of the lack of facilities, resources and proper management so this present study was conducted not only to analyze the knowledge, attitude and practices of Science teachers regarding chemical safety in laboratory, but also to point out the deficiencies present in the system. To remove those deficiencies proper suggestions are given so that the government, school administration and other stake holders could take steps to fulfill the gap.

Chemical Safety other than environmental health issues has been given less attention especially in academic institutions as well as agriculture sector in Pakistan. There has been an effort to manage these chemicals in industrial sectors but in academic institutions there is no inventory of hazardous chemicals and no appropriate disposal of these so-called chemicals. There are no protocols or SOPs for the safe disposal of chemicals which are being used by the students during their practical work at the work place. Moreover there are no training programs and no curriculum development regarding these chemicals which impart health impacts if they are not used properly in the laboratory. At school level students are not well aware and familiar with these chemicals, even teachers are not well educated to train their students to save health and environment.

The proposed study aimed to investigate the knowledge, attitude and practice of science teachers regarding chemical safety measures in laboratory. The aim of this study was to assess chemicals hazardous to human health, exposure (routes, procedures, behavior, prevention, precautions and practices) among the science students at secondary school level during their practical work and to analyze teacher's attitude and practices towards chemical safety.

1.2 Objectives of the Research

The research work carried the following objectives;

1. To assess the knowledge level of Science teachers about chemicals and their hazardous effects on human health.
2. To find out the attitude of science teachers towards safe use of chemicals in laboratory.

3. To investigate the practices being used in laboratory that prevents chemical hazards to ensure health safety.

4. To find out the association between knowledge, attitude and practices of science teachers regarding chemical safety.

1.3 Research Questions

1. Was there any systematic procedure at the level of laboratory to prevent students from chemical exposure during their practical work?

2. To what extent the teachers were well aware of the safe use of chemicals and what measures they took in emergency?

3. Which practices were being advised by the teacher to the students to adopt to manage hazardous chemicals during their practical work?

4. Was there any association between knowledge, attitude and practices of science teachers regarding chemical safety?

1.4 Significance of the Study

The main concept of the study was to investigate the knowledge, attitude and practices of science teachers about chemical safety measures so after the completion of research the teachers, students and other research communities are able to find out the ways to protect themselves from chemical calamities and this work has also made the teachers to control chemical hazards to protect human health and school environment.

It has also alerted a variety of potential stakeholders to the problems of hazardous chemicals in the global environment and the reason that students during experiments are particularly vulnerable.

The present study has not only figured out the contemporary knowledge of science teachers about chemical safety in Public schools but also helped to know the level of practical implications of this knowledge at real laboratory environment. This study has also helped researchers to develop future chemical safety programs at school levels and helps to analyze and explore all the ways to prevent accidents.

1.5 Delimitations of the Study

This study was delimited to:

1. Public Sector Schools in Islamabad.
2. Secondary Schools of Islamabad

1.6 Research Methodology

This study was Descriptive research (both qualitative and quantitative) in nature in which the survey was done to carry out the work. Surveys are a useful way to gather information on important health-related aspects of people's knowledge, attitudes, and practices (such studies are known as "KAP" surveys). KAP surveys are focused evaluations that measure changes in human knowledge, attitudes and practices in response to a specific intervention. That's why this study was Descriptive research in nature (Launiala, 2009).

1.6.1 Population of the Study

This survey was conducted in the capital city (Islamabad) of Pakistan. The survey was completed among the high school science teachers. The population of the study was Secondary school Science teachers currently working in the Public schools of Islamabad. A list of total number (108 schools) of public schools situated in Islamabad was taken from statistical department of ministry of education; at least three science teachers were present in one school, so the total no. of science teachers was about 324 teachers, which was the population of the study.

1.6.2 Sample and Sampling Technique

Two stage sampling technique was adopted. At first stage schools were selected it was found that there are about 108 schools situated in different sectors of Islamabad then 30% of the total number of Public schools was taken as sample (34 schools purposive sampling technique), out of which 50%were boys and 50% were girls schools. At second stage sampling a total of 102, Fifty one (51) male and (51) female teachers were selected from 34 schools (convenient sampling technique, depending upon the availability of science laboratory and science teachers). Individuals sample size was calculated by assuming the 50% of the diseases/accidents/chemical management caused by the hazardous chemicals during the laboratory work. This percentage is assumed because in Pakistan there is no data regarding these diseases/accidents/ chemical management. At least three science teachers were asked to fill the questionnaire from each school to assess about knowledge, attitude and practices. (Stanely, 1990).

1.6.3 Instrument of Research

A semi-structured questionnaire was developed for the collection of data. This questionnaire comprised of 27 questions covering the areas from knowledge, attitude and practice section.

1.6.4 Data Collection

Data were collected through questionnaire in personal. 135 individuals were asked to fill the questionnaire to ensure the return rate of questionnaire up to 102 individuals (which is the actual sample size i.e. 30%).

1.6.5 Data Analysis

Data were analyzed by using the SPSS Version 16. All the information gathered was classified and tabulated as per the nature of the data. Chi square test was applied to up mark the results and combined results cross tabulation was also analyzed. The mean score value regarding the attitude, knowledge and practices was observed in term of education, experience and ages.

CHAPTER 02

REVIEW OF LITERATURE

2.1 Education and Science

Education is the continuous process that transforms the level of knowledge and wisdom of school teachers and students that promote the teaching process. The changes in the society and technology promoted new designs of education. The school chemicals are the matter of concern. The experimental practices are targeted for educating students in solving problems in industries or research studies. These experiments involve the use of chemical compounds with a wide range of classes and toxicity (Anastas and Warner 2005).

The use of chemicals require understanding of what makes the chemicals dangerous as well as appreciative of acute and chronic hazards (Fivizzani 2005). The ability of a chemical to affect the body as noted by Blaauboer 2003 depends on the route of exposure, the quantity (or concentration) of the chemical, the way in which the compound is taken up, distribution and elimination from organism. Organic solvents can cause many health hazards including the central nervous toxicity and respiratory effects (Schenker and Jacob 1996).

Science is the lingo of nature. Without it we cannot correspond with the world, within us or outside. A good background in science permits us to quickly learn and understand how things around us work. One of the distinctive attribute of scientific knowledge is that it provides material explanations for the behavior of the material world, that is, explanations in terms of the entities that make up that world and their properties. Students get help to gain an understanding of the reputable body of scientific knowledge which is suitable to their requirements, wellbeing and capacities. Scientific knowledge also helps to develop students' understanding of the methods by which this knowledge has been achieved, and our justification for confidence in it.

From very early grades students are supposed to perform the practical tasks and hence they are exposed to chemicals in the laboratory. Not only the teachers and lab.attendants handling chemicals are at risk, but students are also exposed to chemical risks during experiments through misuse or by accidents. The environment may be affected, chemicals may pollute the air we breathe, the water we drink, and the food we eat. If their safe disposal is not ensured they may have entered into forests and lakes, destroying wildlife and changing the ecosystem.

2.2 Importance of Practical Work

As practical work is important to get insight of the problem same is true for the chemicals in laboratory. Chemicals have become a part of our life, sustaining many of our activities, preventing and controlling diseases, and increasing agricultural yield. However one cannot ignore that these chemicals may, especially if not properly used, endanger our health and exterminate environment. The chemistry laboratory of high schools is at ten times higher risk then any other chemical industry workplace (Young 1983). Because in Science class room investigation procedures are used so it is the utmost requirement that the students and teachers must be aware of the conditions that affect safety and accident rates.

Hendershot et al. (1999) and Nelson (1999) also suggested that adding the safety course in chemistry curriculum will increase the student information and views. It was also pointed out by Foster (2007) that periodical inspections of laboratory will enhance the safety program in academia.

2.3 What is Chemical Safety?

Chemical Safety refers to safe use of chemicals and practical certainty that there will be no exposure of organisms to toxic amounts of any substance or group of substances: this implies attaining an acceptably low risk of exposure to potentially toxic substances. (http://en.wikipedia.org/wiki/Chemical Safety.)

If you want that there should be excellence in science teaching then that requires safe science investigations in the class room, laboratory and in the field incidence every day practice. The student should follow the strong safety ethics and should be educated in hazard recognition, risk assessment, knowledge and practices. Further the safe methods of using the chemicals in any laboratory depend on the teaching of chemistry in under graduate level (Hill 2003; Penas et al.2006).

2.4 Routes, Effects and Cost of Exposure of Chemicals

There are four main ways that is routes of exposure, for chemical substances to enter the human body:

i) Inhalation (breathing in)

ii) Absorption (through the skin or eyes)

iii) Ingestion (eating, swallowing)

iv) Transfer across the placenta of a pregnant woman to unborn babies

Handling chemical substances without proper precautions exposes the students, teachers and other allied staff to the risk of absorbing harmful amounts of chemicals through the skin. This usually takes place when the chemical is handled in liquid form. Many scientific studies have assessed the effects of exposure to and contamination from hazardous materials and dangerous combustion products. Bearing in mind that there are inconsistencies among different studies about the uncertainties surrounding the available information about exposure, the main health related impacts of chemicals are considered to be:

Acute affects such as asphyxiation and chemical pneumonia which may result in serious health, due to the exposure to dangerous substances; these include carbon monoxide, ammonia, phosgene, and sulfur dioxide (Stefanidou, Athanseli & Spiliopoulou 2008).

