AN EVALUATION OF TEACHING OF CHEMISTRY AT PUBLIC SECONDARY SCHOOLS IN PAKISTAN

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DISSEPTION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE FACULTY OF EDUCATION AND LEARNING SCIENCES OF IQRA UNIVERSITY KARACHI

KARACHI
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DOCTORAL COMMITTEE

The members of the committee appointed to examine the PhD dissertation of Mr Muhammad Ilyas Bhutto, find it satisfactory and recommend that it be approved.

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Muhammad Ilyas Bhutto
DEDICATION

I from the core of my heart dedicate this piece of work to my family: parents, wife,

and especially to my children with a ray of hope that they will also

continue seeking education and broadening their vision

to serve humanity throughout

their lives.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>DEDICATION</td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xvi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>xix</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER I. INTRODUCTION</td>
<td>3</td>
</tr>
<tr>
<td>1.1. Overview</td>
<td>3</td>
</tr>
<tr>
<td>1.2. Background to the Study</td>
<td>4</td>
</tr>
<tr>
<td>1.2.01. Geographical Location, Area, and Population (Pakistan)</td>
<td>4</td>
</tr>
<tr>
<td>1.2.02. Brief History of Pakistan</td>
<td>5</td>
</tr>
<tr>
<td>1.2.03. General Indicators of Education in Pakistan</td>
<td>7</td>
</tr>
<tr>
<td>1.2.04. Structure of the Pakistani Educational System</td>
<td>8</td>
</tr>
<tr>
<td>1.2.04.1. Elementary Education</td>
<td>9</td>
</tr>
<tr>
<td>1.2.04.1.1. Pre-primary Education</td>
<td>9</td>
</tr>
<tr>
<td>1.2.04.1.2. Primary Education</td>
<td>10</td>
</tr>
<tr>
<td>1.2.04.1.3. Elementary/Middle Stage Education</td>
<td>10</td>
</tr>
<tr>
<td>1.2.04.2. Secondary Education</td>
<td>11</td>
</tr>
<tr>
<td>1.2.04.2.1. Secondary School Education</td>
<td>11</td>
</tr>
<tr>
<td>1.2.04.2.2. Higher Secondary (School) Education</td>
<td>12</td>
</tr>
<tr>
<td>1.2.04.3. Tertiary or University Education</td>
<td>12</td>
</tr>
</tbody>
</table>
1.2.05. Administration and Management of Education System
1.2.06. Historical Overview of Educational Policies
1.2.07. Importance of Science and Chemistry in Daily Life
1.2.08. Pedagogical Methods Related to Sciences
1.2.09. Lesson-planning, Presentation, and Formative Assessment
   1.2.09.1. Lesson Planning
   1.2.09.2. Presentation of Lesson
   1.2.09.3. Formative Evaluation of Lesson
1.2.10. Local Studies/ Reports on Science and Chemistry
1.3. Statement of the Problem
1.4. Objective of the Study
1.5. Research Questions
1.6. Significance of the Study
1.7. Delimitations of the Study
1.8. Definition of the Key Terms

CHAPTER II. REVIEW OF THE RELATED LITERATURE
2.1. Development of Education/Teaching
   2.1.1. Historical overview of Pedagogy
      2.1.1.1. Primitive Education/pedagogy
      2.1.1.2. Education in Greek Period (Classical Education)
         2.1.1.2.1. Socrates’ and Plato’s education
         2.1.1.2.2. Aristotelian Education
      2.1.1.3. Education in Muslim Period
2.1.4. Modern Education 41

2.1.2. Philosophical Perspective of Education 42

2.1.2.1. Paradigms 42

2.1.3. Psychological Perspective of Education 43

2.1.3.1. Learning and Education 44

2.1.3.2. Piaget’s Stages of Cognitive Development 45

2.1.3.3. Lev S. Vygotsky’s Social Development Theory 47

2.1.3.4. Erik Erikson’s Eight Developmental Stages 48

2.1.3.5. Howard Gardner’s Multiple Intelligences Theory 49

2.1.3.6. Overview of Child-Development Theories 50

2.1.3.7. Learning Styles or Three Types of Learners 51

2.1.3.8. Laws and Principles of Learning 53

2.2. Professional Standards, Trainings, and Curricula 57

2.2.1. National Professional Standards of Teachers in Pakistan 57

2.2.2. Professional Trainings 61

2.2.2.1. Pre-service Trainings (B.Ed. and M.Ed) 61

2.2.2.2. In-service Trainings 64

2.2.3. Document Analysis of B.Ed Curricula (Sciences/Chemistry) 66

2.2.3.1. Curricula of B.Ed. at Allama Iqbal Open University, Islamabad 67

2.2.3.1.1. Program’s overview 67

2.2.3.1.2. Educational Psychology & Curriculum 68

2.2.3.1.3. Teaching of chemistry, physics, and biology 70

2.2.3.2. Curricula of B.Ed. at University of Sindh, Jamshoro 71
## EVALUATION OF TEACHING OF CHEMISTRY

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.3.2.1. Program’s overview</td>
<td>71</td>
</tr>
<tr>
<td>2.2.3.2.2. Teaching of chemistry, physics, biology, &amp; general science</td>
<td>72</td>
</tr>
<tr>
<td>2.2.3.2.3. Critical review of above subjects</td>
<td>73</td>
</tr>
<tr>
<td>2.2.3.3. Statistics of public secondary schools and teachers of Sindh</td>
<td>75</td>
</tr>
<tr>
<td>2.3. Pedagogy and Teaching of Science and Chemistry</td>
<td>76</td>
</tr>
<tr>
<td>2.3.1. Teaching</td>
<td>76</td>
</tr>
<tr>
<td>2.3.2. Pedagogy</td>
<td>76</td>
</tr>
<tr>
<td>2.3.3. Understanding Pedagogical Approach, Method, and Technique</td>
<td>77</td>
</tr>
<tr>
<td>2.3.4. General Pedagogical Approaches</td>
<td>79</td>
</tr>
<tr>
<td>2.3.4.1. Teacher-Centered vs. Learner-Centered teaching approaches</td>
<td>79</td>
</tr>
<tr>
<td>2.3.4.2. Inductive vs. Deductive teaching approaches</td>
<td>80</td>
</tr>
<tr>
<td>2.3.4.3. Constructive vs. Transmissive teaching approaches</td>
<td>81</td>
</tr>
<tr>
<td>2.3.5. Common Science Teaching Methods</td>
<td>81</td>
</tr>
<tr>
<td>2.3.5.01. Lecture Method</td>
<td>82</td>
</tr>
<tr>
<td>2.3.5.02. Lecture-Demonstration Method</td>
<td>82</td>
</tr>
<tr>
<td>2.3.5.02.1. Advantages</td>
<td>83</td>
</tr>
<tr>
<td>2.3.5.02.2. Disadvantages</td>
<td>83</td>
</tr>
<tr>
<td>2.3.5.03. Discussion Method</td>
<td>83</td>
</tr>
<tr>
<td>2.3.5.04. Discovery Method</td>
<td>85</td>
</tr>
<tr>
<td>2.3.5.05. Cooperative Learning</td>
<td>86</td>
</tr>
<tr>
<td>2.3.5.05.1. Advantages</td>
<td>87</td>
</tr>
<tr>
<td>2.3.5.05.2. Disadvantages</td>
<td>87</td>
</tr>
<tr>
<td>2.3.5.06. Project Method</td>
<td>87</td>
</tr>
</tbody>
</table>
2.3.5.07. Inquiry Teaching Method 88
2.3.5.08. Problem Solving Method 89
2.3.5.09. Laboratory Method 90
2.3.5.10. Role-play and Simulation Method 92
2.3.5.11. Experiential Learning 93
2.3.5.12. Five Es Learning Cycle 95

2.4. Measuring Effectiveness of a Process or Product 97
2.4.1. Defining and Distinguishing Assessment and Evaluation (of Teaching) 97
2.4.2. Assessment 98
2.4.3. Evaluation 99

2.5. Planning 101
2.5.1. Instructional Planning 101
2.5.2. History and Components of Lesson Planning 102
2.5.3. Importance of Lesson Planning 103
2.5.4. Three Stages of Lesson Planning 104
2.5.5. Empirical Evidence on Lesson Planning 105

2.6. Hazards and Safety Measures at Chemistry-Laboratory 107
2.6.1. Classification of Harms 108
2.6.1.1. Flammability 108
2.6.1.2. Corrosivity 108
2.6.1.3. Toxicity 108
2.6.1.4. Reactivity 109

2.7. Empirical Evidence on the Teaching of Chemistry 110
### EVALUATION OF TEACHING OF CHEMISTRY

2.8. Sum-up of Literature Review and Rationale of Present Study 122

CHAPTER III. METHODOLOGY 124

3.01. Research Approach 124

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01.1. Theoretical Perspective of Mixed Research</td>
<td>124</td>
</tr>
<tr>
<td>3.01.2. Theoretical Perspective of Evaluation Research</td>
<td>128</td>
</tr>
</tbody>
</table>

3.02. Research Purpose 130

3.03. Research Design and its Rationale 130

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.03.1. Quantitative Part (Causal and Evaluative Research)</td>
<td>130</td>
</tr>
<tr>
<td>3.03.2. Survey</td>
<td>131</td>
</tr>
<tr>
<td>3.03.3. Qualitative Part (Phenomenology)</td>
<td>131</td>
</tr>
</tbody>
</table>

3.04. Data Collection 133

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.04.1. Respondents’ Data</td>
<td>133</td>
</tr>
<tr>
<td>3.04.2. Document Analysis</td>
<td>133</td>
</tr>
</tbody>
</table>

3.05. Procedure 133

3.06. Population 134

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.06.1. Rationale of Target Population</td>
<td>134</td>
</tr>
<tr>
<td>3.06.2. Target Population</td>
<td>135</td>
</tr>
<tr>
<td>3.06.3. Rationale for Sampling and Sample Size</td>
<td>136</td>
</tr>
<tr>
<td>3.06.4. Population and Sample-size</td>
<td>136</td>
</tr>
<tr>
<td>3.06.5. Criteria of Classification of Rural and Urban population</td>
<td>139</td>
</tr>
</tbody>
</table>

3.07. Data Collection Instruments 139

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.07.1. Questionnaires for the Students</td>
<td>140</td>
</tr>
<tr>
<td>3.07.2. Achievement Test of the Students</td>
<td>141</td>
</tr>
</tbody>
</table>
3.07.3. Semi-structured Interviews with the Students
3.07.3.1. The Areas of Students’ Semi-structured Interviews

3.08. Validity and Reliability
3.08.1. Validity of Questionnaire-items and Achievement Test-items
3.08.2. Reliability of Questionnaire-items and Achievement Test items

3.09. Analysis of Data
3.09.1. Analysis of Quantitative Data
3.09.2. Analysis of Qualitative Data

3.10. Model Hypothesis

3.11. Ethical Consideration

3.12. Conceptual Framework of the Study

CHAPTER IV. FINDINGS

4.1. Quantitative Part
4.1.1. Descriptive Statistics
4.1.1.1. Professional trainings
4.1.1.2. Demographics
4.1.1.3. General professional teaching skills
4.1.1.4. Lesson-planning
4.1.1.5. Teaching Methods
4.1.1.6. Audio-visual aids
4.1.1.7. Students’ classroom activities
4.1.1.8. Teachers’ formative assessment
4.1.1.9. Course coverage
4.1.10. Descriptive statistics (overall of eight variables) 160

4.1.2. Regression Analyses 161

4.1.2.1. Regression analysis all predictors (overall) 162

4.1.2.2. Overall Regression analysis of demographic variables 168

4.1.3. Mean differences Analyses 171

4.1.3.1. Independent samples t-test 171

4.1.3.2. One-way Analysis of Variance ANOVA 172

4.2. Qualitative Findings 180

4.2.1. Confirmatory Data 181

4.2.1.1. Free Textbooks 181

4.2.1.2. Lesson-planning 181

4.2.1.3. Teaching methods 182

4.2.1.4. Audio-visual aids 183

4.2.1.5. Formative assessment 184

4.2.1.6. Course coverage 184

4.2.2. Open-ended Textual Data 185

4.2.2.1. Theme 1: Teaching of chemistry textbook (theoretical part) 186

4.2.2.2. Theme 2: Teaching of practical journal of chemistry (practical part) 188

4.2.2.3. Theme 3: Students’ activities 190

4.2.2.4. Theme 4: Un-fair means in board’s examination 193

4.3. Triangulation of Quantitative and Qualitative Data 195

4.3.1. General Professional Teaching Skills 195

4.3.2. Lesson-planning 196
4.3.3. Teaching Methods

4.3.4. Audio-visual Aids

4.3.5. Students’ Classroom Activities

4.3.6. Students’ Formative Assessment

4.3.7. Course Coverage of Theory

4.3.8. Course Coverage of Practical

CHAPTER V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1. Summary

5.2. Conclusions

5.3. Discussion

  5.3.1. Overall Analysis

  5.3.2. Achievement Test

  5.3.3. Lesson Planning

  5.3.4. Teaching Methods

  5.3.5. Audio Visual Aids

  5.3.6. Students’ Classroom Activities and their Formative Assessment

  5.3.7. Course Coverage of Chemistry Theory and Practical

5.4. Recommendations

  5.4.1. Related to Professional Training Agencies

  5.4.2. Related to Teachers

  5.4.3. Related to School Administration and Management

  5.4.4. Recommendations for Further Research

REFERENCES
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stages of Education in Pakistan</td>
<td>8</td>
</tr>
<tr>
<td>2. Overview of Child-Development Theories</td>
<td>50</td>
</tr>
<tr>
<td>3. Pre-Service Courses: Pre-Requisites, Duration, and Eligible Classes for Teaching</td>
<td>61</td>
</tr>
<tr>
<td>4. Statistics of Secondary Schools and Teachers (HSTs), Participation, &amp; Labs of Sindh</td>
<td>75</td>
</tr>
<tr>
<td>5. Categories of Role-play with Examples of Exercises</td>
<td>93</td>
</tr>
<tr>
<td>6. Targeted Population and Stratified Sampling Drawn</td>
<td>139</td>
</tr>
<tr>
<td>7. Sample Statistics</td>
<td>151</td>
</tr>
<tr>
<td>8. Overall Statistics of Demographic Variables</td>
<td>152</td>
</tr>
<tr>
<td>9. Frequencies of Parents’ Income and Occupation</td>
<td>153</td>
</tr>
<tr>
<td>10. Frequencies of Parents’ Education</td>
<td>154</td>
</tr>
<tr>
<td>11. Frequencies of Students’ Home-study and After-school Tuition</td>
<td>154</td>
</tr>
<tr>
<td>12. Frequencies of Students’ Tuition-subjects and their Favourite Subjects</td>
<td>155</td>
</tr>
<tr>
<td>13. Descriptive Statistics of General Professional Teaching Skills</td>
<td>156</td>
</tr>
<tr>
<td>14. Descriptive Statistics of Lesson Planning</td>
<td>157</td>
</tr>
<tr>
<td>15. Descriptive Statistics of the Existing Teaching Methods</td>
<td>157</td>
</tr>
<tr>
<td>16. Descriptive Statistics of Existing Audio-visual aids</td>
<td>158</td>
</tr>
<tr>
<td>17. Descriptive Statistics of Students’ Classroom Activities</td>
<td>159</td>
</tr>
<tr>
<td>18. Descriptive Statistics of Students’ Formative Assessment by Teachers</td>
<td>159</td>
</tr>
<tr>
<td>19. Descriptive Statistics of Course Coverage</td>
<td>160</td>
</tr>
<tr>
<td>20. Descriptive Statistics (overall of eight variables)</td>
<td>161</td>
</tr>
<tr>
<td>21. Model Summary, Overall Multiple Linear Regression Analysis</td>
<td>163</td>
</tr>
<tr>
<td>22. ANOVA of Overall Multiple Linear Regression (All predictors)</td>
<td>163</td>
</tr>
</tbody>
</table>
23. Coefficients of Overall Multiple Linear Regression (All predictors) 165
24. Multiple Linear Regression Analysis (four significant predictors) 166
25. ANOVA of Overall Multiple Linear Regression (Four significant predictors) 167
26. Coefficients of Four predictors of Multiple Linear Regression 167
27. Overall Multiple Linear Regression Analysis (Demographic Variables) 169
28. ANOVA of Overall Multiple Linear Regression Analysis (Demographic Variables) 169
29. Coefficients of Demographic Predictors of Multiple Linear Regression 170
30. Independent Samples t-test (test-scores vs. gender and location) 172
31. One-way ANOVA of Respondents Test-scores and Type of School, and Parents’ Education 173
32. Post hoc Tukey’s HSD for Homogeneity in test-scores and Type of Schools 174
33. Post hoc Tukey’s HSD for Mean Test-Scores and Parents’ Income Levels 175
34. Post hoc Tukey’s HSD for Test-scores and Parents’ Income 176
35. Post hoc Tukey’s HSD for Test-scores and Respondents’ Home-study 177
36. Post hoc Tukey’s HSD for Mean Test-Scores and After-school Tuition 178
37. Post hoc Tukey’s HSD for Test-scores and Respondents’ After-school Tuition Subjects 179
38. Post hoc Tukey’s HSD for Test-scores and Respondents’ Favourite Subjects 180
39. Interview-summary of the Free Textbooks 181
40. Interview-summary of Lesson Planning 182
41. Interview-Summary of Teaching Methods 183
42. Interview-summary of the use of Audio Visual Aids 183
43. Interview-summary of the Students’ Formative Assessment by the Teachers 184
44. Interview-summary of Course Coverage of Chemistry 185
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Map of the South Asia (Showing Location of Pakistan)</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Structure of Education in Pakistan</td>
<td>13</td>
</tr>
<tr>
<td>3.</td>
<td>A Simple Lesson-plan</td>
<td>19</td>
</tr>
<tr>
<td>4.</td>
<td>Organization of the Study (Flow Chart)</td>
<td>33</td>
</tr>
<tr>
<td>5.</td>
<td>Difference among Approach, Method, and Technique</td>
<td>78</td>
</tr>
<tr>
<td>6.</td>
<td>Kolb’s Four Types of Learners</td>
<td>94</td>
</tr>
<tr>
<td>7.</td>
<td>Target Population and Stratified Random Sampling (9.1%) Drawn</td>
<td>138</td>
</tr>
<tr>
<td>8.</td>
<td>Conceptual Frame-work of the Study</td>
<td>148</td>
</tr>
</tbody>
</table>
LIST OF APPENDICES

Appendix | Page
--- | ---
A. APPENDIX A: STUDENTS’ QUESTIONNAIRE | 259
B. APPENDIX B: PERMISSION LETTER FROM IQRA UNIVERSITY | 264
C. APPENDIX C: PERMISSION LETTER FROM DIRECTORATE OF SCHOOL EDUCATION | 265
D. APPENDIX D: HISTOGRAMS OF MULTIPLE LINEAR REGRESSION | 266
Abstract

AN EVALUATION OF TEACHING OF CHEMISTRY AT PUBLIC SECONDARY SCHOOLS IN PAKISTAN

Muhammad Ilyas Bhutto

Iqra University, Karachi, 2014

Supervisor: Dr Wasim Qazi

This mixed study evaluated the professional teaching of chemistry through learners’ perspective against the criteria of B.Ed at public secondary schools in Pakistan regarding eight aspects: general professional teaching skills, lesson planning, teaching methods, audio-visual aids, students’ classroom activities and formative assessment, and course coverage of theory and practical. I collected quantitative data through self-developed questionnaire of 70 items using stratified sampling of 350 students from boys-only, girls only, boys in co-education, and girls in co-education across rural and urban schools; however, qualitative data involved 20 students’ semi-structured interviews. A panel of experts and pilot testing refined the tools. The overall Coronbach’s alpha stood at 0.9 and 0.8 for professional teaching and test-items respectively. Descriptive statistics, multiple regression, correlation, independent samples t-test, and ANOVA analyses revealed the failure of existing professional teaching of chemistry. The qualitative thematic analyses and triangulation confirmed it: Dictation of questions and answers as dominant teaching method, and constantly locked science laboratories and equipments emerged as the major themes. Laboratory experimentation, audio-visual aids, chemistry theory, and teaching methods strongly predicted students’ test-scores with 41.7% surety. However, demographic variables: Students’ favorite subject, home study, parents’ income, and students’ gender weakly predicted learners’ test-scores. Independent samples t-test and ANOVA analyses revealed that
students devoting more time to home-study and tuition, especially in natural sciences, and
students’ from separate schools for gender, and parents with higher earning and rank got
significantly different test-scores; however, gender and parents’ education had no significant
differences. I presented feasible and realistic recommendations to the concerned stakeholders.

**Key words:** evaluation, chemistry, professional training, teaching, secondary schools
CHAPTER I

INTRODUCTION

1.1. Overview of the Study

Despite the founder of Pakistan (Muhammad Ali Jinnah—known as Quaid-e-Azam or ‘the great leader’) prioritized education and emphasized science and technology, the quality of education in general and science and technology in particular is too far from competing countries of South-Asia (EdQual, 2007; Government of Pakistan, 2009a, 2009b; UNESCO-IBE, 2011).

From time to time different authors and researchers have studied different aspects of existing teaching. They specifically hinted certain flaws: limited resources (Dahar & Faize, 2011; EdQual, 2007; Khurshid, 2008; Naseer-ul-Din, Iqbal, Khaleeq, & Rehman, 2010; Soomro, 2009); low/poor quality teaching, incompetent teachers, and lack of proper professional teaching standards and accreditation (Government of Pakistan, 2009a, 2009b); corporal punishment (Government of Pakistan, 2007; Sarwar & Hussain, 2010; The Express Tribune, January 14th, 2012); ineffective pre and in-service trainings (Ahmed, Azeem, Khalid, Farrukh, Ahmed, & Ahmed, 2012; Gujjar, Bajwa, Shaheen, & Rehman, 2011; Mehrunnisa, 1998; Saeed, 2007; UNESCO, 2011-12); uncompetitive traditional teaching (Hussain, Ahmed, Muben, & Tariq, 2011; Nazir & Naqvi, 2012; Sarwar, & Hussain, 2010); erroneous examination system (Hoodbhoy as cited in Christie & Afzaal, 2005); and no difference in trained and untrained teachers (Khurshid, 2008) etc.

However, hardly any study was available that evaluated existing teaching against the criteria of B.Ed. (the minimum professional degree for induction of secondary school teachers in Pakistan). It served as one of the major stimuli for this study. Thereupon, the study in hand targets at evaluating the teaching of chemistry at public secondary schools (grade 9th and 10th)
with relation to general professional skills, lesson planning, teaching methods, audio-visual aids, students’ activities, teachers’ formative assessment, and course coverage.

### 1.2. Background of the Study

The things become clear when discussed and interpreted in their actual context. Therefore, in this section the researcher presents the context of the study describing Pakistani educational set up in the light of relevant national and local studies.

#### 1.2.01. Geographical Location, Area, and Population

The Islamic Republic of Pakistan is one of the important countries of South-Asia with an estimated population of 180.71 million with 2.03% of growth rate (Government of Pakistan, 2012, p.10). Islamabad is its capital city. Its currency is Pak Rupees (Rs). Currently 1 US $ brings you Rs 105. Pakistan shares its borders with India in the east (1610 km), Arabian-Sea in the south (1046 km), Iran in the west (805 km), Afghanistan in the north-west (2252 km), and Republic of China in the north (595 km) (Sindh Textbook Board, 2012a).

Figure 1

*Map of the South Asia, Showing Location of Pakistan*

Source: http://upload.wikimedia.org/wikipedia/commons/b/b9/South_asia.jpg
The land of Pakistan is spread on an area of 796,096 square kilometers distributed among four provinces Punjab, Sindh, Balochistan, and Khyber Pakhtunkhwa besides Federally Administered Tribal Areas (FATA), Federally Administered Northern Areas (FANA), and Gilgit-Baltistan. Punjab is the biggest province in terms of population, and is most prosperous. While Balochistan is the smallest one but is the largest with respect to area. Both Sindh—the second largest in population—and Balochistan include some of the most poverty stricken regions in the country (EdQual, 2007, p. 4).

Regarding rural and urban divide, the rural population comprises 67% of the total and depend on agriculture. However, the urban population makes up a smaller i.e. 33% only. The overall per capita real income of the country is $1372 with 2.33% growth rate (Government of Pakistan, 2012, p. 1). English is the official language in Pakistan, whereas Urdu despite not inherited by any ethnic groups of the country serves as a national language and a means of communication almost throughout the country. According to Pakistan census, six major ethnic groups represent major Pakistani culture and languages i.e. Punjabi—the people of Punjab (44.15%), Pushto—the language of people of Khyber Pakhtunkhwa (15.42%), Sindhi—the people of Sindh (14.1%), Siraiki—the people of south Punjab (10.53%), Urdu—(7.57%), and Balochi—the people of Balochistan (3.57%) (Pakistan Census, 1998).

1.2.02. Brief History of Pakistan

Though Pakistan historically is only six decades old, its people and civilization is considered one of the oldest civilizations encountering about 10,000 years of history. Being a fertile and developed land, its people were attacked by different rulers including Aryans, Persians, Greeks, Arabs, Turks, and others throughout the history. The ruins of Moen-Jo-Daro
Islam openly came here in the Indian subcontinent in 1712 through the attack of Muhammad Bin Qasim. However, the Muslims and the Hindus had remained united in the Mughul Empire for about 1000 years before the British took them over. The British entered here through East India Company for trade, but took over the territory gradually. Eventually, in 1857 they brought the whole territory under their control, and formed British government after the battle of Plassey. They defeated Indian defending heroes Siradu-Dolah and Tipu Sultan. As a result, our Indian sub-continent remained part of the British Colonization for 100 years (Sindh Textbook Board, 2012).

The Muslims under the leadership of Sir Sayed Ahmed Khan, Moulana Muhammad Ali Johar, Moulana Shoukat Ali, Muhammad Iqbal (Allama), Muhammad Ali Jinnah (Quaid-e-Azam or the great leader) and many others, launched struggle for freedom from British rule. Ultimately, after around a century of slavery they succeeded, and the British had to leave the subcontinent in August 1947. Consequently, two independent countries Pakistan and India for the Muslims and the Hindus of the region occurred on the map of the world. Pakistan initially had two wings: the West Pakistan with four provinces and the East Pakistan with one province Bangal, which separated in December, 1971. Unfortunately, the political institutions could not get developed in Pakistan, thus leaving space for the military take over causing three civil and military wars with India. Pakistan’s military accounted for a rule over the country for two thirds of the period after independence resulting in weaker economy and political institutions (Sindh Textbook Board, 2012). The people of this area have absorbed various and beautiful multicultural identities and fusions from Hindu, Arab, Aryan, and Greek cultures.
1.2.03. General Indicators of Education in Pakistan

The Article 37B of the constitution of Pakistan 1973 claims “to remove illiteracy and provide free and compulsory secondary education within minimum possible period” (Government of Pakistan, 2009b, p. 9). However, the passage of 65 years does not seem to have fulfilled the criteria of minimum possible time. “It is clear that Pakistan is still a long way from achieving universal primary enrolment” (Lynd, 2007, p. 7). In Pakistan, education is the responsibility of provinces, but throughout the history it has been controlled by the Federal Ministry of Education that has recently (April, 2011) been dissolved.

Legally, there is compulsory primary or elementary education, but not in practice. The Net Enrolment Rate for primary (up to grade 5), middle (from grades 6 to 8), secondary (lower: i.e. grades 9 and 10), higher secondary (grades 11 and 12), and university or tertiary level (above grade 12) remained 62%, 35%, 23%, and 09% respectively that is the lowest in the South-Asian region (Lynd, 2007, p. 16). In overall, the private sector contributes for 31% with 19% for rural and 51% for urban population. It accounts for broader population as compared to the regional countries of South Asia (Lynd, 2007, p. 20).

The Gross Domestic Product for the fiscal year 2011-12 remained 174.800 billion US dollars with growth rate of 3.7 (Trading Economics, 2011). The inflation during 2010-11 remained 10.85. Only 58% of the 10+ year population is literate leaving behind 42% as illiterates in the present era of knowledge explosion. The population growth rate remains 2.03%, while the average life expectancy is about 65 years (Government of Pakistan, 2012, p. 7). The Human Development Report 2011 ranked Pakistan at 145th out of 186 countries with 22.3% of population living below the national poverty line and 22.6% earning less than US$1.25/day (Human Development Report, 2011, p. 144).
The general education prevails throughout grade 10 as a general practice. After that level diversification of technical, vocational, and professional education starts. Gender Parity Index (GPI) remained at 0.76 in favor of boys—i.e. male students comprises 24% greater bulk than that of their female counterparts. However, the situation becomes equal or GPI becomes 1 at higher secondary school level (grade 11 and 12). Pakistan Education Statistics 2006 revealed that overall GPI for pre-primary, primary, middle, secondary (lower), and higher secondary levels remained at 0.81, 0.76, 0.70, 0.70, 1.00, and 0.76 respectively ((Lynd, 2007, p. 24).

Pakistan Education Statistics (as cited in Lynd, 2007, p. 11) reveals following figures for different educational stages:

Table 1

<table>
<thead>
<tr>
<th>S. No</th>
<th>Sub-Stage</th>
<th>Years &amp; Grades</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pre-Primary</td>
<td>2 yrs (0 grade)</td>
<td>20.9%</td>
</tr>
<tr>
<td>2.</td>
<td>Primary</td>
<td>5 yrs (1-5 grades)</td>
<td>49.3%</td>
</tr>
<tr>
<td>3.</td>
<td>Middle</td>
<td>3 yrs (6-8 grades)</td>
<td>15.4%</td>
</tr>
<tr>
<td>4.</td>
<td>Secondary (lower)</td>
<td>2 yrs (9-10 grades)</td>
<td>6.9%</td>
</tr>
<tr>
<td>5.</td>
<td>Higher Secondary</td>
<td>2 yrs (11-12 grades)</td>
<td>2.5</td>
</tr>
<tr>
<td>6.</td>
<td>Tertiary</td>
<td>4-6 yrs (13-18 grades)</td>
<td>4.9</td>
</tr>
<tr>
<td>7.</td>
<td>Total</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

Adapted from: Lynd, (2007), P. 11.

1.2.04. **Structure of the Pakistani Educational System**

Pakistan possesses a combination of diverse educational systems: federal education system, provincial education system, British education system, elite’s (private) education system,
local private education system, and religious or Madarssah education system. Here the researcher presents overview of public or masses’ education that involves a three-fold structure i.e. Elementary, Secondary, and Tertiary or University education. Government of Pakistan provides free textbooks to all enrolled students from primary to secondary (grade 1 to 12) levels.

1.2.04.1. Elementary education. Elementary education officially involves pre-primary, primary, and middle stage. Each category is briefly described here:

1.2.04.1.1. Pre-primary education. “Early Childhood Education (ECE), termed “Katchi” or pre-primary, is defined as both formal and informal as well as public or private education services for children aged 3-5 years” (UNESCO, 2006, p. 2), and is claimed to achieve universal access within next ten years i.e. 2019 (Government of Pakistan, 2009b, p. 27). The same document claims to provide one-year ECE for eligible students, and for concerned teachers two years’ mandatory specialized training in ECE (p. 27). Despite being extremely important, it is a part of primary/elementary education but never accepted as independent stage (Shakil, 2002, p. 6). It dates back to 1970s; however, was discontinued during 1980s and got revived in 1998’s educational policy in the aftermath of Dakar Framework of Action with one-year compulsory ECE from 2002 onwards (UNESCO, 2006, p. 6-8). The examination and evaluation is done at local school level.

Though the private sector involves significantly less number of professionally trained teachers, it is considered better than the public sector teachers. Affording parents prefer to getting their children enrolled in private schools. They believe that they offer better quality ECE through Kinder Garten (KG) and Montessori (used synonymously with no difference) systems (Ministry of Education, 2008, p. 8).
1.2.04.1.2. **Primary education.** The primary education covers five years of schooling for 6-10 year aged children. This stage involves six compulsory subjects: social studies, religious education, general science, and mathematics along with three languages i.e. English and mother-tongue (from grade 1 onwards), and Urdu (from grade 3 onwards). The examination and evaluation is done at local school level.

Pakistan does not seem to achieve the target of universal primary education through Education For All (EFA) by 2015, because current participation rate at this level remains 66% with survival rate of 70% at next level. Lower participation and poor quality primary education are the two important drawbacks at this level (Government of Pakistan, 2009b, p. 28). The minimum qualification for induction as a public sector primary school teacher is 12 year of education with a professional degree of Primary Teaching Certificate (PTC) that is expected to have replaced with B.Ed by 2015 (Government of Pakistan, 2009b, p. 33).

1.2.04.1.3. **Middle/elementary education.** The middle stage involves grade 6 through 8 for 11-14 year students, and usually is a part of high school or secondary school. However, some independent middle or elementary schools also exist. English, Urdu, Mother-Tongue, and Arabic languages are compulsory at this stage. Recently, the provincial government of Sindh has announced to introduce Chinese language too. Among other subjects, religious education (Islamiat), general science, mathematics, social studies, drawing, and technical (vocational work i.e. electricity, wood and metal work) make up elementary curricula. The minimum qualification for elementary teacher is HSC with Certificate in Teaching (CT) as pre-service professional qualification. It has been upgraded to bachelors in both academic (B.A. or equivalent) and professional (B.Ed) but not implemented yet.
1.2.04.2. Secondary education. The secondary education comprises two sub-categories i.e. secondary school certificate (SSC) and higher secondary (school) certificate (HSC). They are briefly explained separately:

1.2.04.2.1. Secondary school certificate (SSC). Secondary education comprises two years i.e. grade 9th and 10th and receives 14+ children for admission in either ‘science’ or ‘arts/humanities’ groups. However, a majority of students opt for former group. Through annual system, the regional Board of Intermediate and Secondary Education (BI&SE) is responsible for admission and examination.

In ‘science’ group 13 subjects are distributed in three components. Component I involve six subjects of social sciences: Urdu, Mother-Tongue, English I, English II, Islamiat, and Pakistan-studies. Component II involve four subjects of natural sciences: Physics, Chemistry, Mathematics, and one from Biology or Computer Science. Except Mathematics all the science-subjects are divided into theory and practical components and carry 85:15 marks respectively (mathematics carries 100 marks). The practical component is assessed internally within school through local and external superintendent, while theoretical part involves regional BI&SE’s annual examination. The third component offer optional choice of one subject out of the two: Commerce and Electricity and is non-functional (i.e. does not matter if the columns are left blank in Board’s certificate).

The secondary school teachers are known as High School Teachers (HST) and Trained Graduate Teacher (TGT) in Sindh and other provinces respectively. They involve a small fraction of Science Teachers appointed after graduation in science. The lowest requirement for induction as a secondary school teacher is a bachelor’s degree (B.A. or equivalent) with B.Ed. After this stage students have multiple options: either to join at technical and professional
diplomas (through mono or poly-technical institutes and colleges) or continue general education at HSC.

1.2.04.2.2. Higher secondary (school) certificate (HSC). HSC receives students aged 16+ passing SSC, and offers “science” and “arts or humanities” groups for two-year education (grade 11th and 12th). In science group students can either opt for “pre-medical” or “pre-engineering” groups to entering in the professional fields of medicine and engineering. Regional BIS&Es offer and conduct annual examinations. Like previous stage physics, chemistry, and biology (broken down into botany and zoology) have both theoretical and practical components.

Higher Secondary Schools and Intermediate Colleges offer HSC through “subject-specialists” and “lecturers” respectively within public sector. The colleges are well developed and managed than the former ones. The minimum qualification for subject specialists is a master’s degree in both academic (16 years of education) and professional (M. Ed/ M. A. in Education) degrees, while college lecturers do not require the latter professional degree. The teachers of this stage are Gazetted-Officers in basic pay scale 17 or above. After passing HSC, students can enter professional fields of medicine and engineering, commerce or any other subject for graduation in different professional or general universities.

1.2.04.3. Tertiary or university education. University education (whether professional, technical, and general) starts with qualifying ‘entry or aptitude’ test in related discipline for 18+ students. The Higher Education Commission (HEC) of Pakistan is the controlling body. Universities receive input after HSC for graduation and advanced research degrees of PhD in respective disciplines through three graduation programs: 2-year (under) graduation through affiliated colleges with annual examination; and 3 to 4-year (under) graduation through semester system at universities. Universities are trying to standardize their graduation internationally by
replacing four-year graduation after HSC meanwhile allowing M.Phil to compensate 16-year
against 18-year graduation degree.

A poly-technical diploma takes three years after SSC or matriculation. Professional
graduation in engineering (BE) and veterinary require four years after HSC, while graduation in
medicine requires five years of education after HSC besides one year internship afterwards
(Ministry of Education, 2008, p. 6). A university lecturer requires master’s degree preferably
18 years of education.

In Pakistan currently the number of HEC recognized universities is 137, out of which 74
are public and 63 are private. Sindh has 14 public and 25 private HEC recognized universities
while a few newly established ones are under scrutiny (Higher Education Commission, 2012).

Figure 2
Structure of Education in Pakistan

1.2.05. Administration and Management of the Education System

In the advent of Devolution Plan Action 2000, 18th amendment of the constitution of Pakistan was withdrawn in April, 2011. Consequently, five federal ministries including education ministry and HEC were transferred to the provinces. Before this the education was federally governed through National Bureau of Curriculum and Syllabi and National Textbook Board Islamabad (UNESCO, 1977, pp. 9-10). It still works as a central body for designing and implementing of curricula through limited involvement of provincial bureaus and textbook boards.

The provincial departments concerned to education in conjunction to their respective provincial bureaus of curricula and textbook boards, are responsible for administration and management of education up to HSC or grade 12 through the Ministers and the Secretaries of Education. However, they are not independent but supplementary to federal ones.

At elementary level (especially up to grade 5) the Sub-Divisional Officers for male and female (at Tehsil level) and their team of supervisors monitor primary and elementary schools. They pay regular and surprise visits to their respective schools, and coordinate with the teachers and head teachers. However, at secondary and higher secondary schools the District Education Officer and his team Deputy District Officers are responsible for monitoring and coordination with respective head teachers. Lastly, the Regional Directors of Schools and colleges with their teams, monitor higher secondary schools and colleges.

1.2.06. Historical Overview of Educational Policies

Pakistan inherited educational system with little involvement of science curricula at primary and middle levels while physics and chemistry were part of secondary level (Iqbal as cited in Rehman, 2004, p. 99). The founder of Pakistan from the very beginning in his note at
the First National Educational Conference convened in October-November 1947 emphasized science and technology, and considered it crucial in the development and better economy (Khan, 1997, p. 648). But the government could not address the recommendations as the problems and issues of newly established country posed a problem of survival.

Then, the National Commission on Education (NCE) was established in 1959 during military regime of General Ayoub Khan. It got the maximum implementation period of ten years. During that tenure middle school level poly-technical education enhanced; technical, vocational, and general-science subjects were introduced at secondary level; and science curricula i.e. physics, chemistry, and biology at secondary level was modernized. However, extension of 2-year graduation to 3-year triggered political unrest. Consequently, the government had no other option than to withdraw it (Khan, 1997, p. 649; Rehman, 2004, p. 30).

The latter two educational policies of military and elected governments of 1978 and 1972 respectively emphasized the uplift of science education in terms of raising and equalizing proportion of students in arts and science groups, and introduced mathematics at secondary level. However, both policies wasted their time and energy in “nationalization” and “Islamization” of education respectively (Khan, 1997, pp. 650-51). Additionally, The Educational Policy of 1992 could not be implemented due to political instability.

The main thrust of the National Education Policy 1998-2010 was uplift of higher education, and focused research at university level. The science curricula from grade 9 through 12 was also revised. Under that policy, the Science Education Project (phase I & II) was completed in 1993 and 1998 respectively. It focused mathematics and science education at secondary school level. Under the said project five Science Educational Centers (one at national and four at provincial level), and 935 secondary science laboratories were established; 4350
science-kits were provided at secondary school level; 105 teacher-training-institutes/campuses were opened; and 19 teachers/administrators were trained at international level and 13,630 at national level respectively (Asian Development Bank, 1999, p. 6).

The latest National Education Policy 2009 claim to raise existing expenditure on education from 2.7 GDP to 7% by 2015 (Government of Pakistan, 2009b, p. 13). It seems unrealistic as during last five years it remained below 3%. The current policy lay emphasis on: uplifting of research and related activities through universities; determining National Standards; suggesting English as means of teaching for mathematics and science related subjects from grade 4 onwards; raising minimum qualification graduation in academic and professional (B. A./ B. Sc. or equivalent with B.Ed) for induction of elementary teachers; suggesting introduction of more student-centered pedagogies; recommending special cadre for teacher trainers; ensuring revision of curricula of pre-service degrees; and providing cyclic in-service training of all the teachers (Government of Pakistan, 2009b, pp. 12, 20, 22, 29, 33, 34).

It is a tragedy that all the educational policies were overambitious. They simply failed to achieve targeted objectives due to corruption, political interference, inability to utilize funds, and mismanagement (Government of Pakistan, 2009b). Science subjects are taught at secondary level through lectures and poor-quality textbooks. However science curricula was revised in 1968, 1986, 1990, and 2002 (Rehman, 2004, p. 29), while the latest revision started in 2006 and its few projects are still in process (Government of Pakistan, 2009a).

1.2.07. Importance of Science and Chemistry in Daily-Life

Science plays pivotal role in our daily life. Its role cannot be overemphasized in any walk of life. Hornby (as cited in Rehman, 2004) reveals that ‘Khemia’ flourished in Egyptian and Greek civilizations. During the Muslims’ period it became ‘al-Kimiya’ that later on became
‘Alchemy’ in English (p. 24). Since chemistry studies the composition and properties of matter and the chemical changes involved in it (Sindh Textbook Board Jamshoro, 2012b) thus we can never isolate any product, process, and service from chemistry in our daily life.

Different branches of chemistry contribute in our social life. Hydro-carbons i.e. purification and extraction of natural gas, coal, fuel and petroleum products, alcohols, and other organic compounds (having carbon and hydrogen as major constituents) are the product of organic chemistry. Compounds of all elements other than carbon come under inorganic chemistry. Diseases and their curing medicines, and chemical reactions occurring in living organisms come under bio-chemistry. Environmental pollutants and the way to reduce environmental (air, water, land) pollution, global warming, ozone depletion, green-house-effect are studied through environmental chemistry. Study and use of nuclear particles for human welfare i.e. X-rays, MRIs, CT scans, lithotripsy of renal stones, chemo-therapy in cancer, use of laser in optical diseases, are a few examples studied by nuclear-chemistry.

Chemistry not only is embedded in every visible and touchable object (Helmenstine, 2012) but even “the emotions like love, jealousy, envy, infatuation that you feel are a result of chemical messengers, primarily neurotransmitters” (oppapers.com). Students selecting chemistry could start their career in pharmaceuticals and drugs, medicine, textiles, nutrition, and manufacturing industry. They all confirm that we cannot live without a know-how of chemistry.

1.2.08. Pedagogical Methods related to Sciences

Different authors and researchers studied, and assessed effectiveness of different teaching strategies and methods against our local traditional teaching (in Pakistani context). The empirical evidence in our local context revealed these shortcomings:
a) In-sufficient science-teachers especially female science teachers (EdQual, 2007; Soomro, 2009); teachers hardly cover all the prescribed content of curricula, and are habitual of selective teaching and poor professionalism (Christie & Afzaal, 2005, pp. 3-4).

b) Poor professional teaching, theory-ridden teaching and learning, inadequate and uncompetitive science teachers, overcrowded science classrooms, in-adequate laboratories, equipments, and related ICT/audio-visual aids (Dahar & Faize, 2011; Naseer-ul-Din, Iqbal, Khaleeq, & Rehman, 2010; Khurshid, 2008; Sarwar & Hussain, 2010; Soomro, 2009); poor integration of globalization in 1-year B.Ed curricula (Sadruddin & Wahab, 2013); greater students’ misconceptions about learning of chemistry (Awan & Khan, 2013).

c) Different experimental studies found our traditional teaching of sciences at secondary level as uncompetitive and ineffective against Systematic Approach to Teaching and Learning Chemistry (SATLC) (Nazir & Naqvi, 2012); project-method (Hussain, Ahmed, Muben, & Tariq, 2011); inquiry teaching method (Hussain, 2011).

All these factors call for a thorough evaluative study of science related subjects against the teaching criteria (lesson-planning, presentation/delivery, and formative assessment of teaching) with respect to professional degree of B.Ed. in our Pakistani context.

1.2.09. Lesson-Planning, Presentation, and Formative Assessment

1.2.09.1. Lesson planning. Effective and experienced teachers plan their lessons in detail involving all the important steps and stages of a lesson for ensuring a smooth and clear progression for both the teacher and the taught. The figure 3 on next page explains the ingredients of lesson planning and their relationship:
According to Kochhar (as cited in Gujjar, Bajwa, Shaheen & Rehman, 2011) lesson planning enables teachers to plan, organize, and contemplate over classroom teaching objectives, subject-matter, students’ activities, teacher’s methods and strategies of teaching, and formative assessment in order ensure effective teaching and learning. It helps proper utilization of appropriate resources and activities according to the contextual needs of learners and curricula (pp.111-112).

1.2.09.2. Presentation/delivery of the lesson. There is no single best method that fits all sizes (Allama Iqbal Open University, 2012). The teachers, therefore, choose appropriate teaching and learning resources and methods in relation to the contextual needs of learners and content. As mentioned in earlier section multiple local studies confirm that interactive, and inquiry based teaching and learning through experience and experiments yield better learning outcomes in science related subjects including chemistry. Moreover, setting specific learning objectives on the basis of cognitive, affective, and psychomotor domains of Bloom’s taxonomy not only adds to proper teaching and learning but ensures valid and reliable assessment of the students. The
soul of effective teaching and learning is using varied teaching and learning methods through appropriate ICT/audio-visual aids and activities. Thus the teacher must be creative and innovative in teaching or delivery of the lesson.

**1.2.09.3. Formative assessment of the lesson.** Formative assessment is part of students’ evaluation at large. It not only helps find out the students’ learning hurdles during classroom teaching, but it also helps to overcome them. It can be done through proper questions, quizzes, tasks, simulations, and tests. Baehr (n.d.) presented importance of assessment and evaluation in these words:

> Educators use two distinct processes to help students build lifelong learning skills: assessment and evaluation. Assessment provides feedback on knowledge, skills, attitudes, and work products for the purpose of elevating future performances and learning outcomes. Evaluation determines the level of quality of a performance or outcome and enables decision-making based on the level of quality demonstrated. These two processes are complementary and necessary in education. (Baehr, n.d., p. 441.)

**1.2.10. Local Studies/Reports on Teaching of Sciences and Chemistry**

Local studies in the context of Pakistan and Sindh mostly focus on determining the effectiveness of particular teaching method or approach. However, in our local context of Sindh there is shortage of evaluative studies on teaching of sciences including chemistry regarding lesson planning, lesson delivery/teaching practices, and formative assessment in relation to the criteria of B.Ed. The researcher presents a brief review of related studies:

EdQual’s (2007) report while reviewing literature on Pakistan’s secondary school mathematics and science reveals that science teachers were in short supply throughout, and the situation is worse with regard to female teachers as they were not available even in townships
and cities, because generally there is no specific budget, advertisement and recruitment for the same (p. 9). But they are appointed in a general cadre of secondary school teachers. Hoodbhoy (as cited in Christie & Afzaal, 2005) reviewed related literature and found that at least 30 reports have pointed out multiple flaws in our education and annual examination system: subjectivity, selective coverage of the course, dependence on prescribed textbooks, organizational shortcoming, learning by heart, and unfair means in examinations (pp. 3-4).

Nazir and Naqvi (2012) conducted their study on the effectiveness of SATLC (Systematic Approach to Teaching and Learning Chemistry) against traditional teaching. It involves presentation of ideas in a sequence using sequenced bits of information through multiple diagrams. In this way, learners could understand and find the relationship of all the parts to make up a whole concept and come up with final diagram of the concept in hand. The authors found that SALTC was significantly more effective in teaching of chemistry against traditional one (Nazir and Naqvi, 2012).

Hussain, Ahmed, Muben, and Tariq (2011) conducted an experimental study at a public school of Abottabad. It examined the effectiveness project method on secondary school students’ academic achievement in physics. The treatment was given to 40 students for six weeks involving 40 minutes a day. Findings discovered that students taught through the project method achieved better learning outcomes than traditional teaching in terms of deeper conceptual understanding and translation of knowledge in to real life situations (pp. 23-34).

Sarwar, and Hussain, (2010) in their study (from a sample of 150 teachers) conducted in Punjab province reveal that both student teachers and cooperative classroom teachers of Punjab (Pakistan) were feeble in discipline, instructional planning, behavior management, and subject knowledge. Lesson-planning remained the topmost burning problem of teachers. Out of 25
areas that were studied, the most crucial problems involved lack of lesson planning, teachers’ poor content knowledge and presentation, use of corporal punishment, and poor quality formative assessment. Top 10 burning problems were placed in this sequence: Lesson planning, Previous knowledge, Flow and continuity of lesson, Teaching aids, Induction/introduction of lesson, Student involvement, Amount of course covered, Flow of course, and Recapitulation and Conclusion.

Recognizing lesson planning as the foremost step for better teaching and learning Gujjar, Bajwa, Shaheen & Rehman (2011) conducted their study in Attok (Punjab) from a sample of 100 government high school teachers. They found that majority of the teachers simply did not plan for their lessons for they blamed that they did not get proper training during in or pre-service professional training (p. 126).

Saeed and Mubeen (2010, pp. 36-40) evaluated the competencies of secondary school teachers of Punjab in the context of curriculum planning and instruction. Their study involved a random sample of forty schools (20 each for rural and urban schools) from each district involving 800 head teachers, and 4000 respondents each from teachers and students strata. The researchers found that the majority of students and teachers believed that the teachers had mastery over course content, planned for full academic year, and completed the prescribed course. However, their institutional heads contradicted and did not agree in this regard.

Suleman (2011) in their evaluative study of the performance of promoted secondary school teachers of Khyber Pakhtunkhwa concluded that majority of the teachers teaching science subjects did not possess required knowledge and professional skills in content knowledge; teaching methodology; lesson-planning; good preparation for teaching; support towards developing creativity among learners; use of OHP and other modern audio-visual aids;
appropriate use of scientific equipment and experimentation; and formative evaluation of
learners along with other shortcomings. Moreover, the study revealed that students were not
satisfied with their teachers’ teaching methods (pp. 147-48).

Naseer-ul-Din, Iqbal, Khaleeq, and Rehman (2010) in their evaluative study aimed at
identifying problems of science teachers at secondary level from randomly selected 18 science
teachers. They concluded from their findings that students had no problems of textbooks (they
are provided by the government in free of cost) yet mostly classrooms were overcrowded for
science students. Moreover respondents pointed out theory-ridden teaching with inadequate
periods/classes of practical work or experimentation besides unavailability and ignorance of
available science related audio-visual aids. Though the study did not involve proper sampling, it
at least identified crucial areas in science pedagogy.

Suleman (2011) in their experimental study on the effectiveness of educational
technology in teaching chemistry at secondary level in Pakistan found that use of educational
technology had positive and significant impact of students’ learning outcomes (p. 116).

An experimental study in Pakistan comparing effectiveness of Inquiry Teaching Method
and Traditional Lecture Method implicated a sample of 120 female students of ninth grade. The
author found that former teaching method led to significantly better post scientific attitude than
that of traditional lecture method (Hussain, 2011, p. 441).

Iqbal, Azam, & Rana (2010) conducted a study from a sample of 200 Pakistani secondary
schools science teachers to explore if their beliefs fell into existing/faulty (science as mere a
compilation of facts and unchanging knowledge leaving little room for further discoveries thus
teacher has to transfer the knowledge) or contemporary approach of science (science is always
open for change, and the ideas and their meanings are always prone to be delineated through
learners’ interaction with the teacher and real world). They found that majority of teachers beliefs (60.45%) held the former/faulty view of science, while only 32.32% responses supported contemporary approach, putting the rest 7.23% at neutral (p. 35). This situation points out the failure of both science curricula and its teaching.

Khurshid (2008) in his evaluative study conducted from 5 randomly selected secondary schools (3 girls’ and 2 boys’) with a sample of 80 students and 87 teachers. They author found that even untrained teachers having B.A. or B.Sc accounted for better performance than the trained teachers having same qualification will additional B.Ed and M.Ed (p. 445). Though the sample did not truly represent actual population, it at least points out the ineffectiveness of professional training courses/degrees if not a simple failure.

A study analyzed the impact of presence of science equipments and science laboratories on the students’ related learning outcomes in Punjab (Pakistan). It found that insufficient science laboratory and lack of practical work (Physics, Chemistry, and Biology) negatively influenced students learning leading to isolated theory ridden teaching. The study further revealed that most science teachers for a few days (usually when annual examinations are very near) used science laboratory and equipments for teaching practical component. However, shockingly many of the science teachers were found not using the same throughout the session (Dahar & Faize, 2011).

Soomro (2009) conducted his research in District Shikarpur (Sindh) to find out impact of lab work on quality of science learning. He used questionnaires to collect data from the head teachers. Additionally, he analyzed students’ five-year result/achievement (first three grades—A1, A, and B) with relation to available science laboratories and equipment of all 13 secondary school (9 boys’ and 4 girls’). He concluded that there was perceived shortage of science teachers; the 38% of the total secondary schools had no science laboratory and equipment;
mostly the science laboratories had inadequate science equipment and related facilities; even most of the schools’ time-tables did not show any period of laboratory work; overall analysis showed students’ lower achievement in practical than that of theory examination; no quarter helped science laboratories and no regular budget was provided for proper functioning of science laboratories; however, students with better lab equipment and facilities showed better marks in their SSC practical examination of Physics, Chemistry, and Biology (pp. 82-83).

All these factors demand a thorough evaluative study of science related subjects including chemistry at secondary school level to get true picture in its actual picture of teaching and learning, and to assist the stakeholders in overcoming crucial problems.

1.3. Statement of the Problem

The Government of Pakistan (2009a) with regard to preparation of teachers discerns the fact that “The professional preparation of teachers in Pakistan is neither standardized nor based on acceptable professional standards” (p. 5-6). The B.Ed. is minimum required professional degree for both secondary school teachers including Science Teachers in Pakistan.

Though in Sindh, teachers having M. Ed. Degree comprise 15.98% out of 138,007 total teachers work force which is double than that of Punjab’s 7.68% teachers having M.Ed. out of 304,224 number of total teachers in the province (Pakistan Education Statistics, 2009), their teaching and pedagogy hardly reflect professional knowledge and skills. Mehrunnisa (1998) while discussing the effectiveness of professional pre-service degrees claims that: “There is widespread public agreement that none of these certificates are valid or reliable measures of academic or professional competence” (p. 4). The Government Colleges of Education, the Government Elementary Colleges of Education, and Department/Faculty of Education at public
and private universities offer pre-service training of B.Ed. and M. Ed. for teacher-candidates at secondary schools level including science-teachers.

These professional degrees teach and train the teaching force to use different, diverse, and innovative and inquiry-based teaching methods for teaching different curricula. The professional training claim that there is no single best method to cater for all the teaching and learning needs of diverse students. Thus the teaching methodology and resources must be tailor-made according to the contextual requirements of learners and content. However, inquiry-based teaching methods are considered more effective for science related disciplines (AIOU, 2012; University of Sindh, 2012)

The professional degree B.Ed. teach and train our prospective teachers to plan their lessons in terms of setting specific objectives, using appropriate teaching methods and resources according to contextual requirements of learners and content, and their formative assessment.

Regarding lesson planning, Gujjar, Bajwa, Shaheen & Rehman (2011) conducted their study in Attok (Punjab) on a sample of 100 government high school teachers. They found that majority of the teachers simply did not plan for their lessons for they blamed that they did not have proper training in this regard during in or pre-service professional training. However, in Sindh’s context hardly any specific study is available.

After lesson planning the presentation of the lesson i.e. implementation of planned classroom teaching through specific teaching method, resources, and activities according to the contextual needs of learners and content is the major issue on the part of teacher. The students’ motivation, learning, and generalizability of learned knowledge and skills to practical or professional real life all depend upon teacher’s presentation of the content and selection of learning resources and activities.
Sarwar and Hussain (2010) in their study conducted from a sample of 150 teachers in Punjab province reveal that both student teachers and cooperative classroom teachers of Punjab (Pakistan) were incompatible in planning their lessons, classroom discipline, and knowledge of subject matter. Among top 11 burning problems lesson planning stood in the first place, the remaining 10 problems were sequenced as previous knowledge, flow and continuity of lesson, teaching aids, induction/ introduction of lesson, student involvement, amount of course covered, flow or speed course coverage, and recapitulation and conclusion (p. 183). The situation in Sindh is worse than that of Punjab. However, there is dearth of such evaluative studies.

Formative assessment is an integral and most important part of professional teaching besides ensuring a conducive and learner-friendly environment for teaching and learning process. Well known phenomenologist Carl Rogers believe that two-way communication is impossible where the teacher is dominating factor and teacher-centered education is the rule of thumb. Milhollan and Forisha (1972) while explaining Rogers’ 15th and 16th phenomenological principles argue that people/students hardly experience things that are contradictory to their self-concept and reveal their actual understanding, fears, and hurdles in learning unless they are provided a non-threatening or friendly learning environment (pp. 110-113).

The situation is worse in Pakistan since most of the High School Teachers including science-teachers use corporal punishment during their classroom teaching. Therefore very few students interact and dare to ask or respond to teachers’ questions. Government of Pakistan (2007) in collaboration with UNICEF surveyed 700 children aged 8-18 years and found that about 74% children were reported as being punished in terms of being made murgha, standing in corner, sit ups, taking round etc at schools (p. 22). The situation becomes unbearable when
corporal punishment sometimes results in students’ bone/limb fracture within public schools by teachers and principals (The Express Tribune, January 14th, 2012).

The researcher could not find single study or published paper on formative evaluation/assessment of science related subjects at public sector secondary schools of Sindh. All those facts genuinely call for a evaluation of the existing pedagogical practices, and activities in relation to the criteria of professional degree of B.Ed.

The present study thus aims at evaluation of teaching of chemistry at public secondary level (grade 9th and 10th) in Pakistan with relation to general professional skills, teachers’ lesson-planning, delivery/actual classroom teaching methods, students’ classroom activities, audio-visual aids/resources, students’ formative assessment, and coverage of theoretical and practical curricula, from learners’ perspective.

1.4. Objectives of the Study

My study focuses:

- To find out what are the existing pedagogical practices, methods, techniques, and teaching learning activities in teaching of chemistry at public secondary school level.
- To explore how learners perceive existing professional teaching of chemistry.
- To assess the worth of prevailing pedagogical practices for teaching of chemistry against the criteria of B.Ed. at the above level, from learners’ perspective.
- To examine the association between students’ test-scores and some aspects of professional teaching of chemistry (general professional skills, lesson planning, teaching methods, audio-visual-aids, students’ classroom activities, students’ formative assessment, and coverage of theoretical textbook and practical component).
• To determine the relationship between students’ test-scores and some demographical aspects (gender, type of school, location, parents’ income, occupation and education, students’ home-study, after-school tuition, tuition-subjects, and their favourite subjects).
• To find out difference between students’ test-scores and above demographical aspects.
• To suggest the concerned stakeholders of taking proper corrective measures within available human and material resources for providing better quality education.

1.5. Research Questions

The present study specifically aims at exploring the solution to these research questions:

i) How do the learners perceive existing teaching of chemistry at public secondary schools?

ii) Whether and up to what extent is the existing professional teaching of chemistry in line with the suggested criteria of B.Ed from learners’ perspective?

iii) Whether and up to what extent do the public secondary school students’ test-scores relate to some aspects of professional teaching of chemistry as assessed from learners’ perspective?

iv) Whether and up to what extent do the public secondary school students’ test-scores relate to some of their demographical aspects as assessed from learners’ perspective?

v) Whether and up to what extent do the public secondary school students’ test-scores differ from some of their demographical aspects as assessed from learners’ perspective?

Note: 1. The ‘professional teaching of chemistry’ specifically aimed at assessing these aspects i) general professional teaching skills, ii) lesson-planning, iii) teaching methods, iv) audio-visual aids, v) students’ classroom activities, vi) formative assessment, vii) course coverage theory, and viii) course coverage practical.

2. The demographical aspects specifically involved these aspects: i) gender, ii) type of school (boys-only, girls-only, co-education), iii) location (rural/urban), iv) parents’ income, v) parents’
occupation, vi) parents’ education, vii) students’ home-study, viii) private tuition, ix) tuition-subjects, and x) favourite subject.

1.6. Significance of the Study

Assessment and evaluation are never ending processes in every field of life. They are coral parts of an ongoing process or a finished product. Both processes are crucial in maintaining efficiency and effectiveness, and leading towards better standards and criteria. In educational setup they not only explore the shortcomings and weaknesses within curricula, teaching, learning, and administration against specific criteria or standards, but also are helpful to overcome them through initiating required changes in respective areas. They are cornerstones to maintain and enhance efficient and effective teaching and learning of the students, and are soul of scientific inquiry and experimentation.

Assessment and evaluation of teaching and learning can be done from the view points of: self, peers, teachers, students, and administration against specific criteria/standards. Since all industries involve and evolve through development in chemistry and students are the actual beneficiaries of teaching and learning process. Thus, this study targets at assessing the teaching of chemistry from their perspective at secondary school level.

In Pakistan little effort is done to assess and evaluate existing teaching, contemporary ideas about teaching and learning in our local context. Therefore, our teaching and learning is not competitive with regional and international criteria and standards. Hardly any study is available that has assessed teaching of chemistry at secondary school level with regard to the criteria of lesson-planning; lesson-delivery/classroom teaching methods, activities, and resources; and formative assessment suggested in the curricula of B.Ed. Therefore the present study assessed and evaluated above three variables of professional teaching.
It would help to bring actual and holistic picture of teaching and learning by finding its worth and merit against the criteria of professional teaching of B.Ed that is minimum requirement for induction as a secondary school teacher. Moreover it would assist the teacher educators and policy-makers to improve teaching and learning by incorporating suggested and recommended measures in our pre and in-service trainings, curricula, and administration.

1.7. Delimitations of the Study

The present study is delimited to all (male and female) public secondary school science teachers of grade 9th and 10th of District Jamshoro. And because learners are the actual beneficiaries therefore teaching of chemistry is assessed through students of grade 9th and 10th enrolled in current academic year 2013-14. The other stakeholders related to pedagogy i.e. teachers, administrators, managers, are not included in this study. Moreover, the stakeholders from teachers’ professional degree-awarding institutions are left out for future researchers.

1.8. Definitions of Key Terms

Teaching: “any of a host of activities which have in common the structuring of a situation to enable learning to take place” (Donald Gillies, 2012, A Brief Critical Dictionary of Education).

Teacher Education: “any of the formal programs that have been established for the preparation of teachers at the elementary- and secondary-school levels” (Teacher Education, 2012, in Encyclopedia Britannica [online]).

Inquiry-methods: Traditional lectures and demonstrations are usually blamed as teacher centered method. However, science related disciplines require inquiry-based teaching and learning methods allowing students to explore the natural world by themselves through learning by doing (Dewey, 1934).
**Curriculum:** broadly involves all the planned activities but here it is used in terms of “...the set of courses, course work, and content offered at a school ... that may be partly or entirely determined by an external authoritative body” (Sharma, P. 2009, p. 2).

**Professional Degrees/Qualifications:** professional degrees i.e. Primary Teaching Certificate (PTC), Certificate in Teaching (CT), Bachelor of/in Education (B.Ed), Master of/in Education (M. Ed), Master of Philosophy [in Education] at secondary level.

**Science Pedagogy:** it is limited to the (method and resources used for) teaching of chemistry, physics, mathematics, and biology at public sector secondary schools (grade 9th and 10th).

**Secondary Level/Schools:** pertaining to grade 9th and 10th (especially Government run schools).

**Public sector schools:** the schools fully financed and managed by the government.

**Assessment:** Martin (2006) describes assessment as obtaining and interpreting information about both the students’ and teachers’ attainment in terms of what they know and can do. For this purpose assessment must reflect the goals and objectives of the curriculum and must represent actual achievement (p. 295).

**Evaluation:** “whereas assessment focuses on gathering and synthesizing information, the term evaluation usually refers to the process of making judgments, assigning value, or deciding on worth” (Arends, 2004, p. 218). It is a broader term involving assessment as its part.

**Formative assessment:** is a process to assess both previous and existing knowledge before or during classroom teaching to assist current planning but not to make final judgment. Student grouping, unit and lesson planning, and instructional strategies to overcome students’ problems are its main areas (Arends, 2004, p. 218). Figure 4 presents flow-chart of the study:
Organization of the Study (Flow-Chart)

Chapter 1
Introduction and Background of the Study

Chapter 2
Theoretical Background

Chapter 3
Methodology

Chapter 4
Results

Chapter 5
Discussion And Conclusion

Figure 4
CHAPTER II

REVIEW OF THE RELATED LITERATURE

This chapter is divided into five major sections. The first section, Development of Education/Teaching involves historical, philosophical, and psychological perspectives of education and teaching. The second section, Professional Standards, Trainings, and Curricula deeply looks into existing national professional standards for teachers, professional pre and in-service trainings, and the curricula of B.Ed in the context of Pakistan. The third section, Teaching Methods of Sciences and Chemistry discusses the appropriateness of teaching methods and models for sciences and chemistry. The fourth section, Measuring Effectiveness of a Process or Product analyses the effective ways and methods to determine the worth of teaching and learning at public secondary schools. The fifth section, Instructional Planning critically reviews different aspects of instructional/lesson planning. The sixth section, Hazards and Safety Measures in Chemical Laboratory underscores the precautionary and emergency measures related to use of chemicals. The seventh and the last section, Empirical Evidence on Professional Teaching of Sciences and Chemistry deals with available related studies and their findings.

2.1. Development of Education/Teaching

The most important role of education is the development of human capital for providing effective and need-based services that equip us with required goods and services. Government of Pakistan (2009b) claims, “Education is a vital investment for human and economic development and is influenced by the environment within which it exists” (p. 9). Davis (2003) considers education as a means to develop skillful thinker and problem solver and to adopt flexibility to change and discover new and better things.
Our economy, technology, and social systems are more or less the products of our education. On the one hand, education produces mechanical and habitual skills that do not require too much intellect; whereas, on the other hand, development of critical thinking is its top most and precious product. It enables individual to ponder over the relationship between: the man and society/universe; the man and the God; matter and soul; pain and pleasure; dependence an independence/interdependence of things; and construction and destruction.

Formal education is a conscious effort to create positive change in behavior of individuals so that they could develop their potentials to the maximum, and become balanced people through proper development of physique, intellect, emotions, and social relations and skills. Teaching is inseparable part of formal education, thus many researchers believe teacher as the most important factor contributing towards student’s learning (Cooper & Jackson, 2005; Cooper, 2004; Darling-Hammond, 2000; Frampton, Vaughn & Didelot, 2003; Levine & Cooper, 1991; Sanders & Rivers, 1996; Zohar, 2004; Zohar, Degani, & Vaaknin 2001; Mahmood, 2006).

MacNeil, Cavanagh, and Silcox (2003) state that the term pedagogy is derived from Greek word “paidagogos” meaning, the teacher of children. It is more comprehensive than simple instruction and was not very common a decade ago, but now is used frequently among teachers’ fraternity and other stakeholders of education (p. 5). They clustered literature on pedagogy in to four classes of meaning i.e. pedagogy as a comprehensive term including all aspects of teaching and learning; pedagogy as a political tool to produce students with required mind and skills; pedagogy as a student-centered learning; and pedagogy as student-teacher relationship (p. 5). The researcher on the basis of pedagogy as a comprehensive term discusses its historical, philosophical, and psychological perspectives across the history:
2.1.1. Historical Overview of Pedagogy

The researcher discusses here the history of pedagogy within the themes of primitive education, education in Greece, universal and compulsory education, education in Muslim period, and modern education:

2.1.1.1. Primitive education/pedagogy. Pedagogy (or teaching children) is as old as the family life. It started for the first time when on the Earth the first parents had their children and taught them how to survive. Hindu caste-society is considered the primitive one where social rank and special vocation were determined not by free choice but by the accident of child-birth in particular caste (Brahmins who were priests) thus education did not care for individuality. Chinese people in past taught their children to learn and copy the traditions. Despite not finding much knowledge about primitive educational practice, the history does tell us that teaching was held under the shade of trees or like, exercises in writing were done on the sand with a stick initially, then on palm leaves with an iron style, and later on, on dried plane-tree leaves with ink, corporal punishment with rod and other means existed (Gebril, 1889, pp. 5-6).

The same author states that in the first centuries of Christian era it was Jews (Israelites) who for the first time gave the concept of public education in both senses i.e. obligatory or compulsory and universal or public. Hebrew and Biblical period reveals use of severe punishment with rod and other means for children. Multiple propositions from the Bible favor severe punishment for children: “He that spareth his rod, hateth his son . . . Thou shalt beat him with the rod, and shalt deliver his soul from hell." Moral education was main thrust. Only boys got education of reading and writing. The girls were taught spinning, weaving, cooking, and also singing and dancing (Gebril, 1889, pp.7-8).
The aim of education for the Romans was to develop brave soldiers inured to fatigue, and yield to discipline; for the Athenians to produce people having harmony of moral and physical perfection; for Hebrews inculcating piousness and virtuousness was important (J. Simon as cited in Gabriel, 1889, p. 7). For the Hindus and the Chinese, making children mechanical to follow traditions remained important. The boys were allowed to get education, however, females were trained in house hold skills i.e. spinning, weaving, cooking, and children rearing. The discipline remained harsh. Corporal punishment with rod and other means was common.

From religious point of view Adam and Eve was the first couple landed on the earth. From the first prophet Hazrat Adam to the last prophet Hazrat Muhammad, many prophets and religious reformers in every nation (often quoted as 124,000 prophets or reformers) were sent by the God (Allah) for proper guidance and education of humans. Many prophets explicitly called themselves as teachers. A hadith (saying) of the last prophet Hazrat Muhammad (peace be upon him) states: ‘No doubt, I am sent as a teacher’. Regarding education the last revealed holy book—Quran—states that getting education is obligatory for both Muslim men and women (Sindh Textbook Board Jamshoro, 2011).

**2.1.1.2. Education in Greek period (classical education).** Here in this sub-section, the researcher briefly discusses thoughts of great Greek philosophers and educationists i.e. Socrates, Plato, and Aristotle.

**2.1.1.2.1. Socrates’ and Plato’s education.** Socrates (469-399 BC) and Plato (427-347 BC)—the great Greek philosophers and educationists—were the most significant figures throughout the history of education and pedagogy. Plato—the student and mouth-piece of Socrates—propagated and to some extent extended the ideas of Socrates therefore Socrates and platonic school of thought is often known as Platonic philosophy or ‘Idealism’. In his
“Republic” that is considered the first ever treatise in the history of education, Plato gives an account of Platonic philosophy. He practiced it in his “Academy” (386 B.C.), the oldest seat of learning and is recognized as the first university. The Republic is best known for its defense of philosophy of justice and education (Dillon, 2004). Socrates believed that students themselves should reach the truth but not by force, and education should be “more like play than work” (The Republic 536d, as cited in Dillon, 2004). I sum up the main hallmarks of Platonic society and education as under:

- Contemplation about “forms” or ideas (Idealism based on spirituality) were considered leading to reach ultimate reality of the world.
- There were three layers of society i.e. philosophers or rulers, auxiliaries or military-men, and artisans or craftsmen. State was responsible for providing education to both male and females with no discrimination. And Plato’s education on merit for those who were gifted was criticized for supporting only for the upper or elite class.
- Boys and girls were considered equal to access and get formal education.
- Reasoning, dialect, and logic were focused through mathematics, and they were preferred to industry, business, and military related professions.
- The two components i.e. body and soul were thought to be the basic constituents of humans. Gymnastics and music catered for their development respectively; however, the soul and spirituality were considered more important than physique.
- The ‘dialectic’ or critical dialogue or discussion involving a series of questions and answers remained the method of teaching.
- The tenure for formal education was 7-50 years involving 5 stages: 0-7 (pre-education of morality at home), 7-17 (elementary school education: music, elementary math, and
gymnastics), 18-20 (military training or battle field testing), 20-35 (advance knowledge in literature, mathematics, and philosophy), 35-50 (dialectics and philosophy and working on subordinate post in ruling), 50-above (those who reached the vision of ‘Good’ can divide time between reading and governing).

2.1.1.2.2. Aristotelian education. Aristotle, (427-347 BC) the disciple of Plato, unlike his teacher held that material things exist independent of the human mind. Aristotle gives more importance to material or sensory objects in the first stance thus his philosophy of education is generally known as “realism,” but he does not reject the importance of Platonic “ideas or forms”. He admits the we arrive at enduring ideas or forms through the study of material objects that exist in themselves, independent of our mind. Both Plato and Aristotle believed ideas as reality, but their approaches of reaching at them were different; Plato (and Socrates) thought “dialectic” or critical discussion and discourse led to reality, however, according to Aristotle, we can get to reality by examination of particulars or material objects. The former believed in conceptual knowledge while latter opted for perceptual one (Ozmon & Craver, 1986, pp.1-5).

Aristotle’s focus on specifics/material objects paved the way to refine his logical method of inquiry into an inductive scientific approach leading to industrial revolution in the world.

2.1.1.3. Education in Muslim period. The Muslims dominated in science during 700 to 1500 (Golden Age of Islamic Civilization) when the Europe was in “Dark Ages”. Ibn Sina, Al-Khwarizmi, and Al-Biruni greatly contributed toward mathematics, geography, astronomy, physics, chemistry, and medicine (Faruqi, 2006; Badawi, 2002).

Haitham, Ali ibn Isa, al-Ghazzali, al-Zarqali, and Omar Khayyam were prominent researcher and scholars in different areas of science (Sarton, 1927, p. 17).

According to Faruqi (2006) due to the Muslims advance in science the “Renaissance” occurred among Europeans. The Muslim scholars in Persia, India, and Far East gave a great boost to pharmacology and pharmacy. Manufacture of different syrups, juleps, and apothecary shops are a few examples of their efforts. Ibn al Baytar’s Book ‘Al-Jami fi al-Tib’ involved a significant research that presents detailed records of the herbs and plants found at Mediterranean coast between Spain and Syria (p. 394). Their scholarly writings (hundreds of standard books on research, explorations, and inventions) during 600 to 1500 brought revolutionary changes in science and education. Different authors unanimously accepted that they for the first time:

- Rejected the notion of “demons” and “witches”, and explained unusual human behavior as mental disorder. Discovered cure for small pox and measles.
- Invented many things and processes: preparation of sulphide of mercury, oxides and arsenic compounds etc. Cured smallpox and measles.
- Invented and discovered multiple products for industrial and military applications.
- Introduced the concept of ‘zero’ (0) that led to relief from complex Roman calculations.
- Became fathers of Al-chemy, Algebra, Astronomy etc (Faruqi, 2006, p. 393-394; Kettani, 1976; Sarton, 1927).
- Celestial globes, astrolabes, quadrants, and sundials all evolved and developed in Islamic countries. King (as cited by Faruqi, 2006) revealed that “…Medieval European instrumentation was highly indebted to the Islamic tradition, and now it is clear only after ca.1550 did European instrument-makers make technical innovations that had not been known to Muslim astronomers previously” (p. 397).
2.1.1.4. Modern education. The child-centered approach toward education gained its momentum from the Jean Jacques Rousseau’s philosophical book “Emile” (Worthington, 2009). Rousseau in reaction to the Church’s inhumane treatment toward children of his time for teaching morality and goodness, went to extreme and propagated a system of educating children through Emile—an imaginary character in his book. Sophie was also an imaginary female character and companion of Emile in Rousseau’s book. The book is extraordinary and thought provoking throughout. It starts with these opening lines: “Coming from the hand of the Author of all things, everything is good; in the hands of man, everything degenerates” (Worthington, 2009, p. 10).

Rousseau believes that society’s imposition negatively influences the personality of children. Society seriously hinders natural development of children and they are deprived of natural curiosity, common-sense, and intellect. In the words of Rousseau:

At birth a child cries; his earliest infancy is spent in crying. Sometimes he is tossed, he is petted, to appease him; sometimes he is threatened, beaten, to make him keep quiet. We either do as he pleases, or else we expect from him what we please; we either submit to his whims, or make him submit to ours. There is no middle course; he must either give or receive orders. Thus his first ideas are those of absolute rule and of slavery. Before he knows how to speak, he commands; before he is able to act, he obeys; and sometimes he is punished before he knows what his faults are, or rather, before he is capable of committing them. Thus do we early pour into his young heart the passions that are afterward imputed to nature; and, after having taken pains to make him wicked, we complain of finding him wicked. (Worthington, 2009, p. 18)
In short Rousseau does not favor formal curricula, discipline, teaching, and schools but he seems to be in favor of learning through picnics, observation, experiences, and natural consequences. In this way, Rousseau went on extreme to devise learner centered education and excluded the child from the society. Progressive movement reflected that spirit and allowed children to learn on their own with little instruction and discipline; however, John Dewey brought the child back to society through his experienced education. Progressive, Montessori, Kindergarten, Dalton-Plan, and Dewey’s experience-based systems of education are the outgrowths of Rousseau’s learner-centered education. In conclusion the maximum development of learners’ potentials in a natural/pleasant way is the essence of modern education.

2.1.2. Philosophical Perspective of Education

Here, in this section the researcher presents a bird’s eye view of the important philosophical and learning paradigms through looking at ontology and epistemology; behaviorism and phenomenology; subjectivism and objectivism; humanism and constructivism:

2.1.2.1. Paradigms. A paradigm or an approach generally stands for a mould, ideology, perception, presumption or a map of territory. It determines how we “see” the world and develop our perception, understanding, and interpretation. It is not a thing in itself, but the way how we are going to understand/interpret the things (Covey, 2004, p. 23). Thus, approaches/paradigms are powerful lenses through which we see the world (pp. 28-31).

Many authors claim that there are at least three epistemological positions to study ontology. Within the theoretical perspective of positivism, the objectivist epistemology believes that reality exists independently of consciousness, or it is empirical and objective one; and we can accurately study and measure it through the means and methods of natural sciences thus learning and research only aims to discover what is “out there”. In contrast to objectivism, the
constructivism tradition that is closely related to interpretivism theoretical perspective rejects the notion of reality waiting ‘out there’ to be discovered. It supports that truth and meaning do not exist in external world, but people construct it through interaction with the world. Lastly, the third one is the subjectivist epistemology of being linked to the theoretical perspective of postmodernism. It implies that subjects construct meaning from their collective unconsciousness, dreams, emotions, or religious beliefs, but not through interaction with outer world. Therefore, they tend to impose their subjective meaning on the other people and outer world (Chia as cited in Gray, 2004, p.17; Nelson and Hammerman, 1996; Tahir, 2010; Vygotsky, 1978). In psychology for above three approaches the phenomenology, the behaviorism, and the humanism/third force run parallel to subjectivism, objectivism, and constructivism respectively.

2.1.3. Psychological Perspective of Education

Singer and Revenson (as cited in Seefeldt & Foster, 2007) defines psychological development as the development which “. . . involves the growth of an individual’s thinking, emotions, and strategies for coping with the environment” (p. 6). Whereas, Hergenhahn (2009) suggests that (psychological) study of human may generally involve three areas: physique, intellect, and spirit or emotions (Hergenhahn, 2009, p. 523). Thus education of humans must incorporate proper understanding of those three aspects of human psychology.

The psychology has evolved (and still in process) from study of “psyche” (soul), mind, brain, and finally to behavior. Presently it involves both the study of behavior and the mental operations of organisms and humans (Allama Iqbal Open University, 2012). This thesis does not aim at inquiring deeply into the history of psychology and its evolution, it, however, would touch only the important psychological implications related to modern pedagogy and learning within
formal school education. For this purpose the works of Jean Piaget, Lev Vygotsky, B. F. Skinner, Erik Erikson, and Howard Gardner would be briefly discussed here.

2.1.3.1. Learning and education. Education and learning are often inter-woven therefore used synonymously. However, education often refers to planned and positive development (claimed at least!). On the other hand, learning as part of socialization could be positive or negative, yet unplanned. Since children are naturally curious therefore they are able to learn quicker than adults, in general. Formal education refers to well-defined and planned learning from schools to universities. It involves planned curriculum, instruction, imparting agency, and specific time period. However, informal education refers to socialization and cultural learning that is a part of conscious and unconscious effort to bring up children to the standards of a particular culture (Allama Iqbal Open University, 2012).

Technically, learning may be defined as “occurrence of relatively permanent change in behavior of an individual or organism as a result of experience or practice”. Learning is never-ending process and continues throughout life. It involves acquisition of knowledge and skills necessary for development of required physique, intellect, emotions, and social interactions. All permanent changes in behavior are not learning that are not resultant of experience. For example, changes that occur due to maturation do not fall in learning. Similarly, temporary changes that occur due to fatigue, intoxication or drugs prevail do not satisfy the criteria of being permanent (Allama Iqbal Open University, 2012).

“Children, and even young children are often more competent, more intelligent, and more capable than they are perceived or understood to be” (NSW Department of Community Services, 2001, p. 22). Regarding child’s natural curiosity, Prince (2009) claims that every child is a genius in terms of the original meaning “to give birth” and “to be zestful or joyous”. And
the educators can play crucial role, and bring remarkable change in the culture and society by preserving and developing those characteristics through formal education (p. 74).

Regarding factors influencing students’ learning and their evaluation, there is no “magic bullet” or simple recipe, but solution lies in circles of support that is nothing but the coordination among students’ learning potentials, authentic pedagogy, school organizational capacity, and external support (Newmann & Gray, 1995, p. 3). Different psychologists have focused on different psychological aspects of learning; let us discuss a few at this point:

2.1.3.2. Piaget’s stages of cognitive development. Piaget believed that children pass through four cognitive developmental stages. They help them to fully adapt to their environment and develop required intelligence, knowledge, and social skills. Children’s learning or adaptation involves two interdependent processes: assimilation and accommodation. However, cognitive conflict (or disequilibrium—a new problem that challenges previous learning) paves the way for getting cognitive “equilibrium” or adaptation. Each stage prepares a child and lays foundation for the succeeding stages. Many researchers have criticized for Piaget’s theory on different bases; among them two are prominent. Children’s cognitive abilities develop in a continuous pattern, however, for Piaget they follow sequential progression within and to specific age-related stages. The other criticism that is widely leveled against Piaget is that he considered that cognitive development of children occur universally, but it is mostly cultural-based (Keenan & Evans, 2009). Piaget’s four stages of cognitive development are:

- **Sensory Motor Stage (from birth to 2 years):** children learn through senses and motor and reflex actions i.e. sucking, listening, looking, and grasping etc. Initially, they have no idea of the things which are out of their observation, but at the end of this stage they develop this (object permanence), and also start learning language. They are able to
understand the things through symbols and sounds (Piaget, 1954; Keenan & Evans, 2009, pp. 159-164).

- **Pre-Operational Stage (2-7 years):** Children explore their surroundings and represent things and concepts through symbols and language. They ask lots of questions. However, they hardly see from other’s perspective (ego-centrism); believe all moving things are alive (animism); cannot focus on more than one aspects i.e. height and breadth at a time (centration); cannot think backwards (reversibility: difficulty in understanding that same amount of liquid takes less higher space in a container with broader diameter etc); unable to think of two relationships of one thing (single-classification: all men are fathers or daddies); inability to think and understand conversion of a new or different thing out of something (conversion: difficulty in understanding that a caterpillar or a larva would develop into a butterfly) (Piaget, 1954; Keenan & Evans, 2009, pp. 164-165).

- **Concrete-Operational Stage (7-11 years):** Children overcome above weaknesses and start thinking logically, yet they only understand the world while experiencing and interacting with concrete objects. Abstract thinking and learning is still beyond their approach. Piaget, 1954; Keenan & Evans, 2009, pp. 166-167).

- **Formal-Operational Stage (11-16 or onwards):** Children conquer above shortcomings and are able to perform abstract thinking, easoning, and rational judgment without concrete objects. They are able to manipulate a variable while controlling others; they can perform hypothetical deductions using fine imagination without things being there and even contrary to fact. Piaget believed that after this stage mental development stops and people only deepen their level of understanding (Oakley, 2004).
2.1.3.3. Lev S. Vygotsky’s Social Development Theory. Russian Lev Semyonovich Vygotsky (1896-1934) was a multidimensional contemporary of Piaget. He extended the Piaget’s constructivist approach and propounded his socio-cultural theory that focused both cognitive and social development. According to his theory, higher order thinking and learning occurs first at inter-psychological (between/ among the people interacting). Then, an individual internalize it (intra-psychological) through proper scaffolding (temporary assistance) provided by more knowledgeable peers, or adults (parents or teachers etc). Consequently, a child proceeds from known to unknown or Zone of Actual Development to Zone of Proximal Development (Vygotsky, 1978; Keenan & Evans, 2009, p. 173). Unlike Piaget who considered biological influences, Vygotsky believed social influences as milestones to learning respectively.

Vygotsky contributed significantly on psychological aspects of language learning (speech development). Centre for Learning Innovation (2006) summarizes its four stages:

- **Primitive speech stage**, Birth to 2 years: children learn imitating words to name objects; they learn to respond emotionally (crying) or socially (laughing).

- **Naïve psychological stage**, 2 to 4 years: children begin to realize that words are symbols for objects. They have a great curiosity as to what objects are called.

- **Egocentric or private speech stage**, 4 to 7 years: Children often talk aloud to themselves (private speech) to perform tasks in this stage of ration of their thinking.

- **Ingrowth or inner speech stage**, 8 years on: Private speech declines and becomes much more internalized (Nixon and Aldwinckle as cited in Centre for Learning Innovation, 2006, p. 8).

Regarding Vygotsky’s scaffolding (temporary support) Bransford, Brown, and Cocking (as cited in Rachel & Stuyf, 2002) enlisted six functions of constructivist-scaffolds. They:
Motivate the child’s-interest for doing the task.

Simplify the task to make it manageable and achievable for child.

Provide direction for child’s thinking and actions.

Bridge gap between child’s work and standard or desired work.

Reduce frustration and risk.

Model to do the task, and define expectations (p. 3)

Here is a sum up of fading of scaffolding in Vygotsky’s constructivist approach:

(I=teacher, you = student) I do, you watch→I do, you help→You do, I help→You do, I watch

(Thompson, 2010, p. 6)

2.1.3.4. Erik Erikson’s eight developmental stages. Erik Erikson (1902-1994) was born in Germany to Danish parents and later on settled in USA. He is well known for his (cognitive) developmental theory. It describes eight different stages of development to combat with related identity crisis or conflict within each stage. He propounded that “the course of development is determined by the interaction of the body (genetic biological programming), mind (psychological), and cultural (ethos) influences” (Harder, 2009). Erikson proposed that while an individual is going through psychological development, his or her desire to achieve an integrated identity works as a positive force to come out of particular identity crisis however failure to it could lead to psychological imbalance or mental illness (New World Encyclopedia, 2011; Sue Cohen, n.d., p. 17). Each stage’s conflict presents two extremes—positive and negative. Erikson does not favor to catch either but believes that proper psychological development surely requires a balance. It in turn would create the particular identity-virtue for each stage. I present a blended sum-up of New World Encyclopedia and Sue Cohen to explain characteristics of each stage:
i) Trust vs. Mistrust (infancy—from birth to 18 months; virtue: hope or faith—“Needs maximum comfort with minimal uncertainty to trust himself/herself, others, and the environment”.

ii) Autonomy vs. Shame (early childhood—18 mnths-3 yrs; virtue: will or determination—“Works to master physical environment while maintaining self-esteem”.

iii) Initiative vs. Guilt (play-age or preprimary education—3-5 yrs; virtue: purpose or courage—“Begins to initiate, not imitate, activities; develops conscience and sexual identity”.

iv) Industry vs. Inferiority (later childhood or school-age—6-12 yrs; virtue: competence)—“Tries to develop a sense of self-worth by refining skills”.

v) Identity vs. Role Confusion (adolescence—12-18 or 19 yrs; virtue: fidelity, loyalty)—“Tries integrating many roles i.e. child, sibling, student, athlete, worker into a self-image under role model and peer pressure”.

vi) Intimacy vs. Isolation (early adulthood—20-mid 20s; virtue: love)—“Learns to make personal commitment to another as spouse, parent or partner”.

vii) Generativity vs. Stagnation (middle adulthood—late 20s to 50s; virtue: care)—“Seeks satisfaction through productivity in career, family, and civic interests”.

viii) Integrity vs. Despair (later adulthood—50s or 60s and beyond; virtue: wisdom)—“Reviews life accomplishments and deals with loss and preparation for death” (New World Encyclopedia, 2011; Sue Cohen, n.d., p. 17).