Eyes are extremely sensitive and require protection. Many types of glasses even ordinary glasses are better than no glasses at all, while the use of contact lenses in the laboratory is prohibited. Several varieties of chemical splash goggles exist and are suitable for protection in laboratory, while the face shields completely covering the front of the face also provides protection if needed. However, the visitor's goggles are a form of eye protection that must be worn by the visitors while they are in the lab. The shielding external layer of skin maybe softened (by toluene, dilute washing soda solution) thus permitting other chemicals to enter readily to the bloodstream (such as aniline, phenol, benzene). Eyes may also absorb chemical substances, either from splashes or from vapors. Dangerous chemicals can enter the body through ingestion as gases, dusts, vapors', fumes, liquids or solids. Inhaled dust maybe swallowed and food or cigarettes may be contaminated by dirty hands (Le, Q., et al, 2011).

Unsafe use of chemicals due to lack of information on risks and education on their safe and wise use, and prevailing illiteracy in some areas like increasing pollution and uncontrolled use of chemicals due to lack of appropriate regulatory measures or the impossibility of enforcing them (for example, because of lack of personnel, controls, and surveillance) are the major sources of chemical injuries (WHO, 2006).

Due to the misuse of the chemicals at schools levels children face a lot of problems regarding the health impact. Death rate has increased during the last decades in the developing countries. The diseases like Eye irritation, headache, dizziness and nausea may also a source of chemical exposures at the work place that ultimately affect the eyes (Reisen & Brown, 2009).

Respiratory disorders such as respiratory irritation, coughing, shortness of breath, asthma, emphysema, persistent cough and bronchial hyper-responsiveness, chronic lung dysfunction are also common disorders related to the chemical exposure (Zeitz et al., 2000).

Asthma is very common disease due to the chemical exposures while performing the experiments. The oxide fumes, hydrogen sulphide may cause the impacts of different lung diseases (Landrigan et al., 2004). Non-malignant respiratory diseases which are also due to chemical injuries are a leading source of death (Collins, 2013).

Asbestosis is a chronic inflammatory and fibrotic medical condition affecting the parenchymal tissue of the lungs caused by the inhalation and retention of asbestos fibers. It usually occurs after high intensity and/or long-term exposure to asbestos (particularly in those individuals working on the production or end-use of products containing asbestos) and is therefore regarded as an disease, it is also one of the common disorder related to the chemicals exposure (Bridgman, Claudio, 2001).

Skin disorders, such as injuries due to skin contact with corrosive substances like acids (IAFC, 2009), chlordane and other symptoms appear in case of exposure to substances such as polychlorinated biphenyls, polychlorinated dibenzofurans and dibenzodioxins including 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (NIOSH, 1986). Reproductive disorders of human reproductive systems are also due to exposure to hazardous materials (Stefanidou et al., 2008).

2.4.1 Hazardous Wastes

A hazardous waste is defined as a substance that is corrosive, ignitable, reactive or toxic. Hazardous wastes need to be managed from their initial point of generation until their ultimate disposal, known as "cradle to grave responsibility." Schools should realize that their liability does not end when the wastes leave the school, and school administrators must make sure they receive a copy of the shipping paper (manifest) stating that their wastes arrived at their destination (treatment/storage/disposal facility).

Hazardous substances in schools may fall into one or more of the following categories: flammables, oxidizers, explosives, low level hazard, corrosives (the majority of which in high school laboratories are acids and bases), severe chronic hazard, poison, and environmental hazard. The United Nations (UN) has developed an internationally accepted set of symbols (Globally Harmonized System of Classification and Labeling of Chemicals).

Individual countries may have developed specific definitions for each of these categories; however, the hazards are generally described by the categories along with example safety measures (Globally Harmonized System of Classification and Labeling of Chemicals, United Nations, 2009).

Hazardous wastes found in schools may include:

- **Used Oil**

Used oil is classified as a hazardous waste when it is mixed with a hazardous substance, exhibits hazardous waste characteristics or it is not recycled. When used oil is recycled and burned, it is subject to less rigorous requirements. Containers of used oil must clearly be labeled with the words "Used Oil for Recycle" at all times.

- **Waste Photo processing Solutions**

Some spent photo processing solutions are considered hazardous wastes. The Material Safety Data Sheet (MSDS) should list any hazardous components in the product. The spent solutions may have different characteristics than the unused product; therefore testing of the spent solutions may be required to determine if they are hazardous wastes.

- **Solvent**

Solvent waste can be generated in many areas of a school, including the science laboratory (acetone), industrial arts shop (polyurethanes, stains), art rooms (paint thinners), and maintenance departments (oil based paints).

- **Laboratory Chemicals**

Science laboratories may contain numerous chemicals that are considered hazardous, including acids, bases and heavy metals. Highly toxic chemicals include mercury and its compounds, formaldehyde, and cyanide compounds (potassium cyanide and sodium cyanide). Chemicals that are known human carcinogens include arsenic, benzene, asbestos and certain chromium compounds. Flammable compounds include acetone, ether and xylenes. Reactive or explosive compounds include picric acid, potassium or sodium metal, and perchloric acid (Orloff, Kenneth, and Henry Falk. 2003).

Harmful chemicals damage the environment, thus impairing its ability to provide environmental goods (such as food and water) and ecosystem services (such as air and water purification). There is a growing body of economic research on environmental values that have been used to highlight the cost of losses to ecosystem services and biodiversity. However, this data are often not readily disaggregated into its chemical components as research is more focused on the environmental resource, rather than on the chemicals effects.

Moreover, the search for literature on the costs of chemicals effects on the environment (air, water, and soil) uncovered even less data compared to the chemicals effects data that focused on human health endpoints. Of the identified environmental effects data, most relate to water, ecosystem services and biodiversity, while a few mention direct effects to air and soil.

In most cases, studies that monetized and/ or quantified the effects of pollution on the environment did not provide disaggregated data on effects attributed to specific chemicals. The environmental effects of harmful chemicals are qualified and illustrated with some quantified data in the key literature. In addition, the 2010 report on "Practices in the Sound Management of Chemicals", prepared by the Division for Sustainable Development, United Nations Department of Economic and Social Affairs (UNDESA), the Secretariat of the Stockholm Convention on Persistent Organic Pollutants (POPs), UNEP29 generally qualifies effects to atmosphere, water and soil resources, biodiversity, agriculture, and fisheries. In addition, the 2008 OECD "Costs of Inaction on Key Environmental Challenges"30 gives consideration to general categories of chemical effects on the environment, including air and water pollution. However, the 2008 OECD "Environmental Outlook to 2030" (OECD 2008) notes that there remains "a need for better understanding of certain uses or sources of exposures (e.g. chemicals used in products)". It is only with such type of scientific data that economic assessment of the costs of chemicals pollution to the environment can begin. Apart from the literature that qualified and quantified the effects of general pollution on the environment, some chemicals' relevant monetized environmental effects data were uncovered during the development of this report. As most environmental resources do not have traditional market prices, the uncovered environmental effects data were mainly monetized using proxy market data such as financial losses to agriculture and fisheries or drinking water treatment and supply costs.31 Similarly, the effects of chemicals on air, land and water are illustrated in the costs of cleaning up toxic wastes and emissions (Wilson et al 2008).

With such monetized data, we can begin to understand the magnitude of the effects of harmful chemicals on the environment and the implications for development planning. These costs, however, can only be considered as underestimates, as they do not capture the total value of losses to ecosystems and societies.

In addition to the data reported in this study, there is a significant amount of literature on economic values for ecosystem goods and services that can be used to monetize quantified losses of, for example, forests and soil, due to any number of causes. Each year in the United States, more than USD 1 billion is spent on efforts to clean up hazardous waste Superfund sites. Cleanup costs for future sites are estimated at about USD 250 billion (Wilson et al 2008).

While the US may spend at least USD 1 billion per year in hazardous waste clean-up, less developed countries cannot afford such costs. The effects of chemicals pollution are felt more acutely by the world's poor, increasingly so as production and use of chemicals increases in developing countries and countries with economies in transition.

"The development that has taken place in the rich world, where we are increasingly surrounded by various chemicals and articles that contain hazardous chemicals, can be expected to spread rapidly to the newly industrialized countries and later to countries that today is less technically developed. People's exposure to a number of hazardous chemicals, such as pesticides, is already greater today in developing countries than in the rich countries (Pesticide Action Network Asia and the Pacific 2010). This is due to weak policy on chemicals and inadequate knowledge among the population. In addition to this there is waste or articles containing hazardous chemicals that have been exported from rich countries. Developing countries already face difficult challenges today in steering away from chemicals hazardous to health and the environment. In addition, they will increasingly have to grapple with the massive complexity and quantity of information that follow from the trend towards more and increasingly complex chemicals, including synergistic effects " (KemI 2011).

It is expected that the sound management of chemicals will decrease or even eliminate these costs to business and society as chemical pollution and the need for environmental remediation will be avoided or minimized. More economic data on the health, environmental and economic development impacts of toxic chemicals waste are required for all regions, particularly given the forecasted global growth in chemicals production (OECD 2008).

Some studies present cross-sectoral costs of health and environmental effects in specific situations. For example, in the US, the economic effects of harmful algal blooms caused by excess nutrients, particularly phosphorous from agricultural fertilizers and household detergents, are at least USD 82 million per year (Hoagland and Scatasta, 2006). This cost includes:

- Commercial Fisheries Impacts: USD 38 million per year
- Public Health Costs of Illnesses: USD 37 million per year
- Recreation and Tourism Impacts: USD 4 million per year
- Coastal Monitoring & Management: USD 3 million per year.