2.1.3.5. **Howard Gardner’s Multiple Intelligences Theory.** While challenging inherited intelligence especially Intelligence Quotient (I.Q.), Gardner proposed his Multiple Intelligence (M.I.) theory. According to him existing teaching caters only lingual and
mathematical intelligences, but ignores other intelligences of an individual that could be present to a remarkable extent and could be developed further to their maximum through proper facilitation (Gardner, 1983). The eight intelligences of Gardner became popular throughout the world; however, he and others, later on added a few intelligences. The acronym BILLNISM stands for: Bodily Kinesthetic Intelligence (Body smart); Inter-Personal Intelligence (Social-smart); Logical Mathematical Intelligence (Logic-smart); Lingual Intelligence (Language-smart); Naturalistic Intelligence (Nature-smart); Intra-Personal Intelligence (Self-smart); Spatial Intelligence (Picture-smart); Musical Intelligence (Music-smart).

M.I. theory suggests that a child can possess and develop in more than one intelligences at the same time. It served as a focus for “revised curriculum, varied instructional techniques, alternative assessment, and new ways of communicating with parents” (Hoerr, 1994, p. 32).

2.1.3.6. Overview of child-development theories. There are many other theories and theorists that contributed toward studying child development; the Centre for Learning Innovation (2006) presents a nice sum-up of them:

Table 2

<table>
<thead>
<tr>
<th>Theoretical Approach</th>
<th>Principles of the Theory</th>
<th>Theorist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturation</td>
<td>Growth and development occur in orderly stages and sequence. The individual genetic timetable affects rate of maturation.</td>
<td>Arnold Gesell (1880-1961)</td>
</tr>
<tr>
<td>Psychodynamic</td>
<td>Behaviour is controlled by unconscious urges. Three components of the mind are id, ego, and super ego.</td>
<td>Sigmund Freud (1856-1939)</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>Qualitative changes in the way children think. The child is considered an active learner going through stages.</td>
<td>Jean Piaget (1896-1980)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lev Vygotsky (1896-1934)</td>
</tr>
</tbody>
</table>
Cognitive | Personality develops in eight stages throughout a lifetime. Development is influenced through interactions with family, friends, and culture. | Erik Erikson (1902-1994)

Behaviourist | Learning is gradual and continuous. Development is a sequence of specific conditional behaviours. Main emphasis is on the environment, not heredity. Observable behaviours are considered most important. | John Watson (1878-1958)  
BF Skinner (1904-1990)  
Albert Bandura (1925)

Ecological | Balance between nature and nurture. Child is placed in the middle of concentric factors which all influence the child. Emphasis is placed both on environment and heredity. | Uri Bronfenbrenner (1917 2005)

Information processing theory | We all have an innate learning ability. Children are born with specialised information processing abilities that enable them to figure out structure of development. | Noam Chomsky (1928-)

Source: Centre for Learning Innovation, 2006, p. 3.

2.1.3.7. Learning styles or three types of learners. A well known maxim of Confucius hints to the diversity of learning styles. It focuses learning by doing while rejecting simple auditory lectures: I hear and I forget; I see and I believe; I do and I understand (Damodharan & Rengarajan, n.d., p. 4).

Every individual is unique from others. It makes our cultures diverse and beautiful. On the other hand, it could pose problems for teachers and educators to facilitate students’ learning because their different and diverse learners may not equally benefit from a single teaching strategy. Based on utilization of sensory information, learners and learning styles could be differentiated into three broad classes: visual, auditory, kinesthetic or tactile. A learner could either fall in any of the three categories or he/she tends to learn through combinations. Unless the teachers are aware of the way how students learn, they cannot maximize their students’ learning. Additionally, if the learners themselves know what type of learners they are and how
they learn, they obviously would be in a better position to assimilate and accommodate their learning by making or asking for proper adjustments.

D-Amico and Gallaway (2010) while discussing “Assessing Learning Styles”, also classified learners into above three classes. A learner may either fit into any of the three categories or tend to learn through combinations (p. 18). Therefore, teachers must be able to know the types of their learners and how to adjust teaching strategy, so that all could benefit from it.

Dunn and Griggs (as cited in Montemayor, Aplaten, Mendoza, & Perey, 2009) found that students enjoy learning and learn more when they are facilitated through their appropriate learning styles (p. 59). A website Ldpride.net’s “Learning Styles” (2008) estimates that in general a majority 65% of people are visual learners, while auditory and kinesthetic (Tactile) make up 30% and 5% of the total population respectively.

Regarding above three types of learners many researchers state that visual learners learn through reading the text and other visuals i.e. slide-shows, charts, diagrams, maps, highlighted text, notes, videos, flash-cards etc, but plain audio lectures are the worst for them. They are often good writers and feel comfortable with writing assignments and essay-type tests or tests involving maps and diagramming. However, listen and respond type of test is worst for them. Second type of learners i.e. auditory are comfortable with lectures discussions, presentations, audio-books, and music and foreign languages. However, they struggle with reading-comprehension tests. They feel relaxed in oral-exam and writing responses during a lecture, but the reading-comprehension tests are worst type of tests for them. The last category i.e. kinesthetic learners learn by doing things or while doing some physical activity or involvement. They have good sense of touch and feel and learn the things through body. They usually get
bored from lectures, but tend to take lots of notes during lectures, yet they hardly see them again. Learners of this type tend to frequently touch other person on the shoulder or the arm. They love learning through material arts, field-trips, sports, computers, demonstrations, role-plays, scientific experiments etc. They often take study-breaks, perform dance, and play musical instruments. Kinesthetic learners work well in filling in blanks or MCQ tests, but essay type tests are the worst for them (Montemayor, Aplaten, Mendoza, & Perey, 2009, p. 18; Ldpride.net, 2008, pp. 1-18).

2.1.3.8. Laws and principles of learning. E. L. Thorndike is well known for introducing for the first time the laws of learning while working on his experiments on ‘operant conditioning’. He propounded his laws of learning in early 1900s. It was the start of the race into studying learning. His laws though still seem to be applicable, however, due to complex process of learning every sort of learning cannot fit into his laws. Over the years, further studies afterwards have restated and supplemented the knowledge to a great deal in finding new insights about how we learn. Thorndike’s introduced three basic laws of learning became the foundation of behaviorism. They were: law of readiness (individuals and organisms do not learn unless they are motivated), law of exercise (repetition makes learning more stable), and law of effect (individuals and organisms repeat those actions that bring favourable consequences or success and vice versa). He introduced three laws later: law of primacy (first experience creates stronger impression), law of intensity (a vivid, dramatic or exciting learning experience is more effective), and law of recency (most recent experiences are better remembered) (Davidoff, 1987; The Drill Pad Instructional Resource Library, n.d.).

“In non-threatening and trusting classroom environments, students can show their willingness to seek understanding and express their curiosity” (Cymer, 2007, p. 31). Merrill
(2001) studied multiple teaching models and plans i.e. Vanderbilt Learning Technology Center’s Star Legacy; MoCarthy’s 4-MAT; Andre’s Instructional Episode; Gardner’s Multiple Approaches to Understanding; Nelson’s Collaborative Problem Solving; Jonassen’s Constructivist Learning Environment; Van Merrienboer’s Four Component Instructional Design Model; Schank’s Learning by Doing. He analyzed whether and to what extent Reigeluth’s four elements of Basic Methods of Instruction (called The First Principles) were effective. They involved four basic phases of learning environment: a) activation of prior experience, b) demonstration of skills, c) application of skills, and d) integration of these skills with real-life situations (p. 44). He found that:

- Learning is facilitated when learners are engaged in solving real-world problems.
- Learning is facilitated when their existing knowledge is activated and related to new.
- Learning is facilitated when new knowledge is demonstrated to the learner.
- Learning is facilitated when new knowledge is applied by the learner.
- Learning is facilitated when new knowledge is integrated into the learner's world.
- Learning is facilitated when learners are engaged in solving real world problems (pp. 44-45).

Merrill (2001) concluded that all the (above) theories and models incorporate some of the first principles of instruction; however, none involves all of the principles. Moreover, some theories/models have different principles, but none had contrasting ones to the examined first principles. It clearly highlighted the effectiveness of problem-based learning (p. 57).

The author later on added task-centeredness to his first principles. It involves the concept of scaffolding in constructivist approach. It ensures that learners move from simple to complex tasks, that is contrary to sink or swim approach of problem based learning. In task-centeredness
learners are taught everything needed for every task first, and then gradually coaching or support is faded-off (Merrill, 2009).

Cymer (2007) reviewed related literature on effective teaching in science. The author focused on seven teaching models: The Learning Cycle (Renner, Abraham & Birnie; Lawson); The Cooperative Learning (Kagan; Johnson, Johnson & Holubec); The 5E Instructional Model (Trowbridge, Bybee & Powell); The Conceptual Change Model (Strike and Posner); The Inquiry Model (Deboer); The Generative Learning Model (Osborne & Wittrock, 1983; Wittrock); The Information-Processing Teaching Models (Joyce, Weil & Calhoun). The author Cymer (2007) with regard to constructivist approach summed up above teaching and learning models and presented and considered following effective teaching principles as of great importance:

i. dealing with students' existing ideas and conceptions,

ii. encouraging students to apply new concepts or skills into different contexts,

iii. encouraging student participation in lessons,

iv. encouraging student inquiry,

v. encouraging co-operative learning among students, and

vi. offering continuous assessment and providing related feedback (pp. 20-44).

I reviewed related content by different authors (The Department of Psychology, University of Memphis, n.d.; Cymer, 2007, pp. 20-44; Ellis & Worthington, 1994, 15-74; Ewell, 1997, pp. 7-10; Merill, 2001, pp. 44-45) and blended following learning principles. According to them learning is fostered when:

- Learners are motivated through checking and relating their previous knowledge and experiences to the new topic in hand; and they are provided with encouraging feedback.
• Learners are taught through varied instruction i.e. visuo-spatial, verbal, and direct experience to support visual, auditory, and kinesthetic categories.

• Learners are actively engaged during instructional task and it is often at odd at our traditional schools where passive learning through lectures is common.

• Learners work in an enjoyable, conducive learning environment and have fun learning.

• Learners often work collaboratively in groups or engage in individual tasks or assignments according to the situation and learners’ preferred learning style.

• Learners receive immediate and frequent feedback in encouraging mode as it works as an effective reinforcer to produce desired learning or response.

• Learners are provided increased opportunity to learn; and are exposed to a challenging and problem posing situation. It provides opportunity to satisfy and develop their curiosity, critical thinking, and decision making.

• Learners are provided proper scaffolding (providing opportunity to observe and work with proficient teacher doing things and to do things on their own through required assistance by the teacher) to become proficient in knowledge and skills.

• Learners are taught through organized teaching i.e. catering for declarative, procedural, and conditional (alternative) knowledge to perform a task.

• Learners are taught in such a way that supports and offers opportunities to link the new knowledge to real life situations and within and across different subjects.

• Learners experience varied learning opportunities (i.e. teaching through different modes and models of teaching) involving diverse activities and resources.

• Learners are allowed to ask/discuss and are assessed properly (reliability and objectivity).
Learners reflect upon to get new insights to deal with a problem in a novel form when their knowledge and methods of dealing with the situation do not work properly.

Learners or teachers sum up or summarize the content to get a gist or an overview of a bigger or holistic picture.

2.2. Professional Standards, Trainings, and Curricula

This section presents a document analysis of the professional standards of teachers and the analysis of the prevailing professional trainings and curricula with relation to science (including chemistry) pedagogy so that readers could get familiar about the ideal scenario of professional science pedagogy at secondary schools level.

2.2.1. National Professional Standards of Teachers in Pakistan

There is a visible change and concern regarding quality assurance of teachers in Pakistan. The Government of Pakistan through its Higher Education Commission (HEC) have established National Accreditation Council for Teacher Education (NACTE) as an independent body to ensure standardized programs for teacher education program at government and non-government sectors (National Accreditation Council for Teacher Education, 2009, p. iii); however, Pakistan still faces two fundamental issues in entire educational system: lower access and participation rates and lower educational quality/standard (Government of Pakistan, 2009b, p. 36).

The Government of Pakistan (2009a) through its Policy and Planning Wing under the Ministry of Education collaborated with UNESCO under their Strengthening Teacher Education in Pakistan (STEP) funded by United States Agency for International Development (USAID) to come up ultimately with ten National Professional Standards for teachers in February 2009. They are devised for the primary level teachers, but can be adapted and used for secondary
teachers and related stakeholders (Government of Pakistan, 2009a, preface). Each standard has three parts:

a) Knowledge and Understanding of Content (What teacher must know)

b) Dispositions (Teachers’ must display related attitude and values concerned attributes)

c) Performances or Skills (What teacher must do in classroom teaching) (p. 9).

Content analysis of above professional standards of teachers reveals that they involve major psychological constructs required for effective teaching and learning. I present a bird’s eye-view with regard of the National Professional Standards of Teachers. They claim that the teachers must know, inculcate the values and characteristics, and properly apply following things in their respective classroom teaching:

- **Subject Matter/Content:** having command on content and relating to national curricula and standards, other disciplines and real life situations; designing related appropriate learning experiences; developing 3Rs (reading, writing, arithmetic); facilitating learner through different and diverse teaching methods, activities and resources; assessing and evaluating through appropriate tools (Government of Pakistan, 2009a, p. 10).

- **Human Growth and Development:** understanding and facilitating how learners and adolescents grow physically and intellectually and learn in varied culture/context i.e. language, family, school, and community; facilitating students’ physical, intellectual, emotional and social development according to their needs; how students construct knowledge and skills; promoting critical thinking, creativity, decision-making through use of questioning and inquiry; use of diverse learning theories properly for different learning situations (Government of Pakistan, 2009a, pp. 10-11).
• Islamic/Ethical Values and Social Life Skills: understanding Quranic/other religious 
  ethical values and practices for promoting peace, brotherhood, tolerance, unity, dialogue, 
  social adjustment, respect for humanity, and celebration of diversity (Government of 
  Pakistan, 2009a, pp. 11-12).

• Instructional Planning and Strategies: designing and employing short and long term 
  instructional planning according to contextual needs of learners, curricula, and school; 
  effective utilizing available resources and instructional technology (IT) and developing 
  required low/no-cost resources; enriching teaching with IT related resources and out-of-
  school activities; developing critical thinking through team work, cooperative learning 
  and other modern pedagogies (Government of Pakistan, 2009a, pp. 12-13).

• Assessment: using multiple assessment i.e. criterion-referenced and norm-referenced 
  testing tools/strategies (essay-type and objective tests), interpreting results, and reporting 
  them periodically; understanding validity and reliability issues and biasness in scoring 
  etc; considering students’ deficiencies as learning opportunities; providing constructive 
  and unbiased feedback to learners(Government of Pakistan, 2009a, pp. 13-14).

• Learning Environment: motivating students to actively participate in learning within 
  classroom, community and society/surrounding; inculcating positive learning 
  environment and peer relationship through cooperation, collaboration, and respect for 
  others; ensuring effective classroom management so that students own and take 
  responsibilities by themselves (Government of Pakistan, 2009a, pp. 14-15).

• Effective Communication: effective and proficient use of cultural-friendly verbal, non-
  verbal and IT tools in routine classroom teaching; properly knowing and using computer 
  for teaching, research and assessment purposes; proficient use of Urdu and English in
addition to local language; preparing and enriching report cards, portfolios, and lesson plans etc through computers (Government of Pakistan, 2009a, pp. 15-16).

- Collaboration and Partnership: building relationship with parents, guardians, families and professional organizations (business, industry, arts, and crafts) to identify and utilize available knowledge, skills, and resources within community and cultural life to support student learning (Government of Pakistan, 2009a, pp. 16-17).

- Continuous Professional Development and Code of Conduct: studying and utilizing new research findings, ideas, and concepts for professional development; reflecting upon their own teaching styles and developing and maintaining teachers professional portfolios; following these professional standards in teaching learning situations and code of ethics; seeking help from other teachers/professional organizations; conducting action-research and sharing experience (Government of Pakistan, 2009a, p. 17).

- Teaching of English as Second/Foreign Language ESL/EFL: knowing and understanding importance of English and Specific Learning Difficulties in learning ESL and addressing learners’ specific needs respectively; using simple English with Urdu/local language during teaching; providing the students’ opportunities to acquire naturally the four skills: listening, speaking, reading and writing (Government of Pakistan, 2009a, p. 18).

Though the professional standards for teachers have been framed, no sincere effort has been taken to materialize them for better quality classroom teaching. The situation throughout Pakistan especially in Sindh is too worse that even teachers simply are unaware of any existing professional standards. It calls for immediate orientation and such in-service training.
2.2.2. Professional Trainings

In this section the researcher analyzes both the pre and in-service trainings regarding teaching of sciences including chemistry at secondary school level:

2.2.2.1. Pre service trainings (B.Ed. and M.Ed.). The Provincial Institutes of Teacher Education that were initially established for providing in-service to the serving teachers, Government Elementary Colleges of Education, Government Colleges of Education, and departments of Education at public and private universities offer pre-service training courses for primary, middle and secondary school teachers i.e. Primary Teaching Course (PTC), Certificate in Teaching (CT), Bachelor in Education (B.Ed.) and Master of Education (M. Ed.) or M. A. in Education degree programmes.

USAID Commissioned Paper (2004) has summed up the prevailing pre-service courses and their related pre-requisites and eligible classes for teaching in Pakistan in following table:

Table 3

<table>
<thead>
<tr>
<th>Training Program</th>
<th>Qualification Requirements for Admission</th>
<th>Duration of Training in Academic years</th>
<th>Levels/classes that can be taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.T.C</td>
<td>Matriculation</td>
<td>1</td>
<td>I-V</td>
</tr>
<tr>
<td>C.T</td>
<td>Intermediate</td>
<td>1</td>
<td>I-VIII</td>
</tr>
<tr>
<td>Diploma Ed</td>
<td>Matric Intermediate</td>
<td>3 years after matric</td>
<td>1-VIII</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year after intermediate</td>
<td></td>
</tr>
<tr>
<td>B.S.Ed. (12 +3)</td>
<td>Intermediate</td>
<td>3</td>
<td>VI-X</td>
</tr>
<tr>
<td>B.Ed</td>
<td>B.A/B.Sc.</td>
<td>1½ years after BA, B.Sc or 3 years after Intermediate</td>
<td>VI-X</td>
</tr>
<tr>
<td>B.A in Education</td>
<td>Intermediate FA /FSC, A Levels</td>
<td>4 years</td>
<td>1-VIII in Private Sector</td>
</tr>
<tr>
<td>M.A Education</td>
<td>BA, BSC, B.Ed.</td>
<td>M.Ed. 1½ years after B.Ed, MA and all specialized subjects in Education</td>
<td>VI - XII + Students Teachers of PTC, CT and B.Ed + Supervision Professional Institutions</td>
</tr>
</tbody>
</table>
UNESCO (2011-12) while discussing the issue of quality education in Pakistan, claims “Poor quality of teachers in the system in large numbers is owed to the mutations in governance, an obsolete pre-service training structure and a less than adequate in service training regime” (p. 53). Khan (n.d.) conducted her study sponsored by British government on teachers job satisfaction and incentives and revealed that provincial Government Colleges of Education (GCE), Government Colleges of Elementary Teachers (GCET), Provincial Institute of Teacher Education (PITE), and University of Education (Punjab) are the main teacher training institutes within public sector that involve in pre and in-service trainings (pp. 13-14). Moreover, the Education Departments of general Universities offer the undergraduate and advance teacher training courses.

The PTC and CT curricula were last revised in 1995 (they are undergoing gradual phasing out by replacing it with B.Ed. as minimum pre service training). The provincial bureaus are responsible for PTC and CT curricula development and implementation. The curriculum-wing designs B.Ed. and M.Ed. curricula, but prefer to work with universities through the Higher Education Commission. The pre-service curricula are outdated and focus theoretical aspects which in turn result in poor quality teacher training and classroom teaching. The lecture method
is common in teacher training institutions, but problem based learning and group work are hardly seen. The teachers do not get ample exposure to effectively deal with real teaching challenges like large class size and poor teaching/learning infrastructure etc (Khan, n.d., p. 6-7).

Ahmed, Azeem, Khalid, Farrukh, Ahmed, & Ahmed (2012) qualitatively compared teacher education program in SAARC countries and found that Bhutan and India were in best position as they strictly followed specific admission criteria to select teacher candidates for pre-service training (PTC, CT, and B.Ed) while Bangladesh, Maldives and Pakistan were at the worst position in this regard for not having such criteria (p. 143). They further reveal that regarding professional teaching the faculty of Maldives and Pakistan were found weaker than other countries of SAARC (p. 144). Saeed (2007) while comparing Pakistan’s education system with the four countries of UK revealed that one-year induction (professional training) for newly appointed teachers was compulsory in the four countries of the UK however, in Pakistan it was almost absent throughout the country (p. 50).

Teacher education is a provincial subject with district centralized structure for preparing primary, middle and secondary school teachers. There are 270 teacher education institutions with 227 public and the remaining under private control countrywide which work under the control of provincial departments of education respectively (UNESCO-IBE, 2011, p. 22). In Sindh, the total number of teacher training institutions is 69 involving 48 government or public institutions and 21 controlled by private or non-government sector. Out of them, only 12 institutions offer B.Ed, 5 are government run and remaining 7 are run by non-government or private sector (Provincial Institute of Teacher Education, Sindh, 2009, pp. 8-9).

Neither teacher professional development institutions nor do their programmes undergo serious scrutiny through overt and objective professional standards or accreditation. Therefore,
pre-service programmes at all levels offer out-dated and disconnected theoretical training that encourages rote learning among student teachers. The teacher educators use one-way lecture method to teach the curricula hence student teachers are quite unaware of the contemporary models and ideas that properly facilitate teaching and learning. Consequently, the quality of student teachers and serving teachers at all levels is abysmally low and are not able to know, understand, and implement the same in the classroom teaching. For these reasons, formal education does not support critical and creative thinking and problem solving skills. According to two independent studies, the pre-service and in-service teachers were tested on professional content knowledge, there was negligible difference between their performance. No effort is made to standardize and uplift the quality of teacher educators, student teachers, serving teachers and pre and in-service training curricula (UNESCO-IBE, 2011, pp. 22-24).

The National Education Policy 2009 (the latest one) has claimed gradual phasing out of obsolete pre-service training degrees of PTC and CT by 2018 by allowing academic graduation with B.Ed. as minimum induction criteria at elementary level; however, a Diploma in Education would be considered as temporary qualification till trained teachers with B.Ed are accessible everywhere. While for secondary school teachers academic master’s degree with B.Ed is minimum requirement for induction (National Education Policy, 2009b, p. 33).

2.2.2.2. In-service trainings. Buch (as cited in Khatoon, 2008) defines in-service education/training as “a programme of activities aiming at the continuing growth of teachers and educational personnel in-service” (p. 22). Rao and Rao, (as cited in Khatoon, 2008) quoted Cane to define as ”all those activities and courses which aim at enhancing and strengthening the professional knowledge, interest and skills of serving teachers” (p. 22).
In-service trainings not only aim at maintaining and reviving the professional knowledge and skills of the teaching-force, but also provide a continuous opportunities for serving teachers. They help them excel in professional development through exploring modern ideas and theories of teaching and learning that emerge as a result of valid educational research. Haider and Ali (2012) claim that at least in-service trainings have broken the inertia and cynicism (p. 561).

Government-run public institutions for teacher training programmes including PITEs and BOCs within their respective provinces offer in-service trainings with meager local funds but they mostly depend on foreign agencies in this regard. In this race many private institutions have mushroomed to provide in-service trainings in collaboration and funding from foreign agencies (UNESCO-IBE, 2011, PP. 22-24; USAID Commissioned Paper, 2004, p. 11).

Policy documents of Pakistan claim to involve all teachers in a five-year cyclic in-service training at all levels; however, it does not seem possible because an overall budget allocation remained slightly over 2% of GDP over the last decade. It is almost spent for recurrent expenditure and provide a little provision for developmental activities or in-service trainings.

USAID Commissioned Paper (2004) cites Pakistan Education Foundation’s evaluative report on in-service training (INSET) that found that “a primary teacher can only access INSET after 13 years, a middle school teacher after 7-8 years, and high school teacher after 16 years” (p. 15). It implies that a high school teacher could get opportunity of having in-service training twice in his or her entire serving period. Khan (n.d.) states that most in-service trainings are provided through private donor agencies and pay a handsome amount. Therefore due to favoritism in selection process only a few teachers attend multiple trainings regardless of being relevant to them. It leaves no option of in-service training for the teachers who do not have political or bureaucratic support (p. 8).
Regarding designing course content for in-service training in Pakistani context, USAID Commissioned Paper (2004) pointed out these areas that need careful consideration: subject based content knowledge; quality of teaching and learning—pedagogical methods, joyful learning; low cost aids for supporting interactive student-centered learning; community involvement; learning assessment systems; IT literacy skills; multi-grade teaching; leadership and management (including capacity building for admin and accounts) (p. 17).

According to Khan (n.d.), in Pakistan potential issues of in-service training are:

- No mechanism for identifying relevant potential teachers
- Favoritism in selection process due to financial incentives
- Lack of infrastructure and human resource capacity to teach and train the teachers
- Little or no coordination among donor agencies thus duplication of effort is common
- Complex management and administration system result in lack of coordination among relevant stakeholders
- Lack of adequate facilities for women teachers i.e. issues of residence, day-care centers for children, and absence of women resource persons
- Quality control or poor quality of resource persons i.e. lecture style of delivery and short duration of the training
- Lack of monitoring and performance assessment (pp. 8-9).

2.2.3. Document Analysis of B.Ed Curricula (Sciences/Chemistry)

In this section, the researcher presents critical analysis of existing B.Ed curricula offered at two well reputed universities: Allama Iqbal Open University Islamabad (Distance Education Program) and University of Sindh, Jamshoro.
2.2.3. Curricula of B.Ed. at Allama Iqbal Open University, Islamabad.

2.2.3.1. Program’s overview. Allama Iqbal Open University (AIOU) Islamabad offers pre-service program to prepare qualified and trained teachers for induction at school level. It offers Primary Teaching Certificate (PTC) for primary school teachers, Certificate in Teaching (CT) for elementary school teachers, Bachelor of Education (B.Ed.) for secondary school teachers, Master of Education (M.Ed.) for secondary and higher secondary school teachers, Master of Philosophy in Education (M.Phil.) and Doctor of Philosophy (PhD) in Education for specialization in disciplines of education that could be utilized by the teachers at any of the educational levels. Here, the researcher evaluates the curricula of one-year B.Ed. as part of distance education program for high school teachers with regard to teaching methodology.

According to the Allama Iqbal Open University, AIOU, Prospectus (2012) the university offers one-year B.Ed (General) program once a year for both pre-service candidate teachers and in-service school teachers having a bachelor degree with a minimum of 45% of marks or second class. The number of admissions in spring-semester 2011 touched 104,000 candidates.

The program involves two semesters. The fees for first semester is Rs: 5140/- and it is Rs: 5080/- with a total of Rs: 10,220/-. The first semester offers six compulsory half-credit subjects/courses while the second one involves two full-credit optional courses and a compulsory full-credit practical training (Workshop)

Practical Workshop or practice teaching involves three sections: teaching-session (25 Marks), practice-teaching (25 Marks), and teaching of final lessons (50 Marks). The first teaching-session comprises of two-week model-teaching organized by local tutors and the regional director. Here, the candidates (student teachers) observe, analyze, and discuss upon model lessons delivered usually by tutors. The student teachers are guided and facilitated to
prepare required material and plans for their practice teaching lessons. The second section offers four-week practice teaching opportunity to student teachers to deliver 40 lessons (20 from each optional subject). While the third section that is usually conducted at the end of the workshop offers delivery of two final lessons. The student teachers are required to teach two lessons in a real class-room setting from their optional courses which are observed and evaluated by assessment team (Allama Iqbal Open University, AIOU, Prospectus, 2012, p. 13-14)

Every student of B.Ed has to take two formative assessment assignments (100 marks each) during a half-credit course while they are four in number for a full-credit course. The solved assignments have to be sent to the concerned tutor within specified time period. The weight age of written exam (at the center) and assignments (at home) is 70:30 respectively. The minimum passing percentage lies at 40% for every assessment. The final grading is based on criterion-referenced assessment (Allama Iqbal Open University, AIOU, Prospectus, 2012, p. 17)

I, here, present a brief evaluation of the Taleemi Nafsiyat or Nisab (Educational Psychology and Curriculum), and three science related courses i.e. Tadrees Kimiya (teaching of chemistry), Tadrees Tabieyat (teaching of physics), and Tadrees Hayatiyat (Teaching of Biology) with regard to teaching methods and approaches.

2.2.3.1.2. Taleemi Nafsiyat or Nisab (educational psychology and curriculum). The course Taleemi Nafsiyat or Nisab (Educational Psychology and Curriculum) is a compulsory half-credit course of first semester includes a unit (with 106 pages) titled as “Tariq-haye-Tadrees” (Teaching Methods) as a last unit out of 9 units (Allama Iqbal Open University, 2012). The authors of the course have put their great effort to discuss the important theories and concepts related to learning in different contexts; however, I feel that they are not connected to the actual classroom teaching and learning situations.
Firstly, I am of the opinion that despite incorporating most of the important teaching methods in the unit, it does not seem to connect the teaching methods to the classroom teaching and learning situations because the text does not seem to provide adequate explanation on how to make a lesson plans. Moreover, no specimens or model lesson plans are found in this regard. The researcher feels that the text of the said course has discussed in length the important theories and concepts of learning along with important teaching methods. However, the researcher feels that it could have been made better if the authors of the course had taken extra effort to translate those theories, concepts, teaching techniques, and teaching methods into classroom’s practical teaching learning situations. Doing so would equally beneficial for both the tutors and the student-teachers who have sought admission to develop competency in appropriate professional knowledge and skills required for effective and efficient teaching and learning.

In this regard, I feel that the aim of this course should have been greater than to merely incorporate such text without practical consideration. For this purpose the authors should have devoted appropriate space for presenting specimens of the model classroom teaching regarding a psychological construct in hand throughout the course (a teaching-learning approach, theory, technique, strategy, or method). I think, it will help student teachers to inculcate among them the actual professional competency and development.

Moreover, the researcher thinks that a few teaching methods if had been included it might become more enriched in terms of conceptual material. For teaching of sciences, the researcher supports inclusion of these teaching methods: discovery, experiential, constructivist, social constructivist (scaffolding), and 5Es learning cycle. At least, two related model lesson plans for every psychological construct seems a must.
2.2.3.1.3. Teaching of chemistry, physics, and biology. AIOU’s B.Ed course offers five courses i.e. teaching of biology, physics, chemistry, mathematics, and general science for science graduates. Out of which two courses are to be selected. At grades 9th and 10th of secondary school level (science group) chemistry, physics, and biology are taught as compulsory subjects. Therefore, I present a critical evaluation of the related subjects of B.Ed. i.e. teaching of chemistry (code 653), teaching of physics (656), and teaching of biology (520) with reference to the teaching methods and pedagogy.

The three courses’ curricula seem to be content based i.e. that is taught at grades 9th and 10th at secondary school level in Pakistan. Every course (teaching of chemistry, physics, and biology) involve 18 units, out of which every course has devoted three units (unit number 2, 3, & 4) that deal with following areas of pedagogy respectively:

i) Teaching methods and use of audio-visual aids for related course

ii) Use of science laboratory for related course

iii) Lesson planning and assessment of related course

The above three courses equally involve group-teaching, individualized teaching (project, modules, student research, and educational tour/trip), book method, lecture method, demonstration method, and team-teaching within a unit devoted for teaching methods. The researcher found a general sample of a unit and a lesson plan out of the three courses each. I feel that the courses could have been much better if the laboratory method (guided individual or group laboratory method) that is considered one of the most effective teaching methods for science disciplines had been included in the teaching of chemistry, physics, biology, and general science courses at B.Ed. level. Additionally, scaffolding learning, 5Es learning cycle, and experiential learning model may be included in the teaching of sciences at B.Ed.
Regarding adequate learning material and specimens of model lesson plans for every teaching or learning method, I am of the opinion that a single general lesson-plan does not seem to cater for the translating teaching methods and other psychological constructs to related teaching practice. It calls for integration of adequate specimens of lesson plans against each psychological construct, on the one hand; and expert trainers who could enable and inculcate among student-teachers the ability to decide and design an appropriate lesson plan using single or varied teaching concepts, resources, techniques, methods and activities according to the contextual requirements of the learners and the curriculum.

Moreover, the researcher thinks that it would have been better and more appropriate that an additional subject or course titled “Teaching Approaches and Methods” be introduced at B.Ed. It would facilitate student teachers’ pedagogical understanding by providing opportunities to translate modern teaching and learning concepts (psychological construct) in to concrete lesson-plans. In this way, a collection or a bank of teaching learning resources can be developed at every professional training center. It would provide a strong base for a paradigm shift for leaving traditional teacher centered education in favor of learner-centered education through teacher training institutions.

2.2.3.2. University of Sindh, Jamshoro.

2.2.3.2.1. Program’s overview. The Faculty of Education, University of Sindh Jamshoro (Hyderabad) offers B.Ed.(one-year), B.Ed. Elementary (four-year), M.Ed., M.A. Education, M.Phil. and PhD in Education for teacher education at Elsa Qazi Campus (Old Campus) Hyderabad (University of Sindh, Prospectus, 1995, p. 10). The B.Ed. and M.Ed. are offered both as morning and evening programs. Here, I present critical evaluation of one-year B.Ed General (conducted in two semesters) with regard to pedagogical content and teaching of sciences:
The curriculum for one-year B.Ed. includes ten subjects (each carrying 100 marks with 33% of minimum passing marks) with two for practical components: Special Method No. 1 and 2 (University of Sindh, Prospectus, 1995, p. 10). The Practicum or practice teaching is a compulsory component of the program where the candidate has to deliver 20 lessons each from his or her two optional subjects (University of Sindh, Prospectus, 1995, p. 12).

2.2.3.2.2. Contents of the teaching of chemistry, physics, biology, and general science.

The Sindh University’s courses outlines mostly follow the contents recommended by Higher Education Commission (HEC). I found that the contents of all the above four courses follow the same pattern and number of units. Each course comprises of seven units. The first unit is devoted to the introduction of the subject and discusses its nature, educational value, usefulness in daily life, relationship with other subjects and application to other disciplines. Every course offers a unit titled as: Teaching Approaches and Strategies. It involves: Teaching Approaches (problem-solving, inquiry teaching, and creativity), and Teaching Strategies (planning for a practical activity, activities in the teaching of related subject).

Regarding teaching methods either the above three courses offer a separate unit or involve it as part of the previous unit i.e. Teaching Strategies. These methods were included in the said courses (teaching of physics, biology, and chemistry): demonstration, discovery, lecture, synthetic, and discussion methods. The course “teaching of chemistry” has put Lecture Method at the last pace (choice). Laboratory Management is included as a separate unit in the ‘teaching of chemistry’ and ‘teaching of physics’ respectively while ‘teaching of general science’ includes it as a part of another unit. However, it is missing in the ‘teaching of biology’.

The lesson-planning is the most important aspect of teaching, professional development, and pedagogy. It is included as a separate unit in teaching of chemistry, biology, and physics
respectively but is present as a part of other unit i.e. Effective Science Teaching. Moreover, teaching is said to be incomplete without the use of audio-visual resources. In this regard all the four courses devote a unit titled as ‘Teaching Aids’ where the courses generally deal with:

- The need and significance of audio-visual teaching resources
- Types of teaching resources
- Principles of using audio visual teaching resources

Teaching of biology course-outline comprehensively lists out other related sub-topics i.e. preparation of specimen and skeleton, museum and herbarium, biological garden, individualized instruction, and awareness and utilization of local recourses for preparation of the above aids.

Evaluation and assessment is also a must for prospective teachers. In this regard all the courses offered a unit titled as ‘Measurement/Evaluation of related course’. All the above four courses commonly involve preparation of different tests, their assessment and interpretation issues. The teaching of biology offered a unit on “Instructional Objectives” that discussed the issues thoroughly.

2.2.3.2.3. Critical review of the contents of teaching of physics, chemistry, biology, and general science. The universities do not offer, supply, or suggest a single book as a text-book for a course of study for a regular program. They supply their students with course-outlines and suggest multiple printed or online books and resources for both the teachers and learners for preparation and self-study. Therefore it is not feasible to evaluate the course content in actual meaning however from the outlines of the courses, the researcher concludes that:

- The outlines of the courses regarding teaching or pedagogy offer and cover a fair amount of content. However, some weaknesses were found in the area of pedagogy. For example, the researcher feels that a single unit for teaching approaches and methods may
not fulfill the needs of student-teachers who have entered for their professional training and development, and competency. The course outlines involved different teaching approaches, strategies, and methods, but could not find any clue for how to make a lesson plan following a particular teaching approach, method, strategy, or construct. Thus, according to the researcher, multiple model lesson plans may be included in the course outlines and content that will better facilitate the teachers and the taught to develop their professional knowledge and skills.

- In this regard, the researcher feels that there is a need of introducing a separate course titled “Teaching Approaches and Methods” at B.Ed. level. It should deal individually with the teaching of general teaching approaches, strategies, methods, techniques, and activities. Additionally, it will help to put the psychological constructs into real classroom teaching through developing multiple model lesson-plans accordingly.

Whereas, for the teaching of sciences i.e. physics, chemistry, biology, and general science, the particular course may do the needful in facilitating to translate related content into real classroom teaching using specific teaching approaches and methods through appropriate multiple model lesson plans respectively.

- The modern learning theories and concepts i.e. constructivism, social constructivism (scaffolding), multiple intelligences, 5Es learning cycle, and experiential learning models may either be included in related, existing professional teaching courses or through introducing a separate course i.e. “Teaching Approaches and Methods” at B.Ed. level.

- Lastly, the researcher feels that existing courses’ outlines (teaching of physics, chemistry, biology, and general science) should emphasize group or collaborative and practical (independent or guided laboratory work) that is found missing in the course outlines.
2.2.3.3. Statistics of public secondary schools and teachers of Sindh. In this section, I present statistics of the public secondary schools and teachers of Sindh including District Jamshoro regarding total number of school and teachers, students’ enrollment, and laboratories available. Following table sums up statistical figures at Sindh level for the year 2011-12:

Table 4

Statistics of Public Secondary Schools, Teachers (HSTs), participation, and Labs of Sindh

<table>
<thead>
<tr>
<th>Type of the School</th>
<th>No. of Schools</th>
<th>No. of HSTs</th>
<th>St-participation</th>
<th>No. of laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Co-Ed</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Secondary</td>
<td>1,639</td>
<td>21%</td>
<td>19%</td>
<td>13,501</td>
</tr>
<tr>
<td>(9th-10th)</td>
<td>641</td>
<td>513</td>
<td>485</td>
<td>7,247</td>
</tr>
<tr>
<td></td>
<td>7,247</td>
<td>21%</td>
<td>16%</td>
<td>5,254</td>
</tr>
<tr>
<td></td>
<td>21%</td>
<td>16%</td>
<td>5%</td>
<td>3,404</td>
</tr>
<tr>
<td></td>
<td>21%</td>
<td>16%</td>
<td>5%</td>
<td>2,216</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,168</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6%</td>
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<td></td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Higher-secondary</td>
<td>3,404</td>
<td>21%</td>
<td>19%</td>
<td>163</td>
</tr>
<tr>
<td>(11th-12th)</td>
<td>201</td>
<td>160</td>
<td>158</td>
<td>163</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
| Adapted from Resource Support Unit, 2012, pp. 1, 2, 13, 14, 19.

Reform Support Unit (2012) points out that there were 17,650 High School Teachers (HSTs) in Sindh mostly working at secondary and higher secondary schools of Sindh; however, very small number even worked at public sector primary schools. Almost all HSTs had their B.Ed (majority had M.Ed) as the same documents gave a clue that out of 27,109 secondary school teachers [including HSTs, JSTs (junior school teachers) and others] only 226 were untrained (p. 14). According to the seniority list of HSTs of District Jamshoro, there were 452 HSTs (356 male and 96 female). All of them were trained and had B.Ed professional degree on their credit; however, a majority of three-fourth possessed M.Ed as additional/advance professional degree.
2.3. Pedagogy/Teaching of Science and Chemistry

In this section, the researcher reviews the related literature that empirically supports the ways and methods of teaching sciences including chemistry at secondary school level.

2.3.1. Teaching

Vin-Mbah (2012) cites South and Laslett to define teaching as an all-purpose profession catering for individual and economic growth through human resource development (p. 111). The author further claims that teaching is “... an attempt to help someone acquire or change, some skill, attitude, knowledge, idea or appreciation. In other words, the teacher’s task is to create or influence desirable changes in behavior, or in tendencies toward behavior in his students”.

According to Filedia (2012) the functions of teaching are: informing and explaining; stimulating, directing, guiding and administering; identifying what to learn; identifying learning problems; evaluating, reporting and recording; classroom arrangement; socialization; and school-community relationship. Whereas, according to the author clear objectives, pupils’ readiness, previous experiences, individual differences, and systematic teaching are important principles of teaching (pp. 111-113).

2.3.2. Pedagogy

The term pedagogy has its roots in Greek word “paidagogos” meaning, the teacher of children. It was uncommon a decade ago, but is used frequently among teachers fraternity now a days. It is more comprehensive than instruction and teaching (MacNeil, Cavanagh, & Silcox, 2003, p. 5). “School buildings rarely reflect state-of-the-art pedagogical designs” (Bingler; Copa; Fielding; & May; as cited in ElliotWashor & DesignShare.com, 2003, p. 2). MacNeil, Cavanagh, and Silcox (2003) clustered the literature on pedagogy in to four classes of meanings:


- Pedagogy as a comprehensive term catering for all aspects of teaching but not limited to instruction (Mortimore; Newmann and Associates).
- Pedagogy as a political tool to produce students with required mind and skills (Freire; Smyth; Van Manen).
- Pedagogy as student-centered learning but not a teacher centered and didactic teaching (Hamilton and Mc William); and
- Pedagogy as student-teacher relationships (Van Mann) (p. 5.)

Thus, pedagogy involves complex combination of the efforts and resources required for the proper development of the whole personality of learners within formal educational set up. The integral parts of pedagogy are: psychology of learners, their inner emotions, potentials, learning process, philosophical foundations, special needs of learners, environmental influences, learning resources, nature and presentation of the content, linkage of curricula and instruction with community, guidance and counseling, and assessment and evaluation. All above aspects of pedagogy are directed toward creating required intellectual thought and skills to enable learners to satisfy current and futuristic needs of the individuals and the society as well.

2.3.3. Understanding Pedagogical Approach, Method, and Technique

Many teachers, educators, and laymen confuse using the terms approach, method, and technique synonymously and interchangeably. Garcia (as cited in Acero, Javier & Castro, 2004) while discussing the “‘How’ Dimensions of Teaching” states that approach is a broader and umbrella term involving methods and techniques as its sub-categories.
Figure 5

_Difference among Approach, Method, and Technique_


Approach involves a set of underlying personal correlative assumptions or a general theory to deal with a problem or objective. Teachers may use single or multiple related method(s) or strategy/strategies within an the approach. Lastly, the techniques are tricks that account for specific tasks and activities (in line with method and approach) to attain the objectives (Approach, Method and Technique, n.d., pp. 46-47; Celce-Mursia as cited in Villarreal, 2008, pp. 16-17).

Some authors (Richards and Rodgers, 1982; Villarreal, 2008, p. 20), on the other hand, have put method on the top and defined its three levels i.e. approach, design, and procedure. Here, approach stands for the same theoretical base with difference of being a part of method, while design relatively used in broader meaning. It relates to specification and organization of the content, teaching material, and role of teacher and learner (p. 153). Since, authors and researchers do not seem to have consensus in this regard (Stern as cited in Villarreal, 2008, p. 17). The researcher here decided to follow the classification putting approach on the top followed by methods and techniques as its hierarchal sub-categories.
2.3.4. General Pedagogical Approaches

The approaches in a broad perspective can be classified into two main categories: teacher-centered and learner-centered, however, they overlap and practically it is very difficult, if not impossible, for a teacher to teach through a single approach, method, or technique throughout a specific duration of a class. The researcher believes that no approach or method caters for a single thought or psychological theory, thus following teacher-centered approach there are certain portions of teaching-plan where due to individual differences the approach tends to support certain learner’s individual learning style. For example, teacher’s questioning becomes learner centered or even one way lecture supports fully to audio-learners. Similarly, learner-centered approach may contain certain areas where teacher’s body language, directions, or guidance make it somewhat teacher-centered. The same rule applies to the method. Here the researcher sums up common pedagogical or teaching approaches into following categories:

2.3.4.1. Teacher-centered vs. learner-centered teaching approaches. Teacher-centered approach is based on behaviorist bent of learning. The underlying coral concept of teacher centered approaches is that students learn as a result of reinforcement and punishment provided by the environment. These approaches hardly cater for individual differences, students’ unique emotions, feelings, and cultural context. Lecture, questioning, and demonstration teaching methods support teacher-centered approach (Filedia, 2012, pp. 113-114). On the other hand, learner centered approach caters are based on the assumption that individuals are not passive by nature and do not depend on environment but they feel comfortable and actively engage in certain learning activities and processes that satisfy their unique and innate potentials, emotions, and cultural context. In other words they need facilitation to learn on their own but not imposition from outside. Filedia (2012) enlists these teaching methods that support learner-
centered approach: Activity methods, Assignment, Supervised study, Discussion, Field trip, Project, Play and games method etc. (pp. 113-114). However the above list is not comprehensive. You can add these activity-based methods: Inquiry, Discovery, Experiential Learning, Five Es Learning Cycle etc

2.3.4.2. Inductive vs. deductive teaching approaches. Another way of looking at the teaching methods is classifying them on the basis of teaching or instructional process adopted. Inductive teaching is associated more with learner-centered approach and contrasting to traditional teaching. Here, the teacher carefully selects and presents (asks to read or observe or experience) multiple examples or situations based on single underlying principle for students to go through and come up with a general principle out of them. In this way students learn the concept thoroughly on their own effort. It fits well for teaching sciences and proceeds from specific (examples) to general (conclusion or theory). Inductive teaching supports construction of firsthand knowledge on students’ part through observation, discovery, and inquiry. These teaching methods support inductive teaching: Activity methods (inquiry, discovery, project, problem-solving, experiential, five Es), Assignment, Supervised study, Discussion method, Field trip, Play and games method etc

On the other hand, the deductive teaching is more attached with traditional teacher-centered approach. Here the teacher explains the concept or general principle first and asks the children to apply or verify on similar specific examples and assumes that in this way transfer of knowledge takes place. Hence, the process of teaching and learning flows from general to specific. This approach hardly supports learners to construct knowledge on their own, but they are provided and supposed to verify readymade knowledge provided. Though it offers less
activity and involvement, yet is less time consuming. These teaching methods support deductive teaching and learning: Lecture, Demonstration, Questioning etc.

There is no hard and fast rule whether a teaching method always support inductive teaching or learning. It depends on utilization of the teacher. Any of above method can be transformed to deductive and vice versa. For example, teacher-centered methods can more or less favor inductive learning when lecture, demonstration, and questions are planned in such a way that offer specific situations in order to conclude from or state underlying principles.

2.3.4.3. Constructive vs. transmissive teaching approaches. Constructivist approach holds the view that children are active learners and they construct knowledge through their experience and interaction with the world. It involves inquiry based approaches and caters for individual differences and learner centered education. All the teaching methods within learner centered approach fall into constructivist approach. Here, the teacher is facilitator; teaching and learning revolves around the learner; and learners’ individual differences are taken care of. It involves inductive mode of teaching. Contrastingly, the term transmissive teaching fits synonymously to teacher centered approach, treating a child as a blank slate to be written by the teacher (or environment). Here, learners’ individual differences, learning style, innate potentials, emotions, and cultural influences are not taken care of.

2.3.5. Common Science Teaching Methods

Different researchers (Heinich, Molenda, Russel, & Smaldino, 2002; Filedia, 2012; Line Kolás & Arvid Staupe, 2004) have identified and supported different teaching methods for different contexts i.e. content, learners’ needs, and curricula. They are: lecture, presentation, demonstration, discussion, drill and practice, tutorial, cooperative learning, gaming, simulation, discovery and problem solving, learning by doing, play, Socratic Method, project, problem-
solving, Dalton plan or assignment, remedial, individual, dramatic, and story-telling methods etc. Additionally, there is diversity within a method. For example, Line Kolås and Arvid Staupe (2004) state that cooperative learning’ may include these variations: group administration, genuine interdependence, synchronous communication, asynchronous communication, learning together model, team-assisted individualization.

However, Johnson, D. W., Johnson, R. T., and Stanne (2000) presents ten subgroups in this regard: cooperative learning: learning together and alone; teams-games-tournaments; group investigation; constructive controversy; student teams achievement divisions; complex instruction; team accelerated instruction; cooperative learning structures; cooperative integrated reading and composition (pp. 3-4). Here, the researcher gives a brief detail of the important pedagogical methods, their effectiveness, and relationship toward teaching of science disciplines at secondary school level:

2.3.5.01. Lecture method. Sullivan and McIntosh Noel, (1996) claim, “The lecture in its many forms is the most commonly used method for transferring information. There are, however, serious questions regarding the effectiveness of the traditional lecture approach” (p. 1). The same authors point out that one-way communication; minimum students’ activities, interaction, and involvement; passive and boring learning, teacher as the only source of information and learning; inadequate use of information and communication technology are some of the major disadvantages of lecture method. However, it is effective in disseminating quick information to larger audience, presenting new information before using other media, arising interest, and providing overview of the topic (pp. 3-5).

2.3.5.02. Lecture-demonstration method. Yogesh and Ruchika (2007) state that both lecture and demonstration methods if used in isolation in teaching of chemistry fail to enhance
students active involvement due to teacher’s dominant talking and doing. However, it at least provides an opportunity to learners’ involvement through observing the phenomena being experimented or processed. During demonstration, the teachers’ use of two-way communication and questions add to learners’ understanding. Teacher must ensure that the models and demonstration-equipment or apparatus are of proper size and the lighting arrangement is adequate so that the demo is visible to all the learners (pp. 74-75).

2.3.5.02.1. Advantages of lecture-demonstration. As a general principle the demonstration is useful as it:

i) Enables students to observe the experiment and its steps to reduce procedural ambiguity.

ii) Is economical when resources are insufficient/too expensive thus yielding better learning within affordable resources than that of individual laboratory experiment for each learner.

iii) Helps students to observe the teacher performing experiments that need extra precautionary measures to ensure dealing safety with dangerous chemicals/reactions.

2.3.5.02.2. Disadvantages of lecture-demonstration.

i) Despite being better than lecture method it does not support learning by doing as students do not get opportunity to manipulate the things and process by themselves (Radha Mohan, 2007, p. 168-169).

2.3.5.03. Discussion method. Schmuck and Schmuck (as cited in Gall and Gillete, 2001) have found in their study that discussion method can be effectively used for teaching any subject and level. Despite having great potential for teaching and learning the teachers generally are reluctant to use it in classroom setting. “It is a strategy for achieving instructional objectives that involves a group of persons, usually in the roles of moderator and participant, who communicate
with each other using speaking, nonverbal, and listening processes” (p. 99). The authors suggest that the teacher must be open minded even to learn different ideas from learners.

Gall and Gillette (2001) further reveal that it can be used for subject matter mastery, issue oriented discussions, problem solving, and obviously for improving students’ discussion skills. Smaller group size (5 members being ideal) works best for productive learning while ensuring smooth and adequate involvement of learners. However, they suggest “fishbowl” method for a group of 10-40 students where five or six selected bright learners sit around the discussion circle in the middle of the class and the left over learners sit around them to watch and write down important points. They may discuss after the former have finished. Another way to involve a larger group in discussion is to break it into manageable smaller group having five or six in each headed by a group leader and recorder (p. 100).

Welty (1989) argues, “If you have the proper space, classes of 30 to 40 can proceed comfortably. And, if your institution is a Harvard Business School clone with physical facilities built especially to accommodate case discussion, 80 can be an effective class size” (p. 205). Gall and Gillette (2001) argue that the most important feature of discussion method is that it involves speaking and listening which the traditional teaching mostly ignores (p. 99).

Gall and Gillette (2001) sum up that the facilitator opens the discussion (stating the issue/the discussion and supporting flow of students’ ideas while thinking and speaking; encouraging required silence and participation of silent members); listens to others (restating the issue and summarizing participants’ views); analyzes different perspectives (stating areas of harmony or incongruity and asking for clarifications and reasons and temporary agreement in case of dead lock); and evaluates the discussion (asking students for a sum up and to state their perspective if different than theirs). On the other hand, the students do not monopolize and
initiate personal hit; they listen to and acknowledge others ideas; give reasons to validate their ideas and ask for clarifications to others’ viewpoints; present a brief review and reflect on the discussion activity (p. 101).

Welty (1989) suggests that discussion classes generally require the leader summing up the discussion and providing it with some larger meaning to the text. However, some discussions end up with no results. It may lead them toward individual creativity and further guided inquiry and research. After the discussion, teacher should devote additional time for debriefing. It will not only help out the students with their chaos left in their minds, but also to find out any flaws to improve next discussion session (pp. 210-211). Moreover, the teacher should be careful to evaluate students individual performance and participation because it is very difficult for a teacher to judge on students part who are talking too much saying nothing, or trying irrelevant ideas, or making no contribution or participation (p. 211).

2.3.5.04. Discovery method. Castronova (2002) while reviewing literature on discovery learning, states that traditional method of teaching does not cater for the needs to develop students’ skills and intellect, but teaching through discovery seems promising. The discovery method has its roots in John Dewey’s work “Democracy and Education” (1916/1997) where he explicitly states that children are naturally motivated to actively learn through interaction with community members; and they, in this way, create ideas using their past experiences (Berdin as cited in Castronova, 2000). Jean Piaget (1954) and Vygotsky (1962, 1978) extended Dewey’s concepts of discovery learning.

Castronova (2000) cites the works of Bonwell; Mosca & Howard; and Papert who found discovery method to be better than traditional one for five prominent advantages i.e. active learning; process based rather than fact-based; failure is important; feedback is necessary; and
understanding is deeper. The author presents case-based learning, incidental learning, learning by exploring or conversing, learning by reflection, and simulation-based learning as diverse types of discovery learning. The author sums up discovery based teaching and learning with reference to Bicknell-Holmes & Hoffman in these three attributes:

- Students create, integrate, and generalize knowledge through exploring and problem solving.
- Supports students’ driven/interest-based activities which determine sequence and frequency.
- Encourages activities which incorporate new information into the learners’ existing one.

2.3.5.05. Cooperative learning. Many students (people as well) groan when asked to work in a group. This trait is known as “group-hate” that has been referred to as the feeling of dread and repulsion about working collaboratively (Sorenson, 1981). However, these negative feelings and connotations lessen through proper instruction, guidance, and having realistic expectations of group work. Burke (2011) explains that students who participate in collaborative learning or small groups get better grades, educational satisfaction, and are more likely to complete their education (pp. 87-88).

No single teaching methods or techniques can be claimed as the most appropriate or perfect without consideration of the context and working in groups is no exception. Because by nature some people or learners have more intra-personal attitude and intelligence (Gardner, 1983). Similarly, some perform better while working individually on assignments or projects (Elgort, Smith & Toland, 2008). Nevertheless, if a group understands their pros and potential cons, it can maximize the benefits of working in groups and of course diminish the hurdles that hamper success.

Burke (2011, pp. 87-95) clarifies that just forming a group cannot generate critical thinking benefits. Thus, the teacher ought to know and be able to meet these requirements:
deciding whether to teach/use collaborative work; teaching and guiding to properly work in groups (working together, structuring time, and delegating tasks, ensuring active participation of all members in specific tasks); and assessing the work of group members against objective criteria/concrete rubric (p. 89). Various techniques and strategies are used for collaborative teaching and learning including reciprocal teaching, jigsaw, etc. Beebe and Masterson (as cited in Burke, 2011, p. 88), point out certain pros and cons for group work:

2.3.5.05.1. Advantages. They point out six advantages in this regard:

1. Groups have more and enriched knowledge than one person.
2. Groups stimulate creativity because the old adage runs “two heads are better than one”
3. People retain the material better and longer taught through group work.
4. Cooperative learning helps students achieve greater satisfaction and commitment.
5. Group work and its feedback allow having more accurate picture.
6. Employers obviously value the team work (Graduate Outlook Survey, 2010).

2.3.5.05.2. Disadvantages. There are also times when problems arise. They have listed four disadvantages: people tend to avoid conflict and conform to majority opinion; some individuals may dominate therefore group members feel alienated; some participants may solely depend on others (it calls for specific tasks for each member); it is more time consuming (however time spent results in better understanding) (Burke, 2011, p. 88).

2.3.5.06. Project method. Project method of teaching dates back to the experience-based education of John Dewey who is often considered and known as the father of project, discovery, experience, inquiry, and activity based teaching methods. Mukalel (2007) defines a project as an educational undertaking emerging from a scientific planning. It involves a set of concrete and practical utility to represent and cater for educational (or scientific) theories.
Novelty and creativity are its essential elements (p. 66). A project can be small or big: writing a book/assignment, observing a nearby factory/industry, making a model of hydel or thermal electric power station, or designing a model of solar/lunar eclipse or an electronic model of an element etc.

Mukalel (2007) gives three essential characteristics of a project: creative imagination, novelty, and coordination of skills. The crucial skills for dealing with a project are: spirit of inquiry, discourse development, painting and drawing, planning out sub-elements, organization of ideas, aesthetic judgment, a sense of proportion and beauty, ability to judge maximum relevance, visual expression, coordination of multiple stimuli, a research bent of mind, learning through enquiry, organization of thinking and imagination, principle of do and learn, and achievement motivation (pp. 66-70). Project method can be used for variety of subjects from natural sciences to social sciences as well as for both curricular and co-curricular activities.

2.3.5.07. Inquiry teaching method. Social Studies Center for Educator Development, SSCED (2012) defines inquiry teaching as a procedure of inquiring and responding questions. In inquiry method students frame questions, collect and organize the relevant data, and analyze it to draw inferences and conclusions. It reflects a scientific method to deal with a problem in hand. Student activity is its major hallmark while teacher works as facilitator. The above center presents following merits of inquiry teaching:

- Students create knowledge;
- Students explore answers and solutions therefore they retain them for long;
- Different and ingenious thoughts are inculcated;
- Superior thinking skills (analysis, synthesis, evaluation) are facilitated;
• Skills coordinate with their learning because learners systematize and investigate the data using different methods and things (maps, graphs, charts, etc.)

According to SSCED (2012) there are a number of variations in inquiry teaching; however, following five steps are basic:

Step 1: Identifying and clarifying questions, issues, problems. This can be student generated (within limitations) or teacher-created.

Step 2: Propose a hypothesis. Suggest possible solutions or explanations to the problem/question. Developing a hypothesis will facilitate student research.

Step 3: Gathering and organizing evidence. Locating and collecting data is the key. This stage allows students to develop selecting relevant versus irrelevant data, evaluating the value of primary versus secondary data, organizing and interpreting information, classifying the things, and presenting the information etc.

Step 4: Evaluating, analyzing, and interpreting the data. Based on the evidence and data available, what possible solutions or explanations are feasible?

Step 5: Concluding, inferring, and making generalizations. Is the hypothesis proven or disproved? What is the answer to the question? What inferences can be made from this? What additional questions are raised by the information and analysis? (p. 6).

2.3.5.08. Problem solving method. Problem solving is the key issue of daily life and academics because ultimately schools aim at preparing learners for successful social life that requires solving individual and social problems. Problem solving as a teaching method roots back to the works of John Dewey.

Vin-Mbah (2012) states that we normally tend to discover the solution when confronted with a problem. Thus, the problem method involves the discovery of new facts contributing to
knowledge enhancement (p. 116). The processes of problem-solving and decision making run side by side while utilizing knowledge and skills already learnt. SSCED (2012) enlisted these functions of decision making: realizing and evidently stating the problem, signifying alternative solutions, exploring the possible results of all proposed solutions, considering essentials of a decision and deciding. The thinking skills involve: presentation of facts; raise questions; analysis or identification of key generalizations, issues, and conflicts; interpretation and analysis of data; development of concepts; projection of consequences; evaluation each set of expected results; preference and description of reasons for implementation; and final judgment (p. 7).

Nickerson (1994) presents three approaches to problem solving: Polya’s Four Steps: Understand the problem, Devise a plan, Carry out the plan, Look back; Hayes Six Steps: Find the problem, Represent the problem, Plan the solution, Carry out the plan, Evaluate the solution, Consolidate gains; Bransford and Stein’s five elements IDEAL: I=Identify the problem, D=Define and represent the problem, E=Explore possible strategies, A=Act on the strategies, L=Look back and evaluate the effects of your activities. SSCED (2012) enlisted strategies to solve problems: problem decomposition, working backwards, means-end analysis, forward chaining, considering analogous problems (pp. 7-8).

2.3.5.09. Laboratory method. Science laboratory is an integral part of scientific demonstrations and inquiry based teaching like discovery, problem, and project methods. The credit of introducing laboratory instruction as an independent teaching method goes to Leibeg (1803-1873) who for the first time made laboratory work available to post-graduate students in science (Omosowo, 2006, p. 66). Omosowo (2006) presented two purposes of a science laboratory i.e. students’ guided individual or group work and teacher’s demonstration. Sometimes, a capable student can demonstrate when the equipment and material is safe (p. 70).
In her article Omosewo (2006) reveals that teaching through laboratory facilitates to achieve following objectives:

i) Identification of problems and queries

ii) Categorization of observatory characteristics and performing comparison and contrast

iii) Measurement of qualities and quantities

iv) Manipulation of related things and their data

v) Formulation of tentative assumptions and principles

vi) Derivation of conclusions on the basis of available facts and knowledge (p. 65).

Laboratory work, on the one hand, facilitates learners to develop critical and scientific skills and attitude, and it develops meaningful understanding of the subject being taught, on the other hand. It links the material to relevant life situations in one or the other way. The most importantly, lab work inculcates motor development and promote concrete learning of complex theories through personal observation, experiences, and experimentation which the traditional lectures simply ignores (p. 66). We cannot think of learning about agriculture, health and physical sciences without laboratories. They offer learners the chances to ponder over, talk about, and resolve actual issues through personal experience (p. 68). The author claims that use of computers in laboratories helps the learners for faster acquisition, analysis of the data, and other related work. Laboratories help the learners to:

- develop intuition and deepen understanding of concepts
- apply concepts learn in class to new situations
- have direct experience of basic phenomena
- develop critical quantitative thinking
- develop experimental and data analysis skills
- learn to use scientific apparatus
- learn to estimate statistical errors and recognize systematic errors
- develop reporting skills (written or oral)
- practice collaborative problem solving
- exercise curiosity and creativity by designing a procedure to test hypotheses
- better appreciate the role of experimentation in pure sciences, agriculture, and health sciences
- test important laws and rules (pp. 68-69).

**2.3.5.10. Role-play or simulation method.** Role-plays cater for the kinesthetic or tactile type of learners and the learners with greater intra-personal intelligence. It is a product of play or drama (activity or interaction for enjoyment), games (activity and interaction for enjoyment with an end/payoff/winning target), and simulation (artificial situation reflecting the real world) (McSharry and Jones, 2000, p. 73).

SSCED (2012) presents five stages of role-play and simulation method of teaching:

i) Initiation and direction (identifying a topic and roles)

ii) Describing the context (describing the context and different perspectives)

iii) Assigning roles (assigning the roles, not more than 5 or 6 and explaining what to do)

iv) Ensuring enactment (making sure students are fully involved and proceed positively)

v) Debriefing (asking students to present both orally and in writing to sum up/conclude) (pp. 16-17).

According to McSharry and Jones (2000, pp. 73-82) the main characteristics of role-play or simulation are: deeper and more affective (involving emotions) learning; more active and fuller involvement of students in learning; and more effectively dealing with moral and ethical
issues of science curricula; more concrete form of learning complex scientific phenomena. The authors presented a few role-play examples in this regard: describing the water-cycle to class by performing as weather reporters; demonstrating the way the planets revolve around the Sun; debating and discussing about genetically engineered agricultural products etc; describing predator-prey relationship; explaining why day and night occurs etc; showing kinetic theory, electrical currents and antibody-antigen interaction (pp. 73-82).

Hurdles in Role-Plays

- Since, existing teaching methods, professional training, and curricula do not focus role-plays. Therefore, teachers find them more difficult to control and manage. It is more time taking and boring; and more open to serious behavior problems. Some teachers prefer to listen and watch their students, rather than taking part in doing things because they are used to doing this, and they are trained in this way.

Table 5

*Categories of Role-play with Examples of Exercises*

<table>
<thead>
<tr>
<th>Category of role-play</th>
<th>Example of role-play exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiments/investigations</td>
<td>Any practical experiment</td>
</tr>
<tr>
<td>Games</td>
<td>Cut-and-stick: card games; board games; dice games; memory game</td>
</tr>
<tr>
<td>Presentations</td>
<td>Child-in-role; make a radio or TV commentary; short or extended science plays</td>
</tr>
<tr>
<td>Metaphorical role-play</td>
<td>Human sculpture; mimes</td>
</tr>
<tr>
<td>Analogy role-play</td>
<td>Using children as objects or elements of scientific theory</td>
</tr>
<tr>
<td>Simulation (or moral/ethical role-play)</td>
<td>Organised debates; simulated meetings; simulated court cases</td>
</tr>
<tr>
<td>Theatre in education</td>
<td>‘Outside’ drama companies which encourage audience participation</td>
</tr>
</tbody>
</table>

Source: McSharry and Jones, 2000, p. 76.

2.3.5.11. Experiential learning. According to Gravin, Jessica, Nathalie and Cecilia (2012), Kolb blended the models of Lewin, Dewey, and Piaget to introduce his “Experiential
Learning”. It focuses students’ subjective experience as a key component (p. 25). Experiential Learning model/cycle involves four steps:

i) Concrete Experience

ii) Observation and Reflection

iii) Abstract Conceptualization

iv) Active Experimentation

Above four steps and processes relate and support four types of learners and approaches to deal with a problem: activist (experiencing), reflector (reflecting), theorist (thinking), and pragmatist (acting).

Figure 6

*Kolb’s Four Types of Learners*

Source: [http://www.learningandteaching.info/learning/graphics/honeymum.gif](http://www.learningandteaching.info/learning/graphics/honeymum.gif)

There are two basic processes or stages in experiential learning: concrete experience and abstract experience. Both relate to grasping the experience according to preferred personal learning style—some learners tend to learn through sensory experience that is material, visible,
and touchable or can be felt through our senses while others prefer to learn through linguistic words and concepts through deep thoughts, analysis, and mind maps etc. Similarly in processing experience some of the learners tend to carefully watch others doing experiences and reflect on what happens while others prefer to do the things practically and gain first hand become part of active experimentation. The authors call these patterns as four ‘Learning styles’ within experiential learning (Kolb, Boyatzis, & Mainemelis, 2000, p. 39). Tennant (as cited in Bhat, Handout, n.d.) classified learners into four types—convergers, divergers, assimilators, and accommodators (pp. 9-10).

2.3.5.12. Five Es learning cycle. “It was originally proposed in the early 1960’s by Atkin and Karplus…” (Magonigle, 2011, p. 4). It is adapted from Kolb’s experiential learning theory and involves Piaget’s constructivism principles. Later on others have extended it to 6Es and 7Es models.

Lederman (n.d.) states that this inquiry-based teaching method offers a richer understanding of science related learning. Herron’s Scale describes four levels of inquiry: exploration, direct inquiry, guided inquiry, and open-ended inquiry. And it catered for all these levels. The 5Es correspond to Engagement, Exploration, Explanation, Elaboration, and Evaluation (pp. 1-2). Let us have a brief look at them individually:

i) Engagement

According to Magonigle (2011) first phase involve traditionally presenting and discussing unfamiliar phenomena or objects; discussing objectives of the lesson and teacher’s expectations; and assessing and relating students previous knowledge. The teacher may use demonstration or any other technique or activity for attention-grabbing (p. 7).
ii) **Exploration**

Here, learners try “to explore, raise questions, create statements to test, work without instruction from the teacher” (Magonigle, 2011, p. 7). Hands and minds on activities and active involvement of students are coral. However, the teacher facilitates and provides direction and assistance in organizing the activities and investigations (Lederman J. S., Undated, p. 2). For example, Magonigle (2011) points out that at times the teacher assigns roles: group manager, material collector, recorder and reader to collect and record the data and share observations (p.7).

iii) **Explanation**

Learners experience and sense out their understanding and actively construct knowledge. Here the teacher-led instruction and discussion takes place to look into details, technical terms and definitions and remove misconceptions. The teacher uses appropriate audio-visual-aids including computer software and online help to assimilate and accommodate new information (Magonigle, 2011. pp. 7-8).

iv) **Elaboration**

Magonigle (2011) reveals that in this stage the teacher helps reinforce the concepts by extending and applying to new and real world situations. Here, students can discuss and investigate questions to find their answers from their teacher through open-ended inquiry (p. 8).

v) **Evaluation**

Here the teacher helps students to summarize important aspects and relationship of different variables by asking higher-order thinking and critical questions that could lead to evaluate students work and make judgments of their work: concept maps, constructive response questions, rubrics, monitoring charts, and student self-assessments (Magonigle, 2011, p. 8). This
is not a comprehensive list of teaching methods for sciences; however, I discussed the most common science teaching methods. Now it is time to proceed to next section.

2.4. Measuring Effectiveness of a Process or Product

The effectiveness of a process (for example teaching among many within educational domain) or product (for example passed out graduates of a discipline) can be measured through assessment and evaluation. In this section, the researcher discusses important aspects of assessment and evaluation.

2.4.1. Defining and Distinguishing Assessment and Evaluation (of Teaching)

Hashway while citing the studies of Dubois; Lien; and Ruch pointed out that “the earliest known written tests [assessment and quantitative evaluation] were administered by the emperor of China in about 2200 B.C.” (p. 1). Both assessment and evaluation are part of daily life. We select and evaluate the dress that is suitable for work, party etc; we evaluate while buying a gift or crossing the road (p. 5). Both processes in education are carried out to find out whether and to what extent the specified educational objectives (of teaching, curricula, management etc.) are met. The term assessment has its root in the Latin word “asoidere” meaning “to sit by” in judgment (National Open University of Nigeria, 2006, p. 2). Despite being written extensively on assessment and evaluation the terms still are confused.

The researcher thoroughly reviewed the literature pertaining to assessment and evaluation by different independent authors/researchers and organizations (Chinapah & Miron, 1989; Tollman, 1992; Lacke and Tessmer, 1997; Ellington and Earl, 1999; National Science Foundation, 2002; University of Sydney, 2002; Stern, 2004; ASKe, Oxford Brookes University, 2005; Lorien Eck, 2006; National Open University of Nigeria, 2006; Agrawal, 2008; Taras, 2008; The Saskatchewan Ministry of Education, 2008; Navarro Coy, 2009; National Oceanic and
Assessment involves following crucial aspects:

a) It is a systematic process of studying, measuring, and making inferences of a phenomenon against its objectives/established criteria. In teaching and learning it involves measuring learning outcomes against learning objectives and processes.

b) It aims at diagnosing and addressing potential problems in order to maintain required competitive standards and their further improvement.

c) It can be classified in number of ways: i) on the basis of time: assessment during continuing process (formative), or at the end/product (summative); ii) on the basis of criterion used: comparing one’s scores with predetermined grading criteria (criterion-referenced), comparing one’s scores with whole group’s scores (norm-referenced), comparing one’s score against his/her previous scores (ipsative); on the basis of who is assessing: assessment from and by within the institution (internal), assessment from and by other organization/individuals (external), assessment by teacher/tutor (tutor), assessment by colleagues (peer), assessment by self (self); on the basis of how tests are conducted: asking verbal questions (oral), responding in writing (written), responding to situation (performance); on the basis of use of communication technology: through computer (computer), through traditional/manual (manual).

d) Ensuring validity and reliability is crucial to assessment otherwise it loses its importance.
e) Many researchers believe that each type of assessment has its own merits and demerits and none works best for all situations therefore they suggest complimenting two or more.

f) Majority of researchers agree that assessment is used for on-going processes and is part of and helps in evaluation. Thus evaluation is more comprehensive process.

2.4.3. Evaluation

Evaluation involves following crucial aspects:

i) Mostly researchers and authors claim that evaluation is a broader and includes assessment as its part. In educational situation evaluation caters for studying and development of student-learning, teacher-performance, curriculum-enrichment, and improvement of non-cognitive—physical, emotional, social, and motor—skills.

ii) It is a systematic process to determine whether and to what extent the established specific objectives or criteria and standards are achieved.

iii) It aims at determining overall judgment and decision about the process/product evaluated.

iv) It helps ensure worth and merit with regard to relevance, effectiveness, significance, impact, and degree of efficiency to maintain and improve the quality of things or processes.

v) It involves both quantitative (questionnaires, tests; rating, ranking, and socio-metric scales, checklists etc) and qualititative (observations, interviews, discussions etc) data collection tools to determine the worth and merit of a process or product in hand.

vi) Transparent and merit based evaluation not only helps diagnose the problem in depth but it also helps to address them properly. Sound evaluation system work as a stimulus to maintain and enhance institutional/organizational efficacy and efficiency.
vii) It addresses ‘Wh’ questions (what, why, when, whom, where, whose, how).

viii) It helps in deciding a course of action; providing information to various stakeholders; assessing and bridging gaps between objectives and achievement; determining program/project’s impact and cost-effectiveness; deciding whether or not to continue, amend, expend, or withdraw the program; improving the program and making it competitive; planning for a program or project; and creating and implementing new knowledge according to changing context etc.

ix) There are many approaches and kinds of evaluation. No single approach or type fits all sizes hence researchers should use combination of approaches and types. They could be classified on the basis of:

   a) Time passed after initiation of intervention:
      (Formative, Progressive, Implementation, Summative evaluation)

   b) Methodology adopted:
      (Quantitative, Qualitative, Mixed or holistic evaluation etc)

   c) Participation of respondents or participants:
      (Traditional or expository, Social constructivist, Constructivist evaluation)

   d) Purpose:
      (Diagnostic, Impact, Formative or Summative etc)

   e) Affiliation of evaluator:
      (Internal, External evaluation etc)

   f) Relationship to evaluator or respondents:
      (Self, Peer, Tutor, Administrator’s evaluation etc)

   g) Achievement criteria:
(Criterion-referenced, Norm-reference, Ipsative or with relation to learner’s Previous achievement etc)

h) Involvement of population:

(Program or broader, Project evaluation or relatively narrower)

i) Reach and level:

(Local-level, National, Global-level/International evaluation)

j) Funding

(Fully-funded, Partially-funded, Non-Funded evaluation)

2.5. Planning

In this section, the researcher reviews the literature on evaluating science teaching with regard to three basic stages of teaching i.e. instructional and lesson-planning, presentation (teaching approaches, methods, resources, and activities) of lessons, and formative assessment of the lesson. Let us start with instructional planning:

2.5.1. Instructional Planning

“Effective teaching is organized—it follows a planned sequence of steps intended to encourage learning” (Harker, 1976, p. 568). Due to the complex, uncertain, and changing nature of teaching, it is necessary to make it organized and planned. And instructional planning takes on different forms and levels i.e. Yinger’s three stage process model involve yearly, unit, or weekly planning while Leinhardt’s agenda-formulation model fits for daily planning (Brown, 1988, p. 69). However, in this regard Ornstein (1997) points out five types of planning: yearly, term, unit, weekly, and daily (p. 227).
In Pakistani context, the curricula is designed and implemented through federal government thus from grade 1 to 12 teachers need not worry about yearly, term, or unit planning; however, they are only supposed to do daily planning i.e. individual lesson planning.

2.5.2. History and Components of Lesson Planning

Roots of lesson planning can be traced to the work of Ralph Tyler whose rational-model involves “four components: specifying objectives, selecting learning experiences for attaining objectives, organizing learning experiences, and evaluating effectiveness of learning experiences” (Zazkis, Liljedahl & Sinclair, 2009, p. 40). Tyler’s work emphasized specification of objectives for curriculum development and teaching and it paved the way for traditional lesson plan models. A lesson plan involves specification of:

- **Goals and objectives:** an objective must be specific, measurable, authentic, realistic, and time-specific. Teachers may use Blooms classification of learning objectives to specifically expect and assess their teaching: cognitive domain related to intellect (knowledge, comprehension, application, analysis, synthesis, evaluation; affected domain related to feelings (receiving, responding, valuing, organizing, characterizing); psychomotor domain related to practical performance/skills (sensory perception, set or readiness to perform, guided response, mechanism or somewhat competency and habitual performance, complex overt response or confident/masterly habitual performance, adaptation or modifying response in new situations, organization or creating new task or objectives in the light of learned ones.

- **Teacher’s and students’ activities:** teaching and learning activities involve: checking and relating students previous knowledge with new topic, delivery of lesson i.e. demonstration etc, asking questions and students’ feedback, students’ assignments and projects, lab-work, students’ pair or group work, ice breakers, modeling, intervening etc.
- **Materials or audio-visual AV-aids:** teacher should use appropriate AV-aids according to the preferred learning styles of learners i.e. Printed Material (books, handouts, worksheets, black/white board, charts, posters, projector slides etc for visual learners; Audio-Visual Material (television, CD player, radio etc) to support auditory and visual learners; Computer Based: web search and browsing, power-point-presentations, computer conferencing, simulations and interactive sites for kinesthetic learners; teachers may invite professionals and resources persons having expertise in related subject (SABES/ACLS, 2008, p. 20).

- **Feedback and guidance for students:** teachers should assist students’ learning from their perspective through catering their specific needs and requirements. Moreover, teachers should get feedback from learners to mould their teaching and related activities according to the level and approach of learners.

- **Assessment/evaluation:** teachers must assess whether the objectives have been met through administering well planned verbal/written quizzes and tests, assigning tasks to perform, and giving home-work etc (SABES/ACLS, 2008, pp. 2-34; Zazkis, Liljedahl & Sinclair, 2009, p. 40; Bonner, 1982; National Capital Language Resource Center, 2007, pp. 1-4; Bloom, 1956).

### 2.5.3. Importance of Lesson-Planning

Almost all professional degrees and courses emphasize to spend time for preparing appropriate lesson plans according to the contextual requirements of learners, curricula, and institution (AIOU, 2012), however, many teachers do not write lesson plans (SABES/ACLS, 2008, p. 3). Lesson plans vary in length as some more experienced teachers require a chit or cocktail napkin for a few notes while others require a typed plan with details on each step and activity. SABES/ACLS (2008) claims lesson planning does yield following pedagogical benefits:
Lesson-plans (LPs) stimulate teachers to deeply consider what can and should be accomplished with a class through class-modeling, sequencing, reviewing, and checking. LPs encourage deeper insights on the specific and individual needs of learners according to their preferred learning style i.e. auditory, visual, kinesthetic etc. LPs encourage better and more fruitful discussion with peers, administration, and even learners for making teaching learning more effective and realistic. LPs persuade teachers to come out of their “ruts” or comfortable habits and use innovative and variety of teaching approaches, resources, and activities. LPs enable teacher to be more prepared, confident, and flexible and foresee and handle challenges through better knowledge, skills, and reflection. Written LPs provide a good record. It creates and enhances shared wisdom through discussing with teachers etc and adapting them to fit for another level or future use (SABES/ACLS, 2008, p. 3).

2.5.4. Three Stages of Lesson Planning

To get actual benefit from lesson planning teachers should undergo:

- Pre-planning (the teacher crafts lesson-plans by identifying objectives, materials, teacher’s activities i.e. teaching methods and strategies, students’ activities, and assess the learning outcomes of students)
- Implementing (the teacher implements the lesson-plan in classroom situation)
- Post-planning (the teacher self-reflects upon the lesson and gets students’ feedback and adjust it accordingly for future use) (Center for Excellence in Teaching, 2009, p. 31).
2.5.5. Empirical Evidence on Lesson Planning

Ozogul, Otina, and Sullivan (2008) studied the effect of teacher, self, and peer evaluation of the lesson-plans on pre-service teachers' performance, knowledge, and attitudes through their written lesson plans that incorporate technology. The subjects were exposed to three class periods of instruction on writing lesson plans and randomly assigned to teacher, self, and peer evaluations. After writing the first draft individually they came up with a final draft through respective evaluation and comments. The study revealed that the teacher-evaluation group outclassed the other two in terms of significant better development and writing improved last version than the other two groups. Moreover, self-evaluation group achieved better marks on a posttest involving knowledge-based items than those working in peer-evaluation group (p. 181).

Another study on lesson plan reveals that teachers going through pre-service training face certain serious issues and problems in lesson planning:

. . . (a) concerns about knowing how to begin to plan, (b) difficulty identifying what the children needed to learn, (c) the prominence of decisions made on the fly, (d) comparisons of thinking about teaching and planning with actual written plans, and (e) limited transfer of in-class experiences to teaching in the project. Suggestions for teacher educators include acknowledging the complex nonlinear relationship between planning skills, teaching experience, and professional knowledge; structuring guided experiences with a variety of lesson planning formats (e.g., written, mental, verbal); and maximizing opportunities for pre-service teachers to reflect on connections between their experiences as students and as teachers. (Schmidt, 2005, p. 6)

Zazkis, Liljedahl, and Sinclair (2009) argue that teaching is a complex activity that requires proper planning. Pre and in-service teacher-trainings teach prospective teachers to
devise a lesson plan according to prescribed format. However, no single teacher even a good teacher follows the format. Those formats or templates become an empty shell, therefore criticized in scholarly literature for making them too simple besides ignoring how teachers actually plan. The authors argue that good teachers recognize the fact that articulation of objectives though is necessary but not sufficient for complete teaching. Thus, they introduced the notion of ‘Lesson-Play’ which involves a dialogue and discussion between a teacher and students. It not only accounts for preparation of a lesson according to students’ needs, but also facilitates the teacher to learn from the lesson going on in the classroom (p. 40).

Depending only on outcome based teaching and fixed or prescribed templates of lesson-plans leave little option for both the teacher and taught to allow constructivist intervention where cooperative or individual work may lead the learners and teachers into new insights about the topic in hand. According to Nystrand (1997) it is not very easy always, for example, it is very difficult for a teacher to follow fixed pattern of lesson plan who teaches a class of 125 or more students. Fixed lesson-planning would not facilitate their individual or group work. All this calls for a flexible planning (p. 79). Thus, an appropriate lesson plan must cater for the needs of all the types of learners: above and below average, and average students; and learners with special needs i.e. gifted and mentally retarded or handicapped students.

Craft and Bland (2004) compared teaching styles with cooking styles where some teachers always supply their learners with tested and tried, basic “recipes” of teaching for years and the students enjoy their taste, however, other teachers work as experimenting chefs to experiment new constituents and methods always. Majority, however, use a combination of basic (tested and tried) and innovative (experimental) recipes of instruction and fall somewhere
in between. There is always a room for new ingredients to be used and others altered or removed; and lesson planning is the solution to this conversion (p. 88).

2.6. Hazards and Safety Measures in Chemical Laboratory

American Chemical Society (2001) in their guide “Chemical Safety for Teachers and Their Supervisors, Grades 7-12,” present a brief and meaningful account on the hazards and the measures for their protection that can occur in a chemical laboratory during teaching learning process. Following is a summarized version of the guide:

“All chemicals are hazardous, but they all can be used safely if we know how to control their hazardous characteristics while we use them” (p. 2). The said booklet further points out that “An accident is coming, sooner or later. The way we defeat such a prophecy is to determine the cause or causes of the close call and take corrective steps now, so that at least one forthcoming acci-dent is eliminated” (p. 21).

Chemistry teaching and learning is often associated with certain physical hazards. Different chemicals and experiments have the risk of different physical hazards. For example, concentrated sulfuric acid is very slippery thus possess the risk of spilling; dry-ice can cause freeze burns on hands or skin when exposed; certain chemicals are radioactive and cause physical harm if used without following proper precautionary measures; and loose-fitting clothes (sleeves, shirts, ties), unfastened long hair, large jewelry, rowdiness, hot things (electric bulbs etc), and abandoned fire or lit burners may result in physical harm (pp. 11-12).

The suppliers of chemicals are and should be bound:

- to provide information by proper labeling on the package
- to supply related Material Safety Data Sheets (MSDSs)
• to convey, teach, and train the teachers especially teaching chemistry about general information of hazards, taking precautionary measures, and dealing with emergency in case precautionary measures fail by the employer/education department (p. 5).

2.6.1. Classification of Harms

American Chemical Society (2001) state that the harms or hazards fortunately can be classified into following four categories:

2.6.1.1. Flammability. Not only flammable substances will burn but also their vapors. The dangerous concentration ranges from 1 to 50% for different chemicals, and they can burn as far from the source as 10-30 feet. Protection measures in this regard should be: ensuring proper ventilation; removing ignition surfaces i.e. hot plates and surfaces, electric bulbs, friction sparks; ensuring working fire alarm and safety shower; adopting training/ mock training of ‘stop-drop-and roll’ to reach safety shower in case one’s clothing catches fire (pp. 6-7).

2.6.1.2. Corrosivity. “A corrosive chemical either destroys living tissue or causes permanent change in such tissue through chemical action” (p. 7). Strong acids and bases etc are corrosive chemicals. Precautionary measures against corrosive chemicals may include: wearing safety goggles and full face shield with Z87, clean gloves and sleeve gauntlets made of impervious material; wearing full apron; purchasing diluted corrosives and storing and handling them below eye-level; washing apparatus thoroughly after experiments; ensuring working and properly using safety shower and eye-wash fountain. If corrosives get in touch with skin or eyes flush it off with flowing water or eye-wash fountain for 15 minutes (moving and rolling eyes while holding both eyelids with thumb and forefinger) to avoid internal damage (pp. 7-9).

2.6.1.3. Toxicity. The toxic chemicals/poison upon exposure (inhalation, injection, absorption, ingestion, mist/dust) can cause both acute effects (occurring rapidly: inebriation,
unconsciousness, breathlessness, corrosiveness: burns and blindness) and chronic effects (occurring after repeated exposure: cancer and reproductive malfunctions). Methyl and ethyl alcohol can cause acute inebriation as an acute effect while cirrhosis of liver is their chronic effect. Moreover methyl alcohol can cause blindness and death as additional acute toxic effects. Precautionary measures are same as of above categories. However, the basic ones are: using fume hood; avoidance or limited use of related experiments; and use of diluted solutions. Nevertheless, seeking assistance from teacher/supervisor in case someone experiences symptoms like headache, nausea, and dizziness in the laboratory is crucial (pp. 9-11).

2.6.1.4. Reactivity. Package labels are not all the times providing information that chemicals are self reactive, can spontaneously explode, or can explode if mechanically disturbed, react strongly with some other chemicals, and releases a lot of heat if mixed with certain other chemicals. The suppliers provide such information in their MSDS. For example, picric acid in wet or dry form and peroxide formers i.e. metallic potassium, diethyl ether and other ethers such as dioxane and tetrahydrofuran may detonate/explode if mechanically disturbed. Certain chemicals are incompatible with others even diluted acid base combinations may release a large amount of energy. Metallic sodium can explode when added to water. Such incompatible chemicals must be labeled and kept separately and must not be given to students in combinations, but such experiments must be conducted by the teacher or in the strict supervision of the teacher. Some suppliers use colored strips or codes to avoid such incompatible combinations. However, chemicals with same color strip from different suppliers may be incompatible (pp. 11-12).
2.7. Empirical Evidence on the Teaching of Chemistry

Sakalli, Hursen, and Ozcinar (2007) analyzed the frequency of teaching methods used by the secondary school teachers using four-point likert scale (always, frequently, seldom, never) and collected data from 71 teachers in the context of Turkey. They found that a majority (78%-68%) agreed to “always” using lecture and discussion method of teaching. While considerable number of respondents within remaining minority believed to had been “frequently” using homework, practice in the classroom, problem solving, showing and practicing methods. However, little number of respondents opted for “seldom” or even “never” to teach through project work, analyzing example situations, debates, similarity, computer based education, observing private tutorials, educational games, cooperative learning, brainstorming, field trips and reflecting/mirroring situations, group/team work, experiment, role play, micro-learning technique, statement, speech, meeting, display, drama, conference, formal debates, symposium, seminar, panel, umbrella technique, forum and opposite panel methods of teaching (p. 1).