This section on development planning effects reveals significant, but for the most part discrete, sectoral affects data at the national level. The last example from Hoagland and Scatasta (2006) is one of the few studies uncovered that shows development planning effects to multiple sectors. More effort is needed to highlight cross-sectoral effects, trade effects and future risk scenarios of unsound chemicals management.

According to KemI (2011), "the aggregate health and environmental effects of chemicals, known as synergistic effects, need to be studied more closely". This type of policy-relevant research could help improve understanding of the development planning effects and actions needed for the sound management of chemicals.

2.5 Accidents in Laboratories

According to the survey of educators who attended the safety workshops, mostly the accidents and injuries in the laboratory are caused by the broken glassware and chemical exposure (Lee & Parsa, 2001). Horseplay in the laboratory that is because of inadequate and poor classroom discipline is another contributing factor to accidents. Krajkovich 1983, reported that less experienced teachers have greater risk of accidents. Another contributing factor in Laboratory accidents is the lack of enough space, one accident was reported in which a protractor held by one student penetrated the lower eyelid of another student.

(http://www.realclearscience.com/lists/worst_lab_accidents_in_history)

On Tuesday 10th October, 2000 at Lee High School in Midland, Texas an unexpected accident occurred as students mixed chemicals in a dish during a routine chemistry experiment. As a result one female student was severely burnt and was taken to the memorial hospital. This explosion took place when an open flame in chemistry classroom ignited methanol fume. A fellow student used a fire blanket to save her life. Two other students were also severely burnt (Coffey, 2000).

The teachers who have class sizes greater than 24 students are at greater risk of being injured (Fuller, Picucci & Collins, 2001). "Overcrowding in Science Classrooms and laboratories, where equipment and chemicals are used, should be a safety concern for every teacher and student. Otherwise overcrowded conditions could result in liability problems for the school district" (TEA & DANA Center, 2000).

Beside the other chemicals mercury is found to be the common cause of accidents. An accident is reported on 16th February 2006 when the University of Philippines, Manila National Poison Management and Control Center (UP/NPMCC) received an emergency call from a young person who was complaining about the numbness, and pain of severe nature in extremities. These were the symptoms of acute mercury poisoning, the UP/NPMCC traced out that the young man was exposed to the mercury earlier that day in the class room at St. Andrew's School located in Paranaque City, Republic of Philippines. After the extent of the spill was recognized, a team of local and national public health personnel took appropriate precautions to protect student health by closing the school and examining other potentially exposed students. Between 20th and 22nd February 2006, 203 students and faculty were evaluated for acute mercury exposure, and ten students were admitted to the Philippines General Hospital. After that two contractors were hired to clean up the spill but they were not able to fully remove the hazard, the RP Secretary of Health formally invited a U.S. Environmental Protection Agency (U.S. EPA) team to the Philippines to provide technical guidance for the remediation of the mercury spill. The U.S. EPA team assisted the school, contractor, local and national government officials in determining the extent of mercury contamination and conducting appropriate abatement procedures. Before the school was reopened, the RP/U.S. EPA team monitored mercury vapor levels in the air to ensure that the levels were below recognized safe criteria (Final Report, Mercury Spill Assessment 2006).

2.6 Personal Safety and MSDS

Personnel safety during the work performance only depends upon the handling of the chemicals in the laboratory. Important information about handling chemicals can be found in the Material Safety Data Sheet which is available for all chemicals (Foster 2007) and should be kept in laboratory to be used before handling any hazardous chemicals. Moreover MSDS explain the inhalation and contact health risk as well as the flammability and toxicity of the chemicals.

On the other hand elimination or substitution of the hazards chemicals can also reduce the risk (Elston 2000). However, students should avoid skin contact with chemicals and they should wash the exposed skin and hands as well as removing all the protective clothes before leaving the laboratory.

Suppliers of chemicals provide this information both by sticker on the containers and by Material safety Data sheets (MSDS). A material safety data sheet (MSDS), safety data sheet (SDS) or product safety data sheet (PSDS) is an important component of product stewardship and occupational safety and health. It is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. MSDS formats can vary from source to source within a country depending on national requirements. It is the responsibility of employer to pass on information to teachers. Typically a supervisor informs teachers on behalf of the principal. The teachers inform their students what to do and what to avoid when they prepare and perform experiments that involve chemicals and when they clean up afterwards. The MSDS is an important document that contains information on the potential health impacts of exposure and how to work safely with chemical products. It is an essential starting point for the development of complete health and safety program. It contains hazards evaluation on the usage, storage, handling and emergency procedures all related to material. (http://en.wikipedia.org/wiki/Material_safety_data_sheet)

Frazier et al. (2001) suggests that investigation of the accuracy of health information on MSDSs for hazardous chemicals and periodic review of MSDSs are also required every two years. The purpose of a MSDS is to tell the physical properties or fast-acting health effects that make it dangerous to handle, the level of protective equipment needed, the first aid treatment is to be provided when exposed to hazards, the pre planning needed for safely handling spills, fires and daily operations how to respond to accidents. There has been little research on MSDS in last years; most of them are work place and few in academic areas.

2.6.1 Personal Protective Equipment

2.6.1.1What is PPE?

All equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work to protect them against one or more risks to their health or safety.

2.6.1 .2 when should PPE be used?

PPE is to be supplied and used at work wherever there are risks to health and safety that cannot be adequately controlled in other ways. Because the effectiveness of PPE can be easily compromised, it usually fails to danger and it only protects the individuals wearing it and not others who may enter the environment concerned, it should always be considered a control measure of last resort .The personal protective devices worn to help isolating a person from direct exposure to hazardous material or situation and reducing the illness and injuries. Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury. They are used in many occupational environments to protect employees and they were found on variety of brands. Chemical protective equipments are recommended to be used by all personnel who work in laboratory and are often listed on MSDS. The clothing and suit material are made from both natural and synthetic material, such as latex, cotton and neoprene (Henry 2007).

Moreover storage condition and manufacturer expiration date also influence the efficiency of PPE (Wood-Black & Pasquarelli 2007). Aprons are generally used when mixing chemical to protect against the chemical splashes, they are commonly made of nitrile, PVC or other resistant materials and are less likely to be considered as disposable items (Purschwitz2006).

The Occupational Safety and Health Administration (OSHA) requires that personal protective equipment (PPE) be selected, provided and worn in situations where PPE could help reduce the potential for harm and injury. Specialized PPE is provided by the supervisor or principle investigator of the laboratory where such hazards exist.

2.6.1.3 Eye and face protection

Clark (2002) reported that the washing of the eye with water should be started within seconds, even before calling for emergency assistance because chemical injury to the eye is serious and potentially threatening to vision and it should be followed by complete medical evaluation for every chemical eye injury. Safety glasses are required in all instructional and research laboratories at all times. Chemical splash goggles are highly recommended for all work with corrosive and hazardous liquids and are required for handling volumes over 1 liter. Specialized eye protection must be worn as required--such as with certain lasers. Face and neck shields must be worn when performing any hazardous operation outside a fume hood that could result in chemical splashes, sprays, or irritating mists of corrosive or caustic materials. Face and neck protection must be used whenever a system is under pressure (positive or negative) or when using energetic chemicals or reactions. Face shields must never be used alone. Safety glasses or chemical splash goggles must be worn beneath the face shield.

2.6.1.4 Foot and skin protection

Flame resistant lab coats are required in research laboratories at all times. Lab coats and aprons are available in instructional labs and will be selected by the instructional faculty based on the risks present in the lab. No open-toed shoes or sandals are to be worn in any laboratory. Pants, shorts, skirts, and dresses are not recommended but may be permitted if a closed lab coat is worn that extends below the knee.

2.6.1.5 Hand protection

Appropriate gloves must be worn for operations involving material or equipment that has a potential for: a chemical burn, a cryogenic burn, a thermal burn, adsorption through the skin, an electrical hazard, a biohazard, or any acute or chronic toxicity hazard. Selection of chemically resistant gloves must consider (1) the chemical handled and (2) its ability to permeate various glove materials, (3) the task(s) to be done and required dexterity and (4) any special concerns. For chemicals of unknown toxicity or those chemicals that have a special skin hazard designation--a flexible laminate glove (Silver Shield or 4H) is to be worn under a pair of heavy-duty chemically resistant outer gloves. Information on glove selection and chemical resistance is available through the Chemistry Stockroom and Environmental Health and Safety. Work with pyrophoric materials requires the use of flame resistant sleeves and/or nomex flight gloves in addition to a flame resistant lab coat.

2.6.1.6 Respiratory protection

Chemical fume hoods and ventilation are the primary means of protecting the respiratory system. Respirators may only be worn by participants in the College's Respiratory Program. Fire extinguishers are important items to save human lives at work place. Items of safety equipment are also used to prevent life and property losses caused by fires.

Fires are classified according to the materials they burn. They are coded with the capital letter of the alphabet A, B, C, D, F, etc.With the word 'Class' placed in front of each letter. Example – Class A fires, Class B fires, Class C fires etc.

Class A Fires – Fires involving combustibles such as : wood, paper, boxes, plastic, packing material etc

Class B Fires – Ignition of flammable liquids such as : solvents, kerosene, gas, grease etc.. Class C Fires – Fires arising from electrical equipment such as : AC outlets, wiring, appliances, flammable gases etc..

Class D Fires – Combustible metal fires such as : Mg, K, Na, Al, Titanium, Lithium (includes powders and swarfs).

Class E Fires – Electrical fires : Fires involving electrical apparatus.