Hussain, Azeem, and Shakoor (2011) conducted a study on the 10th grade students of government schools (in the context of Faisalabad, Punjab) involving three experimental groups to compare the effectiveness of three strategies of scientific inquiry i.e. guided, unguided, and a mix/combination of guided and unguided scientific inquiry against traditional lecture method of control group. All the groups were randomly selected from the population. From the t-test analyses the authors found that all the three treatments in above sequence yielded better statistically significant results respectively against traditional (lecture) method of teaching. The authors recommended that existing teaching of science subjects should be taught through scientific inquiry method and such revision in curricula be extended and ensured in teachers’ pre and in-service trainings in our country (pp. 269, 273).
Watkar (2012) conducted an study on a random sample of 100 students of grade 9th in India’s context to compare effectiveness of lecture-demonstration and laboratory method of teaching ‘science’ against traditional teaching method. The author found from t-test analyses that while teaching the unit “Metals and Mixtures” both the lecture-demonstration and laboratory methods of teaching found to be statistically significant and yielded better learning outcomes against traditional (lecture) teaching method. However, the laboratory method was found better than the lecture-demonstration method of teaching for teaching science subject (p. 2).

Veselinovska (2011) carried out a comprehensive study on 47 university students of biology to determine whether and to what extent the sequence of teaching learning activities influences the students’ cognitive achievement (pre and posttest), and retention (posttest vs posttest after 30 days) toward learning biology. For this purpose three groups were formed to use following sequence of teaching learning activities:

- **Group I:** Laboratory work (student’s experiment) – lecture method – slide demonstration
- **Group II:** Lecture method – slide demonstration – Laboratory work (student’s experiment)
- **Group III:** Slide demonstration – Laboratory work (student’s experiment) – lecture method.

The data collected through pre and post tests were analyzed through one-way ANNOVA test. The author concluded from the findings that the Group I and Group II who began their lesson with laboratory work or student experiment or slide demonstration or PPT got better and statistical significant results in both students’ cognitive achievement and retention respectively that that of Group III who started their lesson with teacher’s lecture. The author believed that the results confirmed the validity of a well-known maxim that people remember 10% of what they read, 20% of what they hear, 30% of what they see/watch, and 90% of what they do; and suggested that laboratory work and experimentation should be focused in the teaching of science
related disciplines and a lesson started with students’ laboratory work or experiments (pp. 175, 179, 183).

Under the influence and criticism of Dewey on traditional education newer or “progressive” education started to flourish that made a great distinction between the two. However, Pantic (2007) argues that at times such perceived distinction is so-called systems of education with their associated pedagogies. The author raises a few serious questions on both systems of education in terms of their actual process and performance and concluded in the following words:

. . . Research evidence suggests that the employment of progressive methods do not necessarily lead to pupil’s independent inquiry and self-confidence. Despite seating arrangements, "interactive lesson plans", and the project work in progressive schools, genuinely "open" questions hardly ever occur (Barnes, 1969), many children fail to internalise educational input into their own individual experience or collectively translate it into social actions outside the classroom. The paper further recognised the effect of issues such as selection of curriculum, subliminal imposition of a dominant culture, ideology, whether by teachers themselves or wider educational and societal systems. On the other hand, the example of Summerhill School as a radical experiment in education for freedom was used to illustrate how progressive ideas can be cherished even while using traditional methods of instruction. More accurately, it can be used to suggest that the employment of traditional methods does not affect the development of a general atmosphere of freedom and democracy, once children willingly accept the authority of teachers as more knowledgeable, but equal in status.
The conclusion is drawn that pedagogy is not the crucial factor in accomplishment of the professed purpose of progressive education, as is often assumed in growing research in area of effective teaching and learning methodologies. It was suggested that issues of school ethos and relations between teachers and students and building democratic community in schools deserve a much more prominent place in education thinking (p. 17).

Science teachers especially chemistry teachers realize the importance and truthfulness of the maxim “Prevention is better than cure” because having safety consciousness and taking necessary precautionary measure is the only key to maximally avoid an untoward accidents while handling the chemicals and doing related experiments. Dong, Liu, and Yang, (2011) in their paper emphasized the need of promoting safety consciousness in the teaching of chemistry whether carried out in the laboratory or classroom setting. The authors reiterate that chemistry being an important branch of natural science do require guided individual or group experimentation to deeply understand the chemical concepts and reactions, on the one hand; and to promote safety consciousness among students for better experimental work and avoiding any accidents that could occur as a result of little precautionary knowledge, on the other hand. Therefore it is necessary for the teachers to cultivate safety consciousness in the teaching of chemistry (p. 269).

Discussing on Project Based Learning, Liu and Zou (2011) summed up that:

The PBL tutors have to be reminded that they are not starring on the stage; instead, the leading roles are always played by the students. The tutors should stay attentive but refrain from too much interruption. Most importantly, tutors should not give the answers to the questions directly, instead, they should encourage and motivate the students to be
active and search for needed facts and solutions themselves. One ancient Chinese philosopher once said that to teach a disciple how to fish is better than to give a fish. PBL is a good example of this pedagogical philosophy. Therefore, the role of the tutor in PBL is not “to offer fish” but rather “to teach how to catch fish”. In PBL, the tutor acts as a facilitator and a mentor, but not a source of "solutions" (pp. 1384-85).

Udo and Etiubon (2011) conducted their pretest-posttest control group experimental study involving 89 students from Senior Secondary II schools in the context of Nigeria to determine effectiveness of computer simulations and guided discovery method against traditional expository teaching methods for the teaching of chemistry. The ANCOVA analysis confirmed that science related computer simulations and discovery method yielded equally better and statistically significant learning outcomes than the traditional ones. The authors suggested that teachers ought to incorporate computer simulations in their classroom teaching and learning of chemistry (p. 211).

Mandina and Mambanda (2012) conducted a qualitative study from a sample of 60 urban junior secondary school students in Zimbabwe to explore students’ perceptions about effective science teachers. The researchers concluded that the foremost characteristic of effective science teacher from the students’ perspective was teacher’s pedagogical skills i.e. those who know how to teach. The ability of facilitating them to learn science and making learning an interesting and fun also perceived the most important aspects on the part of teachers. It confirms that students love to learn from those teachers who care about their learners’ interests and emotions and treat them with respect. The authors recommended and pointed out the need to routinely observe teachers’ content knowledge, teaching skills, and attitude toward learners (p.164).
The tremendous development in eLearning involvement though has brought significant contribution to the development of education in all aspects; however, direly need to device and improve appropriate standards to ensure quality eLearning. Moreover, lot of work is to be done in designing proper eLearning simulations and online teaching methods and their assessment (Ceobanu, Criu, & Asandului, 2009, pp. 133-135).

A mixed study involving quantitative (experimental) and qualitative (document analysis) was conducted in Istanbul on a sample of 50 seventh graders to find out the impact of problem-based learning on learners’ conceptual knowledge and understanding. The researchers concluded from findings that not only the problem-based active learning model yielded better results than the traditional method, but it also accounted for inculcating among the students more positive attitudes and conceptual development towards science learning, and kept students’ misconceptions at the lowest level (Akınoğlu & Tandoğan, 2007, p. 71).

Ergul, Eklo, Caliu, Ozdolek, Göçmençelebi, and Sanli (2011) conducted a comprehensive experimental study on a sample of 241 Turkish elementary students (71 and 68 students from grades 4, 5, and 6 for experimental and control groups respectively; and 50 and 52 students from grades 7, and 8 for experimental and control groups respectively) to measure their Science Process Skills through Science Process Skill Test developed by Burns et al. (adapted) with 38 items i.e. 24 for grades 4 to 6, and 14 for grades 7 to 8 (Cronbach’s alpha reliability coefficients of the tests were found to be 0.74 and 0.78 respectively) and their attitudes through Attitude Scale Toward Science developed by Oruc containing 40 items (reliability was found to be 0.87). The study and data collection process involved two semesters or a full academic year. The treatment groups did 108 hands-on activities (for 50, 25, and 33 experiments related to physics, chemistry, and biology respectively) in groups having 2 to 4 students, whereas, the class size had
an average of 40 students i.e. larger classes. ANCOVA analysis revealed that hands-on activities incorporating inquiry based science teaching yielded statistically significant and better students’ achievement and attitude toward science learning (pp. 48, 54, 55, 56, and 63).

An experimental study was conducted on 24 eighth graders who were taught through computer based Modular Technical Education where the teacher facilitates the learners who are actively involved in self learning. It compared its effect on 19 students taught through traditional lecture-demonstration method. The study findings did not support that either method of teaching was more statistically significant over the other in the context of Burlington Middle School, USA (Silkwood, 2000, pp. 1, 16, 23, and 24).

Gujjar, Naoreen, Saifi, & Bajwa (2010) conducted their study on a sample of 650 Pakistani student teachers/prospective teachers who had completed teaching practice during their B.Ed course out of 26 teacher training institutes (25 student teachers from each). The 20-item questionnaires’ data were analyzed through descriptive statistical procedures. The findings revealed a shocking picture of the effectiveness of pre service training and public sector teachers’ professional knowledge and skills:

- Most student teachers (87.6%) agreed that practice teaching was an important milestone.
- Most student teachers (42.3%) simply denied to have proper orientation and training for practical/practice teaching; however, 36.9 agreed to have “maximum” or proper orientation, while 20.8% opted for “to some extent”.
- A majority of teachers (67.4%) denied to have any audio-visual material available to them, while 21.6% opted for “to some extent” having such audio-visual aids, however, only 11% claimed that they were provided such material to “maximum”.
• On an item whether supervisors assessed their practice teaching, a majority either opted for “to some extent” (44.6%) or “not at all” (28.9%), while a minority (26.5%) agreed to “maximum”

• Most of the respondents believed that there is a dire need to improve the process of practice teaching (62.15) and more time should be given to it (64.6%).

• Majority of respondents (56.7%) simply denied to be provided any required instructional material during practice teaching by the institution where they went to practice teaching.

• Majority of the student teachers (53.8) showed their strong dissatisfaction to the overall process of practice teaching, whereas, 19.2% of the teachers showed their satisfaction “to some extent” while 26.9% were found totally satisfied (pp. 339, 346-356, 360).

The study revealed overall failure of pre service training (B.Ed) and student teachers’ professional knowledge and skills due to weaknesses in teaching and training, instructional material, and audio-visual aids. Deslauriers and Wieman (2011) conducted their study on two equivalent cohorts of university students (University of British Columbia) taught through different pedagogical approaches. The study measured the impact and retention level of traditional (lecture-demonstration) and interactive engagement methods. The findings revealed that the latter cohort achieved 19% greater and statistically significant scores. However, both methods were found almost equally good (with a few % decrease) in retention of the concepts (retested and measured 6 and 18 months after completion of the course) with no exposure afterwards (p. 010101-1).

Marus and Slis’ko (2012) studied efficiency of two teaching methods i.e. Reading, Presenting, and Questioning (RPQ) and Experimenting and Discussion (ED) on learners’ perceptions and ideas about learning of physics at high school level on two samples of 91 and 85
students for RPQ and ED methods respectively for one semester. Colorado Learning Attitudes about Science Survey (CLASS v3) was used examine students’ attitudes and beliefs. The authors found that both methods positively influenced students’ attitudes and beliefs. The RPQ and ED accounted for +5.8% and +25.6% improvement respectively. The finding suggested that in science teaching and learning the learning by doing (ED) was more promising than the method that does not offer experimentation (p. 010107-1). Moreover the discussion method was equally found effective for teaching social sciences like poetry at secondary level (Owoeye, 1994, p. 1).

Yaman (2005) found in his study conducted on pre-service elementary teachers that for science disciplines problem-based learning (PBL) was a better choice as it developed logical thinking skills equally for male and female student teachers (pp. 31-32).

Constructivist approach to teaching and learning is not always the best choice. Many researchers claim that it is overemphasized and wrongly perceived to be the best approach toward teaching and learning as other forms of knowledge, in times, work better than that. The big flaw that is pointed out against constructivism is that it does not enable learners to grasp the reality of physical world (Kuhn, 1970; Pietrocola, 1999).

Al Barwani, Al-Ani, and Azmat (2012) conducted their study on a multi-stage random sample of 2668 students of general school education in Oman to find out the most important characteristic for effective teaching as perceived by the learners. From confirmatory factor analysis, they found that the foremost perceived characteristic was community relationship and teaching strategies stood as second factor and predictor of effective teaching (p. 23).

A study conducted by Hunaiti, Grimaldi, Goven, Mootanah, and Martin (2010) found that traditional assessment needs some modifications as it does not merely mean a factual and categorical score of the performance of students, but it positively contributes to their learning
especially in the field of research and science and technology. Moreover, it creates conducive learning environment as a result of two-way feedback on the other hand (p. 189).

In a quantitative assessment of the perceptions of secondary school students in the context of Cyprus, a study examined three factors of school climate i.e. physical, social, and learning environment. The self developed five-point likert scale questionnaire containing 53 items was used. The author found that social environment was perceived with a lowest mean, while learning environment appeared at the top with the highest mean, putting the physical facilities/climate in between. The researcher suggested related modifications in teaching, and professional practices and curricula (Pashiardis, 2008, p. 399).

Sipila (2011) investigated the difference of knowledge, use/implementation, and perceived values of 99 Finnish primary and secondary teachers regarding ICT on the basis of expectancy theory. Findings revealed that teachers use ICT mostly for the purpose of communication to administration; their use of student-centered strategies and resources, proficiency and integration of ICT in teaching strongly depended on how ICT teachers use them; primary teachers value using ICT more positively. However their counterparts—secondary school teachers were found more active in utilizing ICT in their teaching; pedagogical thinking has not grown and is uncompetitive with technological advancement; at lower level teachers were not using ICT for communication, activities, and expression purposes but was limited to informational, organizational, evaluative and lesson-planning related activities (p. 39).

Mhlongo, Kriek, and Basson, (2011) studied the effect of simulations on 20 students of tertiary level through experimental study at 0.5 significance level supported with students’ interviews. They found that simulations positively contributed students’ learning; however,
there was no difference of understanding and learning between those who participated and not participated in simulation roles in the class (p. 288).

In her post-doctoral study Tayyaba (2012) investigated the effect of gender and location factors on middle school students’ achievement across four provinces of Pakistan and four core subjects. The study involved two-stage stratified sampling with proportionally adequate sample. The findings from computing averages of different groups at 0.5 confidence level revealed that:

- In some areas rural and urban divide showed comparable achievement.
- In Baluchistan province rural students outclassed their urban counterparts.
- In Punjab and Sindh contrastingly urban learners outclassed rural students.
- In North-West both strata did not differ significantly in social studies and languages.
- The researcher concluded that difference in school facilities, students' home environment, and teachers' influence, accessibility of funds and things, and multi-grade teaching partly accounted for students’ better learning. However Teachers' training appeared as decisive in determining students' achievement.

Dahl and Smimou (2011) surveyed perceived relationship between teaching quality and student motivation from 271 undergraduate students. Correlation analysis at .05 alpha level revealed strong positive correlation between learners’ intrinsic motivation and perceived teaching quality. However there was moderate positive correlation between students’ extrinsic motivation and perceived teaching quality (p. 582).

Another study investigated the influence of learners’ attendance, gender, and size of class on their learning outcomes in the subjects of math and Hindi in Indian context. The quantitative data were collected from 1434 students’ 10 day attendance over five month period. Hierarchical linear model’s analysis pointed out no significant or very weak relationship between students’
EVALUATION OF TEACHING OF CHEMISTRY

attendance and their achievement. However, students’ class in terms of who taught them was found statistically significant, but too small significance was found between boys and girls on achievement test (Jami, Burton, & Chapman, 2012, p. 208).

Nielsen (2008) provided evidence that experienced in-service teachers’ beliefs about teaching and pedagogy can be changed through in-service related trainings and workshops. The author through qualitative study explored after 14 months of two-day workshop on learning and teaching styles found that respective beliefs were explicit and alive (p. 155).

Salfi and Saeed (2007) studied the association between size and culture of school and students’ performance in the context secondary schools of Pakistan. The sample involved 630 respondents (including 90 high school head-teachers and 540 students from primary, elementary, and high schools of Punjab province). The data were collected from Education Management Information System, annual result of the students of grades 9th and 10th across BISEs of Punjab, a self-designed five-point Likert scale whose reliability was found to be at 0.967. The researchers found statistically significant association between above targeted variables and students achievement. Further analysis exposed that smaller schools had favorable school culture and accounted for better students’ learning (p. 606).

In their qualitative study to explore whether and to what extent professionally trained teachers continued to learn and practice through inquiry teaching after their professional training, Fast and Harbor (2007) revealed that “a) there was little or no change in teachers’ individual understanding of inquiry, and b) professional development enhanced teachers’ ability to design inquiry based activities—however, classroom implications did not reflect a high level of inquiry” (p. 63). In another follow-up study during the same academic year, Rushton, Lotter and Singer (2010) explored the attitude and behavior of seven chemistry teachers of high school regarding
one year project on inquiry teaching as part of professional. The data were collected through interviews, reflections in written form, and classroom observations. They found that the teachers had good concepts about inquiry teaching and preferred it in their teaching practices (p. 23).

Moore (2007) observed and investigated teachers’ compensating ways and methods for science teaching in a backward school district and suggested the respective teacher educators, professional development personnel, and administration for provision of uniform and more awareness in teaching and pedagogical content and skills throughout the country (p. 773).

2.8. Sum-up of the Literature Review and Rationale of Present Study

From above review of the related literature, the researcher came to know that the teaching can be evaluated through Student-ratings, Peer ratings, Alumni ratings, Employer ratings, Administrator ratings, Teaching scholarship, Teaching awards, Self (teachers) evaluation, Measuring learning outcomes, and Teaching portfolios. All above forms of teachers’ evaluation determine to what extent students’ learning is taking place in each discipline. Since, we do not have the required and reliable proper culture and infrastructure. Therefore, the researcher felt the need to evaluate teaching of chemistry (that is the backbone of all industries) with relation to the criteria of B.Ed. that is the minimum required professional degree for induction as a secondary school teacher in Pakistan. Because the students are the actual beneficiaries, the researcher felt a genuine need to evaluate the teaching of chemistry at public secondary schools from learners’ perspective for getting the actual picture.

From the content-analysis of the curricula of B.Ed offered at two universities and review of related literature, I found that the eight variables are crucial in the professional development of teachers for their effective classroom teaching, especially of sciences. They are: general professional teaching skills (regularity, punctuality, clarity of voice and hand-writing, mastery on
subject, intimacy to students, clear directions, equal and fair attitude to learners, fulfillment of special needs of special children, development of curiosity among learners, sense of humor, allowance to do mistakes while learning, quick and happy response to learners’ questions); lesson-planning (written or mind planning, flexibility, assessing and relating students’ previous learning to new topic, balance between teachers and students activities and time); teaching methods (lecture, demonstration, laboratory, inquiry, project, field-trip, discussion, problem-solving, role-play, dictation, punishment); audio-visual aids (board/chalk, charts, real things, models, projectors, computers and modern resources); students’ classroom activities (silent-reading, individual and group work, students’ presentations etc); students’ formative assessment (verbal questions, quizzes, tests, home-work, assignments) and coverage of prescribed course (theory and practical components).

Therefore, I decided to evaluate above eight aspects of professional teaching of chemistry at secondary level against the criteria of B.Ed. Moreover, I wanted to find out the effect of above predictors and some demographics on students’ respective test-scores.
CHAPTER III

METHODOLOGY

In this chapter, the researcher discusses the theoretical and methodological aspects and their rationale. It will help the readers understand why and how I dealt with the different aspects of this study: method, sampling, data collection, and analysis. Better to have a look at research questions of the study again in order to understand them in proper philosophical and related theoretical perspective:

i) How do the learners perceive existing teaching of chemistry at public secondary schools?

ii) Whether and up to what extent is the existing professional teaching of chemistry in line with the suggested criteria of B.Ed from learners’ perspective?

iii) Whether and up to what extent do the public secondary school students’ test-scores relate to some aspects of professional teaching of chemistry as assessed from learners’ perspective?

iv) Whether and up to what extent do the public secondary school students’ test-scores relate to some of their demographical aspects as assessed from learners’ perspective?

v) Whether and up to what extent do the public secondary school students’ test-scores differ from some of their demographical aspects as assessed from learners’ perspective?

The main sections of this chapter are research approach, purpose, design, population, sample, data collection and analysis, model hypothesis, and ethical considerations.

3.01. Research Approach

3.01.1. Theoretical Perspective of Mixed Research

The present evaluative study falls into mixed research because it uses both quantitative and qualitative methods of investigation. The purpose of quantitative and qualitative data was to triangulate and complement the either in order to providing a fuller picture and more confident
results. The researcher presents following justification and discussion regarding philosophical and theoretical perspective of the selection of mixed research:

Tuli (2010) cites multiple studies of Sarantakos and Kazdin to explain that “Methodology is a research strategy that translates ontological and epistemological principles into guidelines that show how research is to be conducted . . . and principles, procedures, and practices that govern research. . . (p. 102). The author argues that since each method across a wide range of research methodologies has its own strengths and weaknesses therefore no single method fits for all research problems (p. 99).

There are two main paradigms or epistemological theories to see the world—positivist and interpretive or constructivist. They account for quantitative and qualitative studies respectively. The positivism (or objectivism) that dominated mostly in the last 20th century supports the belief of independent and sharply defined reality “out there” in the world. However, constructionism (or interpretivism) that got its momentum in the last quarter of 20th century (can be traced back to the middle of last century) assumes that reality is a human construct and is constructed within a social process, thus paving the way for multiple realities or interpretations (Tuli, 2010, p. 98; Niglas, 2004, p. 11). Initially the two paradigms rejected the either and were deemed to be incompatible until the paradigm shift has occurred recently. It ended the phase of ‘paradigm-war’ and paved the way for recognition of construtionism or interpretivism in social research. (Bryman, 2006, Introduction; Cupchik, 2001, para. 11). Qualitative research helps in deep understanding the meaning of social phenomenon in the context of cultural values and beliefs (Tuli, 2010, p. 103).

Quantitative (objective) investigation is linear and aims at studying a phenomenon specifically against well-established/defined variables, criteria, and standards to produce value-
free results. On the other hand, qualitative (subjective/interpretive) research is not linear and accepts that people cannot be value-free because our attitude largely is influenced by our beliefs and perceptions, thus social reality cannot be studied in isolation and objectively. Myers and Barnes (2005) argue that though the qualitative research is not an easy option as it is more time consuming and labor intensive, yet if done properly it positively contributes to program evaluation because it focuses on personal contact with participants and their subjective experiences within actual or natural context (p. 3).

Presently many authors suggest integrating both qualitative and quantitative approaches for getting more holistic picture and deeper understanding a phenomenon (McCall & Bobko, 1990, p. 8; Eisenhart & Howe, 1992; Currall, Hammer, & Baggett, 1999, p. 8; Myers & Barnes, 2005, p. 4; Bryman, 2006; Curry, Nembbard & Bradley, 2009). However, some researchers point out issues of inappropriate integration of mixed methodologies in most of the studies (Bryman, 2006, 2007; McEvoy & Richards, 2006).

Since social reality cannot exist and studied without knowing respective social beliefs and perceptions that in turn shape community’s attitude and behavior. Therefore, the triangulation of data is one of the major advantages of quantitative and qualitative methodological combination or a mixed research dealing with the same problem (Neuman, 2007, p. 84; Berg, 1989; Yin, 2003). Fielding and Schreier (2001) support combining survey through questionnaires with semi-structured interviews (Para. 35). The triangulation can be done through two ways: “sequencing” and “hybrids” (Para, 31). Sequencing holds that both qualitative and quantitative strategies are used in a study at different stages (Para, 32). Conversely, hybrid implies that both approaches are interwoven or so narrowly packed and are practically indistinguishable (Para, 33).
Proper triangulation of both types of data not only neutralizes the flaws of the either to reap the strengths and benefits of the two (Hussein, 2009, p. 1), but it also ensures more confidence in the conclusions by adding broader and deeper understanding and analysis (Fielding & Schreier, 2001, para, 35 & 53; Thurmond, 2001, p. 257).

With regard to the complementary nature of triangulation in research Erzberger and Kelle (as cited in Hammersley, 2008) consider using different methods of investigation as seeing the things from dissimilar perspectives which might give diverse pictures not corroborating each other, yet they obviously provide a broader and more comprehensive depiction of the problem in hand. They explain this with a metaphor: “… Empirical research results obtained with different methods are like the pieces of a jigsaw puzzle that provide a full image of a certain object if put together in the correct way’ (Hammersley, 2008, Triangulation as seeking complementary information).

Selection of methodology of a study depends on many things. Studying a thing or process objectively against specific criteria, objectives, and standards requires quantitative study; nonetheless, exploring a phenomenon in social context through respondents’ beliefs and perceptions needs a qualitative one. While classifying combined or mixed research, Morgan (1998) conceptualized that the two decisions regarding priority-sequence-model are important i.e. deciding if study would be qualitative or quantitative with principal or complementary nature and which would be the sequence or follow up. In this regard, the author talked about four research designs: (a) preliminary qualitative methods in a quantitative study, (b) preliminary quantitative methods in a qualitative study, (c) follow-up qualitative methods in a quantitative study, and (d) follow-up quantitative methods in a qualitative study (p. 362).
In this connection, the design of present mixed study was “follow-up qualitative methods in a quantitative study” where main or principal study involved the quantitative investigation (positivist or objective) of teaching of chemistry through students’ questionnaires against specific criteria of B.Ed. which was supported by follow-up qualitative semi-structured interviews (interpretivist) of the students and head-teachers for getting deeper insights and holistic understanding.

3.01.2. Theoretical Perspective of Evaluative Research

The evaluative research falls in applied research that is designed to find out whether or not and to what extent the existing or new program is effective i.e. to what extent the established objectives have been achieved; and to find out flaws and their contextual causes and remedies through proper planning, implementation, and improvement. In other words, it focuses on the question “Does it work?” It is widely used in bureaucratic organizations like business, hospitals, schools etc (Neuman, 2007, pp. 12-13) and is booming “across a diverse range of community, organizational, government, and global settings” (Donaldson, 2009, p. 239; Patton, 1987). The applied research borrows its objectives and conceptual framework from other social research or theory that needs to be applied for producing required knowledge and skills or products. Applied and evaluation research uses different methods like surveys and experiments; however, surveys are most commonly used (University of Kentucky, n.d., Evaluation). According to Issac and Michael (as cited in Glasow, 2005):

Survey is used to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future
comparisons can be made, to analyze trends across time, and generally, to describe what exists, in what amount, and in what context. (p. 1)

There are many approaches and types of evaluation i.e. accountability for policy-making evaluations, developmental evaluations, knowledge production evaluations, social improvement evaluations (Stern, 2004, pp. 16-17); results-focused (goal-based, goal-free, theory-based), utilization, collaborative, balanced scorecards, appreciative, external, Kirkpatrick, and CIPP as evaluative approaches (The Saskatchewan Ministry of Education, 2008. pp. 2, 27). However, no single approach fits for all purposes. It calls for combination of approaches (The Saskatchewan Ministry of Education, 2008, p. 55; Rogers and Fraser, 2003).

Besides above categories of approaches many researchers tend to classify and quote formative and summative evaluations as broader classes or approaches (Scriven, 1996; Wholey, 1996; Patton, 1996; Schloss, Smit, & Posluzsny, 1990) that could fit all evaluations into either category. Wholey (1996) claims that formative evaluation (carried out during on-going process) is typically more useful than summative that is carried out at the end of a process (p. 145).

Many authors have used different terminology for the same approach for example there is little difference between goal-based (The Saskatchewan Ministry of Education, 2008) and accountability (Stern, 2004) as both are meant to study the phenomenon against specific objectives, standards, and criteria using quantitative measures as a principle methodology. In this regard, the present study comes under a formative evaluation because it aims at studying on-going process of teaching of chemistry i.e. whether and to what extent the public sector secondary school teachers (science teachers) follow the professional criteria of teaching laid down in B.Ed.—the minimum required professional degree; if not following, then what the underlying causes are and how the teaching and learning situation can be improved.
3.02. Research Purpose

The purpose of present study involved both explanatory and exploratory. Explanatory in the sense that it aimed at explaining ‘how’ and ‘why’ (survey) the teaching of chemistry is in line with professional criteria of B.Ed. It tried to determine the usefulness of professional teaching against specific professional criteria. Additionally, at second stage the root causes that came to surface as a result of quantitative survey were further explored from learners’ perspective through semi-structured interviews in order to get deeper and broader understanding.

3.03. Research Design and its Rationale

The research design for this present mixed research basically involves survey containing 70 items (with 18 objective-type students’ chemistry achievement test questions) that make up quantitative part of the study; whereas, explorative study using phenomenology to have deeper insights and understanding the teaching of chemistry from learners’ perspective falls in qualitative paradigm.

3.03.1. Quantitative Part (Causal and Evaluative Research)

Causal Research and reasoning involves the most important cognitive processes and higher order activities like conceptual understanding and solving a problem. It plays a pivotal role in explaining the problem, making predictions, and drawing implications and inferences (Jonassen & Ionas, 2008, p. 286) and is considered as a powerful methodological tool to bridge the gap between theory and research (Anderson & Evans, 1974, p. 29). Causal research is often associated with positivist inquiry that involves a quantitative approach to study the problem. However Maxwell (2004, 2012) criticized quantitative studies for being too narrow, outdated, and misrepresentative of social reality and suggested complimenting with qualitative measures in
studying causal relationship and experimentation because they depend on the in-depth understanding of meanings, contexts and processes (pp. 3, 655).

Many social sciences-researchers prefer nonintervention causal research to intervention or research based on manipulation of variables (Robinson, Levin, Thomas, Pituch & Vaughn, 2007; McGuel, Osler, & Christensen, 2010). The growth was found to have increased from 33% in 1994 to 43% in 2004 in the favour of nonintervention causal research (Robinson, Levin, Thomas, Pituch & Vaughn, 2007, p. 400).

3.03.2. Survey

Janes (1999) defines survey as “A survey is a good way, often the only way, of getting a picture of the current state of a group: a community, an organization, an electorate, a set of corporations, a profession” (p. 321). Mailed questionnaires, telephonic talk, and personal interviews are the common instruments of data collection in survey (Forza, 2002, p.155; Synodinos, 2003, p. 225). The questionnaires are associated with surveys and are considered their most common research tools (Janes, 1999, 2001, p. 323; Chauvel & Despres, 2002; McDonald & Adam, 2003, p. 85).

Chauvel and Despres (2002) support and prefer surveys for: clarifying an issue through specific definitions and details, collecting data from a small representative sample and generalizing to larger population, easy-quantifying of data for statistical procedures with some authority and precision, saving time and cost, having straightforward and relatively less complex method (p. 208).

3.03.3. Qualitative Part (Phenomenology)

Phenomenology is both a philosophy and a methodology to build up a comprehension of intricate problems that otherwise are not accessible (Goulding, 2005, p. 301). Construction of
meaning in contextual framework is its focal point thus explores fore-structured communication across cultures (Wilson, 2012, p. 239). Holt and Sandberg (2011) defined phenomenology as:

Phenomenology, from phenomena, the Greek for appearances, is the study of our experience, how things and events appear to us. Knowledge, beauty, right and wrong, and the immaterial and the material are all understood experientially. It is in explicating the relationship between things and ourselves that we “get at” what “is” and what it is “to be.” (p. 217)

Husserl (1962) and Heidegger (1962) propounded it as philosophy. The former talked of ‘essence’ and ‘going back to the things themselves’ and the latter believed in subjective lived experience and contextual meaning. According to Van Manen (as cited in Roger, Russell, Catherine & Aquino-Russell, 2011), “Lived experience is the world as persons directly experience it and describe it in their own words” (p. 179). This lived experience is studied regarding person’s relationships with time, space, and personal history to discover the deeper meaning of a social phenomenon (Stern as cited in Goulding, 2005, p. 303). Schultz (1967, 2009) developed it into a method to study and understand the lifeworld through lived experience. He defines lifeworld “. . . as the world in which we, as human beings among fellow human beings, experience culture and society, take a stand with regard to their objects, are influenced by them, and act on them” (Goulding, 2005, p. 302). Here, the researcher depends on the participants’ views (perception and experience) as valid and unique entities therefore participants who have undergone the lived experience are selected purposively and the interviews remain one of the main sources of collection of data (Goulding, 2005, p. 302).
3.04. Data Collection

3.04.1. Respondents’ Data

The sources of data collection in this study were: 347 students’ questionnaires and 20 students’ semi-structured interviews. I discussed their construction, phases, and validity and reliability issues in the section of “Research Instruments” of this chapter.

3.04.2. Document Analysis

The researcher analyzed the B.Ed. curricula/syllabi of two renowned universities i.e. the Allama Iqbal Open University Islamabad and the University of Sindh, Hyderabad offering regular and distance program of B.Ed as pre service training for secondary school teachers. I had discussed such account in section 2.2.3 of the previous chapter.

3.05. Procedure

The procedure of the present study involved following phases:

Phase 1: The researcher reviewed the related literature about teaching of sciences with especial focus on different teaching methods, strategies, activities, and resources used for better teaching and learning at our local, national, and international context. It resulted in defining and framing the research problem, questions, and methodology of the present study.

Phase 2: Secondly, the researcher thoroughly reviewed the curricula of professional degrees i.e. B.Ed offered by the University of Sindh (Hyderabad) and Allama Iqbal Open University (Islamabad) to find out the specific pedagogical content and criteria for teaching of science related disciplines. Additionally the researcher reviewed the National Professional Standards for Teachers designed and prescribed by Ministry of Education, Government of Pakistan as general guidelines for teachers’ evaluation. Moreover, the researcher conducted document analysis of
the teachers’ academic and professional qualifications and experience through the seniority list of all existing high school teachers including science-teachers of district Jamshoro (Sindh).

**Phase 3:** Thirdly, the research tools (students’ questionnaire items, achievement test items, and mind-map of semi-structured interviews of students) were designed and pilot-tested.

**Phase 4:** Fourthly, quantitative and qualitative data were collected

**Phase 5:** Finally, data were analyzed and reported.

### 3.06. Population

#### 3.06.1. Rationale of Target Population

The review of related literature reveals that evaluation of teachers and teaching is relatively a new concept, but is very complex and difficult to actually do so. There are multiple and diverse methods to evaluate teaching and pedagogy, nevertheless none is sufficient and final. Therefore, the selection of method is contingent on different perspectives and context and varies from situation to situation. Generally, researchers use these methods to determine the worth of teaching and pedagogy: Student ratings; Peer ratings; Self-evaluation; Videos; Student interviews; Alumni ratings; Employer ratings; Administrator ratings; Teaching scholarship; Teaching awards; Measuring learning outcomes; and Teaching portfolios.

Chris Kyriacou (1983) while reviewing research on ‘teacher effectiveness’ in British secondary schools classified it into four main categories: studies based on teachers’ opinions; studies based on the relationship between rated teaching ability and other variables (teacher’s personality, performance etc); studies based on observations of teaching; and studies based on pupils’ opinions.

In Pakistan especially Sindh, the examination system is not fair and transparent. Media often report prevailing discrepancies. Students generally use unfair means during examination
therefore evaluation of pedagogy cannot be based on both the learning outcomes/exam-results and teachers’ opinions. Moreover, our educational institutions are miles away from maintaining teachers’ portfolios. Awards, scholarships, and employer’s and administrator’s rating for teachers are simply missing. The teachers’ opinions could provide insights, but they could easily dump incorrect data therefore within our local context and existing circumstances evaluation of teaching of chemistry through the students’ perspective fits well for present research.

3.06.2. Target Population

The present study was conducted in Sindh, one of the four provinces of Pakistan with an estimated population of 55.3 million out of an estimated total of 192.3 million countrywide (City Population, 2011). Sindh is divided into 23 administrative units including two city administrations i.e. Karachi and Hyderabad, and 21 district administrations. To make the study feasible in terms of time and resources, the one of the districts i.e. District Jamshoro was selected because it involved both rural and urban strata of boys and girls. Since the study involved evaluation of teaching of chemistry therefore the target population involved all the public secondary school teachers, head-teachers, students of grade 9th and 10th, and all the chemistry/science laboratories existing in public secondary schools.

The public secondary school teachers who teach chemistry to grade 9th and 10th (called as science-teachers) were not accessed and studied directly, but were evaluated through their respective learners. However, the demographic data (academic and professional qualifications, experience, nature of posting) of all the secondary school teachers of the district were collected and analyzed. Thus, the actual target population of the present investigation consisted of all male and female students of grade 9th and 10th of public sector secondary schools of Sindh for the academic session of 2013-14.
3.06.3. Rationale for Sampling and Sample Size

“Choosing a study sample is an important step in any research project since it is rarely practical, efficient or ethical to study whole populations” (Marshall, 1996, p. 522). The same author confirms that representative quantitative sampling enables the researcher to generalize the findings of a representative sample to the whole population (p. 522).

A mix of stratified-random and purposive sampling was done for quantitative and qualitative parts respectively. Firstly, the researcher carried out stratified random sampling for collection of quantitative data (students’ questionnaires). The number of respondents were calculated for each of the strata i.e. boys only, boys in co-education, girls only, girls in co-education across rural and urban students from all Tehsils (tehsil is a sub-district administration) of District Jamshoro maintaining true proportion in relation to the target population. Then, through pure random sampling required number of the respondents was selected for each Tehsil.

With regard to qualitative data, the criteria for selecting purposive sample of respondents was selecting regular and punctual students having at least average academic performance with the help of respective subject teachers. It helped the researcher to ensure that the selected respondents represent at least the average working school with average students. Qualitative data were collected uniformly from the purposively selected respondents across strata through semi-structured interviews for deeper understanding from the students’ perspective.

3.06.4. Population and Sample Size

The target population of 3864 public sector students of class ninth existed throughout four tehsils of District Jamshoro which were initially grouped into two categories i.e. rural (Manjhand and Thano Bula Khan tehsils) and urban (Sehwan and Kotri tehsils) strata with 763 and 3101 students respectively. Those rural and urban strata were further classified into two sub-
categories i.e. separate and co-education for boys and girls students in each category. The 763 rural students involved 480 boys (where 203 boys studied at separate boys schools and 277 boys studied at co-education schools) and 283 girls (where 118 girls studied at separate schools for girls and 165 girls studied at co-education schools).

Out of above targeted population the 9.1% stratified sample (350 students) was drawn for collection of quantitative data. The size of sample was calculated according to Johnson & Christene (2000) which different researchers (Majid, 2012, pp. 86-89 etc) use presently in educational research. The rural and urban sample involved 69 and 281 students respectively. Regarding 69 rural students it involved 44 boys (out of which 18 boys were randomly selected from separate boys’ schools and 26 from co-education schools) and 25 girls respectively (out of which 10 girls were randomly selected from separate girls’ schools and 15 from co-education schools). On the other hand stratified random sample of urban students involved 165 boys (143 from separate boys’ schools and 22 from co-education schools) and 116 girls respectively (109 from separate girls’ schools and 7 from co-education schools). The figure on next page precisely shows the way stratified-random sample drawn from the target-population.
Regarding purposive qualitative data 20 students (10 each for boys & girls) were selected for semi-structured interviews across rural and urban divide. Table 5 sums up the categories and the respective number of population and sample taken from them:
Table 6

Targeted Population and Stratified Sampling Drawn

<table>
<thead>
<tr>
<th>Category</th>
<th>Rural Tehsils</th>
<th></th>
<th>Urban Tehsils</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manjhad</td>
<td>Thano Bula Khan</td>
<td>Sehwan</td>
<td>Kotri</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>70</td>
<td>133</td>
<td>52</td>
<td>734</td>
<td></td>
<td>3,864</td>
</tr>
<tr>
<td>Sample (9.1%) Questionnaire</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>67</td>
<td>15</td>
<td>350</td>
</tr>
<tr>
<td>Students' Interviews</td>
<td>1</td>
<td>11</td>
<td>6</td>
<td>33</td>
<td>67</td>
<td>20</td>
</tr>
</tbody>
</table>

3.06.5. Criteria of Classification of Rural and Urban Population

The rural and urban divide of students were made on the basis of strength of enrollment of students at each tehsil i.e. one of the four administrative unit across the district. For this, the researcher decided to classify rural tehsil as the one where below 500 students (both boys and girls) were enrolled, whereas urban one occupied an enrollment of exact 500 or more students. In present case, the two rural tehsils (Manjhand and Thano Bula Khan) had 469 and 294 students respectively and on the other hand the two urban tehsils (Sehwan and Kotri) had 1339 and 1762 students (both boys and girls) respectively.

3.07. Data Collection Instruments

Students’ questionnaires (350), document analysis (B.Ed curricula of Allama Iqbal Open University Islamabad and University of Sindh Hyderabad), and students’ semi-structured
interviews (20) were the tools of data collection for the present study. Let us discuss them in detail individually:

3.07.1. Questionnaires for the Students

“Questionnaires are most effective when used in conjunction with other methods, especially one or more varieties of interview technique” (Grix, 2010, p. 129). The researcher could not find relevant research tool that could meet the local requirements of evaluation teaching learning situation of the teaching of chemistry at secondary school level (grade 9th) within the framework of professional degree of B.Ed in Pakistan. “In the development of the questionnaires, particular attention was given to ensure that questions are unambiguous, unbiased, unloaded, relevant, succinctly conceptualized as well as avoiding vagueness.” (May as cited in Ogunmade, 2011, pp. 67-68).

Under the above guidelines, I took the responsibility of designing the appropriate and required tool. The questionnaire involved demographics, students’ achievement test, and eight areas of professional teaching of chemistry. The demographic data included the gender, school-type, parent(s) occupation and income, after-school tuition hours, after-school home reading, and favourite subjects while the chemistry-achievement-test comprised 18 objective-type questions with equal MCQs and blanks; lastly, professional teaching of chemistry implicated eight parts: general pedagogical skills (12 items); lesson planning (7 items); teaching methods (13 items); audio-visual aids (6 items); students’ classroom activities (4 items); formative assessment (4 items); and course coverage (6 items).

The questionnaire assessed students’ responses against five-point Likert scale items except for demographics and test-items. The items of general professional teaching skills and lesson-planning involved the options of strongly disagree, disagree, neutral, agree, and strongly
agree. All other parts implicated the options of never, rarely, sometimes, often, and always except the items of course coverage of theory and practical which included the options of 0%, up to 25%, up to 50%, up to 75%, and up to 100% (For details, please refer to Appendix A). The questionnaire was translated into Sindhi and Urdu with the help of personnel having expertise in related languages. They were further refined as a result of piloting.

3.07.2. Achievement Test of the Students

Since the malpractices within the Pakistani public sector assessment and examination system especially in Sindh are too common to solely depend on annual results. Media reports reflect serious flaws during annual examination days. Therefore, the researcher decided to administer researcher-made achievement test to the 9th graders. Due to better reliability and objectivity in scoring it was decided to administer objective type test.

The syllabus of chemistry involved two parts: part I (basic concepts of chemistry) and II (industrial application of chemistry) with 10 and 8 chapters respectively, now available in single book too. I designed an objective type test with 18 questions (9 each for MCQs, and blanks). It covered the basics of all chapters of the first part of textbook i.e. chapters 1 through 10. It involved almost 2 questions (1 each for MCQ and blank) from each chapter. I selected the items from self-assessment exercises given at the end of chapters. Since the test-items were not researcher-made (but were made by experts and developers of chemistry curriculum) therefore it, on the one hand, not only saved the time and energy, but added to the better validity and reliability, on the other hand. The items were selected on the criteria of Bloom’s cognitive domain’s knowledge and comprehension level. The researcher assumed that professional teaching of chemistry at our local (Sindh province) level was a simple failure and the public sector teachers do not and cannot inculcate the understanding of the basic concept of chemistry.
If this assumption is true then a clear majority of students would surely not provide the correct answers to the questions; otherwise, the students would get full (ideal) scores on the test. The test items were embedded in the questionnaire as first part out of eight parts responded to by all the sample students (350).