Class F Fires – Fires involving coking oils and Fats : burning hot oil, cooking oil, lard.

Class K Fires – Fires in cooking utensils and appliances caused by oils and fats. Note

• There is no class E or class F fires in the US system of classification. Class E is equivalent to class C and class F is equivalent to class K.

• Class E is no longer applicable because when power is turned off, electrical fires can fall into any category. Similarly light and ventilation is very important while working at schools and laboratories (Stricoff and Walters 1990; Thomson 2001).

At laboratories fume hoods are being used while performing the jobs but it is reported that the excess numbers of fume hoods in particular lab do not improve the safety rather than the efficiency of the fume hood (Mathew et al.2007). The same for first aid is important to protect the health at the point of source. Although over many years only few reports were published for first aid treatment but useful and effective information for each chemical can be found in MSDS.

Respirator are used to provide protection against hazards from exposure to chemical vapors and fumes and they are classified as air purifying respirators and atmosphere supplying respirators that protect removing the contaminants from inhaled air, while atmosphere supplying respirators provide the user with supply of air of oxygen (Hodson et al.2002). Chemical respirators have a cartridge of activated carbon and have standard color code for ease of identification; it is black for organic vapors (Purschwitz2006).

School laboratories can be insecure for staff and students because of the presence of toxic or combustible chemicals. There can be unnecessary stocks of chemicals, ones with a greater hazardous nature than educational utility, and chemicals that are outdated, unlabeled, and non-laboratory type containers. Knowledge, attitude, proper management and use of chemicals reduce risks to staff, students, and the environment. Local associations and science teachers can take an active role in assuring that school districts meet their obligation to provide a good lab chemical safety program for staff and students. It is obligatory for the school administration to provide the guidelines to the respective teachers and laboratory attendants about the nature, properties, classification labeling, transport and storage of chemicals so that they could disseminate the information to the students before the performance of practical task for the safe use of chemicals and to minimize the risk of chemical injuries.

(http://chemistry.about.com/od/healthsafety)

2.7 Proper Disposal of School Chemicals

Several options are available for schools when deciding how to dispose of unneeded or unusable chemical wastes. These disposal methods are dependent on the type of chemical and its hazardous characteristics. For no-longer-useful pure chemical compounds in the science laboratories, search for the chemical's name in the school chemicals database and, once the search is complete, click on the chemical's name for in-depth information on its hazards and proper disposal method.

For the three most commonly generated waste mixtures from school science labs - heavy metals solutions, corrosive liquid wastes, and organic solvent wastes:

- **Heavy Metals Solutions**: Collect waste liquids containing heavy metals in a single large wide-mouthed container lined with a sliding lock plastic bag. Leave the bag open so most of the water can be evaporated in a fume hood. When the bag is full of settled solids, zip it closed and place it in a five-gallon bucket labeled "Hazardous Waste – Heavy Metals" and snap the lid closed. When this five-gallon bucket is full of bags of sludge, dispose of it as hazardous waste. Keep log sheets listing the name and amount of the waste solutions that are placed in the bags and the date they were added. An inventory of what the waste is made of can save you the expense of testing for identification by the hazardous waste disposal vendor or site when it is disposed.

- **Organic Solvents**: Collect waste solvents in a glass or metal container with a tight-sealing lid. Label this container with the words Hazardous Waste. Keep a log of the amount and type of organic compounds added to the container on a log sheet with the date they were added. If you have chlorinated solvent waste, store it in a separate container labeled "Chlorinated Solvents" to reduce costs. Waste solutions containing over 24 percent alcohol are ignitable hazardous waste and cannot be disposed down the drain nor evaporated in the fume hood.

- **Corrosive Liquids**: Concentrated acids and bases must be disposed as hazardous waste. Dilute inorganic acid and base solutions (1.0 molar or less) can be neutralized to a pH between 6.0 and 11.0 and discharged to the sanitary sewer, provided they've not been contaminated with heavy metals. Keep a log sheet that tracks the amount of acidic or basic waste generated and the date it was neutralized on a log sheet. When the pH is

correct, the solution can be drained to the sanitary sewer with a water rinse of 50 times the acid or base's volume.

2.8 Remedial Measures

School staff should maintain a complete inventory of all laboratory chemicals. In order to reduce the quantity of chemicals used in science experiments, schools should try to institute micro scale chemistry experiments, and substitute non-hazardous materials.

Governments from around the world have agreed that addressing chemical threats to children's health should be an integral component of every country's public health and environmental agenda. Individuals, organizations, and agencies responsible for protecting children need to become more aware of threats and take action to prevent them. The achievements of Millennium Development Goals(MDGs) especially those which aim at reducing child mortality (MDG 4) and ensuring Environmental Sustainability (MDG 7) require the safe and sound management of chemicals.(www.un.org/millenniumgoals)

CHAPTER 03

METHODOLOGY

3.1 Research Methodology

This study was Descriptive research (both qualitative and quantitative) in nature in which the survey was done to carry out the work. Qualitative research was used in attitude section where the behavior and beliefs of the teachers were observed and Quantitative approach was used in Practice and Knowledge section. Surveys are a useful way to gather information on important health-related aspects of people's knowledge, attitudes, and practices (such studies are known as "KAP" surveys). The survey studies are often used as a basis for health-policy decisions, and it is important to ensure that only current, rather than obsolete, information is used for this purpose. That's why this study was Descriptive research in nature

(Thomson Wadsworth, 2008).

3.2 Population of the Study

A study population can be defined as all the science teachers of public sector secondary schools that meet the sample criteria for inclusion in a study and are sometimes referred to as the target population (Burns & Grove, 2003).

This survey was conducted in the capital city (Islamabad) of Pakistan. The survey was completed among the high school science teachers. The population of the study was Secondary school Science teachers currently working in the Public schools of Islamabad. A list of total number of public schools situated in Islamabad was taken as total population from statistical department of ministry of education. Total number of public sector schools located in Islamabad was 108 and three science teachers were present in each school which makes total population of 324 teachers.

3.3 Sampling Technique and Sample Size

Two stage sampling technique was adopted. At first stage schools were selected it was found that there are about 108 schools situated in different sectors of Islamabad then 30% of the total number of Public schools was taken as sample (34 schools, these 30% schools were selected by purposive sampling,), out of which 50%were boys and 50% were girls schools. At second stage Convenient sampling technique was used, a total of 102 (Fifty one (51) male and (51) female teachers (depending upon the availability of science laboratory and science teachers in schools) were selected from 34 schools. Individuals sample size was calculated by assuming the 50% of the diseases/injuries/chemical management caused by the hazardous chemicals during the laboratory work. This percentage is assumed because in Pakistan there is no data regarding these diseases/injuries. At least three science teachers were asked to fill the questionnaire from each school to assess about knowledge, attitude and practices.

Calculation of Sample Size

P=50% of diseases/injuries/chemical management

1-p=q=50% of not diseases/injuries/chemical management

α =5% = level of significance

$$n = \frac{z^2_{\alpha/2}\ p\ q}{e^2}$$

e= marginal error= 10% $n = \frac{(1.96)^2\ (0.5)(1-0.5)}{(0.10)^2}$

=96.04

n= 96.04+5% non –response (n=102)

Total sample size = 102

(Stanely Leneshow, 1990).

3.4 Research Instrument

A semi-structured questionnaire was developed for the collection of data. This questionnaire comprised of 27 questions regarding the management of the chemicals from collection to disposal depicting the knowledge, attitude and practices of the science teachers in the schools. The questionnaire was structured keeping in view the objectives of the study. The knowledge section of questionnaire was constructed on multiple choice alternative options having eight questions; while the attitude section of questionnaire was based on 5 point likert scale from strongly agree to Strongly Disagree and it was comprised of nine questions, while in practice section there were ten questions, based on 3point scale having options like regularly, sometimes and rarely. While developing the questionnaire, following variables were considered keeping in view previous researches: age group, education, gender and experience.

3.5 Pilot Testing

A pilot study is a small scale study of the prospective study, and it was conducted to refine the methodological aspects of the study. De Vos, 2005 refers to it as a "dress rehearsal" undertaken to identify possible obstacles. The pilot testing was conducted at 4 high schools in Islamabad other than the schools selected for sample to test the validity and accuracy of the questionnaire.

3.6 Validity and Reliability of the Questionnaire

Validity of the questionnaire was done by refining the questions in knowledge and practice section after pilot testing, the alternative options were changed in knowledge section and then the questionnaire was also checked by Dr.Jamal Abdul Nasir of Environmental Health Protection Unit, National Institute of Health (NIH) Islamabad.

Reliability of the questionnaire was calculated by using Cronbach's alpha which is commonly used as a measure of the internal consistency or reliability of a test for a sample of examinees. The calculated value was 0.821 which comes in excellent range according to Cronbach, Lee J., and Richard J. Shavelson (2004). These results of the pretest were analyzed by using the software Package for Social Sciences (SPSS version 16).

No of Questions/Items	Alpha Test
27	0.821

3.7 Data Collection

Data were collected through questionnaire in personal. 135 individuals were asked to fill the questionnaire to ensure the return rate of questionnaire up to 102 individuals (which is the actual sample size i.e. 30%).