3.07.3. Semi-Structured Interviews with the Students

To get a holistic picture of the actual teaching of chemistry, to look deeper into the problem at hand, and to validate and triangulate the data collected through quantitative measures, I conducted 20 students’ semi-structured interviews with equal number of males and females across rural and urban divide. Following areas were selected for above interviews with students:

3.07.3.1. The areas of students’ semi-structured interviews. The students’ semi-structured interviews focused on the following areas and questions:

i) Do you get free textbooks?

ii) How does your chemistry teacher teach you the prescribed textbook?

iii) How does your chemistry teacher teach you the experiments of practical journal?

iv) Does your teacher have a written plan/paper for daily teaching that shows the procedure and activities to be conducted during daily teaching?

v) Does and how frequent your chemistry teacher use blackboard, charts and models during classroom teaching?

vi) Which classroom activities you do in your chemistry class (individual or group work, silent reading, discussion, students’ presentations, writing)?

vii) Does and how frequent your chemistry teacher ask questions, assigns home-work, tests, quizzes, and assignments?
viii) Does your chemistry teacher use verbal scolding and physical punishment i.e. slapping or beating with stick? And why?
ix) Has ever any student got serious injury (bleeding, swelling, bone-fracture) in chemistry class?
x) Do/can you ask frequent questions or discuss about related topic in chemistry class?
xi) Does your teacher respond happily to your questions?
xii) Do you believe that there is much difference between the teaching of chemistry and other subjects i.e. languages and social studies?

xiii) Do you believe that your school has required science material, equipment and laboratory especially for teaching and learning of chemistry?
xiv) Does and how frequent your chemistry teacher demonstrate experiments while teaching the prescribed textbook?
xv) Does and how frequent your teacher demonstrate experiments while teaching the prescribed curriculum of chemistry practical journal?
xvi) Do you perform laboratory experiments for learning the practical journal under guidance of your chemistry teacher? Specify individual or group lab-work.
xvii) How much of the textbook has your chemistry teacher covered out of 18 chapters?
xviii) How much of the practical journal has your chemistry teacher covered out of 10 experiments?
xix) Which unfair means do exist in Board’s examination (grade 9th & 10th) and why?

3.08. Validity and Reliability

“The concept of validity refers to what the test or measurement strategy measures and how well it does so” (Marczyk, DeMatteo, & Festinger, 2005, p. 106). The same authors define
content validity in these words: “Content-related validity refers to the relevance of the instrument or measurement strategy to the construct being measured . . . The test developer defines the construct and then attempts to develop item content that will accurately capture it” (Marczyk, DeMatteo, & Festinger, 2005, p. 107). Reliability refers to consistency or dependability. It suggests that when our measuring instruments are reliable we can get same findings or results under identical conditions across time (Neuman, 2007, p. 115). The same author reveals that although reliability is essential for validity and relatively easier to attain, yet it does not guarantee to fulfill the purpose of measurement without being valid (p. 120).

3.08.1. Validity of Questionnaire Items and Achievement Test Items

The face validity is a judgment and consensus of the research fraternity that the definition and the measurement fit properly. The content validity is making the measurement tool representative of all the ideas and areas of targeted content (Neuman, 2007, pp. 117-118).

After designing the questionnaire items including achievement test items, they were presented to three experts of Iqra University, in the field of science education, for determining face validity. Moreover, the questionnaire was pilot tested on 15 randomly selected relevant respondents that were not included in the actual study. It further refined the instruments in terms of removing ambiguity and getting more clarity of meaning from the respondents’ perspective.

As mentioned above the content validity works like a stratified sampling that ensures proper representation of all the areas in proper proportion within a measuring tool. For this purpose, the professional teaching criteria of B.Ed, and the first part of chemistry textbook (chapter 1-10) were considered for determining the content validity of eight areas of the questionnaire and achievement test respectively.
3.08.2. Reliability of Questionnaire Items including Achievement Test Items

There is always some extent of error in measurement therefore it is necessary to calculate the level of error in research tools to make them more valid and reliable. Typically researchers use Cronbach’s alpha coefficient to calculate the internal consistency of a measurement tool scored by ratings (1,2,3…) pertaining to unidimensional trait (Tan, 2009, p. 102).

Therefore, Coronbach’s alpha was used for each part of questionnaire to determine reliability of the students’ questionnaire through SPSS package 16.0. It was calculated for both components of the questionnaire i.e. the items of chemistry achievement test and five-point Likert items of questionnaire. The chemistry test involved 18 objective type items (9 each for MCQs and blanks). The Coronbach’s alpha values were found to be 0.7 for MCQs, and 0.9 for Blanks, with an overall alpha value of 0.8 showing considerable or acceptable internal consistency of the test-items.

Here is the Coronbach’s alpha for eight parts of the questionnaire. The general professional teaching skills (12 items) alpha had 0.9, lesson planning (7 items) got 0.6, teaching methods (13 items) got 0.6, audio-visual aids (6 items) scored 0.7, students’ activities (4 items) obtained 0.6, students’ formative assessment by teacher (4 items) stood on 0.8, course coverage of theory (3 items) scored 0.6, and course coverage of practical (3 items) scored 0.8 values of Coronbach’s alpha. The overall Coronbach’s alpha value for the questionnaire used in this study was found to be 0.946 which explicitly indicates excellent internal consistency.

3.09. Analysis of Data

Since the study collected and involved both types of data i.e. quantitative and qualitative therefore they were analyzed accordingly. The researcher presents the related details on the next page.
3.09.1. Analysis of Quantitative Data

The researcher used descriptive and inferential statistical techniques to analyze both the quantitative data and the qualitative data. I used measures of central tendency (mean, frequencies, percentage, standard deviation etc) to analyze eight aspects of the professional teaching of chemistry (general professional skills, lesson-planning, teaching methods, audio-visual aids or resources, students’ classroom activities, students’ formative assessment, course coverage of theoretical textbook, and course coverage of practical component), besides the demographic variables. Additionally, I used independent-samples t-test and ANOVA to find out the differences of mean-scores between/among the sub-categories against each demographic aspect. On the other hand, I used correlation and multiple linear regression analyses to find out statistical association between respondents’ test-scores and different aspects of professional teaching of chemistry, assessed through students’ questionnaires.

3.09.2. Analysis of Qualitative Data

I did thematic analyses using phenomenological procedure to analyze the data collected through semi-structured interviews of the students. In the first stage, I coded all the data that was in the form of written notes. Secondly, the researcher grouped all the qualitative data in general themes and their sub-themes. Thirdly, the researcher looked for an emerging pattern out of the themes while analyzing the data into relevant contextual meanings. Lastly, researcher converged and triangulated the quantitative and qualitative data to come up with general conclusion/theory.

3.10. Model Hypothesis

There is significant association and difference between actual and required professional teaching of chemistry at public secondary level with relation to the criteria laid down in B.Ed among public secondary school teachers of Pakistan as perceived by their students.
3.11. Ethical Consideration

Neuman (2007) points out, “Social research can harm a research participant in several ways: physical, psychological, and legal harm, as well as harm to a person's career, reputation, or income” (p. 51). According to Grix (2010), issues of harm to respondents, informed consent, and respondents’ confidentiality are crucial for a social-sciences researcher (p. 145).

The researcher sought legal and informed consent for the present study. The Iqra University Karachi issued a letter to the Director Schools Hyderabad Region mentioning researcher’s affiliation as a doctoral student and requesting to allow collection of required data from students of grade ninth within their jurisdiction. The Director of Schools Hyderabad was pleased to allow the researcher to collect data from the above respondents and issued such letter to the concerned head-teachers of District Jamshoro. Consequently, such legal permission was accorded by the head-teachers.

Since respondents’ have right whether or not to be part of the study. Therefore, the researcher obtained free informed verbal consent from the head teachers and students. Fortunately, all the head-teachers and students gave their free informed consent; however, a few head-teachers and students had shown concern of confidentiality which was withdrawn after the researcher ensured that their identity would never be exposed at any cost and the research tools did not ask for providing their identity. They were assured that the research report (thesis) would never indicate the names of respondents and even their schools therefore there was no reason for leaking out the confidentiality.

The researcher did not reveal the names of respondents and even their names of schools were not disclosed in data collecting and reporting to avoid any legal, social, and political harm. In this regard the present study ensures maximum anonymity and complete confidentiality.
3.12. Conceptual Framework of the Study

The readers can get the holistic conceptual framework of the study through Figure 8 on the next page:

Figure 8

*Conceptual Framework of the Study*
CHAPTER IV

FINDINGS

In present study the researcher evaluated the teaching of chemistry with respect to professional teaching criteria laid down in B.Ed.—that is the minimum required professional degree—at public secondary school (grade 9th and 10th) level using a mixed method. The study focused on following specific research questions:

i) How do the learners perceive existing professional teaching of chemistry at public secondary schools?

ii) Whether and up to what extent is the existing professional teaching of chemistry in line with the suggested criteria of B.Ed. from learners’ perspective?

iii) Whether and up to what extent do the public secondary school students’ test-scores relate to some aspects of professional teaching of chemistry as assessed from learners’ perspective?

iv) Whether and up to what extent do the public secondary school students’ test-scores relate to some of their demographical aspects as assessed from learners’ perspective?

v) Whether and up to what extent do the public secondary school students’ test-scores differ from some of their demographical aspects as assessed from learners’ perspective?

Note: 1. The ‘professional teaching of chemistry’ specifically aimed at assessing these aspects i) general professional teaching skills, ii) lesson-planning, iii) teaching methods, iv) audio-visual aids, v) students’ classroom activities, vi) students’ formative assessment, vii) course coverage theory, and viii) course coverage practical.

2. The demographical aspects specifically involved these aspects: i) gender, ii) type of school (boys-only, girls-only, co-education), iii) location (rural/urban), iv) parents’ income, v) parents’
occupation, vi) parents’ education, vii) students’ home-study, viii) private tuition, ix) tuition-subjects, and x) favourite subject.

Quantitative data were collected from a stratified sample of 350 students through 5-point Likert scale questionnaire having 70 items. The questionnaires were personally administered, and the respondents filled on the spot in the presence and guidance of the researcher. It served three benefits i.e. clarity of respondents’ doubts and ambiguities, enhanced willingness to participate, and 100% response rate. Whereas, qualitative data were collected through 20 semi-structured interviews involving four open-ended questions for triangulation and deeper insights.

This chapter deals with the findings from both quantitative and qualitative data using inferential statistical procedures and thematic analyses against specific hypotheses and research questions.

4.1. Quantitative Part

The researcher used both descriptive (frequencies, percentage, mean, and standard deviation) and inferential (multiple linear regression, independent samples t-test, and ANOVA) statistical procedures on the 350 students’ questionnaires to analyze and sum up huge quantitative data. Quantitative findings are presented in three categories to answer the research questions two to five. Let us start with descriptive statistics:

4.1.1. Descriptive Statistics

4.1.1.1. Professional training. I performed the document analysis of the seniority list of the secondary school teachers, generally known as high school teachers (HSTs), regarding their pre-service professional degrees and training. It disclosed extremely positive facts and figures. The total number of HSTs at District Jamshoro teaching to grade 9th and 10th students was 452 involving 356 males and 96 females. They all had B.Ed. on their credit, while a majority (75%) of teachers possessed additional advanced professional degree of M.Ed.
4.1.1.2. Demographics. In this section, demographic findings are presented with brief textual description but detailed numerical and statistical description through respective tables. These tables presents descriptive statistics of the demographical aspects of the stratified sample; parents’ income, occupation and education; respondents’ home-study, after-school tuition, tuition subjects, and favourite subjects.

Let us start with details of stratified sampling. Have a look at the details of sampling used in this study:

Table 7

*Sample Statistics*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Strata</th>
<th>Boys-only</th>
<th>Girls-only</th>
<th>Boys in co-ed</th>
<th>Girls in co-ed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td></td>
<td>18</td>
<td>10</td>
<td>26</td>
<td>15</td>
<td>69</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td>143</td>
<td>109</td>
<td>22</td>
<td>7</td>
<td>281</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td></td>
<td>46%</td>
<td>34%</td>
<td>13.7%</td>
<td>6.3%</td>
<td>100%</td>
</tr>
<tr>
<td>Overall Total</td>
<td></td>
<td>161</td>
<td>119</td>
<td>48</td>
<td>22</td>
<td>350</td>
</tr>
</tbody>
</table>

The table on the next page presents mean, median, mode, standard deviation, standard error of mean, and minimum and maximum of the eight important demographic variables:
Table 8

*Overall Statistics of Demographic Variables*

<table>
<thead>
<tr>
<th>Statistical element</th>
<th>Gender</th>
<th>Type of school</th>
<th>Rural/Urban</th>
<th>Income of parents</th>
<th>Occupation of parent</th>
<th>Education of parents</th>
<th>Home study</th>
<th>After-school tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Valid</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mean</td>
<td>1.40</td>
<td>1.74</td>
<td>1.80</td>
<td>2.82</td>
<td>3.34</td>
<td>2.29</td>
<td>2.08</td>
<td>1.49</td>
</tr>
<tr>
<td>SEM</td>
<td>.026</td>
<td>.041</td>
<td>.021</td>
<td>.074</td>
<td>.080</td>
<td>.053</td>
<td>.035</td>
<td>.035</td>
</tr>
<tr>
<td>Median</td>
<td>1.00</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.00</td>
<td>2.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Mode</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>SD</td>
<td>.491</td>
<td>.771</td>
<td>.398</td>
<td>1.384</td>
<td>1.492</td>
<td>.995</td>
<td>.658</td>
<td>.663</td>
</tr>
<tr>
<td>Minimum</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maximum</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

The next tables present observed frequencies and percentage. They will help the ordinary reader to get a clear concept about the general trend and diversity within each category. Let us start with the of parents income and education first. The parents earning above Rs 3,000 to 10,000 per month were in majority (41%) followed by 33% earning Rs 11,000-20,000, and 9% of the parents were those who earned Rs 21,000-30,000 per month. Whereas 32% of the parents were associated to technical jobs, while 26% comprised lower grade employees, and 16% of the parents were teachers by occupation (see table 8 on the next page).
Table 9

 Frequencies of Parents’ Income and Occupation

<table>
<thead>
<tr>
<th>Categories of Parents’ Income</th>
<th>f</th>
<th>%</th>
<th>Sub-groups of parents’ occupation</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-employed or &lt; Rs 3000pm</td>
<td>27</td>
<td>7.7</td>
<td>Un-employed</td>
<td>22</td>
<td>6.3</td>
</tr>
<tr>
<td>up to Rs 10,000pm</td>
<td>144</td>
<td>41.1</td>
<td>Technical/Industrial (labourer, technician, worker, helper)</td>
<td>113</td>
<td>32.3</td>
</tr>
<tr>
<td>Rs 11,000 to 20,000pm</td>
<td>116</td>
<td>33.1</td>
<td>Teaching (Primary/secondary/tertiary Trs)</td>
<td>57</td>
<td>16.3</td>
</tr>
<tr>
<td>Rs 21,000 to 30,000pm</td>
<td>32</td>
<td>9.1</td>
<td>Lower-grade employee (clerk, policeman, peon, watchman, soldier etc)</td>
<td>92</td>
<td>26.3</td>
</tr>
<tr>
<td>Rs 31,000 to 40,000pm</td>
<td>13</td>
<td>3.7</td>
<td>Officer (Grade 16 or above Gazzetted cadre)</td>
<td>14</td>
<td>4.0</td>
</tr>
<tr>
<td>Rs 41,000 to 50,000pm</td>
<td>6</td>
<td>1.7</td>
<td>Own small business (retailer, whole-sale, milkman etc)</td>
<td>52</td>
<td>14.9</td>
</tr>
<tr>
<td>Rs 51,000 to 60,000pm</td>
<td>6</td>
<td>1.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rs 61,000 to 70,000pm</td>
<td>2</td>
<td>.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rs 71,000 to 80,000pm</td>
<td>4</td>
<td>1.1</td>
<td>Total</td>
<td>350</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>350</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table on the next page is going to present the frequencies and percent of the sub-categories of the education of respondents’ parents. The most parents (36%) had 5 to 10 years of education, followed by 26% of parents with 11 to 14 years of education. On the other hand, almost equal number 25% were illiterate. The parents with higher education/masters i.e. 15 to 16 years of education comprised 13% of the total stratified sample, while 0.6% (only 2 parents) had 17 to 18 years of education M. Phil/M.S. The other details are given in table 9 on the next page:
Table 10

Frequencies of Parents’ Education

<table>
<thead>
<tr>
<th>Sub-categories of parents’ education</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>86</td>
<td>24.6</td>
<td>24.6</td>
<td>24.6</td>
</tr>
<tr>
<td>Primary to matriculation</td>
<td>127</td>
<td>36.3</td>
<td>36.3</td>
<td>60.9</td>
</tr>
<tr>
<td>11 to 14 year of education</td>
<td>90</td>
<td>25.7</td>
<td>25.7</td>
<td>86.6</td>
</tr>
<tr>
<td>15 to 16 years of education</td>
<td>45</td>
<td>12.9</td>
<td>12.9</td>
<td>99.4</td>
</tr>
<tr>
<td>17 to 18 years of education and above</td>
<td>2</td>
<td>.6</td>
<td>.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>350</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Following table presents frequencies and percent of the sub-categories of home-study and after-school private tuition of the respondents. A clear majority 67% of the respondents used to study for 1-2 hours daily after their school while 60% on the other hand got no after-school tuition and 32% got 1-2 hours of tuition daily. Let us have a look at table 10:

Table 11

Frequencies of Students’ Home-study and After-school Tuition

<table>
<thead>
<tr>
<th>Sub-categories</th>
<th>Home-study Frequency</th>
<th>Percent</th>
<th>After-school tuition Sub-categories</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>no tuition</td>
<td>210</td>
<td>60.0</td>
</tr>
<tr>
<td>no study</td>
<td>51</td>
<td>14.6</td>
<td>1-2 hours daily</td>
<td>111</td>
<td>31.7</td>
</tr>
<tr>
<td>1-2 hours daily</td>
<td>233</td>
<td>66.6</td>
<td>3-4 hours daily</td>
<td>27</td>
<td>7.7</td>
</tr>
<tr>
<td>3-4 hours daily</td>
<td>54</td>
<td>15.4</td>
<td>4-5 hours daily</td>
<td>2</td>
<td>.6</td>
</tr>
<tr>
<td>4-5 hours daily</td>
<td>12</td>
<td>3.4</td>
<td>Total</td>
<td>350</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>350</td>
<td>100.0</td>
<td></td>
<td>350</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The last table 11 presents the frequencies and percent of respondents’ tuition subjects and their favourite subjects. It points out that majority, almost 60%, of the respondents got no after-
school tuition, while the majority (65%) students revealed that languages and social sciences were their favourite subjects. Let us have a look at table:

Table 12

*Frequencies of Students’ Tuition-subjects and their Favourite Subjects*

<table>
<thead>
<tr>
<th>Tuition subjects Sub-categories</th>
<th>Frequency</th>
<th>Percent</th>
<th>Favourite Subjects Sub-Categories</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No tuition</td>
<td>208</td>
<td>59.4</td>
<td>No subject</td>
<td>2</td>
<td>.6</td>
</tr>
<tr>
<td>Languages and social sciences</td>
<td>71</td>
<td>20.3</td>
<td>Languages and social sciences</td>
<td>227</td>
<td>64.9</td>
</tr>
<tr>
<td>Natural sciences (chemistry and biology)</td>
<td>23</td>
<td>6.6</td>
<td>Natural sciences (chemistry and biology)</td>
<td>117</td>
<td>33.4</td>
</tr>
<tr>
<td>All subjects</td>
<td>48</td>
<td>13.7</td>
<td>All subjects</td>
<td>4</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>350</td>
<td>100.0</td>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### 4.1.1.3. General professional teaching skills.
This section involved eleven items. The mean ($M>4.00$) and median ($Md=5.00$) of first three items and seventh one revealed respondents’ positive findings to the respective questions. While almost neutral or near to neutral responses corresponded to all the other items except for the 11th item that showed relatively worse situation of disagreement of allowing students’ mistakes by their chemistry teachers. Overall, from the findings of this we cannot say that the situation is favorable for students’ teaching and learning, but have to believe that the teachers lacked in general professional skills.

Among the descriptive statistics of eight variables of teaching of chemistry, the general professional teaching skills, fortunately, got better mean scores than all other variables. Nevertheless, it does not reflect the ideal picture, but shows potential flaws in certain areas that need prompt consideration. The table 12 on the next page sums up the descriptive statistics obtained in this regard.
### Table 13

*Descriptive Statistics of General Professional Teaching Skills*

<table>
<thead>
<tr>
<th>GPTS items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Comes on time</td>
<td>4.36</td>
<td>.055</td>
<td>5.00</td>
<td>1.031</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Has clear &amp; understandable voice throughout</td>
<td>4.48</td>
<td>.054</td>
<td>5.00</td>
<td>1.009</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Write in clear &amp; understandable handwriting</td>
<td>4.42</td>
<td>.053</td>
<td>5.00</td>
<td>.992</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Has mastery on subject matter</td>
<td>3.11</td>
<td>.067</td>
<td>3.00</td>
<td>1.256</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5. Calls students with their names</td>
<td>3.43</td>
<td>.069</td>
<td>3.00</td>
<td>1.298</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6. Gives clear directions for students’ tasks</td>
<td>3.74</td>
<td>.073</td>
<td>4.00</td>
<td>1.366</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7. Behaves equally to all students</td>
<td>4.03</td>
<td>.061</td>
<td>4.00</td>
<td>1.133</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>8. Caters for specific needs of special children</td>
<td>3.29</td>
<td>.077</td>
<td>3.00</td>
<td>1.446</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>9. Enhances curiosity of learning</td>
<td>3.15</td>
<td>.084</td>
<td>3.00</td>
<td>1.572</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>10. Possesses good sense of humor</td>
<td>3.22</td>
<td>.072</td>
<td>3.00</td>
<td>1.353</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>11. Allows students’ mistakes during learning</td>
<td>2.30</td>
<td>.084</td>
<td>2.00</td>
<td>1.572</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>12. Happily responds to students’ questions</td>
<td>3.50</td>
<td>.083</td>
<td>4.00</td>
<td>1.551</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(Likert scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)

**4.1.1.4. Lesson-planning.** All students disagreed that their teachers planned their lessons. It indicates the worse professional teaching and learning situation in the context of Sindh, besides putting multiple tags on the pre and in-service curricula, teaching, and assessment criteria. The table on the next page presents and sums up the statistical findings collected, in this regard, through related descriptive statistics:
Table 14

Descriptive Statistics of Lesson Planning

<table>
<thead>
<tr>
<th>Lesson-planning items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Has a written plan</td>
<td>1.08</td>
<td>.018</td>
<td>1.00</td>
<td>.338</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Has no written plan but has a mind-plan</td>
<td>2.14</td>
<td>.078</td>
<td>1.00</td>
<td>1.463</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Has neither a written plan nor a mind-plan</td>
<td>3.64</td>
<td>.081</td>
<td>4.00</td>
<td>1.512</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Has flexibility to alter the plan contingently</td>
<td>2.34</td>
<td>.074</td>
<td>2.00</td>
<td>1.388</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5. Asks Qs to check students’ previous knowledge</td>
<td>2.21</td>
<td>.071</td>
<td>2.00</td>
<td>1.321</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6. Relates their previous knowledge to new topic</td>
<td>2.00</td>
<td>.067</td>
<td>1.00</td>
<td>1.260</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7. Maintains balance between his/her &amp; students' tasks</td>
<td>2.29</td>
<td>.065</td>
<td>2.00</td>
<td>1.220</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(Likert scale: 1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree)

4.1.1.5. Teaching Methods. Dictation of questions and answers by the teachers remained the most dominant teaching method. While some of the teachers used lectures, but all other teaching methods were simply missing. Following table presents related statistics:

Table 15

Descriptive Statistics of the Existing Teaching Methods

<table>
<thead>
<tr>
<th>No. Teaching-methods items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dictation of Qs/Answers</td>
<td>4.65</td>
<td>.049</td>
<td>5.00</td>
<td>.920</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. One-way lecture method</td>
<td>2.86</td>
<td>.063</td>
<td>3.00</td>
<td>1.172</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Two-way lecture method</td>
<td>2.60</td>
<td>.073</td>
<td>2.00</td>
<td>1.361</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Demonstration method</td>
<td>1.54</td>
<td>.055</td>
<td>1.00</td>
<td>1.022</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5. Laboratory method</td>
<td>1.35</td>
<td>.051</td>
<td>1.00</td>
<td>.953</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6. Inquiry method</td>
<td>1.23</td>
<td>.038</td>
<td>1.00</td>
<td>.720</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
7. Project method  
8. Picnic/Observation method  
9. Discussion method  
10. Problem-solving method  
11. Role-play method  
12. Dictation (as only teaching method)  
13. Punishment method  

(Five-point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

4.1.1.6. Audio-visual aids. Majority of the teachers depended on traditional visual aid i.e. blackboard and chalks. A few of them used charts during classroom teaching of chemistry at public secondary school of District Jamshoro. However, the others resources seemed to be extinct in this regard. Following table summarizes the descriptive statistical findings:

Table 16

Descriptive Statistics of Existing Audio-visual aids

<table>
<thead>
<tr>
<th>AV-aids Items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blackboard &amp; chalks</td>
<td>3.49</td>
<td>.072</td>
<td>3.00</td>
<td>1.349</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Charts</td>
<td>1.57</td>
<td>.057</td>
<td>1.00</td>
<td>1.065</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Real things (elements &amp; compounds)</td>
<td>1.33</td>
<td>.043</td>
<td>1.00</td>
<td>.803</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Models (i.e. rod-ball models of molecules/compounds)</td>
<td>1.15</td>
<td>.030</td>
<td>1.00</td>
<td>.564</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5. Projectors</td>
<td>1.03</td>
<td>.012</td>
<td>1.00</td>
<td>.218</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6. Modern aids (computer, internet, multimedia)</td>
<td>1.11</td>
<td>.031</td>
<td>1.00</td>
<td>.579</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(Five-point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)
4.1.1.7. **Students’ classroom activities.** The present study assessed four students’
classroom activities: reading from textbook, individual tasks, group-work, and classroom
presentations. Following table presents the descriptive statistics of them in this regard:

Table 17

*Descriptive Statistics of Students’ Classroom Activities*

<table>
<thead>
<tr>
<th>Students’ classroom activities Items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reading from textbook</td>
<td>3.16</td>
<td>.071</td>
<td>3.00</td>
<td>1.328</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Individual work (Whole-class as group)</td>
<td>3.59</td>
<td>.78</td>
<td>4.00</td>
<td>1.467</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Group-work</td>
<td>1.29</td>
<td>.42</td>
<td>1.00</td>
<td>.788</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Presentations</td>
<td>1.89</td>
<td>.062</td>
<td>1.00</td>
<td>1.154</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(Five-point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

4.1.1.8. **Teachers’ formative assessment.** You will conclude from the following table
that the teachers depended mostly on verbal questions for formative assessment:

Table 18

*Descriptive Statistics of Students’ Formative Assessment by Teachers*

<table>
<thead>
<tr>
<th>Formative assessment items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Verbal Questions after/during classroom teaching</td>
<td>3.29</td>
<td>.072</td>
<td>3.00</td>
<td>1.354</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Short MCQ-test/quiz after classroom teaching</td>
<td>1.76</td>
<td>.059</td>
<td>1.00</td>
<td>1.097</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Home-work after classroom teaching</td>
<td>2.49</td>
<td>.68</td>
<td>2.50</td>
<td>1.268</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4. Detailed MCQ test after completion of a chapter</td>
<td>1.84</td>
<td>.070</td>
<td>1.00</td>
<td>1.317</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(Five-point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)
4.1.1.9. Course coverage. One-fourth of the theoretical curricula remained untouched while the practical component in terms of teachers’ demonstration and students’ laboratory work simply found missing. Table 18 shows that first part of theoretical textbook was almost completed by all respondents (M=4.48) while the 50% of the second part of textbook remained untouched, with no teachers’ demonstrations for the theoretical part. Following table sums up the descriptive statistics in this regard:

Table 19

Descriptive Statistics of Course Coverage

<table>
<thead>
<tr>
<th>Course coverage items (shortened)</th>
<th>Mean</th>
<th>SEM</th>
<th>Median</th>
<th>SD</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) Theoretical Component</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Chemistry textbook part I (chapter 1 to 10)</td>
<td>4.48</td>
<td>.057</td>
<td>5.00</td>
<td>1.075</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2. Chemistry textbook part II (chapter 11 to 18)</td>
<td>2.42</td>
<td>.074</td>
<td>2.00</td>
<td>1.389</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3. Teachers demo of chemistry theory</td>
<td>1.31</td>
<td>.051</td>
<td>1.00</td>
<td>.947</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>b) Practical Component</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Teachers’ demo of chemistry practical journal</td>
<td>1.63</td>
<td>.064</td>
<td>1.00</td>
<td>1.191</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5. Students’ individual laboratory experimentation</td>
<td>1.11</td>
<td>.021</td>
<td>1.00</td>
<td>.393</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6. Students’ laboratory experimentation (group-work)</td>
<td>1.63</td>
<td>.069</td>
<td>1.00</td>
<td>1.296</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

((Five-point Likert Scale: 1= 0%, 2=up to 25%, 3=up to 50%, 4=up to 75%, 5=up to 100%)

4.1.1.10. Descriptive statistics (overall of eight variables). The following table presents an overall mean, standard deviation, standard error mean, and other related statistics of the eight variables of professional teaching of chemistry. General professional teaching skills got relatively better mean scores (M=3.5) than other variables, followed by course coverage of chemistry theory (M=2.74). Audio-visual aids (M=1.61) and course coverage of the practical component (M=1.45) got the least mean scores while the others also fell within disagreement.
Table 20

*Descriptive Statistics (overall of eight variables)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
</tr>
<tr>
<td>MCQs (Achievement test)</td>
<td>350</td>
<td>0</td>
<td>9</td>
<td>3.56</td>
<td>.100</td>
</tr>
<tr>
<td>Blanks (Achievement test)</td>
<td>350</td>
<td>0</td>
<td>8</td>
<td>.93</td>
<td>.075</td>
</tr>
<tr>
<td>Overall (Achievement test)</td>
<td>350</td>
<td>00</td>
<td>16.00</td>
<td>4.4914</td>
<td>.15063</td>
</tr>
<tr>
<td>General professional skills</td>
<td>350</td>
<td>1.00</td>
<td>5.00</td>
<td>3.5919</td>
<td>.05188</td>
</tr>
<tr>
<td>Lesson planning</td>
<td>350</td>
<td>1.00</td>
<td>4.14</td>
<td>2.2433</td>
<td>.03639</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>350</td>
<td>1.00</td>
<td>3.23</td>
<td>2.0512</td>
<td>.01951</td>
</tr>
<tr>
<td>Audio-visual aids</td>
<td>350</td>
<td>1.00</td>
<td>4.33</td>
<td>1.6124</td>
<td>.02878</td>
</tr>
<tr>
<td>Students’ activities</td>
<td>350</td>
<td>1.00</td>
<td>5.00</td>
<td>2.5193</td>
<td>.04316</td>
</tr>
<tr>
<td>Formative assessment</td>
<td>350</td>
<td>1.00</td>
<td>5.00</td>
<td>2.3450</td>
<td>.05495</td>
</tr>
<tr>
<td>Course coverage theory</td>
<td>350</td>
<td>1.00</td>
<td>5.00</td>
<td>2.7371</td>
<td>.04528</td>
</tr>
<tr>
<td>Course coverage practical</td>
<td>350</td>
<td>1.00</td>
<td>4.00</td>
<td>1.4552</td>
<td>.04668</td>
</tr>
<tr>
<td>Valid N (list-wise)</td>
<td>350</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.2. **Regression Analyses**

While examining the scatter plots, the researcher found that there was some direct relationship between targeted independent variables and the students’ achievement test-scores. Therefore, the researcher used multiple linear regression analysis to analyze and predict the effect of multiple independent variables (general professional teaching skills, lesson-planning, teaching methods, audio-visual aids, students’ activities, formative assessment, and course
coverage along with certain demographics) on the dependent variable (students’ scores in chemistry achievement test). Since the multiple linear regression model is the extension of simple linear regression, therefore the model goes like this:

\[ Y_i = B_0 + B_1x_1 + e_i \ldots \ldots (1) \quad \text{(Simple Linear Regression)} \]

Dependent (predicted) = Constant + B_1 Independent_1 + Error term

Since there were eight independent variables in the present study, therefore:

\[ Y_i = B_0 + B_1x_{i1} + B_2x_{i2} + \ldots + B_7x_{i8} + e_i \ldots \ldots (2) \quad \text{(Multiple Linear Regression)} \]

\[ Y_i' = B_0 + B_1x_{i1} + B_2x_{i2} + \ldots + B_7x_{i8} \quad (i= 1, 2, 3\ldots n) \ldots \ldots (3) \quad \text{(Prediction Model)} \]

Where \( Y \) is predicted or explained value of the Dependent variable; \( B_0 \) is the Constant or Intercept; \( B_1, B_2 \ldots \) are the Slope (Beta coefficient for \( x_1, x_2 \ldots \) respectively) for targeted explanatory or independent variables; \( x_1, x_2 \ldots \) are the specific Independent variables that explain the variance in \( Y \). The regression equation in word will be:

Students’ scores in chemistry achievement test= Constant + Beta coefficient for General Professional Teaching Skills + Beta coefficient for Lesson-planning + Beta coefficient for Teaching Methods + Beta coefficient for Audio-visual Aids + Beta coefficient for Students’ Activities + Beta coefficient for Formative Assessment + Beta coefficient for Course Coverage + respective errors.

Multiple linear regression analyses were performed against following null hypotheses:

**4.1.2.1. Regression analysis all predictors (overall).** The null hypothesis was:

\( H_0 \) 01: There is no significant association between respondents’ test-scores in chemistry achievement test and i) general professional teaching skills, ii) lesson-planning, iii) teaching methods, iv) audio-visual aids, v) students’ classroom activities, vi) formative assessment, vii) course coverage theory, and viii) course coverage practical.
Multiple linear regression was used to predict students’ achievement test scores from eight independent variables related to professional criteria of teaching of chemistry. A total of 350 students comprised the stratified sample of the study. Regression analysis revealed that above stated eight independent variables predicted respondents scores in chemistry achievement test, $r^2=.421$ (adjusted $r^2=.408$), $F(3, 36)=7.54$, $p<.05$.

Table 21

*Model Summary, Overall Multiple Linear Regression Analysis*

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.649a</td>
<td>.421</td>
<td>.408</td>
<td>2.16887</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), General professional teaching skills, Lesson-planning, Teaching methods, Audio-visual aids, Students’ activities, Formative assessment, Course coverage of Chemistry theory and Course coverage of chemistry practical

Multiple linear regression analysis revealed that that the targeted dependent and independent variables had statistically significant and positive association ($p < .05$). A stratified random sample of 350 secondary students’ test-scores were positively attributed to the above eight independent variables at .05 level of confidence. The results revealed that the overall above eight independent variables accounted for 42.1% variability in respondents’ test scores. The change in ‘$R$ or variance’ for those predictors is significant at alpha value .000a.

Table 22

*ANOVA of Overall Multiple Linear Regression (All predictors)*

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1167.405</td>
<td>8</td>
<td>145.926</td>
<td>31.022</td>
<td>.000a</td>
</tr>
<tr>
<td>Residual</td>
<td>1604.069</td>
<td>341</td>
<td>4.704</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2771.474</td>
<td>349</td>
<td>4.704</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
a. Predictors: (Constant), General professional teaching skills, Lesson-planning, Teaching methods, Audio-visual aids, Students’ activities, Formative assessment, Course coverage of Chemistry theory and Course coverage of chemistry practical

b. Dependent Variable: Overall Marks

The calculated value of correlation, R= .649\(^a\) shows moderately strong positive correlation between stated independent variables and their overall dependent variable for stratified random sample of 350 students at .05 alpha level. In other words, an average increase of one unit of all independent variables accounts for respondents’ scores in chemistry test by 42.1\% of a unit of dependent variable. It overall indicates the fitness of regression model used in present study. In this case our regression equation \[Y’ = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_8 x_8\]
becomes
\[\beta_0 = \text{predicted STUDENTS ChAT SCORES when GPTS, LP, TM, AVA, SA, FA, CCT and CCP are zero} = -2.274\]

For each unit increase in stated independent variables the regression model predicts following:

\[B_1=\text{for each unit increase in GPTS (general professional teaching skills) predicted rise in students’ ChAT scores (chemistry achievement test scores) is -.288 unit}\]
\[B_2=\text{for each unit increase in LP (lesson planning) the predicted rise in ChAT scores is .261 unit}\]
\[B_3=\text{for each unit increase in TM (teaching methods) the predicted rise in ChAT=1.223 or 122\%}\]
\[B_4=\text{for each unit increase in AVA (audio-visual aids) the predicted rise in ChAT=1.206 or 120\%}\]
\[B_5=\text{for each unit increase in SA (students activities) the predicted rise in ChAT is -.143 unit}\]
\[B_6=\text{for each unit increase in FA (formative assessment) the predicted rise in ChAT is .108 unit}\]
\[B_7=\text{for each unit increase in CCT (course coverage theory) the predicted rise is .72 unit or 72\%}\]
\[B_8=\text{for each unit increase in CCP (course coverage practical) predicted rise is .617 unit or 62\%}\]
Y’ = -2.274 +(-.288*GPTS) +.261*LP+1.223*TM+1.206*AVA +(-.143*SA)+.108*FA+.718*CCT+.617*CCP

But the negative beta values and higher p-values point out insignificant effect of four out of eight predictors. as you will seen in the table 22 on the next page:

Table 23

*Coefficients of Overall Multiple Linear Regression (All predictors)*

<table>
<thead>
<tr>
<th>Model</th>
<th>Independent variables</th>
<th>Unstandardized coeff.</th>
<th>SD coefficients</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Constant)</td>
<td></td>
<td>-2.274</td>
<td>.730</td>
<td>-3.115</td>
<td>.002</td>
</tr>
<tr>
<td>General professional skills</td>
<td></td>
<td>-.288</td>
<td>.237</td>
<td>-.099</td>
<td>1.214</td>
</tr>
<tr>
<td>Average lesson planning</td>
<td></td>
<td>.261</td>
<td>.251</td>
<td>.063</td>
<td>1.043</td>
</tr>
<tr>
<td>Teaching methods</td>
<td></td>
<td>1.223</td>
<td>.650</td>
<td>.158</td>
<td>1.881</td>
</tr>
<tr>
<td>Audio visual aids</td>
<td></td>
<td>1.206</td>
<td>.335</td>
<td>.230</td>
<td>3.597</td>
</tr>
<tr>
<td>Students’ activities</td>
<td></td>
<td>-.143</td>
<td>.219</td>
<td>-.041</td>
<td>-.649</td>
</tr>
<tr>
<td>Formative assessment</td>
<td></td>
<td>.108</td>
<td>.186</td>
<td>.039</td>
<td>.581</td>
</tr>
<tr>
<td>Coverage chemistry theory</td>
<td></td>
<td>.718</td>
<td>.254</td>
<td>.216</td>
<td>2.823</td>
</tr>
<tr>
<td>Coverage chemistry practical</td>
<td></td>
<td>.617</td>
<td>.185</td>
<td>.191</td>
<td>3.332</td>
</tr>
</tbody>
</table>

a. Dependent variable: Overall marks

The negative beta sign of unstandardized coefficients against general professional teaching skills and students’ activities (Table 21) indicate the negative effect on dependent or predicted variable i.e. respondents’ test scores. Teaching methods and audio-visual aids (with beta coefficients 1.223 and 1.206) occurred as two dominant predictors of respondents’ test-scores. They imply that increase in one unit of above variables account for an average increase of 122% and 120% of a unit (more than one unit) for respondents’ test-scores. Additionally, present findings do suggest that course coverage in both chemistry theory and practical (beta coefficients of .718 and .617) is linked with test scores of respondents to a great extent.
In analysis of coefficients of predictors or dependent variables it is crucial to know and interpret their t-values and p-values. The t-value >2 is considered significant while p value should be < .05 (or the confidence level). If there are any such variables not fulfilling those values, then the researcher has an option to remove them one by one because their effect is not significant and no prediction can be made on their values. From this perspective, I removed the variables one by one starting with the least t-value and highest p-value until all the predictors had significant values for each statistic.

In this way, four predictors were removed (general professional teaching skills, lesson-planning, students’ activities, and formative assessment) and the other four predictors retained (teaching methods, audio-visual aids, course coverage theory, and course coverage practical). They had significant beta coefficients, t-values, and p-values. Following table presents overall regression analysis of left-out predictors:

Table 24

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R square</th>
<th>Adjusted R square</th>
<th>Std. error of the estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.645a</td>
<td>.417</td>
<td>.410</td>
<td>2.16478</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Chemistry practical, Teaching methods, Audio visual aids, Chemistry theory

The above table shows that moderately strong positive association (R= .645) existed between the dependent (students’ achievement scores) and four predictor variables namely coverage of chemistry practical, teaching methods, audio-visual aids, and coverage of chemistry theory at p<.05 (.000a). The data were collected from 350 students. The above four predictors accounted for 41.7% variability in respondents’ test-scores. The value of $r^2$ (.417) indicates that one unit increase in above predictors accounted for 41.7% unit-increase in test-scores.
The next table shows that the regression value was statistically significant (p value=.000) with higher F-value (61.6). The other detailed are presented in following ANOVA table on the next page. It also gives an account of sum of squares, degrees of freedom, mean squares, F-value and p-value:

Table 25

\textit{ANOVA of Overall Multiple Linear Regression (Four significant predictors)}

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regression</td>
<td>1154.715</td>
<td>4</td>
<td>288.679</td>
<td>61.601</td>
<td>.000a</td>
</tr>
<tr>
<td>Residual</td>
<td>1616.759</td>
<td>345</td>
<td>4.686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2771.474</td>
<td>349</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textit{a. Predictors: (Constant), Chemistry practical, Teaching methods, Audio visual aids, Chemistry theory}

\textit{b. Dependent Variable: Overall Marks}

Table 26

\textit{Coefficients of Four predictors of Multiple Linear Regression}

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized coefficients</th>
<th>Standardized</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1 (Constant)</td>
<td>-2.132</td>
<td>.685</td>
<td></td>
<td>-3.111</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>.872</td>
<td>.433</td>
<td>.113</td>
<td>2.014</td>
</tr>
<tr>
<td>Audio visual aids</td>
<td>1.299</td>
<td>.322</td>
<td>.248</td>
<td>4.037</td>
</tr>
<tr>
<td>Chemistry theory</td>
<td>.659</td>
<td>.212</td>
<td>.198</td>
<td>3.103</td>
</tr>
<tr>
<td>Chemistry practical</td>
<td>.644</td>
<td>.182</td>
<td>.200</td>
<td>3.542</td>
</tr>
</tbody>
</table>

\textit{a. Dependent Variable: Overall marks}

The positive beta sign of un-standardized and standardized coefficients, with respect to teaching methods, audio-visual aids, course coverage theory, and course coverage practical, predicts positive effect on learners’ test-scores at statistically significant p-values (p<.05).
Among above four variables audio-visual aids $t(345) = 4.037$, $p = .000$ is dominant predictor of respondents’ test-scores with standardized positive beta value of .248. It means that one unit increase in audio-visual aids accounts for .25 points rise in standard deviation (or 130% un-standardized units rise) of respondents’ test-scores. Secondly, chemistry practical (or students’ lab-work) $t(345) = 3.542$, $p = .000$, stood on second place to contribute positively towards students’ test-scores. It means that one unit rise in chemistry practical accounts for 20% greater score on standard deviation (with overall 64.4% un-standardized units rise).

Thirdly, chemistry theory $t(345) = 3.103$, $p = .002$ predicted .198 points (standard beta value .198) increase in standard deviation of respondents’ test-scores (65.9% rise in un-standardized units); whereas, teaching methods $t(345) = 2.014$, $p = .055$ predicted .113 points rise in standard deviation of students’ test-scores (or 87.2 un-standardized units ) rise in students’ test-scores in unit standard deviation.

4.1.2.2. Overall Regression analysis of demographic variables. Following null hypothesis was used:

$H_0$ 02: There is no significant association between respondents’ scores in chemistry achievement test and i) gender, ii) type of school (boys-only, girls-only, co-education), iii) location (rural/urban), iv) parents’ income, v) parents’ occupation, vi) parents’ education, vii) students’ home-study, viii) private tuition, ix) tuition-subjects, and x) favourite subject.