3.8 Data Analysis

Data analysis in quantitative studies are conducted to reduce, organize, give meaning to the data and to address the research aim and its specific objectives (Burns & Grove, 2003). Data were analyzed by using the SPSS Version 16. SPSS is used widely among social science researchers for calculating specifications that allows the researcher to make different kinds of inferences of the research problem. SPSS allows the researcher to generate analysis using descriptive statistics and present it with high quality tabular and graphical output. All the information gathered was classified and tabulated as per the nature of the data. For statistical analysis to see the association between two criteria of the classification chi square test was applied to up mark the results and combined results cross tabulation was also analyzed. The

mean score value regarding the attitude, knowledge and practices was observed in term of education, experience and ages.

3.9 Tabulation and Interpretation of Data

Questions in the knowledge, attitude and practice section were analyzed separately, numerical values or score were assigned to each choice in the range of responses and in this way the score was calculated. The statistics produced was descriptive comprising frequency and percent age distribution of responses and association structured in the pre-defined categories.

CHAPTER 04

PRESENTATION AND ANALYSIS OF DATA

4.1 Demographic Characteristics of the population

Table 4.1.1: Age Groups

Age	**22-27 years**	**28-33 Years**	**34-39 years**	**40-45 Years**	**46-51 years**	**52& above Years**	**Total**
Frequency	36	22	23	11	09	01	102
Percentage	35.3	21.6	22.5	10.8	8.8	1.0	100.0

The result of table no 4.1.1 shows the respondent's age ranging between 22 years to 52 years and above. The percentage observed was 35.3% (36) respondents, 21.6% (22), 22.5% (23) , 10.8% (11), 8.8%(9) and 1%(1) . The high percentage observed, were the individuals between the ages of 22-27.

Table 4.1.2: Gender

Gender	Male	Female	Total
Frequency	51	51	102
Percentage	50.0	50.0	100.0

The result of table no 4.1.2 shows 51% (50) respondents were male and 51% (50) respondents were female who responded against the questionnaire delivered to them.

Table 4.1.3: Education

Education	Bachelor	Master	M. Phil	Total
Frequency	47	44	11	102
Percentage	46.1	45.8	10.1	100.0

The result of table no 4.1.3 shows those 46.1% (47) respondents whose qualification was graduation, 45.8% (44) master and only 10.1% (11) respondents whose qualification was M.Phil. The high percentage of individuals was observed whose qualification was bachelor in different disciplines of the study.

Table 4.1.4 Experience

Experience	1-10	11-20	21-30	30 & above	Total
Frequency	39	40	11	12	102
Percentage	38.2	39.2	10.8	11.8	100.0

The result of table no 4.1.4 shows that 39 individuals whose working experienced was 1-10 years while 40 Individuals (39.2%) whose experience of teaching was 11-20 years. Similarly 11 individuals (10.8%) and 12 individuals (11.8%) were those whose experience was 21-30 and above 30 years respectively. The maximum percentage was the individuals whose teaching experience was 11-20 and 12 individuals whose experience was more than 30 years to teach at different schools.

4.2 Knowledge Section

Table 4.2.1: Management of Chemicals

Chemical Inventory process to manage the chemicals	**Frequency**	**Percent**
Identification & elimination of unneeded chemicals	33	32.4
Identification & elimination of unsafe chemicals	19	18.6
Identification & elimination of unidentified chemicals	27	26.5
Identification & elimination of unneeded, unsafe & unidentified chemicals	23	22.5
Total	102	100.0

The result of table no 4.2.1 shows that knowledge about the chemical inventory, the way to identify and their proper disposal. 33 individuals (32.4%) responded that chemical inventory is the identification & elimination of unneeded chemicals, while23 individuals (22.5%) responded about the identification of unneeded, unsafe and unidentified chemicals at the work place which is the chemical inventory process.

Table 4.2.2: High Risk Chemicals

Chemicals	Conc. H_2SO_4	Conc.HNO_3	Conc. HCl	Mercury	Chloroform	Total
Frequency	26	21	19	11	25	102
Percentage	25.5	20.6	18.6	10.8	24.5	100.0

The result of table no 4.2.3 shows the importance of high risk chemicals at the laboratory to perform experiments. It was observed that 26 individuals (25.5%) responded that Sulphuric acid is the high risk chemicals being used in the laboratories. 21(20.6%) responded about the Nitric acids, 19(18.6%) individuals responded about the Hydrochloric acids, 11 (10.8%) responded about the Mercury while 25 (24.5%) responded about the chloroform, the chemicals of high risk respectively.

Table 4.2.3: Health Impact of High Risk Chemicals

Diseases	Environmental Asthma	Skin Burn	Skin lesion	Mental Disorder	Eye injuries	Total
Frequency	11	44	13	07	27	102
Percentage	10.8	43.1	12.7	6.9	26.5	100.0

The result of table no 4.2.3 shows that 44 individuals (43.1%) responded that high risk may cause skin burns while 13 individuals (12.7%) responded about the skin lesion. 11 individuals

(10.8%) responded about the environmental Asthma which is most probably an incidence during the lab procedures. Similarly 7 individuals (6.9%) and 27 (26.5%) responded about the risks of Mental Disorder and Eye Injuries at the work places environment.

Table 4.2.4: Good Chemical Management System

Methods	Storage	Segregation	Transportation	Disposal	Handling	Total
Frequency	21	32	23	11	15	102
Percentage	20.6	31.4	22.5	10.8	14.7	100.0

The result of table no 4.2.4 shows that 21 individuals (20.6%) responded that good storage is the only way of good chemical management system. 32 (31.4%) responded about the good segregation, 23 individuals (22.5%) responded about good transportation. Similarly 11 individuals (10.8%) and 15 individuals (14.7%) responded about the good disposal and good handling of the chemicals respectively.

Table 4.2.5: Steps of Minimization of Hazardous Chemicals

Steps	Elimination	Substitution	Reduction	Total
Frequency	37	41	24	102
Percentage	36.3	40.2	23.5	100.0

The result of table no 4.2.5 shows that 37 individuals responded that elimination is the only way to control the hazards of the chemicals while 41 individuals (40.2%) responded about the substitution of some hazardous chemicals. Similarly 24 individuals (23.5%) responded about the reduction is the way to control the hazards of a chemical while performing and disposing chemicals.

Table 4.2.6: Techniques to Control Risk Exposure

Risk control	Proper PPE	Training	BCC	Admin control	Total
Frequency	30	38	21	13	102
Percentage	29.4	37.3	20.6	12.7	100.0

The result of table no 4.2.6 shows that risk can be controlled by different techniques. 30 individuals 29.4%) responded that risk can be controlled by appropriate personnel Protective equipments, while 38 individuals (37.3%) responded about the training and education programs. Similarly 21 individuals (20.6%) and 13 individuals (12.7%) responded about the behavior Change Communication and administrative Control respectively.

Table 4.2.7: Proper Waste Disposal System

Disposal	Drain	Septic tank	Sewer	Total
Frequency	20	28	20	102
Percentage	19.6	27.5	19.6	100.0

The result of table no 4.2.7shows that 20 individuals (19.6%) responded that drain is the best way for the disposal of hazardous chemicals, while 28 individuals (27.5%) responded about the septic tanks and 20 individuals (19.6%) about the sewer. Similarly 16 individuals (15.7%) responded that these chemical should return tom the company and 18 individuals 917.6%) responded that these chemicals should sent to the other school to use and dispose.

Table 4.2.8: Chemical Spillage Management

Spill control	Spill kit	Washing & drying	Washing only	Drying only	Total
Frequency	22	41	23	16	102
Percentage	21.6	40.2	22.5	15.	100.0

The result of table no 4.2.8 shows that 22 individuals (21.6%) responded that spill kit may be used to manage chemical spillage, while 41 individuals (40.2%) responded about the washing and drying and 23 individuals (22.5%) responded about the only washing. Whereas 16 individuals (15.7%) responded that the chemical spillage should be managed by only drying at the work place.

4.3 Attitude Section

Table 4.3.1: Identification & Elimination of Chemicals

Inventory	SA	Agree	Undecided	SD	Disagree	Total
Frequency	45	31	19	06	01	102
Percentage	44.1	30.4	18.9	5.9	1.0	100.0

The result of table 4.3.1 shows that individuals (44.1%) responded that they were strongly agreed regarding the importance of chemical inventory process in the laboratory. Similarly 31 individuals (30.4%) responded that they are agree, where as 6 individuals responded that they strongly disagree with the importance of the chemical inventory in the management of hazardous chemicals.

Table 4.3.2: Guidance to Students about High Risk Chemicals

Chemicals	SA	Agree	Undecided	SD	Disagree	Total
Frequency	90	06	06	0	0	102
Percentage	88.2	5.9	5.9	0.00	0.00	100.0

The result of table 4.3.2 shows that 90(88.2%) individuals were strongly agree that they should be well aware about the hazardous effects of the chemicals. while 6 (5.9%) individuals were found undecided regarding the student's awareness programs at the schools.

Table 4.3.3: Labeling and Sorting of Chemicals

Labeling	SA	Agree	Undecided	SD	Disagree	Total
Frequency	73	22	0	0	7	102
Percentage	71.6	21.6	0	0	6.9	100.0

The result of table 4.3.3 shows that 73 individuals (71.6%) responded that they strongly agree regarding the labeling and sorting of chemicals, while 22 individuals (21.6%) were agree and 7 individuals (6.9%) responded that that disagree about the labeling and sorting of the chemicals.

Table 4.3.4: Training for the Safe Use of Chemicals

Training	SA	Agree	Undecided	SD	Disagree	Total
Frequency	64	27	02	0	9	102
Percentage	62.7	26.3	1.9	0	8.9	100.0

The result of table 4.3.4 shows that 64 individuals (62.7%) were strongly agreed about the training regarding the safe use of the chemicals. Whereas 27 individuals were agree, 2 remain undecided and 9 respondents were disagreeing about the importance of the training to use the chemicals in a safe way at the work place.