Gender, type of school, location, parents’ income, occupation and education, students’ home-study, after-school private tuition, tuition-subjects, and their favourite subjects were used in a standard regression analysis to predict students’ scores in chemistry achievement test. The prediction model was statistically significant, $F(10, 350) = 6.389$, $p < .001$, and accounted for approximately 15.9% of the variance of respondents’ test-scores ($R^2 = .159$, Adjusted $R^2 = .134$).
However, an overall moderate association \((R=0.398)\) was found between independent variable (test-scores) and above ten predictors. Have a look at tables 26 and 27:

**Table 27**

*Overall Multiple Linear Regression Analysis (Demographic Variables)*

<table>
<thead>
<tr>
<th>Model</th>
<th>(R)</th>
<th>(R \text{ square})</th>
<th>Adjusted (R \text{ square})</th>
<th>(SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.398(^a)</td>
<td>0.159</td>
<td>0.134</td>
<td>2.62279</td>
</tr>
</tbody>
</table>

Predictors: (Constant), Favourite subjects, Income of Parents, Gender, Home study, Rural/Urban, After school tuition, Occupation of Parent, Education of Parent(s), Type of School, After school tuition subjects

**Table 28**

*ANOVA of Overall Multiple Linear Regression Analysis (Demographic Variables)*

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of squares</th>
<th>(df)</th>
<th>Mean square</th>
<th>(F)</th>
<th>(Sig.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>439.485</td>
<td>10</td>
<td>43.948</td>
<td>6.389</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>2331.990</td>
<td>339</td>
<td>6.879</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2771.474</td>
<td>349</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Predictors: (Constant), Favourite subjects, Income of Parents, Gender, Home study, Rural/Urban, After school tuition, Occupation of Parent, Education of Parent(s), Type of School, After school tuition subjects

b. Dependent Variable: Overall Marks

Test-scores were primarily predicted by students’ favourite subjects and home-study, and to a lesser extent by parents’ income and gender. The correlations of the variables are shown in Table (28). As can be seen, all correlations were either insignificant or of lowest value. The raw and standardized regression coefficients of the predictors together with their correlations with respondents’ test-scores, and regression coefficients are shown in Table (28). Students’ favourite
subject got the relatively strongest weight in the model, followed by their home-study duration, parents’ income and respondents’ gender.

Table 29

*Coefficients of Demographic Predictors of Multiple Linear Regression*

<table>
<thead>
<tr>
<th>Model</th>
<th>Predictor</th>
<th>Raw coefficients</th>
<th>Standardized coeff.</th>
<th>t</th>
<th>Sig.</th>
<th>Pearson R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>-2.291</td>
<td>1.164</td>
<td>-1.967</td>
<td>.050</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gender</td>
<td>.726</td>
<td>.333</td>
<td>.127</td>
<td>2.180</td>
<td>.030</td>
</tr>
<tr>
<td></td>
<td>Type of school</td>
<td>-.460</td>
<td>.218</td>
<td>-.126</td>
<td>-2.109</td>
<td>.036</td>
</tr>
<tr>
<td></td>
<td>Rural/urban</td>
<td>.553</td>
<td>.383</td>
<td>.078</td>
<td>1.443</td>
<td>.150</td>
</tr>
<tr>
<td></td>
<td>Income of parents</td>
<td>.269</td>
<td>.122</td>
<td>.132</td>
<td>2.200</td>
<td>.028</td>
</tr>
<tr>
<td></td>
<td>Occupation of parent</td>
<td>.091</td>
<td>.101</td>
<td>.048</td>
<td>.897</td>
<td>.370</td>
</tr>
<tr>
<td></td>
<td>Education of parent(s)</td>
<td>.009</td>
<td>.163</td>
<td>.003</td>
<td>.053</td>
<td>.957</td>
</tr>
<tr>
<td></td>
<td>Home study</td>
<td>.653</td>
<td>.221</td>
<td>.152</td>
<td>2.961</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td>After school tuition duration</td>
<td>.124</td>
<td>.367</td>
<td>.029</td>
<td>.339</td>
<td>.735</td>
</tr>
<tr>
<td></td>
<td>After school tuition subjects</td>
<td>.042</td>
<td>.228</td>
<td>.016</td>
<td>.184</td>
<td>.854</td>
</tr>
<tr>
<td></td>
<td>Favourite subjects</td>
<td>1.222</td>
<td>.282</td>
<td>.222</td>
<td>4.342</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Dependent Variable: Overall Marks

No sizeable correlations between the predictors was found with relation to predicted test-scores. Overall all predictors showed quite low or marginal zero-order and partial correlations except the favourite subject with overall correlation of .257 (.3 rounded off) correlation which was relatively higher within weak range of correlation. Inspection of the coefficients suggest
one unit increase in students’ favourite subject accounted for 122% units of their test-scores. It appeared as dominant predictor with higher significance \((p < .001)\) and greater difference \((t = 4.342)\), followed by students home-study that predicted 65% units increase in predicted scores \((p = .003, t = 2.961, \text{un-standardized } B = .653)\), income of parents predicted 26.9% units increase \((p = .028, t = 2.20, \text{un-standardized } B = .269)\), and students’ gender predicted 72.6% units increase with relatively lesser significance \((p = .03, t = 2.180, \text{un-standardized } B = .726)\), see Table ()

The same table of coefficients places the six predictors as non-significant with poor respective values and strength, hence six variables i.e. location (rural and urban), type of school (boys-only, girls-only, and co-education), parents’ education and income, and respondents’ after-school tuition duration and tuition-subjects did not significantly predicted students’ test-scores, therefore were discarded in analysis.

4.1.3. Mean-differences Analyses

Mean differences analyses were performed to find out which demographic variables and their specific sub-categories significantly affected, and accounted for students’ higher chemistry test-scores. Independent samples t-test was used to determine the potential difference between two sub-groups of a variable i.e. gender, and location (rural/urban). While ANOVA was used where a predictor involved more than two sub-categories i.e. type of school (boys-only, girls-only, co-education), parents’ income, education, and occupation; and home-study duration, after-school tuition duration and subjects, and students’ favourite subjects.

4.1.3.1. Independent samples t-test. It involved following null-hypotheses:

\(H_0\) 1. There is no significant difference between students’ chemistry test-scores and gender.

\(H_0\) 2. There is no significant difference between students’ chemistry test-scores and location i.e. rural and urban.
The independent samples t-test for first null hypothesis showed no significant difference between test-scores and respondents gender. For males ($M=4.3, SD=2.2$) and for females ($M=4.8, SD=3.5$) at $t(350)=-1.41, p=.16$. Therefore the researcher could not find ample evidence to reject the $H_0$ 1 null hypothesis (see table 29).

Table 30

**Independent Samples t-test (test-scores vs. gender and location)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>$N$</th>
<th>Mean</th>
<th>$SD$</th>
<th>$t$-value</th>
<th>$p$-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test-scores</td>
<td>Male</td>
<td>209</td>
<td>4.30</td>
<td>2.20</td>
<td>-1.41</td>
<td>.16</td>
<td>$H_0$ 1 not Rejected</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>141</td>
<td>4.77</td>
<td>3.52</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test-scores</td>
<td>Rural</td>
<td>89</td>
<td>3.55</td>
<td>1.77</td>
<td></td>
<td></td>
<td>$H_0$ 2 Rejected</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>281</td>
<td>4.72</td>
<td>2.98</td>
<td></td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

However, the independent samples t-test for second null hypothesis revealed significant difference between test-scores of rural and urban strata at .05 significance level, hence $H_0$ 2 was rejected. Given a violation of Levene’s test for homogeneity of variables, $F(1, 348)=8.98$, $p=.003$, while not assuming homogeneous variances, a t-test was calculated and found significant difference in test-scores of both groups, $t(174)=-4.2, p=.000$. The result suggests that urban students ($M=4.72, SD=2.98$) scored significantly better in chemistry achievement test than their rural counterparts ($M=3.55, SD=1.77$) at $p>.001$.

**4.1.3.2. One-way Analysis of Variance ANOVA.** It was applied to find the mean difference between the two groups where independent variable involved three or more sub-categories. Following null hypotheses were used:
There is no significant difference between students’ chemistry test-scores and education of parents (0 years of education or illiterate, 5-10yrs, 11-14yrs, 15-16yrs, 17-18yrs of ed).

One-way ANOVA on above null hypotheses revealed no significant difference between test-scores of the respondents and parents’ education (illiterate, 5-10yrs, 11-14yrs, 15-16yrs, 17-18yrs of education), therefore not rejected. Following table presents related statistical figures:

Table 31

One-way ANOVA of Respondents Test-scores and Type of School, and Parents’ Education

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Group</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>p-value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H₀ 3</strong> Parents’ Education</td>
<td>Between groups</td>
<td>64.463</td>
<td>4</td>
<td>16.116</td>
<td></td>
<td></td>
<td>H₀ 3 not Rejected</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>2707.011</td>
<td>345</td>
<td>7.846</td>
<td>2.054</td>
<td>.086</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2771.474</td>
<td>349</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There is no significant difference between students’ chemistry test-scores and type of school (i.e. boys-only, girls-only, and co-education).

One-way ANOVA was used to compare mean differences of respondents’ test-scores across three sub-levels of school types. ANOVA revealed that significant difference existed between test scores across boys-only, girls, only, and co-education schools $p < .05$ for the three levels $F(2, 247) = 9.24, p = .001$, therefore $H₀ 4$ was rejected. Thus the findings were further analyzed using Tukey HSD for post hoc comparisons. The homogeneity table suggests that separate education schools (girls-only and boys-only) scored significantly better mean-scores than their counterparts in co-education schools. The girls-only ($M=5.17, SD=3.56$) stood the most dominant and effective group in terms of sequence, followed by boys-only ($M=4.47, SD=2.26$) against coeducation ($M=3.38, SD=2.16$).

The table 32 on the next page presents the related statistics:
### Table 32

*Post hoc Tukey’s HSD for Homogeneity in test-scores and Type of Schools*

<table>
<thead>
<tr>
<th>Type of School</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Co-education</td>
<td>70</td>
<td>3.3857</td>
</tr>
<tr>
<td>Boys-only</td>
<td>161</td>
<td>4.4720</td>
</tr>
<tr>
<td>Girls-only</td>
<td>119</td>
<td>5.1681</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>1.000</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

**H₀ 5.** There is no significant difference between students’ chemistry test-scores and their parents’ income levels (unemployed or <Rs 3Kpm, <Rs10Kpm, Rs11-20Kpm, Rs21-30Kpm, Rs31-40Kpm, Rs41-50Kpm, Rs51-60Kpm, Rs61-70Kpm, Rs71-80Kpm).

Kpm=thousand per month.

A one-way ANOVA was conducted to find out the mean difference between respondents’ test-scores and different levels of parents’ income. The findings suggested significant difference existed at least one of the level across 10 levels $p = .001$, $F (8, 341) = 3.52$, $p = .001$, therefore H₀ 5 was rejected. Levene’s test of homogeneity of variance also confirmed the difference ($p=.03$).

The post hoc analysis using Tukey’s table for homogeneity though put all the 10 levels in one sub-group showing little significant difference, however, students of parents earning Rs41-50Kpm, Rs51-60Kpm, and Rs61-70Kpm obtained better mean scores $M=6.5$, $SD=3.73$; $M=7.2$, $SD=5.19$; $M=7.5$, $SD=2.12$ respectively in achievement test than other sub-groups. Details are presented in table 32 on the next page.
Table 33

Post hoc Tukey’s HSD for Mean Test-Scores and Parents’ Income Levels

<table>
<thead>
<tr>
<th>Test</th>
<th>Income of Parents</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tukey HSD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>less than Rs 3000pm</td>
<td>27</td>
<td>3.1111</td>
</tr>
<tr>
<td></td>
<td>Rs 71,000 to 80,000pm</td>
<td>4</td>
<td>3.2500</td>
</tr>
<tr>
<td></td>
<td>up to Rs 10,000pm</td>
<td>144</td>
<td>4.0833</td>
</tr>
<tr>
<td></td>
<td>Rs 11,000 to 20,000pm</td>
<td>116</td>
<td>4.8621</td>
</tr>
<tr>
<td></td>
<td>Rs 31,000 to 40,000pm</td>
<td>13</td>
<td>4.9231</td>
</tr>
<tr>
<td></td>
<td>Rs 21,000 to 30,000pm</td>
<td>32</td>
<td>4.9375</td>
</tr>
<tr>
<td></td>
<td>Rs 61,000 to 70,000pm</td>
<td>2</td>
<td>6.5000</td>
</tr>
<tr>
<td></td>
<td>Rs 51,000 to 60,000pm</td>
<td>6</td>
<td>7.1667</td>
</tr>
<tr>
<td></td>
<td>Rs 41,000 to 50,000pm</td>
<td>6</td>
<td>7.5000</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td></td>
<td>.062</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

**H<sub>0</sub> 6.** There is no significant difference between students’ chemistry test-scores and their parents’ occupation levels (un-employed, technical/industrial, teaching, low-grade employee, officer, own small shop/business).

One-way ANOVA gave strong clue that there was significant difference in the respondents’ mean-scores and their parents’ occupation levels \( p < .001 \), \( F (5, 344) = 5.41, p = .000 \), therefore \( H_0 6 \) was rejected. It was further analyzed through post hoc analysis using Tukey’s test for homogeneity. Multiple comparisons revealed that children of officer’s sub-group got significantly distinct test-scores from other five sub-groups. Tukey’s overall homogeneity pointed out that respondents from officers’ sub-category excelled in achieving significantly better mean test-scores \( M = 7.43, SD = 4.01 \) than all other sub-groups which did not
differ significantly from other subset (means ranged from $M=3.12$, $SD=1.70$ to $M=4.97$, $SD=2.93$).

Table 34

*Post hoc Tukey’s HSD for Test-scores and Parents’ Income*

<table>
<thead>
<tr>
<th>Occupation of parent</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-employed</td>
<td>22</td>
<td>3.3182</td>
</tr>
<tr>
<td>Teaching (Primary, Secondary, Tertiary teacher)</td>
<td>57</td>
<td>3.8596</td>
</tr>
<tr>
<td>Own small business (retailer, whole-sale, milkman etc)</td>
<td>52</td>
<td>4.1154</td>
</tr>
<tr>
<td>Technical/Industrial (laborer, technician, worker, helper)</td>
<td>113</td>
<td>4.4602</td>
</tr>
<tr>
<td>Lower-grade employee (clerk, policeman, peon, watchman, soldier etc)</td>
<td>92</td>
<td>4.9674</td>
</tr>
<tr>
<td>Officer (Grade 16 or above Gazzetted cadre)</td>
<td>14</td>
<td>7.4286</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.124</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

**H₀ 7.** There is no significant difference between students’ chemistry test-scores and their home-study duration (no study, 1-2hrs, 3-4hrs, 5-6hrs daily).

One-way ANOVA was used to compare the students four sub-groups of home-study duration. As expected it was found that there was significant difference between at least one of the four sub-groups $F(3, 346) = 6.43$, $p < .001$, therefore $H₀ 7$ was rejected. The finding was further explored using Tukey’s HSD post hoc test which confirmed that respondents’ sub-group with maximum or 5-6 hours of home study ($M=7.50$, $SD=3.94$) obtained significantly better mean scores in chemistry test than all other sub-groups having significant homogeneity throughout i.e. they did not differ significantly between their respective sub-groups (means
ranged from $M=3.67$, $SD=2.61$ to $M=4.97$, $SD=2.88$). Following table presents Tukey’s post hoc summary of homogeneity:

Table 35

*Post hoc Tukey’s HSD for Test-scores and Respondents’ Home-study*

<table>
<thead>
<tr>
<th>Home study</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>no study</td>
<td>51</td>
<td>3.6667</td>
</tr>
<tr>
<td>1-2 hours daily</td>
<td>233</td>
<td>4.4635</td>
</tr>
<tr>
<td>3-4 hours daily</td>
<td>54</td>
<td>4.7222</td>
</tr>
<tr>
<td>5-6 hours daily</td>
<td>12</td>
<td>7.5000</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.422</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

**H₀ 8.** There is no significant difference between students’ chemistry test-scores and after-school tuition duration (no tuition, 1-2hrs, 3-4hrs, 5-6hrs daily).

A one-way ANOVA was conducted to find out the mean difference between respondents’ test-scores and different levels of their after-school tuition duration. The findings suggested significant difference existed at least one of the level across four levels at 0.05 level of confidence $F(3, 346) = 3.09$, $p = .027$, therefore $H₀ 8$ was rejected. The post hoc analysis using Tukey’s HSD test for homogeneity though put all the four levels in one sub-group showing little significant difference between them, however, it pointed out an positive increasing trend in means of the four sub-groups with relation to their increasing duration of after-school tuition. Students spending maximum time (5-6hrs daily) in after-school tuition got maximum mean test-scores $M=8.00$, $SD=5.66$ in comparison to other categories of the same sub-group whose mean test-scores and $SD$ range corresponded to $M=5.74$, $SD=3.42$ for 3-4hrs, $M=4.41$, $SD=3.00$ for 1-
2hrs, and $M=4.34, SD=2.56$ for no tuition respectively at $p=.027$. Details are presented in following table:

Table 36

*Post hoc Tukey’s HSD for Mean Test-Scores and After-school Tuition*

<table>
<thead>
<tr>
<th>After school tuition</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>no study</td>
<td>210</td>
<td>4.3429</td>
</tr>
<tr>
<td>1-2 hours daily</td>
<td>111</td>
<td>4.4054</td>
</tr>
<tr>
<td>3-4 hours daily</td>
<td>27</td>
<td>5.7407</td>
</tr>
<tr>
<td>5-6 hours daily</td>
<td>2</td>
<td>8.0000</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.062</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

$H_0$ 9. There is no significant difference between students’ chemistry test-scores and after-school tuition subjects (no tuition, languages/social sciences, natural sciences, and all subjects).

One-way ANOVA was used to compare the students four sub-groups of after-school tuition subjects. As expected it was found that there was significant difference between at least one of the four sub-groups $F (3, 346) = 7.59, p<.001$, therefore $H_0$ 9 was rejected. Levene’s test of homogeneity also confirmed that the sub-groups had significant difference in their variances ($p<.001$). The finding was further explored using Tukey’s HSD post hoc test which confirmed that respondents’ sub-group receiving after-school tuition in related natural sciences got significantly better mean-scores ($M=6.87, SD=4.68$) than all other sub-groups having significant homogeneity throughout i.e. they did not differ significantly. However, it is shocking to note that respondents of the sub-group receiving tuition in all subjects ($M=4.96, SD=2.64$) did not significantly differ from those getting no tuition ($M=4.32, SD=2.57$) and those getting tuition in
languages/social sciences ($M=3.90$, $SD=2.47$) at $p<.001$. Following table presents Tukey’s post hoc summary of homogeneity:

Table 37

*Post hoc Tukey’s HSD for Test-scores and Respondents’ After-school Tuition Subjects*

<table>
<thead>
<tr>
<th>After school tuition subjects</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languages and social sciences</td>
<td>71</td>
<td>3.9014</td>
</tr>
<tr>
<td>no subject</td>
<td>208</td>
<td>4.3221</td>
</tr>
<tr>
<td>all subjects</td>
<td>48</td>
<td>4.9583</td>
</tr>
<tr>
<td>Natural Sciences (Chemistry and Biology)</td>
<td>23</td>
<td>6.8696</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.234 1.000</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

$H_0$ 10. There is no significant difference between students’ chemistry test-scores and their favourite subjects (no subject, languages/social sciences, natural sciences, and all subjects).

One-way ANOVA was used to compare the students four sub-groups of home-study duration. As expected it was found that there was significant difference between at least one of the four sub-groups $F (3, 346) = 11.16, p<.001$, therefore $H_0$ 10 was rejected.

The finding was further explored using Tukey’s HSD post hoc test which surprisingly put respondents having no favourite subject superior ($M=8.00$, $SD=2.83$) than the rest of sub-groups, however, all sub-groups did not differ significantly and were placed in one sub-set. Moreover, the number of respondents against no subject category was simply negligible i.e. only 2 out of 350. The respondents having chemistry or natural sciences favourite subjects fell in somewhat between the extremes. The table 37 on next page presents Tukey’s post hoc summary:
Table 38

*Post hoc Tukey’s HSD for Test-scores and Respondents’ Favourite Subjects*

<table>
<thead>
<tr>
<th>Favourite subjects</th>
<th>N</th>
<th>Subset for alpha = 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languages and social sciences</td>
<td>227</td>
<td>3.9075</td>
</tr>
<tr>
<td>Natural Sciences (Chem and Bio)</td>
<td>117</td>
<td>5.4701</td>
</tr>
<tr>
<td>Social and natural sciences</td>
<td>4</td>
<td>7.2500</td>
</tr>
<tr>
<td>no subject</td>
<td>2</td>
<td>8.0000</td>
</tr>
<tr>
<td>Sig.</td>
<td></td>
<td>.070</td>
</tr>
</tbody>
</table>

Means for groups in homogeneous subsets are displayed.

### 4.2. Qualitative Findings

For collection of qualitative data 20 students (true representative of four strata i.e. boys only, boys in co-education, girls only, and girls in co-education across rural and urban divide) of public sector secondary schools were interviewed through semi-structured interviews. The items involved almost same areas that were covered through students’ questionnaires for triangulation and deeper understanding purpose. However, there were some open ended questions asking for respondents’ in-depth understanding and perceptions about teaching and learning situations. The researcher used to take notes/direct quotes during the interviews because the respondents did not show their consent to recording their interviews. The interviews were conducted from September 31, 2013 to November 23, 2013. Each interview took about 25-30 minutes. The qualitative data fitted into two categories i.e. confirmatory (presence or absence of specific teaching or learning quality) and open-ended textual data revealing related deeper insights.
4.2.1. Confirmatory Data

The semi-structured interviews of students involved 19 items with regard to free textbooks, lesson-planning, teaching methods, students’ activities, audio-visual aids, formative assessment, and course coverage. Each of them is presented and explained through respective tabular form involving all the sub-areas and their number of perceived responses across rural and urban strata:

4.2.1.1. Free Textbooks. Almost all respondents agreed that they received the free textbooks from the Government of Sindh through the Sindh Textbook Board, Jamshoro. However, two students of boys only and girls-only schools reported shortage of one or two subjects in this regard, but you will read in further analyses that mostly students and teachers do not support using those textbooks. Following table presents the related statistics:

Table 39

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Number of schools with availability of free textbooks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total No. of schools</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
</tr>
<tr>
<td>1. Boys-only (R)</td>
<td>01</td>
</tr>
<tr>
<td>2. Girls-only (R)</td>
<td>01</td>
</tr>
<tr>
<td>3. Co-Ed (R)</td>
<td>03</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td>4. Boys-only (U)</td>
<td>07</td>
</tr>
<tr>
<td>5. Girls-only (U)</td>
<td>06</td>
</tr>
<tr>
<td>6. Co-ed (U)</td>
<td>02</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
</tr>
</tbody>
</table>

4.2.1.2. Lesson-planning. The twenty semi-structured interviews of students confirmed the absence of lesson planning in the subject of chemistry at secondary school level throughout the sample (Sindh). Table 40 on the next page presents related summary:
Table 40

*Interview-summary of Lesson Planning*

<table>
<thead>
<tr>
<th>Type of School</th>
<th>No of schools showing lesson planning in the subject of chemistry</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of schools</td>
<td>LP on paper</td>
</tr>
<tr>
<td>1. Boys-only (R)</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>2. Girls-only (R)</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>3. Co-ed (R)</td>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td>4. Boys-only (U)</td>
<td>7</td>
<td>--</td>
</tr>
<tr>
<td>5. Girls-only (U)</td>
<td>6</td>
<td>--</td>
</tr>
<tr>
<td>6. Co-ed (U)</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>00</td>
</tr>
</tbody>
</table>

4.2.1.3. Teaching methods.

On the other hand, two students shockingly revealed no teaching and learning methods even dictation was simply absent. Explanation of the dictated content through one-way lecture method stood on second number, with an agreement frequency of 9 respondents. Two-way lecture and teachers’ demonstration of chemistry practical component stood on third position. However, the teacher demonstrations covered a range of 10% to 80% of the prescribed content. Discussion and Inquiry through questions got agreement of only two respondents from girls-only schools of urban area. Project, picnic/observation, problem-solving, and role-play or simulation teaching methods were simply missing. But the rural schools seemed to have been more deprived than urban ones. Table 41 presents the summary of teaching methods:
### Table 41

**Interview-Summary of Teaching Methods**

<table>
<thead>
<tr>
<th>Teaching Method</th>
<th>B-only (R)</th>
<th>G-only (R)</th>
<th>Co-ed (R)</th>
<th>B-only (U)</th>
<th>G-only (U)</th>
<th>Co-ed (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Schools (20)</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1. Dictation or fair-note-book</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>2. One-way lecture</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3. Two-way lecture</td>
<td>-- 1</td>
<td>--</td>
<td>1</td>
<td>-- 3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>4. Demonstration</td>
<td>-- 1</td>
<td>--</td>
<td>1</td>
<td>-- 1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5. Laboratory</td>
<td>-- 1</td>
<td>--</td>
<td>1</td>
<td>-- 3</td>
<td>-- 6</td>
<td>1</td>
</tr>
<tr>
<td>6. Discussion or inquiry</td>
<td>-- 1</td>
<td>--</td>
<td>1</td>
<td>-- 3</td>
<td>-- 6</td>
<td>2</td>
</tr>
</tbody>
</table>

#### 4.2.1.4. Audio-visual aids.

Semi-structured interviews of students reflected that chemistry teachers depended on blackboards and chalks. However, four students from both rural and urban schools reported that their teachers never used blackboards or any other audio-visual aids during teaching learning of chemistry. One student from girls only school of rural area pointed out no teaching and audio-visual aids! See table 42:

### Table 42

**Interview-summary of the use of Audio Visual Aids**

<table>
<thead>
<tr>
<th>Audio-visual aids</th>
<th>B-only 1 (R)</th>
<th>G-only 1 (R)</th>
<th>Co-ed 3 (R)</th>
<th>B-only 7 (U)</th>
<th>G-only 6 (U)</th>
<th>Co-ed 2 (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blackboard/chalks</td>
<td>Yes 1</td>
<td>No --</td>
<td>Yes 3</td>
<td>Yes 5</td>
<td>Yes 6</td>
<td>Yes 1</td>
</tr>
<tr>
<td>2. Charts</td>
<td>-- 1</td>
<td>-- 1</td>
<td>1 2</td>
<td>1 6</td>
<td>2 4</td>
<td>-- 2</td>
</tr>
<tr>
<td>3. Real things (Elements &amp; Compounds)</td>
<td>-- 1</td>
<td>-- 1</td>
<td>-- 3</td>
<td>-- 7</td>
<td>1 5</td>
<td>-- 2</td>
</tr>
</tbody>
</table>
4. Models (rod-ball models of molecules) | -- | 1 | -- | 1 | -- | 3 | -- | 7 | -- | 6 | -- | 2
5. Projectors | -- | 1 | -- | 1 | -- | 3 | -- | 7 | -- | 6 | -- | 2
6. Mobile-internet | -- | 1 | -- | 1 | -- | 3 | -- | 7 | 1 | 5 | -- | 2
7. Computer & Internet | -- | 1 | -- | 1 | -- | 3 | -- | 7 | -- | 6 | -- | 2

4.2.1.5. Formative assessment. Majority of the respondents (14 out of 20) across different strata confirmed that their chemistry teachers depended on frequent questions and answers; while half of them reported ‘sometimes’ the frequency of questions. However, four students opted for monthly or mid-term tests; only one student from girls-only school of rural area reported students’ presentations as additional one. Assessment in rural schools was found more shocking. The table on the next page sums up the related information:

Table 43

<table>
<thead>
<tr>
<th>Formative Assessment source</th>
<th>B-only 1 (R)</th>
<th>G-only 1 (R)</th>
<th>Co-ed 3 (R)</th>
<th>B-only 7 (U)</th>
<th>G-only 6 (U)</th>
<th>Co-ed 2 (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teachers’ questions (frequent)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2. Teachers’ questions (sometimes)</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3. MCQs test (after classroom teaching)</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>3</td>
</tr>
<tr>
<td>4. MCQs test (monthly/mid-term)</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5. MCQs test (after completing a chapter)</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>3</td>
</tr>
<tr>
<td>6. Home-work</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>3</td>
</tr>
</tbody>
</table>

4.2.1.6. Course coverage. Students’ responses during semi-structured interviews hinted toward only copying the questions and answers of the chemistry textbook. For theory, nearly
half (9 out of 20) of the students responses fell for each 50% and 75% coverage respectively.

Only two students revealed 100% coverage in this regard throughout. Practical component in terms of students’ lab-work or experimentation was simply missing throughout except for one girls-only school of urban area. Following table presents the interview-summary of the course coverage:

Table 44

*Interview-summary of Course Coverage of Chemistry*

<table>
<thead>
<tr>
<th>Type and Number of School</th>
<th>CHEMISTRY THEORY</th>
<th>CHEMISTRY PRACTICAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>1. Boys-only 1 (R)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2. Girls-only 1 (R)</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>3. Co-Ed 3 (R)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>4. Boys-only 7 (U)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>5. Girls-only 6 (U)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>6. Co-Ed 2 (U)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total 20</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

4.2.2. Open-ended Textual Data

The 20 semi-structured interviews from students aimed at exploring deeper understanding and perceptions regarding secondary school teachers’ professional knowledge and skills about: teaching methods, students’ active involvement in teaching and learning of theoretical and
practical components of chemistry, in addition to use of unfair means to pass in board’s examinations at secondary level. They involved following questions:

1. How does your chemistry teacher teach the concepts of chemistry textbook?
2. How does your chemistry teacher teach the practical component of chemistry practical journal?
3. Which activities do students engage in during chemistry’s teaching-learning process?
4. Which unfair means do exist in Board’s examination (grade 9th & 10th) and why?

Above questions served as major themes or categories of qualitative data. Their responses were grouped in appropriate sub-themes as perceived by students. The researcher presents below their thematic findings along with a summary finding that best reflects respondents’ comments and understanding into specific area:

4.2.2.1. Theme 1: Teaching of chemistry textbook (theoretical part)

Question 1. How do chemistry teachers teach the concepts of chemistry textbook?

Students’ responses showed consistent views with a little diversity across gender and rural/urban divide regarding classroom teaching of chemistry textbook. Following sub-themes surfaced in this regard:

Sub-theme 1: Fair-note-book method. All students who were interviewed unanimously revealed that their teachers used fair-note-book method for teaching and learning. Here, the teacher dictated the questions and answers of related content (chemistry textbook). Sometimes they wrote on black board, and the students copied it down on their ‘rough’ note-books in the classroom (because students had to write it down quickly while being dictated so the handwriting becomes rough). Later on, they rewrote it in their fair-note-books in neat/fair hand.
One female rural student of girls-school stated: “Our chemistry teacher comes in the class and writes a question on the blackboard and then dictates its answer. She uses old (previous year’s) fair-note-book for dictation (personal communication, Oct 03, 2013)”. Another urban student from boys school revealed shocking picture by saying: “Our teachers do not know anything else other than dictating from the textbook. They are not concerned with their teaching and our learning, but with their salary that they get regardless of what they do in their classes. Presently some of them are getting nearly six-digit salary, but they hardly teach us (personal communication, November 23, 2013)”.

**Sub-theme 2: Lecture and Explanation.** Majority of students (15 out of 20) revealed that their teachers only dictated the content i.e. questions and answers from the textbook, and they had to write them quickly in their rough copies in their classrooms; and they got them rewritten in good hand in their ‘fair-note-books’ at homes. Their teachers neither demonstrated nor used science laboratories. A few (5 out of 20) students revealed that teachers used lecture or verbal explanation after dictating the question and answers to the students. They additionally used questioning technique as a sort of formative assessment of their classroom teaching.

**Summary Finding 4.2.2.1.**

Our existing teaching of chemistry hardly involves even traditional lecture method that is widely criticized throughout the world, especially for teaching of sciences including chemistry of teaching. Almost all students confirmed that their teachers dictated questions and answers from chemistry textbook or previous year’s ‘fair-note-book’—called so because students had to maintain such dictation in their fair-note-books. Very few teachers supplemented their local fair-note-book method with lectures/explanation.
4.2.2.2. Theme 2: Teaching of practical journal of chemistry (practical part)

Question 2. How do chemistry teachers teach the practical component of chemistry practical journal?

Shockingly, the researcher got almost same responses for practical component as obtained earlier for teaching of theoretical textbook of chemistry. Their responses reflect no distinction between teaching of theoretical and practical components across all strata! The researcher presents details of students’ perceptions in following sub-themes:

Sub-theme 1: Dictation. About three-fourth of the respondents (14 out of 20) across gender and location were of the opinion that their teachers neither demonstrated nor allowed students’ individual/group laboratory experimentation of compulsory practical component. Five out of 20 students reported that their teachers only dictated the content of experiments from 30% to 80% (given in chemistry practical journal) and students had no option other than to write it down in their rough-note-books which they rewrote in a good hand on their chemistry practical journals. “Our teacher dictates the experiments of chemistry practical journal, and we write it on our ‘rough note-books’ in the class. Later on, we rewrite the same in a good hand at home (personal communication with a girl student of grade 9th, Interview, Oct 31, 2013)”. “For our part there is no difference between the teaching of chemistry theory and practical because our teachers use the same method of teaching for both components that is nothing but the dictation of content (comment by rural male student, personal communication, Oct, 31, 2013)”.

Sub-theme 2: Rare teachers’-demonstrations and scarce students’-lab work. Very few teachers give demonstration of science related experiments of chemistry at grade 9th and 10th. The demo for theoretical part is simply absent, while it is occasionally used by a few teachers for practical component. Very few (2 students out of 20) pointed out that sometimes chemistry
teachers used demonstration in their classes in order to facilitate students’ understanding about how a scientific principle worked. “Our teachers are competent. They not only ensure that students are maintaining their fair-note-books but also supplement their teaching with proper explanation (lecture) and demonstration (English version of Sindhi quote of a female student, personal communication, Oct 10, 2013)”. One urban female student out of 20 said that their chemistry teacher facilitated students’ guided lab-work in groups for teaching and learning of practical component (personal communication, November 23, 2013).

**Sub-theme 3: Science-labs are locked always.** More than half students (11 out of 20) stated that science laboratory was available with adequate related equipment and resources, but unfortunately remained locked always. Six students of different boys and girls schools revealed that either their schools did not have any science lab or had inadequate equipment/material. Three students revealed that their schools’ science labs were under-construction/repair, but adequate equipment and material was available; however, teachers only used a few demonstrations at the end of academic year. A male student revealed, “Our classroom time-table mentions two periods of chemistry practical a week, but the teacher does not come in those periods and we are left free (personal communication, October 3, 2013)”. A girl student pointed out, “Science almirahs/cupboards are full of equipment and material but always locked! We don’t know if they are for our use!” (personal communication, November 21, 2013).

<table>
<thead>
<tr>
<th>Summary Finding 4.2.2.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ lab-work was simply missing at public secondary schools across gender and location strata except for a girls-only school of urban area, out of 20 students interviewed. Even teachers demonstration were missing likewise. It points out failure of professional teaching of chemistry and respective administration.</td>
</tr>
</tbody>
</table>
4.2.2.3. Theme 3: Students’ activities.

Question 3. Which activities do students engage in during chemistry’s teaching-learning process?

Students responses revealed similar pattern of responses across all strata. No satisfactory answers were sought from students about how chemistry teachers ensured students’ active participation in learning textual concepts of chemistry, during classroom teaching-learning process. However, one student from girls-only school of urban school reflected appropriate teaching and learning and students activities. Following sub-themes emerged in this regard:

Sub-theme 1: No lecture, no explanation, no demonstration, no lab-work but fair-notebook, the only activity. Clear majority (15 out of 20) of students across all strata i.e. boys-only, girls-only, and co-education schools across urban and rural areas notified that there is a single activity in their schools throughout the year i.e. dictation and writing the questions and answers of the textbook. They observed it as whole class as a group method, in a sense that all students wrote the dictated content simultaneously, and individual in a sense that every student has to write it down on their rough-note-books. A male student of boys-only school exclaimed, “Teachers lack in knowledge of subject-matter, therefore they focus on maintaining related fair-note-books, and hide their shortcomings (personal communication, October 24, 2013)”. Many students supported this point in one or the other way. They complained that science material and labs were always locked; higher officials come for less than one hour a year during ‘inspection’ and go back after having rich food arranged by school teachers and administration.

Sub-theme 2: Absence of teaching and learning. Two students (out of 20) one each from boys-only and girls-only schools of rural and urban areas respectively provided shocking experience of no such teaching or activity throughout! Even dictation of textual questions and answers was missing! “Teachers are available but they appear sometimes at school and have a
chat with their colleagues but do not take their classes (personal communication with a male student of co-education school, October 12, 2013). The students of above school were of the opinion that their school ran for one or two period a day, and that was all for a day.

**Sub-theme 3: Ghost teachers.** About one-fourth of the students i.e. four students out of 20 (one from each strata—boys-only, girls-only, and two from co-education) reported that their chemistry teachers remained absent for most of the days, and when came, they did not take their classes. They spent their time in chatting with their colleagues and students. The researcher found a girls-only school of rural area (but main school) where students who were inquired of, disclosed the worst teaching and learning situation in sciences. They unanimously notified: “Our original teachers come to school once a month; spend their time in chatting; and leave the school without teaching a word. The head-mistress comes once a year! But there are some [2 or 3] volunteer teachers. They teach us English and other social sciences in the best way. It is because of their effort, passion, and hard-work that we are speaking in English with you! (personal communication, October 24, 2013).

Those volunteer teachers were actually ex-students of that school and were candidates of graduation at that time. The researcher met with two of those volunteers. They were really symbol of passion and hard-work. And it was the first school throughout the district whose students could fluently communicate in English. From their effort the researcher concludes that sincere teachers can obviously bring revolution in teaching and learning. Since they did not teach chemistry or science subjects therefore students scored zero marks in chemistry achievement test included in the questionnaire.

**Sub-theme 4: Textbook reading and students’ presentations.** Only two students (1 each from co-education and girls only school) in their interviews responded positively regarding
textbook reading and students’ presentations as classroom activities respectively. They indicated that they often had textbook reading and students’ presentations as core activities.

*Sub-theme 5: Good professional teaching.*

Only one student from girls-only school (out of 20) across all strata shared positive learning experience enriched with students’ book reading, teacher’s demonstration and facilitating them in guided laboratory practical/experiments, and students presentations before the class. She reported that their chemistry teacher had certain teaching-plan in mind (though not in paper form). She (their teacher) used board and chalks, charts, and mobile-internet as audio-visual aids during classroom teaching and learning. She did not punish their students and happily responded to students’ questions and quarries. She covered 90% of theoretical textbook curriculum and facilitated their students in guided lab-work or experiments to cover 80% of the practical work. “Our chemistry teacher is very talented and competent. She uses different teaching methods and resources so that we can understand the content (comment of a female student of an urban girls-only school, personal communication, November 23, 2013)”.

**Summary Finding 4.2.2.3.**

The writing or copying down the questions and answers of the chemistry curricula known as maintaining ‘fair-note-books’ remained the only dominant student activity. Almost all teachers except one female teacher were reported (by their students) to having little interest in students’ active participation in learning activities i.e. silent reading of textbook, individual or group work, and presentations. Significant number of teachers either remained ghost or did not simply take their classes! It puts tags on administration besides professional teaching and trainings.
4.2.2.4. Un-fair means in board’s examination.

Question 4. Which unfair means exist in Board’s examination and why?

Following sub-themes emerged out of 20 students’ responses who were interviewed:

**Sub-theme 1: Cheating/copying, out-side help, and impersonation.** All the students throughout all strata directly or indirectly agreed or hinted that cheating or copying, out-side help, and impersonation practices existed in board’s examinations of grade 9th and 10th and onwards. Cheating has been replaced by copying where students openly copy from the pages of textbooks/guide-books/solved papers to solve the exam-paper in the presence of invigilators and other staff. Students revealed that copying was part of their education system and culture.

“Students stop copying when the board’s team visits the examination centre—usually for some minutes to an hour once throughout the examination days, otherwise they are allowed to copying” (a comment by a male student of urban school, personal communication, September 30, 2013).

“In order to get good grade some parents and relatives hire the services of experienced teachers to solve the questions or find them from the books/notes at their homes. Once he or she finishes the question it is sent to the respective student at the examination hall” A male student of rural school reported about out-side help (personal communication, November 21, 2013). He further elaborated impersonation practice that sometimes they (parents or relatives) arrange dummy student to sit in place of original student to solve the question papers for better grades.

**Sub-theme 4: Solving question paper at home.** Two urban students each from girls-only and co-education school reported that some female students solved or got solved their question papers at their homes, and submitted the same to the concerned staff afterwards in order to get better marks (comment made by male and female student whose schools worked as examination centre during board’s exam, personal communication, October 10, 2013).
**Sub-theme 5: Approaching board’s officials/examinees.** A few students (2 out of 20) indicated or clued toward involvement of board’s officials. They pointed out that some parents and relatives got undue marks and grades from the board officials directly.

**Sub-theme 6: Why unfair means in board’s exam (grade 9th & 10th)?** Almost all students of all strata believed that existing copy culture has developed through decades and now it is deep rooted in whole system of education and stakeholders. Now it inspires and promotes all malpractices and unfair means. “All students cheat and copy in examinations therefore we also do so (quote from a girl student of girls-only school of urban area, personal communication, October 3, 2013)”. A male student of urban boys-only school also confirmed this point in these words: “Copy culture exists since years. Everybody is sure that passing in exam is no problem. Only one has to copy down the answers (personal communication, October 4, 2013)”.

Half of the respondents (10 out of 20) from all strata believed that teachers were responsible for copy-culture and unfair means in the board’s exams for they lacked in content knowledge, ignored demonstrations and lab-work, didn’t come to school or take their classes, and spent time in chatting with their colleagues. “Teachers do not teach properly. They only make us write the questions and answers, and focus on maintaining ‘fair-note-books’ therefore, we can’t understand the content (a rural male student’s comment, personal communication, October 24, 2013)”. An urban male student commented, “Our chemistry teacher beats us with stick when we ask him a question (personal communication, October 3, 2013)”.

However six students (out of 20) from different strata declined to blame their teachers but took the responsibility of unfair means on their shoulders. “All stakeholders are responsible,”
came from two urban students of boys-only and girls-only respectively, while two opted for parents’ carelessness and community’s ignorance for not forcing their children to study at homes.

Summary Finding 4.2.2.4.

All students unanimously agreed that unfair means and irregularities exist in Board’s examinations (9th and 10th). They included cheating or copying, getting outside help to solving the exam questions, involving into impersonation (replacement of original student by someone else in the examination), solving question-paper at home, and approaching board’s officials/examinees during assessment. Students were divided in their responses about why above unfair means existed in Board’s annual examination. Majority in one or the other way thought that improper teaching was responsible for such unfair means but considerable number took the burden on their shoulders and declined to blame their teachers.

4.3. Triangulation of Quantitative and Qualitative Data

The researcher used both (quantitative and qualitative) types of the data to triangulate each other to get a holistic, more valid, and reliable picture of existing professional teaching and learning of chemistry at the secondary school level, from learners’ perspective. The both types of findings with regard to eight aspects of professional teaching are presented below:

4.3.1. General Professional Teaching Skills

The mean of the items of general professional lie at 3.59 at five-point Likert scale (1=SD, 2=D, 3=Neutral, 4=A, 5=SA) (Table 19) which slightly corresponds to ‘agree’ however, detailed item-analysis of frequencies showed serious issues. For example, the mean frequency of 2.30 with the median 2.00 revealed potential professional flaws against an item asking for whether the teacher allowed students’ mistakes during teaching and learning process. The findings from
semi-structured interviews of students also revealed mixed responses that did not show effective skills in this regard.

4.3.2. Lesson-planning

Lesson planning was found to be the least focused area among secondary school teachers of Jamshoro (Sindh). The descriptive statistics (Table 19) show 2.24 average that leans toward ‘disagreement’ of all the aspects of lesson planning throughout. The same findings were obtained from 20 students’ semi-structured interviews (see Table 39) which indicate total absence of written lesson planning except for one female student of girls-only school of urban area who stated that their chemistry teacher had somewhat mind-planning. Rural schools depicted worse situation than the urban ones as revealed in both types of findings.

4.3.3. Teaching Methods.

The dictation or ‘fair-note-book’ method remained the most dominating method throughout the sample; however, some urban teachers especially from girls-only school of rural area used one and two-way lectures, demonstrations, and laboratory methods as well. Nevertheless, the mean average stood at 2.05, which corresponded to ‘seldom’ being used in classroom teaching (see Tables 19 and 14). The individual means of demonstration, laboratory, inquiry, project, picnic, discussion, problem-solving and role-plays got 1.00 or slightly higher scores on the five-point scale which fell mostly for ‘never’ category. The confirmative qualitative data (table 40) revealed same picture. Additionally, the sub-themes of lecture and explanation, rare teachers’-demonstrations and scarce students’-lab-work, and locked science labs that emerged from qualitative interviews clearly confirmed the quantitative findings and drew the worst ever picture in this regard.
4.3.4. Audio-visual Aids

Quantitative findings reveal that majority of teachers, according to their students, depended on traditional visual aid: board and chalk (individual item’s mean 3.5). On the other hand a few inclined to using charts (1.5 individual mean) (see tables15). The overall mean stood to be 1.6 with a median value of 1.5 corresponding to ‘seldom’ (Table 19). The individual means for items corresponding to real things, models, projectors, and modern audio-visual aids ranged from 1.0 to 1.3. Almost same findings emerged from qualitative confirmatory and open-ended interviews (see table 41). They revealed more deteriorating condition for rural schools throughout in this regard.