Table 4.3.5: MSDS Procedure

MSDS	SA	Agree	Undecided	SD	Disagree	Total
Frequency	39	41	10	04	08	102
Percentage	38.2	40.2	9.8	3.9	7.8	100.0

The result of table 4.3.5 shows that 39 (38.2%) respondents were strongly agree that material safety Data procedures should be adopted in the laboratory while 41(40.2%) respondents were agree, 4 (3.9%)individuals were strongly disagree and 8 (7.8%) individuals were disagree to adopt the MSDS at the work place.

Table 4.3.6: Use of Personal Protective Equipments

Proper PPE	**SA**	**Agree**	**Undecided**	**SD**	**Disagree**	**Total**
Frequency	38	43	03	07	11	102
Percentage	37.3	42.2	2.9	6.9	10.8	100.0

The result of table 4.3.6 shows that 38 individuals (37.3%) are strongly agreeing about the PPE in the laboratory while performing experiments or transporting the chemicals within the laboratory in the schools. Similarly 43 individuals (42.2%) were agreeing, 3 undecided, 7(6.9%) respondents were strongly disagreeing and 11 (10.8%) individuals were found disagree regarding the use of PPE in the laboratory.

Table 4.3.7: First Aid Facility

First Aid	SA	Agree	Undecided	SDA	Disagree	Total
Frequency	84	10	04	0	04	102
Percentage	82.4	9.8	3.9	0	3.9	100.0

The result of table 4.3.7 shows that 84 (82.4%) respondents were strongly agreeing to have a first aid facility at the schools. Similarly 10 individuals (9.8%) responded that they are agreed and 4 individuals (3.9%) responded that they are strongly disagreeing to have a first aid facility.

Table 4.3.8: Proper Chemical Disposal & Spill Management

Disposal	SA	Agree	Undecided	SDA	Disagree	Total
Frequency	29	57	06	03	07	102
Percentage	28.4	55.9	5.9	2.9	6.9	100.0

The result of table 4.3.8 shows that 29(28.4%) respondents were strongly agreeing regarding the proper chemical disposal and spill management to prevent hazards at the work place. 57 (55.9%) respondents were agree, 6 respondents could not decide while 10 respondents were strongly disagreeing about the importance of the chemical spillage and proper disposal.

Table 4.3.9 Awareness about Chemical Hazards

Awareness	SA	Agree	Undecided	SDA	Disagree	Total
Frequency	55	42	0	0	05	102
Percentage	53.9	41.2	0.00	0.00	4.9	100.0

The result of table 4.3.9 shows that 55 (53.9%) individuals were strongly agreeing that all staff must be trained regarding the hazards of the chemicals. Similarly 42 (41.2%) respondents were agreeing; while 5 (4.9%) respondents were disagreeing regarding the training about the hazards of the chemicals.

4.4 Practice Section

Table 4.4.1: Chemical Inventory Process

Chemical inventory	Regularly	Sometime	Rarely	Total
Frequency	21	49	32	102
Percentage	20.6	48.0	31.4	100.0

The result of table 4.4.1shows chemical inventory process was followed by 21(20.6%) respondents regularly, 49(48%) respondent uses this procedure sometimes and 32 (31.4%)

respondents were using this process rarely while performing and managing the experimental work.

Table 4.4.2: Instruction to students about Chemical Hazards

Hazardous Chemicals	Regularly	Sometime	Rarely	Total
Frequency	34	48	20	102
Percentage	33.3	47.1	19.6	100.0

The result of table 4.4.2 shows that 34(33.3%) respondents were in regular practice to instruct the students about the hazards of the chemicals. Similarly 48(47.1%) respondents were using this practice sometime and 20 (19.6%) individuals were rarely instructing their students about the hazards of the chemicals.

Table 4.4.3: Use of SOPs

SOPs	Regularly	Sometime	Rarely	Total
Frequency	31	51	20	102
Percentage	30.4	50.0	19.6	100.0

The result of table 4.4.3 shows that 31(30.4%) respondents were following the protocols for the safe use of the chemicals in the laboratory, while 51(50%) individuals responded they use these techniques sometime and 20 (19.6%) individuals responded that they rarely use the protocol for the safe use and disposal of the chemicals.

Table 4.4.4: Use of PPE

Use of PPE	Regularly	Sometime	Rarely	Total
Frequency	30	24	48	102
Percentage	29.4	23.5	47.1	100.0

The result of table 4.4.4 shows that 30 (29.4%) individuals responded that they regularly wear the personal protective equipments during the laboratory work and 24(23.5%) respondents replied that they use PPE sometime and 48(47.1%) individuals responded that they rarely use the PPE during the laboratory work.

Table 4.4.5: Incident regarding the Skin Burn

Use of PPE	Regularly	Sometime	Rarely	Total
Frequency	27	48	27	102
Percentage	26.5	47.1	26.5	100.0

The result of table 4.4.5 shows that 27(26.5%) individuals responded that there is high risk of the skin burn during the practical work and 48 (47.1%) individuals responded that this risk may occur sometime. While 27(26.5%) individuals responded that this risk may occur rarely while performing a laboratory work.

Table 4.4.6: Use of First Aid Facility

Use of PPE	Regularly	Sometime	Rarely	Total
Frequency	31	25	46	102
Percentage	30.4	24.5	45.1	100.0

The result of table 4.4.6 shows that 31(30.4%) individuals responded that first aid facility is being used at the facility regularly while 25(24.5%) individuals responded that they use this facility sometime. Similarly 46 (45.1%) individuals responded that they rarely use this facility at the work place.

Table 4.4.7: Practice regarding the Storage and Labeling of Chemicals

Storage & labeling	Regularly	Sometime	Rarely	Total
Frequency	47	45	10	102
Percentage	46.1	44.1	9.8	100.0

The result of table 4.4.7 shows that 47(46.1%) individuals regularly store and label the chemicals and 45 (44.1%) individuals store and label chemicals sometimes. Similarly 10(9.8%) individuals rarely store and label the chemicals.

Table 4.4.8: Managing Spill with Proper Methods

Spill Management	Regularly	Sometime	Rarely	Total
Frequency	31	34	37	102
Percentage	30.4	33.3	36.3	100.0

The result of table 4.4.8 shows that 31(30.4%) individuals responded about the regular management of spillage and 34(33.3%) responded to manage it sometime. Similarly 37 (36.3%) individuals responded that they rarely use the methods to manage the spillage at the work place.

Table 4.4.9: Proper Disposal of Chemical Waste

Spill Management	Regularly	Sometime	Rarely	Total
Frequency	39	28	35	102
Percentage	38.2	27.5	34.3	100.0

The result of table 4.4.9 shows that 39 (38.2%) individuals responded that they manage to dispose of the chemicals regularly whereas 28 (27.5%) individuals responded that they do these practices sometime only. Similarly 35(34.3%) individuals responded that they rarely dispose of chemicals in a proper way after performing experiments in the laboratory.

Table 4.4.10: Training regarding the Safe Use of Chemicals

Safe use of chemicals	Regularly	Sometime	Rarely	Total
Frequency	19	16	67	102
Percentage	18.6	15.7	65.7	100.0

The result of table 4.4.10 shows that 19(18.6%) individuals responded that they have been given a training regarding the safe use of the chemicals, while 16 (15.7%) individuals responded that sometime they have been given training and 67(65.7%) individuals responded that they rarely find a chance to attain these trainings regarding the safe use and disposal of hazardous chemicals.

Table 4.5.1 Mean Score on KAP based on Gender

Aspect	Male (n=51)	Female (n=51)	Sig
Knowledge	20.02 ± 3.94	20.23± 3.72	0.785
Attitude	15.52± 3.21	15.23± 3.15	0.650
Practices	20.22± 2.67	20.43± 2.85	0.042

The table no 4.5.1 shows the different average mean points of respondents on the aspect of their knowledge, attitude and practices. Male and Female respondents have got almost equal grades in all three aspects. The both groups got equal but lower points then they were expected to achieve (total 100 points). However there was a significant difference in average points of practice with respect to the gender variable ($p<0.05$).

Table 4.5.2 Mean Score on KAP based on age

Aspect	23-30 years (n=36)	31-38 years (n=22)	39-46 (n=23)	47-54 & above (n=21)	Sig
Knowledge	19.61±4.01	19.82±3.05	20.48±4.52	20.55±4.41	0.03
Attitude	14.61± 3.10	16.22± 3.22	15.91±3.21	15.72±2.83	.271
Practices	20.16±2.94	21.68±2.74	19.78±2.37	19.45±2.01	.172

The table no 4.5.2 shows that respondents have been evaluated in four different age groups. The difference between the average points received from all three aspects and the age group was statistically insignificant (P>0.05). All three group of respondents received lower points then they were expected to (total 100 points for each aspects). On the other hand, these points increased with age (P<0.05) which shows that knowledge increases with the age. The highest average recorded by the respondents who were at the age of 31-38 years old (21.68±2.74) in the aspect of practice, while respondents with age of 23-30 shows lowest average mean points (14.61± 3.10) for the aspect of attitude. It is fact that both knowledge and experience increases with age. This is clearly observed in the high average of points received by those 47 years old or above.

Table 4.5.3 Mean Score on KAP based on Education

Aspect	Bachelor (n=47)	Master (n=44)	M.Phil (n=11)	Sig
Knowledge	20.07±3.87	20.23±3.86	19.95±3.85	.037
Attitude	14.88± 2.98	16.17± 3.34	14.57±2.37	.178
Practices	20.19±2.65	20.08±2.81	20.80±3.02	.022

The table no 4.5.3 shows that the higher the education status, the higher the level of practices and knowledge. Statistically there was significant difference between the education and practices. P values (.037) and (.022).

Table 4.5.4 Mean Score on KAP based on work Experience

Aspect	1-10 years (n=39)	11-20 years (n=40)	21-30 years (n=11)	30 yrs & above (n=12)	Sig
Knowledge	14.41±3.76	20.40±3.57	23.72±5.3	26.50±3.20	.011
Attitude	15.84± 3.22	15.15± 3.23	14.45±2.73	14.91±3.11	.534
Practices	20.33±2.33	22.17±2.97	22.45±2.42	21.58±3.60	.970

The findings with respect to the working experience in table 4.5.4 shows that the higher the experience, the higher the level of knowledge and practices. Statistically there was significant difference between the knowledge aspect and the duration of the working experience ($P<0.05$). It was observed that teachers with working experience 1-10 years acquired the lowest knowledge score (14.41±3.76) as compared to those working more than 30 years (26.50±3.20) and above.

Table 4.6.1 Knowledge * Attitude

Attitude	Knowledge					Total
	V. Poor	Poor	Satisfactory	Good	V. Good	
Disagree	2	7	6	5	0	20
Strongly DA	4	12	12	11	0	39
Undecided	0	2	5	7	2	16
Agree	1	2	13	5	1	22
Strongly Agree	0	0	2	3	0	5
Total	7	23	38	31	3	102

The results of table 4.6.1 shows that 31 individuals who had good knowledge about the good management of the chemicals and 22 respondents showed positive attitudes regarding the all questions asked from them. Similarly 23 individuals showed poor knowledge and the percentage of strongly disagree was observed regarding the attitudes of the respondents. A good knowledge bears positive attitudes to work more efficiently.

Table 4.6.2: Chi-Square Tests (Knowledge * Attitude)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**22.518**[a]	**16**	**.027**
Likelihood Ratio	24.186	16	.086
Linear-by-Linear Association	6.940	1	.008
N of Valid Cases	102		

a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .15.

The results of table 4.6.2 (.027) show association between the two criteria of the classification. The significance of the results shows that there is an association between the knowledge and attitudes. ($P<0.05$).

Table 4.6.3: Knowledge * Practice

Practice	Knowledge					Total
	V. Poor	Poor	Satisfactory	Good	V. Good	
Rarely	3	5	6	3	0	17
Sometime	4	12	18	14	0	48
Regularly	0	6	14	14	3	37
Total	7	23	38	31	3	102

The result of table 4.6.3 shows that highest percentage 38 (45.2%) of the individuals was observed regarding the knowledge and 37 (36.2%) of the respondents were observed who practice regularly to manage the hazardous chemicals in the laboratories. The results also showed poor knowledge of the respondents 3(2.9%) who rarely practice for the good management of the chemicals and wastes they produce.

Table 4.6.4: Chi-Square Tests (Knowledge * Practice)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**13.612[a]**	**8**	**.022**
Likelihood Ratio	16.225	8	.039
Linear-by-Linear Association	10.385	1	.001
N of Valid Cases	102		

a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .50.

The result of table 4.6.4 shows association between the two criteria of the classification. It shows that there is strong association between the knowledge and practices. ($P<0.05$).

Table 4.6.5: Attitude * Practice

Practice	Attitude					Total
	Disagree	S. Disagree	Undecided	Agree	S. Agree	
Rarely	2	10	1	2	2	17
Sometime	10	17	7	12	2	48
Regularly	8	12	8	8	1	37
Total	20	39	16	22	5	102

The result of table 4.6.5 shows that 22(21.5%) respondents were agree and responded positively and 5(4.9%) responded as strongly agree to adopt the practiced with positive attitudes to manage the chemicals in the best possible ways and procedures. Similarly 39(38.2%) individuals responded that they strongly disagree and they practice rarely for the proper disposal of the used chemicals.

Table 4.6.6: Chi-Square Tests (Attitude * Practice)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	**7.938[a]**	**8**	**.040**
Likelihood Ratio	7.766	8	.457
Linear-by-Linear Association	.009	1	.925
N of Valid Cases	102		

a. 6 cells (40.0%) have expected count less than 5. The minimum expected count is .83.

The result of table 4.6.6 shows the association between the positive attitude and the practices. A good attitude is important to do a good work with good practices. There is an association (P<0.05) between the two criteria of the classification.

CHAPTER 05

SUMMARY, FINDINGS, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

5.1 SUMMARY

The safe use of chemicals and its proper disposal is a particular concern regarding the health of the students at schools. There are many hazardous chemicals used in the schools during the practical works in the science laboratories. Students are not well aware about the health hazards of these chemicals during the early years of their education. Incidents regarding the skin burn, eye splash and deaths have occurred due to the improper use of the chemicals during the laboratory work. In developing countries the mortality rate is high because of lack and improper use of the chemicals. Pakistan like other developing countries is also facing the problems to manage theses chemicals in agriculture, industrial and commercial uses. A large quantity of chemicals is being used in the school laboratories. The improper use and disposal of these chemicals have increased the health hazards in the last decades. In Pakistan there is no chemical safety center at national level and thousands of chemicals are imported each year in the country. The present study reveals the impact analysis regarding the knowledge, attitude and practices of the teachers for the safe use and disposal of the chemicals in the schools. The results show the lack of knowledge, facilities, and national policies for the sound management of the chemicals used during the practical works. Moreover the situation is worse in the rural areas lacking facilities for teacher to come and misuse of chemicals is common in the schools of rural areas as compare to the urban areas. Education and experience matters for the good management of the chemicals but in many schools teachers are not well trained to teach the students. For the good management of the chemicals we need sound policies to up grade the education standards with a special focus on the environmental Health education at provincial and national levels.

This study will help policy makers, stakeholders and community supervisors to come close to solve the issues regarding the proper use and disposal of chemicals to save our children and environment.

5.2 FINDINGS

i) Mean Score on KAP based on Gender regarding the chemicals management(Collection, handlings, storage, transportation and final disposal) was observed and found that Male and Female respondents have got almost equal grades in all three aspects. However there was a significant difference in average point of practice with respect to the gender variable ($p<0.05$) (Table 4.5.1).

ii) The Mean Score on KAP based on age was calculated and found that ($P<0.05$) which shows that knowledge increases with the age. The highest average recorded by the respondents who were at the age of 31-40 years old (21.68 ± 2.74) in the aspect of practice (Table, 4.5.2).

iii) On the other hand higher the education status, the higher the level of practices and knowledge. Statistically there was significant difference between the education and practices (.037) and (.022) (Table, 4.5.3).

iv) The finding with respect to the working experience in table (4.5.4) shows that the higher the experience the higher the level of knowledge and practices ($P<0.05$). It was observed that teachers with working experience less than six (6) years acquired the lowest knowledge score (14.41±3.76) as compared to those working more than 16-20 years (26.50±3.20) and above.

v) The results show that 35.5% respondents have good knowledge about the good management of the chemicals, but on the other hand they strongly disagree for the safe use of chemicals. The poor knowledge (30.45) of the respondents was observed for disagreeing about the safe use of the chemicals and the practices for the safe disposal of the chemicals. A good knowledge bears good attitude. The significance of the results shows that there is an association between the knowledge and attitudes ($P<0.05$) (Table, 4.6.2).

vi) The association between knowledge and practices showed that the highest percentage (45.2%) of the individuals was observed who bears good knowledge to exercise their practices regularly. Similarly high percentage (36.3%) of individuals was observed to practice their knowledge and work. The individuals having satisfactory knowledge were found 47.4% and they practice sometime for the safe management of the chemicals in their schools. It shows that there is strong association between the knowledge and practices ($P<0.05$) (Table, 4.6.4).

vii) The association between the positive attitude and the practices showed that a good attitude is important to do a good work with good practices. There is an association ($P<0.05$) between the two criteria of the classification (Table, 4.6.6).

5.3 CONCLUSIONS

i) School administrators and teachers have an important role to play in reducing the hazards of the chemicals used in the laboratory by taking specific actions and adopting policies that promote chemical safety in the schools (table, 4.6.2).

ii) Unfortunately weak practices were observed in almost all schools because of lack of awareness and proper education for the safe use of the chemicals and their proper disposal.

iii) Poor practices were observed regarding the safe use and disposal because there had been never inventor process of such chemicals (table, 4.4.10).

iv) Teachers were not fully aware about the hazards of the chemicals and no protective clothing or MSDS were present at workplace to guide the students (table, 4.4.4).

v) Poor practices about the segregation of the chemicals were observed and all chemicals were poured in the drainage to contaminate the water quality. It was observed that teachers bearing higher education level, experience and training had good knowledge, practices and attitude towards the safe use of the chemical and proper disposal. But unfortunately our school system lacks concerned staff, solid polices, health & safety standards to protect environment and future generation (table, 4.5.3, 4.5.4).

5.4 DISCUSSION

Identification & elimination of unneeded, unsafe & unidentified chemicals is chemical inventory. It is an important step to manage the hazardous chemicals. Poor practices were observed regarding the chemical labeling and storage. (Stalling, et al; 2001) also suggested that All chemical should be labeled with their chemical name and formula and they must be placed in their specific places to reduce the health hazards. Providing safety training to the teachers including use of Material Safety Data Sheets will help to reduce the chemical hazards in the laboratory (Stallings, Gerlovich, & Parsa, 2001). It was observed that there was no safety inspection by the schools administration or district authority regarding the safe use of chemicals. In other study of Nebraska teachers surveyed 48% indicated that safety inspections were not conducted (Gerlovich & Woodlawn, 2001).

Different averages mean points of respondents on the aspect of their knowledge, attitude and practices were observed where male and female respondents have got almost equal grades in all three aspects. The both groups got equal but lower points then they were expected to (total 100 points). However there was a significant difference in average pint of practice with respect to the gender variable ($p<0.05$).

The respondents have been evaluated in five different age groups. The difference between the average points received from all three aspects and the age group was statistically insignificant ($P>0.05$). All three group of respondents received lower points then they were expected to (total 100 points) for each aspects. On the other hand, these points increased with age

(P<0.05) which shows that knowledge increases with the age. The highest average recorded by the respondents who were at the age of 31-40 years old (21.68±2.74) in the aspect of practice, while respondents with age of 18-30 shows lowest average mean points (14.61± 3.10) for the aspect of attitude. It is fact that both knowledge and experience increases with age. This is clearly observed in the high average of points received by those 60 years old or above.

The table shows that the higher the education status, the higher the level of practices and knowledge. Statistically there was significant difference between the education and practices. (.037) and (.022). Most of the teachers in the schools were not given safety training and poor practices were observed in the workplaces. (Lee & Parsa, 2001) observed that injury related accidents in the science class room are caused by burns when students pick up hot objects and when students cut themselves on broken glasses. Another study showed that the type of degree held by the teacher and their teaching experience may affect safety in laboratory. Teacher with advanced degrees and the most experience have significantly fewer accidents (KarajKovich 1983).

The finding with respect to the working experience in table shows that the higher the experience, the higher the level of knowledge and practices. Statistically there was significant difference between the knowledge aspect and the duration of the working experience (P<0.05). It was observed that teachers with working experience less than 11-20 years acquired the lowest knowledge score (14.41±3.76) compare to those working more than 20 years and above.

Gerlovich and Woodlawn, 2001 also explained that teacher with fewer than four years of teaching experience have more laboratory accidents.

The combined result cross tabulation was also observed between the knowledge & attitudes, knowledge & practice and between the attitude & practice. The association between the two criteria of the classification was observed significant ($p<0.005$) in all cases regarding the knowledge, attitude and practices. Beside that it was also observed that no First Aid facilitates were available in schools which could be immediately given to the affected individuals of chemical injuries.

5.5 RECOMMENDATIONS

The best method for handling chemicals is documented management plan which includes written procedures and school information. This plan ensures best management practices regarding the storage, use and disposal of chemicals including the emergency procedures. The chemical management plan should be reviewed annually and updated to reflect the current practices, allow administration and teachers to track incoming chemicals.

1. The first step of the plan may be to designate a chemical coordinator /science teacher. who will be responsible for conducting and maintaining an inventory of all chemicals,

Coordinating the proper disposal of unwanted chemicals, purchasing chemicals (or authorizing the purchase) when needed, and ordering appropriate safety supplies related to safe chemical handling.

2. An inventory of all chemicals located on-site may be conducted under the direction of the chemical coordinator or any other responsible person. This inventory should include the identity and quantity of each chemical, and an evaluation of the condition of the chemical container and of the chemical itself (crystallized liquid, both liquid and solid phase present, evaporated solvent, discoloration, etc.), as well as the specific location, classification, and purpose of the chemical.

3. The science teacher may determine what chemicals are needed and will be used, and what are not needed and can be properly disposed. Most chemicals will probably need to be disposed as hazardous waste, which will require arranging for a licensed hazardous waste company to safely package and transport the waste to the disposal site.

4. The science teacher may ensure that a copy of the Material Safety Data Sheet (MSDS) for each remaining chemical is present at the site and available for review. This will protect students against any burn and chemical spillage in the laboratory. Additional information on MSDS and other sources of chemical hazard information should also be available workplace.

5. The school administration/science teachers may evaluate the storage, locations and storage systems (including flammables storage cabinets, shelving, and the method of chemical organization). It is important to ensure that chemicals are stored properly and handled safely.

6. The teacher may keep an eye on while performing practical works to prevent spillage. Student should be well aware about the Personal Protective Equipment. The chemical coordinator, in cooperation with allied staff may evaluate and implement strategies for reducing the use of hazardous chemicals in all areas of the school.

7. Teacher and student may be trained regarding the safe use and disposal of chemicals. There is need to maintain the sense of trust between the district and surrounding community. Lab. Safety programs for Science Teachers maybe included in Curriculum of In-Service and Pre-Service Training Programs. There may be sensitization programs at district level for the capacity building of the teachers to manage and reduce the health hazards associated with the use and disposal of the chemicals.

8. Ministry of Education, Health, Policy makers and Stakeholders may contribute to evaluate and monitor the health hazards associated with these chemicals to protect human health and environment by enforcing health education system.

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APPENDIX

QUESTIONAIRE

This is an independent research being carried out as a student for sample collection and analysis for the completion of MS thesis. The information provided would not be used for any purpose other than the one stated above. Please be honest while answering.

Questionnaire Part-1 (Demographic Characteristics)

Descriptive Characteristics

Characteristics	Demographic	Number	Percentage
Age group	22-27		
	28-33		
	34-39		
	40-45		
	46-51		
	52 & above		
Gender	Male		
	Female		
Education Level	Bachelor		
	Master		
	M.Phil		
Working experience	1-10		
	11-20		
	21-30		
	above 30		

Questionnaire Part-2 (Knowledge section)

(Chemical inventory)

- Do you know the chemical inventory procedure in laboratory like identification & elimination of unneeded, unsafe, unidentified chemicals?

S/N	Chemical Inventory	Respondents	Percentage
1	identification & elimination of unneeded Chemicals		
2	identification & elimination of unsafe Chemicals		
3	identification & elimination of unidentified Chemicals		
4	Identification & elimination of unneeded, unsafe &unidentified chemicals?		

(High Risk chemical)

- Do you know about the high risk chemicals used in laboratory?

S/N	CHEMICAL	Respondents	%
1	Conc. H_2SO_4		
2	Conc. HNO_3		
3	Conc. HCl		
4	Mercury		
5	Chloroform		

- Do you know about the health impacts of high risk chemical?

S/N	Health Impact		
1	Env, asthma		
2	skin burn		
3	skin lesion		
4	mental disorder		
5	eye injuries		

(Chemical Management)

- Do you know about the chemical management system?
-

S/N	Management	Respondents	%
1	good storage		
2	good segregation		
3	good transportation		
4	good disposal		
5	good handling		

(Minimizing use of hazardous chemical)

- How would you minimize the use of hazardous chemical?

S/N	Process	Respondents	Percentage
1	Elimination		
2	Substitution		
3	Reduction		

(Control of chemical exposure risks)

- Do you know about the techniques to control risk exposure?

S/N	Risk Control		Percentage
1	by appropriate PPE		
2	by training & education		
3	behavior change communication		
4	administrative control		

(Chemical disposal)

- Do you know about the proper waste disposal system of the chemicals?

S/N	Waste Disposal	Respondents	Percentage
1	Drains		
2	Septic tanks		
3	Sewer		
4	return to company		
5	other schools		

(Spill management)

- How do you manage the chemical spillage?

S/N	Management	Respondents	Percentage
1	by using spill kit		
2	washing & Drying		
3	only washing		
4	only drying		

Part-3 (Attitude Section)

- identification & elimination of unneeded, unsafe, unidentified chemicals is important

SA	A	UD	SDA	DA

- material safety data sheet procedure should be adopted

SA	A	UD	SDA	DA

- teacher should guide the student regarding the high risk chemical and their impact on health

SA	A	UD	SDA	DA

- Labeling and storing of chemical is essential part of the chemical management system.

SA	A	UD	SDA	DA

- Student & teacher should wear personal protective equipment during the experimental work.

SA	A	UD	SDA	DA

- first aid facility should be available in each school to treat injuries

SA	A	UD	SDA	DA

- Students should be given training regarding the safe use of chemicals.

SA	A	UD	SDA	DA

- Proper chemical disposal and spill management is necessary to prevent hazards.

SA	A	UD	SDA	DA

- All staff working in school should be well aware about the hazards of chemicals

SA	A	UD	SDA	DA

Key-

SA	Strongly Agree
A	Agree
UD	Undecided
SDA	Strongly Disagree
DA	Disagree

Part-4 (Practice Section)

- Are you following the identification & elimination of unneeded, unsafe, unidentified chemicals?

Regularly	Sometime	Rarely

- **Do you instruct the students about the hazards of chemicals?**

Regularly	Sometime	Rarely

- **Use of SOPs/ protocol for safe use of the chemical**

Regularly	Sometime	Rarely

- **Use personal protective equipments during the experiments**

Regularly	Sometime	Rarely

- **Incident regarding the skin burn by chemical during the procedure**

Regularly	Sometime	Rarely

- **First aid facility during chemical hazards**

Regularly	Sometime	Rarely

- **Practices regarding storage and labeling of chemicals**

Regularly	Sometime	Rarely

- **Managing spills with proper methods/techniques**

Regularly	Sometime	Rarely

- **Proper disposal of chemical waste after experiments**

Regularly	Sometime	Rarely

- **Any training regarding the safe use of chemicals & their management**

Regularly	Sometime	Rarely