4.3.5. Students’ Classroom Activities

Out of four activities first two (reading from textbook and individual-work in the sense that the teachers dictated the content, and each student had to copy or write it down individually) got relatively better individual mean scores 3.16 and 3.59 against 1.29 and 1.89 for the remaining two i.e. group-work and students’ presentations respectively (see table 16). However, an overall mean was found to be 2.5 (see table 18). Students blamed teachers for using dictation method as the only teaching method; they even blamed their content knowledge and professional skills (see first two themes of open-ended interviews). The researcher could not find any difference between rural and urban divide in this regard.

4.3.6. Students’ Formative Assessment

Students formative assessment involved four items of the questionnaire: teachers’ verbal questions during classroom teaching, short MCQ test during classroom teaching, assigning home-work, and administering detailed MCQ test after completion of a chapter. According to the 350 students from the sample, verbal questions and home-work got relatively better
consideration with individual mean scores of items 3.29 and 2.49 respectively (see table 17), whereas, the remaining two got 1.76 and 1.84 respectively that clearly indicates their ignorance. The overall mean stood at 2.35. The qualitative confirmatory findings also revealed not much difference in this regard (see table 42).

4.3.7. Course Coverage of Theory

It is shocking to note from the quantitative findings that more than half of the second part of prescribed textbook remained untouched by the teachers. The individual items’ means were 4.5 for coverage of first part (chapter 1 to 10), 2.4 for the second or last part (chapter 11 to 18), and 1.3 for teachers’ demonstrations of the embedded experiments within theoretical part (see tables 18 and 43). The qualitative findings revealed almost the same figures i.e. an overall coverage of 50 to 75% of the course. Teachers of rural schools were too behind in coverage of theoretical course than their urban counterparts.

4.3.8. Course Coverage of Practical

The worst ever findings from both quantitative and qualitative tools revealed that practical component was simply missing throughout the targeted sample. The individual mean occurred to be 1.63, 1.11, and 1.63 for teachers’ demonstration of prescribed experiments of practical journal, students’ individual laboratory experimentation, and students’ laboratory experimentation in groups respectively (Table 18). The confirmatory qualitative findings explicitly revealed the absence of the practical demo or work on the part of teachers and students throughout the sample except single girls-only school of urban area (see Table 43 and summary findings 4.2.2.2).
CHAPTER V

SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

In the first instance, I provide a summary of the study. Secondly, I present the conclusions drawn from both quantitative and qualitative findings. Thirdly, I discuss, and relate my findings to the previous findings to develop an enriched vision besides justifying them in the local context. Finally, on the basis of findings, the researcher presents crucial and realistic recommendations to the concerned stakeholders for making in-practice teaching more effective at secondary school level. Moreover, I suggest a future plan of action and research in the field of effective teaching and learning of sciences at secondary school level in Pakistan, especially in Sindh where I conducted the research.

5.1. Summary

The present study aimed at evaluating the teaching of chemistry at public secondary school level (grade 9th and 10th) in Sindh, Pakistan regarding the professional teaching criteria of B.Ed, the minimum professional pre-service training secondary school teachers.

The researcher reviewed the related literature to get a comprehensive view and find the gaps between ideal or effective teaching of sciences and existing teaching practices in national and international levels. Moreover, I performed the content analysis of the B.Ed. curricula to get a clear vision of professional teaching. While reviewing the related literature, I found that evaluation of teaching could be done through different and diverse perspectives of different stakeholders. Ratings through self, students, peers, alumni, employers, and administrators are the common forms, in addition to teachers’ teaching scholarship and awards, and learners’ learning outcomes. A few studies were found at our national level that evaluated teaching from teachers’ and administrators’ perspective, but there is a dearth of above approaches and their
required infra-structure in our educational system. Therefore, the researcher decided to evaluate teaching of chemistry through learners’ perspective as they are the actual beneficiaries. This study involved both quantitative (survey) and qualitative (phenomenological students’ interviews) methods.

The present study focuses to evaluate the professional teaching of chemistry with relation to general professional skills, lesson-planning, teaching methods, audio-visual aids, students’ classroom activities, students’ formative assessment, and coverage of the curricula of chemistry theory and practical. In this connection, I could not find a proper research tool that could fit well in our local context, so I took the responsibility of developing the same. A comprehensive questionnaire was developed by the researcher involving 70 items covering all above eight areas of professional teaching of chemistry. It also implicated 18 items of chemistry achievement test. Those test-items were framed on the lower level of cognition using Bloom’s taxonomy with an assumption that existing teaching hardly inculcates proper knowledge and comprehension of related topics among students. It went through a panel of three expert and senior professors of Iqra University and pilot-testing for ensuring face-validity and refinement. The Coronbach’s alpha of the questionnaire stood at 0.8 which indicates a good internal consistency. And well thought basic sketch of 20 students’ semi-structured interviews was part of qualitative part that served for triangulation and holistic understanding.

A stratified random sampling procedure was used to draw a truly representative sample of 350 students falling in four strata: boys-only, girls-only, boys in co-education, and girls in co-education across rural and urban areas. The researcher followed informed legal consent procedure along with ensuring respondents’ anonymity and confidentiality. The researcher personally administered the questionnaires in his presence. It ensured clarifying any confusions
and 100% response rate. The quantitative data were entered into SPSS package 16.00 and was analyzed through multiple regression, correlation, independent samples t-test, and ANOVA while thematic analysis was performed on semi-structured interviews. And both were converged to triangulate and get comprehensive and deeper insights.

Descriptive statistics of 350 respondents and confirmatory qualitative data from 20 students’ semi-structured interviews regarding above eight independent variables show an overall poor picture leading to the failure of professional teaching of chemistry. However, overall multiple regression analysis reveal moderately significant strong association between above eight predictors and students’ test-scores. Out of the above predictors, however, only four are found to have significant p-values and standard beta values toward respondents’ test-scores. They are audio-visual aids (b= .248) coverage of chemistry practical (b=.200), coverage of chemistry theory (b= .198), and teaching methods (b= .113) to account for .645 regression value (p<.001) with 41.7% prediction surety.

Multiple linear regression analysis of demographic factors and respondents’ test-scores showed statistically significant but overall weak or moderate (R=.398) association with 15.9% of prediction surety. Among ten demographic predictors six showed insignificant statistical values and were discarded. The left out four i.e. students’ favourite subjects, students’ home-study, income of parents, and students’ gender are found to have significant association with test-scores, though it was found to be weak or moderate one.

Differences in respondents’ test-scores due to demographic predictors are calculated through independent samples t-test (with two sub-groups) and ANOVA (with more than two sub-categories). Significant differences in mean-scores of respondents’ are found between rural and urban students; however, the case is vice-versa regarding gender (no significant
difference). The one-way ANOVA is used against eight predictors out of the ten. All findings reveal significant differences except for type of school i.e. boys-only, girls-only, and co-education showing no significant difference on respondents’ test-scores. Mostly respondents from parents of higher monthly income and rank (officer-group) get better test-scores. Similarly, students who have maximum home-study and after-school tuition get significantly better mean scores in achievement-test than those who spent fewer hours on home-study or after-school tuition. Again, expected findings come regarding respondents’ after-school tuition subjects: The students who get tuition in natural sciences (chemistry and biology subjects) get significantly higher mean score in achievement-test than the groups of other sub-set getting tuition in social sciences or no-tuition group. However, unexpected findings come when the researcher finds that students who does not show any preference for favourite subject get better mean test-scores than those who opt for natural, social or both sciences as their favourite subjects.

The findings almost reveal absence of professional teaching in terms of general professional teaching skills, lesson planning, teaching methods, audio-visual aids, students’ classroom activities, students’ formative assessment, course coverage of theory, and course coverage of practical. this situation reveals nothing but the failure of both i.e. existing teaching of chemistry and pre-service training of B.Ed in terms of its curricula, examination, and administration, because all teachers possess B.Ed. while the majority have M.Ed. to their credit. They account for little effect on the learners’ chemistry test-scores out of 18 (1 mark for each correct item). The findings support the assumption that existing teaching of chemistry could not support knowledge and understanding of the basic concepts of chemistry. The respondents’ poorest mean scores and standard deviation for MCQs (M=3.56, SD= 1.87), Blanks (M=0.93, SD=1.41), and Overall Marks (M= 4.49, SD= 2.82) clearly indicate the failure of professional
teaching of chemistry. The researcher has presented related recommendations to the concerned stakeholders on the basis of findings for uplifting of teaching of chemistry at public secondary school level.

5.2. Conclusions

Let us conclude from the findings and deal with them in the sequence of research questions of this study. Since first two research questions focus on above eight areas using qualitative and quantitative assessment procedures respectively, therefore, it is better to bring them together for holistic conclusion.

RQ 1. How do the learners perceive existing professional teaching of chemistry at public secondary schools?

RQ 2. Whether and up to what extent is the existing professional teaching of chemistry in line with the suggested criteria of B.Ed from learners’ perspective?

The researcher delimited assessment of ‘professional teaching of chemistry’ specifically to these eight aspects i) general professional teaching skills, ii) lesson-planning, iii) teaching methods, iv) audio-visual aids, v) students’ classroom activities, vi) formative assessment, vii) course coverage theory, and viii) course coverage practical, with relation to the criteria laid down in B.Ed that is the minimum pre-service training for secondary school teachers in Pakistan.

In previous chapter we found from the students’ questionnaires and semi-structured interviews that all the secondary school teachers except a few of district Jamshoro, did not show proper general professional teaching skills; did not plan their lessons; did not teach through laboratory experimentation, inquiry, project, picnic (observation), discussion, problem-solving, and role-play teaching methods; did not use charts, real things (elements and compounds), models, projectors, and modern technology related things (computer and internet); did not
engage students in group-work, individual exploration and presentations; did not assess students learning through short quizzes, MCQs, and assignments/home-work; did not cover the second theoretical part (chapter 11 to 18); and did not even bother to touch the practical component.

Contrastingly, they only dictated the textual questions and answers to their students; they mostly depended on blackboard and chalks; and they could not go beyond rare verbal questions in assessing students’ learning. Therefore, the researcher finds a solid base to conclude that overall teaching of chemistry at public secondary schools of Sindh (Pakistan) deviates from the professional criteria of B.Ed in terms of above eight aspects of teaching of chemistry. It openly points out toward the failure of professional teaching of chemistry, school administration and management, professional trainings especially pre-service curricula of B.Ed and its examination system; and recruitment of teachers, and district administration and monitoring as well.

**RQ 3. Whether and up to what extent do the public secondary school students’ test-scores relate to some aspects of professional teaching as assessed from learners’ perspective?**

Out of the eight predictors, the multiple regression analysis reveal that four variables i.e. coverage of chemistry practical, teaching methods, audio-visual aids, and coverage of chemistry theory significantly predict the students’ test-scores at p<.05 (.000). The prediction is found to be moderately strong ($R=.645$) with 42% prediction surety. But the left out four predictors (students’ formative assessment, p=.56; students’ classroom activities, p=.52; lesson-planning, p=.30; and general professional teaching skills, p=.23) fail to significantly predict students’ test-scores.

I think that it does not mean that these left-out four aspects of professional teaching are unimportant. But it reflects absence of significant data on their part. For example, no student reported formal written lesson plans on the part of their chemistry teachers, therefore, the
statistical analysis software could not get evidence to correlate it to any student’s test-scores!

Same is the case with formative assessment, and students’ classroom activities. The descriptive statistics section reveals such potential flaws regarding those variables.

On the basis of the findings and their related clues the researcher concludes that out of targeted eight aspects of teaching of chemistry the four: coverage of chemistry practical, teaching methods, audio-visual aids, and coverage of chemistry theory play crucial role in learners’ knowledge and understanding of the curricula. However the left out four might have the same role but it is to be determined by replicated future studies with a sample where the professional teaching is better in terms of different aspects of students’ formative assessment and classroom activities, and teachers’ lesson-planning and general professional skills.

**RQ 4. Whether and up to what extent do the public secondary school students’ chemistry achievement test-scores relate to some of their demographical aspects as assessed from learners’ perspective?**

From the multiple linear regression analysis of the ten demographic predictors (gender, type of school, location, parents’ income, occupation and education, students’ home-study, after-school private tuition, tuition-subjects, and their favourite subjects) the test-scores are primarily predicted by students’ favourite subjects and home-study, and to a lesser extent by parents’ income and respondents’ gender. Though the prediction is statistically significant ($p < .001$), yet it is of moderate or weak level ($R = .398$) with lower prediction value i.e. $15.9\%$ ($R^2 = .159$). From these findings, I conclude that learners’ intrinsic motivation/reinforcement accounts for better academic knowledge and understanding of the curricula and it works better than all other targeted demographic variables. However, wealthy parents and respondents’ gender also seem to have significant effect on learners’ test-scores. Students from wealthy parents might have better
access to knowledge developing resources i.e. books, computer, internet, private tuition etc.

Secondly, in our culture females do not have more opportunities to go out and spend time out of their houses due to cultural and religious influences, therefore, they generally give more time to their studies and get better marks than their male counterparts.

As mentioned earlier the existing professional teaching is either very poor or a failure one, therefore, I am of the opinion that the targeted demographic (including left-out) predictors might reveal significant association with respondents’ test-scores from a sample taken from a location with better teaching and learning situation.

RQ 5. Whether and up to what extent do the public secondary school students’ chemistry achievement test-scores differ from some of their demographical aspects as assessed from learners’ perspective?

Significant differences are found between students test-scores and almost all demographic variables i.e. type of school, location, parents’ income and occupation, students’ home-study, after-school private tuition, tuition-subjects, and their favourite subjects. However no such differences are found with relation to gender and parents’ education levels.

Since students from urban areas, separate education school (boys-only and girls-only), officer-grade parents, middle-class parents (earning between Rs 41,000 to 60,000 per month), devoting greater time (5-6 hours daily) to home-study and tuition, and after-school tuition in natural sciences, get significantly different and better mean-scores in chemistry achievement test than their other respective sub-categories. Putting it in other words, students living in rural areas, studying in co-education schools, relating to those parents having lower social status and monthly income, devoting lesser time or no time to home-study and after-school tuition, getting
tuition in social sciences or no tuition significantly get lesser mean scores in their chemistry achievement test.

It certainly points out at least two things. First, learners’ personal aptitude and interest (giving more time to their studies) equally competes with environmental (after-school tuition duration, and tuition in sciences) influences to bring positive learning outcomes. All this calls for providing free of cost volunteer-based tuition in collaboration with provincial government and local community (details can be seen in the section of recommendations) throughout rural and urban areas. Second, backwardness and poverty negatively affects students’ knowledge and understanding of the curricula. Either students of those areas might prefer in helping their parents in making their both ends meets, thus, not be able to give proper time and consideration to their studies or lack of/poor monitoring and check and balance might have put the teachers at ease (semi-structured interviews of students confirmed teachers’ absenteeism or even not taking classes). It may be overcome through strict monitoring of teaching and learning especially at rural schools.

5.3. Discussion

Students perceive pedagogy or knowing how to teaching as the foremost characteristic of effective science teachers followed by making learning interesting and fun (Mandina & Mambanda, 2012) and call for periodic assessment of teachers’ performance. Multiple independent and international surveys consistently point out that our professional teaching at all levels and subjects deviates from the professional criteria and standards (Government of Pakistan, 2009a and 2009b; Mehrunnisa, 1998). A few previous studies examined some of the aspects of professional teaching in general, but hardly tried to bring forward a comprehensive picture of professional teaching of chemistry at Pakistani public secondary school level in
particular. Therefore, the present mixed method study examined the professional teaching of chemistry with relation the criteria of B.Ed regarding eight crucial aspects of teaching i) general professional teaching skills, ii) lesson-planning, iii) teaching methods, iv) audio-visual aids, v) students’ classroom activities, vi) formative assessment, vii) course coverage theory, and viii) course coverage practical. The findings of this study show a blend of agreement and disagreement to different focused areas while it extends or explains some of the critical issues and provide deeper insights as well. Let us discuss each of the aspect in following sequence:

5.3.1. Overall Analysis

Present study involves representative stratified sample with accurate sample size (350 respondents) to study professional teaching of chemistry against above eight specific areas. Shockingly, no aspect is found fulfilling the criteria of B.Ed. It supports the findings of Sarwar and Hussain (2010) who studied twenty-five areas of professional teaching from relatively smaller and non-representative sample (150 secondary school teachers). They found that the teachers were weak in lesson planning, classroom discipline management, and content knowledge mostly. Lesson planning remained the most burning professional issue. The top 11 burning problems stood in this sequence: lesson-planning, students’ previous knowledge, flow and continuity of lesson, teaching aids, induction or introduction of lesson, students’ involvement, quantity of subject matter taught, quantum of subject matter, and recapitulation and conclusion (p. 183). The findings of present study are in total agreement to above study with a couple of advantages of representative sampling technique and proper sample size.

Saeed and Mubeen (2010) while evaluating the competencies of secondary school teachers’ planning and instruction arrived at contradictory findings (from a sample of 800 head teachers and 4000 respondents each from teachers and students). The teachers and students
believed that teachers had mastery over course content, planned for full academic year, and completed the prescribed course; however, their head-teachers disagreed in this regard. The present study contradicts above findings in a sense that the students of District Jamshoro (Sindh, Pakistan) themselves accept that their teachers do not have mastery on subject matter (mean of the item $M=3.11$, $Md=3.00$, see table 12); do not plan ($M=3.11$, see table 13), and do not complete prescribed course (for theory overall mean score $M=2.74$, and for practical component overall mean score is only $M=1.45$, see table 19). It might be due to social and cultural influences (i.e. respect for teachers etc) on the part of students and exaggeration on the teachers’ part. Our students seem not holding their teachers into higher esteem due to teachers’ incompetency and their involvement in unfair means in board’s exams (copying, outside help, impersonation of original candidates, solving papers at homes, getting undue marks/grades directly from the board officials etc) in Sindh.

### 5.3.2. Achievement Test

I designed the achievement test (containing 18 items involving 9 MCQs and 9 Blanks) from the self-assessment items given at the end of each chapter; its Coronbach’s alpha value was found to be 0.7 for MCQs, and 0.9 for Blanks, with an overall alpha value of 0.8 showing good internal consistency of the test-items. It implicated an assumption that our existing teaching of chemistry hardly support students’ lower-levels of cognitive skills i.e. conceptual knowledge and understanding. For this purpose the items were carefully selected against the cognitive domain of Bloom’s taxonomy from the first 10 chapters which explain the basic concepts of chemistry. The descriptive statistics evidently support above assumption.

The lowest mean scores (one-fourth of the total score of 18 marks, see table 19) for MCQs ($M=3.6$), blanks ($M=0.9$), and overall ($M=4.5$) indicate the failure of existing professional
teaching of chemistry at public secondary schools of District Jamshoro. The weakest scores at measurement of lower-cognitive skills of students raise strong questions toward higher-order thinking skills i.e. synthesis and evaluation. Gender does not seem to influence test-scores significantly; however, location does have effect in this regard. Urban students get significantly different and better mean scores ($M=4.7$) than their rural counterparts ($M=3.6$). Despite the difference in grade and subject these findings are in line with a study of Tayyaba (2012) who found that grade-four urban students of Sindh and Punjab excelled in getting better achievement scores in languages and social studies than their rural competitors. The present study extends her study to the natural sciences and students’ grade.

The document analysis (seniority list of the secondary school teachers of District Jamshoro, Sindh) reveals that all the teachers are professionally trained having B.Ed at least—though mostly possess M.Ed too. In this regard though this study has not examined the difference and effectiveness between professionally trained (having B.A/B.Sc. with B.Ed/M.Ed) and untrained secondary school teachers, yet it does confirm partly the findings of Khurshid (2008) who found that the trained teachers even accounted for students’ poorer performance than their untrained counterparts who only had B. A/ B. Sc. It calls for breakthrough in the areas of pre and in-service professional training programs, their curricula, and examination and assessment besides bringing major improvements in general appointment procedures of teachers, administration and management, and monitoring of teachers’ performance throughout.

5.3.3. Lesson Planning

The findings place lesson panning as the worst ever and the most neglected aspect of our professional teaching of chemistry, because no single student across gender, location (rural/urban), and type of school (boys-only, girls-only, co-education) responded positively
against the questions asking for written or mind planning on the part of teachers. They all opt for ‘no-planning’ except students of a girls-only school of urban school who report that their teacher have somewhat mind-plans for classroom teaching. Mean-scores of written-planning, mind-planning, no-planning, flexibility to alter planning on contingent situations, asking questions to check students’ previous learning, relating students’ previous learning to new topic, and balance between teacher’s and students’ activities show overall ‘disagreement’ (see Tables 13 and 19).

This is along the lines of the couple of findings from Sarwar and Hussain (2010) as mentioned in above sub-section, and a study from Gujjar, Bajwa, Shaheen, and Rehman (2011). The latter authors also found from 100 public secondary teachers that majority of teachers of Attok, Punjab (Pakistan) did not plan for their lessons due to lack of proper training during pre and in-service courses. The same worst situation prevails in our Sindh’s context across gender and location (rural and urban) strata.

5.3.4. Teaching Methods

Teaching methods play crucial role to bridge the gap between students and curricula. If teaching methods fully cater for the needs of learners and curricula then learners gain the targeted knowledge, intellect, and skills up to their individual capabilities otherwise it is impossible to do so. Therefore the teachers must use a variety of interesting and different and diverse teaching methods. Inquiry based teaching methods have their place in the teaching of sciences including chemistry. Literature review clearly indicates that lecture-demonstration (Watkar, 2012), laboratory based (Watkar, 2012), inquiry based (Hussain, Azeem, & Shakoor, 2011), project based (Hussain, Ahmed, Muben, & Tariq, 2011), picnic/field-trip (Filedia, 2012), discussion (Gall and Gillete, 2001), problem-solving (Akınoğlu & Tandoğan, 2007), and role-play (McSharry and Jones, 2000) work better than the lecture-based teaching of sciences.
Therefore, the present study assesses if and to what extent the existing teaching of chemistry incorporates above teaching methods. According to the students their teachers do not teach through laboratory experimentation, inquiry, project, picnic (field-trip), discussion, problem-solving, and role-play teaching methods. But dictation of questions and their answers and memorization of concepts through punishment remain the dominating teaching methods on the part of teachers, while maintaining ‘fair-note-books’ of the dictated content remain all the students’ learning. It is in line with a study conducted by Government of Pakistan (2007) in collaboration with UNICEF. They found that about 70% of the children were reported as being punished physically. However, a few teachers who are perceived as talented and hardworking, use lectures and explanations of the dictated questions and answers. Very few of them facilitate students with demonstrations and guided group lab-experiments. These finding openly cry for failure of professional teaching of chemistry, merit-based appointment of teachers, effective and efficient school administration, management, and monitoring along with failure of pre and in-service trainings, their curricula, examination, and their administration and management.

The most extraordinary finding of this study is that the lectures are not part of traditional teaching at District Jamshoro/Sindh, but the dictation of questions and answers by the teachers—known as ‘fair-note-book’ method, because the students usually write the content roughly in their ‘rough-note-books’ at school which they have to write in fair hand in ‘fair-note-books’ at their homes—is the most commonly, if not only, used teaching method for chemistry. Qualitative findings also confirmed this situation (see question/theme 1 at section 4.2.2.). Relatively better teaching methods exist at urban girls-only schools than all rural schools where dictation is the only teaching method (table 40).
Ghost (teachers available but either remain absent or do not take their classes) and incompetent teachers remain burning issues in our teaching and learning of chemistry across all strata. Some of the local volunteer teachers have been trying to overcome the teachers’ permanent absence or being ‘ghost’, and are successful in bringing positive learning outcomes among the learners at one of the rural girls-only schools of District Jamshoro. They are teaching English and social sciences. I was very happy to find that students of volunteer teachers were able to communicate in English. It calls for introduction of voluntary services of after-school tuition at the buildings of public secondary schools in collaboration with local school teachers and community members.

5.3.5. Audio Visual Aids

It is noteworthy to mention here that all students of public secondary schools agree that they receive a complete set of all prescribed textbooks in free of cost by the Sindh Government. Our public sector secondary school teachers (chemistry teachers) mostly do not frequently support their teaching with audio-visual aids. However, they depend on traditional use of blackboards and chalks and use them more frequently (often) than other teaching learning materials. The individual item-means for blackboard/chalks ($M=3.5$), charts ($M=1.6$), real things i.e. elements and compounds ($M=1.3$), models ($M=1.2$), projectors ($M=1.0$), and modern technological resources i.e. computer, multimedia and internet ($M=1.1$) reveal that our teachers almost never use real things, models, projectors, and computer, multimedia or internet. The item mean for charts ($M=1.6$) fall between never and seldom. The overall mean of audio-visual aids also shows the same picture ($M=1.6$) (see tables 15 and 19). Semi structured interviews also confirm this situation with additional insights that schools of rural areas are found in worse situation, where teachers even sometimes use blackboards and chalks. These findings totally
agree to that of Sarwar and Hussain (2010) who besides other things that are in consistent with present findings, revealed that the public secondary school teachers had been facing serious problems in proper usage of teaching aids. The present findings in this regard are more reliable because they are obtained from representative sample of proper size i.e. 350 students.

5.3.6. Students’ Classroom Activities and their Formative Assessment

Descriptive statistics in terms of item-wise mean scores for: reading from the textbooks \( (M=3.2) \), and copying down the questions and answers as whole-class activity \( (M=3.6) \), reveal relatively better situation, though cannot be called as proper activities by any means. The small group-work activities \( (M=1.3) \) and students presentations \( (M=1.9) \) are mostly ignored throughout all strata especially among students of rural areas (see tables 16 and 19). The overall mean-value for students’ classroom activities stand at \( (M=2.52) \), falling in between ‘seldom’ and ‘sometimes’ for above activities. It boldly disclose potential flaws in professional teaching and school administration, management, and routine monitoring.

With regard to students’ formative assessment the responses from 350 students show that our chemistry teachers depend mostly on verbal questions \( (M=3.3) \) which seems to tilt toward ‘sometimes’ if not ‘often’ on five-point Likert scale. While short quizzes or MCQ-test during classroom teaching, and detailed MCQ-test after completion of a chapter are simply missing. Their mean-scores \( (M=1.8 \text{ for both}) \) indicate alignment to ‘rarely’ if not ‘never’. Again, it boldly hints to the breakdown of professional teaching in this regard (see tables 17 and 19). Sarwar and Hussain (2010) also found impending issues of students’ active involvement and recapitulation in teaching and learning process. The students’ classroom activities and formative assessment are found more critical among the students of rural areas as confirmed by the qualitative findings (see table 42 and section 4.2.2 for qualitative analysis)
5.3.7. Course Coverage of Chemistry Theory and Practical

Item-wise mean-scores and overall means scores (see tables 18 and 19) confirm the qualitative data (see table 43 and themes 1 and 2 at section 4.2.2) categorically confirm that most teachers completes the first part (chapter 1 to 10) of theoretical textbook of chemistry; however, majority of students agree that their teacher do not touch the second part (chapter 11 to 18). It means that almost 50% of the theoretical part remain untouched. And the covered/taught curriculum only imply that the students copy-down the questions and answers dictated by the teachers throughout. The rural students are relatively more unfortunate to have even that kind of teaching and learning.

On the other hand, the coverage of practical component is almost missing, however students of couple of schools reveal students’ involvement either in the form of guided laboratory work in groups or even teachers’ demonstrations only. The students of a girls-only school where their female teacher facilitates students learning through guided laboratory work in groups, excel in getting highest marks in both MCQs and blanks of the achievement test administered as a part of students’ questionnaires. It proves that practical lab work plays pivotal role in teaching of chemistry and sciences.

Though Naseer-ul-Din, Iqbal, and Rehman (2010) revealed such professional blunders and failure of professional teaching of science teachers (teaching chemistry, physics, and biology) from relatively smaller sample (only 18 teachers of Punjab). They found that there was no issue of availability of textbooks yet classrooms were overcrowded, theory-ridden teaching prevailed with inadequate practical work, and either the science related teaching material and resources were unavailable or not used by the science teachers. Those findings are in complete harmony with present findings in all respects except a couple of deviations. This study found
that the issue of overcrowded classrooms is only at urban schools. Moreover, it disconfirms the inadequate science equipment and resources. The majority of students reveal in semi-structured interviews that there are no issues of science laboratories in our context (District Jamshoro, Sindh). The 75% of students agree that sufficient science material and equipment are available in their schools, however, the science equipment cupboards and laboratories remain locked for years as reported in present findings. For example a girl student points out, “Science almirahs/cupboards are full of equipment and material but always locked! We don’t know if they are for our use!” (personal communication, November 21, 2013).

Nevertheless, a few students report perceived shortage of science equipment and unavailability of science laboratories. Overall, this is plus point for our existing teaching of chemistry, but shockingly the students practical work is simply missing. It puts our existing teaching of chemistry significantly incomparable and ineffective than theirs. This situation openly points out crashed professional teaching of chemistry in Jamshoro and Sindh at large.

Present findings are in consistent with the findings of Dahar and Faize (2011) who found through step-wise linear regression that lack of practical work in chemistry, physics, and biology negatively influenced students learning. It led to isolated theory ridden teaching. Additionally they found that considerable number of teachers used science labs and material at the end of academic year for a few days while the majority did not even do so. Present study finds all this and confirms through multiple linear regression that four variables out of eight namely coverage of chemistry practical, teaching methods, audio-visual aids, and coverage of chemistry theory are strongly associated with students’ chemistry test-scores. They account for 41.7% variability in respondents’ test-scores in the context of Jamshoro, Sindh. Soomro (2009) also found in the context of Shikarpur, Sindh that students having little opportunity to perform laboratory
experimentation revealed relatively lower achievement in board’s exams while students having greater and better facilities of laboratory work got better marks in chemistry and other science subjects.

Lastly, the researcher finds a link between unfair means prevailing at Boards’ examinations (grade 9th and 10th) and improper teaching of chemistry. Cheating or copying, getting outside help to solve the exam questions, involving into impersonation (replacement of original student by someone else in the examination), solving question-paper at home, and approaching board’s officials/examinees during assessment to get higher marks/grades are forms of unfair means in Sindh’s context. Findings from the semi-structured interviews expose that majority of students blame their teachers for those unfair means in one or the other way. They believe that had their teachers taught them properly and effectively through proper learning material and laboratory work, then they could easily understand the prescribed curriculum and get through the examinations without involving in any unfair means.

5.4. Recommendations

On the basis of findings of this study the researchers found that our (Sindh’s) public secondary school teachers have nothing but paper-degrees of B.Ed./M.Ed. in the name of pre-service training and professional development. It is the time to put the derailed professional trainings back on track.

Therefore, I put forward the specific in-practice recommendations for related stakeholders:

5.4.1. Related to Professional Training Agencies

- The existing tutors/teachers in the context of Sindh who teach and train student teachers in their pre-service training especially B.Ed, are not competitive. Even there is no difference
between an ordinary teacher or even untrained teacher and a tutor of B.Ed. Therefore they fail to inculcate the required professional teaching knowledge, intellect, and skills among student teachers, even they demotivate them in this regard. Therefore the appointment criteria of tutors/teachers must be revised so that talented, hard-working, innovative, and experienced tutors could enter in the profession. They must be well-versed in the subject matter besides the ability and skill of translating the psychological and pedagogical content in to classroom situation. This can be done by getting services from National Testing Services (NTS) or provincial Public Service Commission to conduct related appointment examination/test for selection of eligible, competent, energetic, and innovative candidates.

- Provincial bureaus of curricula must take initiative to revise the curricula of B.Ed in terms of giving more importance to observation of model lesson planning and related teaching practice by the competent tutors/teachers. At least three model lesson plans must be included for each psychological construct (i.e. group work, think-pair-share, reinforcement etc) and pedagogical content i.e. lesson-planning, students’ active involvement, teaching methods, formative assessment etc. For sciences (chemistry, physics, biology) more model teaching and practice of lesson-planning on these teaching methods i.e. demonstration, guided lab-work, inquiry, discovery, problem-solving, two-way lecture, discussion etc must be included during pre-service teachers training (B.Ed).

- Existing examination system supports and assesses rote or memorized information at regular B.Ed/M.Ed at universities like university of Sindh. While the situation is worse for such off-campus programs of general universities and distance education universities where all unfair means (copying, impersonation, solving papers at home, out-side help etc) are common like boards’ examinations. Therefore, it should be changed to more
comprehensive assessment of the candidate teachers’ professional knowledge and skills through introducing more MCQs, and short-answer questions, in addition to subjective questions on framing comprehensive lesson plans on particular psychological or pedagogical construct. In this way rote practice can be reduced. Additionally, related help may be sought from local NGOs, rangers, and army officers for ensuring transparent conduct of both theoretical examination B.Ed/M.Ed and practice teaching (practical component) respectively.

5.4.2. Related to Teachers

- Appointment of school teachers especially secondary school teachers must be made only on merit through Provincial Public Service Commission examinations. There should be no political influence and quota system (i.e. employees’ quota, disabled quota, chief-minister quota etc).

- For uplifting professional competence among existing secondary school teachers it is suggested that a ‘general proficiency test’ may be introduced periodically (every 4th or 5th year) with a minimum percentage of 70% as passing criterion. The services of private sector universities and institutions or NTS may be hired to develop and conduct such test transparently. The test should comprise a mix of MCQs, short-answer questions, and conceptual or essay-type questions in the areas of lesson-planning, teaching methods, students’ active involvement activities, measures of formative assessment of students, and general professional teaching skills. All existing secondary school teachers must take the test and qualify it at least from maximum of three attempts. Failing to get through may put the concerned teacher a penalty of loss of one annual increment.
Similarly, there must be an incentive for talented and competitive teachers. The above proficiency test may be used for award of an allowance of Rs 1000-2000 per month for top standing 100 to 500 teachers on the merit list. It should be open for all competitors—falling behind the cut line may lose the earlier privileged award/allowance. It means that all teachers compete every time when the test is being administered. The government may provide required funding or alternately it could be developed through minor deduction in pay i.e. Rs 50 or 100 per month of teachers at provincial level. Even at local (school) level such amount in lump-sum may be given to professionally competent teacher once a year.

5.4.3. Related to School Administration and Management

- A new cadre of head-teachers or administrators be introduced with higher pay-scales (than subordinates) and benefits through provincial Public Service Commission.

- The researcher suggests at least two-week orientation training of head teachers on the basis of ‘downward filtration’ at district/tehsil level in the areas of lesson-planning, teaching methods, students’ active involvement activities, measures of formative assessment of students, and general professional teaching skills. Once the head-teachers are trained they are required to transmit the same to their teachers and bound them to follow during routine teaching. Private firms and individuals having doctoral degree in pedagogy or teaching may be invited to design proper module/resources.

- Since the present findings depicted the worst professional teaching of chemistry at rural schools due to ‘ghost’ teachers or teachers’ absenteeism. It calls for strict and more frequent monitoring of rural schools by related district officers (District Education Officers) and District Commissioners respectively.
The findings of this study through multi-factor linear regression pointed out moderately strong relation between students’ test-scores and home-study, after-school tuition hours, and poverty. Moreover, it points out that volunteer teachers are available and contributing to the best learning outcomes. Therefore, it is suggested that voluntary tuition services for poor and eager students be introduced at local school level in collaboration with local teachers and interested people. This voluntary after-school tuition may be given at the school buildings available in free of cost after school is over. Such certificates and appreciation be accorded by the district administration to the volunteer teachers.

5.4.4. Recommendations for Further Research

- This study out of eight professional teaching related predictors found that four predictors i.e. coverage of chemistry practical, teaching methods, audio-visual aids, and coverage of chemistry theory significantly predicted the students’ test-scores at p<.001. Due to mere absence of related data this study could not find association of left out four variables with the respondents’ test-scores i.e. students’ formative assessment, students’ classroom activities, lesson-planning, and general professional teaching skills. Therefore, I recommend a replicate study from a sample where the students and teachers actually involve in above areas to know whether there exists an association between respondents’ test-scores and those four predictors. It also would provide insights into different demographic predictors which this study failed to find their association with test-scores.
- This study examined professional teaching of chemistry from learners’ perspective, therefore, I suggest replicate studies involving teachers and head-teachers.
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APPENDICES
APPENDIX A

STUDENTS’ QUESTIONNAIRE

Dear Research Participant!

May you succeed in your aim of life!

I am a PhD student at Iqra University Karachi, and doing PhD in Education subject. I am conducting an evaluative study titled “An Evaluation of Teaching of Chemistry at Public Secondary Schools in Pakistan” to assess the quality of teaching and learning in the subject of chemistry at grade ninth.

The quality of teaching and learning in our country Pakistan is not as good as it should be. This study would bring a real picture of teaching and learning of chemistry at the above level from learners’ perspective and suggest the concerned stakeholders appropriate measures for improvement.

It is therefore requested to you to provide actual data through the questionnaire (attached herewith) by choosing the option that you think is the closest according to your perception and belief. I assure you that the names of students, teachers, and even the schools would not be disclosed at any cost to anybody or any stakeholder to safeguard your interests. I hope that you would provide the true reflecting data of existing teaching and learning in the interest of the better future teaching and learning.

I thank you for your precious time and cooperation.
Sincerely yours,

Muhammad Ilyas Bhutto
PhD student at Iqra University, Karachi

QUESTIONNAIRE (Demographic Data)

Kindly go through the items carefully and fill in the required information or tick the relevant field

- Your gender: Male ____, Female _____, Class __________
- Name of the School:____________________________
- Type of School: For boys only ____ , For girls only ____ , For both boys and girls _____
- Your school is located in: Town______or Village______
- Parents’ (father’s)/Guardian’s Education:__________________
- Parents’/Guardian’s Occupation:_______________________
- Parent’s/Guardian’s monthly income (Rs):__________________/-
- Do you study at home: Yes___ No____
- If yes, please specify how much time do you spend at home for your study ____________ (hours)
- Do you get after-school tuition: Yes___ No____
- If yes, please specify how much time do you spend for after-school tuition:_______(hours) daily
- Which subjects do you study during after-school tuition:____________________________
- Is chemistry one of your favourite subjects: Yes___ No____
- Your favourite subject(s):_________________________________________
Part I
Achievement Test (Chemistry Class IXth and Xth)
Attempt all questions of both sections.
Section (A) consists of 8 MCQs and encircle the most appropriate option’s alphabet—(a), (b), (c), or (d) while Section (B) contains 7 BLANKS to write appropriate word or term for each blank

Section A: Multiple choice questions MCQs:
1. _______________ is generally known as the father of Al-chemy (chemistry).
   a) Plato          b) Al-Razi           c) Robert Boyle         d) Jabir Ibne-Haiyan
2. The mass of one mole of a substance expressed in grams is called:
   a) Empirical formula   b) Molecular formula  c) Molecular mass   d) Molar mass
3. The nucleus of an atom consists of:
   a) Electrons & protons  b) Protons & neutrons  c) Electrons & neutrons   d) None of these
4. The only liquid metal is:
   a) Molybdenum       b) Gold              c) Mercury           d) Bromine
5. The bond which is formed by the transfer of one or more electrons from one to another atom is called:
   a) Ionic bond       b) Covalent bond      c) Coordinate covalent   d) chemical bond
6. The process in which molecules escape from the surface of a liquid is called:
   a) Sublimation      b) Evaporation      c) Boiling           d) Melting
7. Solubility is defined at the amount of solute in grams at a given temperature dissolved in _____ of the solvent.
   a) 10g or ml        b) 20g or ml       c) 100g or ml      d) 1000g or ml
8. _______________ is the process of electrolysis which is used to coat one metal onto another.
   a) Electrode  b) Electroplating  c) Nickel-plating   d) Electrocardiography
9. The substance having a tendency to lose one or more protons is called:
   a) Salt          b) Base             c) Acid            d) both (b) and (c)

Section B: BLANKS
10. Observation, hypothesis and experiments, theory, and scientific-law are components of _______________ method.
11. In 18 grams of H₂O (water) there are _______________ number of molecules.
12. _______________ are the atoms of the same element having same number of protons but different number of neutrons.
13. The repetition of properties after regular intervals in the periodic table is called _______________.
14. The force which holds atoms together in a molecule or crystal is called _______________.
15. The _______________ is the intermediate state between solid and gas.
16. A solution is a _______________ mixture of two or more substances.
17. The substance used for electrolysis is called _______________.
18. In an endothermic reaction, the container becomes _______________.

Observation, hypothesis and experiments, theory, and scientific-law are components of _______________ method.
**QUESTIONNAIRE**

Note: this questionnaire is related to the information related to your CHEMISTRY TEACHER.

Kindly go through the items carefully and tick the most appropriate option/column that fits the best according to your knowledge and belief

**Part II: General professional skills**

1=Strongly disagree, 2=Disagree, 3=Undecided (Neutral), 4=Agree, 5=Strongly agree

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Items/Statements</th>
<th>1 SD</th>
<th>2 D</th>
<th>3 N</th>
<th>4 A</th>
<th>5 SA</th>
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<tbody>
<tr>
<td>19</td>
<td>Your CHEMISTRY TEACHER:</td>
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<tr>
<td>20</td>
<td>Your teacher comes on time to take your class.</td>
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<tr>
<td>21</td>
<td>Your teacher’s voice is easily audible/understandable throughout the class.</td>
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<td>22</td>
<td>Your teacher’s hand-writing (on black/white board) is easily understandable.</td>
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<td>23</td>
<td>Your teacher has mastery on content knowledge/subject matter of chemistry textbook.</td>
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<tr>
<td>24</td>
<td>Your teacher knows/calls students with their names.</td>
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<tr>
<td>25</td>
<td>Your teacher gives clear directions for doing different activities/tasks (e.g. questions-answers; discussion; students’ individual work, group work, presentations etc)</td>
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<tr>
<td>26</td>
<td>Your teacher is fair to all students (respecting all with no discrimination or favoritism).</td>
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<tr>
<td>27</td>
<td>Your teacher caters for special needs of special (handicapped) learners .</td>
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<tr>
<td>28</td>
<td>Your teacher is always supports curiosity among learners to think “Why and how the things are like that?”</td>
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<tr>
<td>29</td>
<td>Your teacher has a good sense of humour.</td>
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<tr>
<td>30</td>
<td>Your teacher <strong>happily responds</strong> to your questions</td>
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</tbody>
</table>

**Part III (Lesson Planning)**

1=Strongly disagree, 2=Disagree, 3=Undecided (Neutral), 4=Agree, 5=Strongly agree

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Items/Statements</th>
<th>1 SD</th>
<th>2 D</th>
<th>3 N</th>
<th>4 A</th>
<th>5 SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>Your teacher has a written document that includes the objectives, process, activities, methods, techniques, and resources to be used or followed for classroom teaching.</td>
<td></td>
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<tr>
<td>32</td>
<td>Your teacher does not have a written document but surely has such a mind map because s/he follows organized and specific process, and uses different teaching methods, techniques, activities, and resources for each period/class.</td>
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<tr>
<td>33</td>
<td>Your teacher neither has a written document nor has a mind map for each class/period because he uses same teaching method and resources for every period/class.</td>
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<tr>
<td>34</td>
<td>Your teacher allows flexibility to alter the plan on the situational requirements.</td>
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<tr>
<td>35</td>
<td>Before coming to the topic, your teacher starts teaching by asking questions to check your previous knowledge and learning related to the new topic.</td>
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<tr>
<td>36</td>
<td>Before announcing topic your teacher relates students’ previous knowledge to new topic</td>
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<tr>
<td>37</td>
<td>Your teacher maintains balance between the time taken by him/her and students’ activities</td>
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</tbody>
</table>
### Part IV: Teaching methods, resources, activities

1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Items/Statements</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>38</td>
<td><strong>Teaching methods</strong></td>
<td></td>
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<tr>
<td></td>
<td>Your teacher mostly dictates/writes the textbook’s questions and answers verbally/on board and the class has to write it down (dictation/copying method).</td>
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<tr>
<td>39</td>
<td>Your teacher uses one-way lecture to teach the content with little opportunity for the class to participate or ask questions (one-way lecture method).</td>
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<td>40</td>
<td>Your teacher uses lectures by allowing frequent questions by both the teacher and the students (Two-way lecture method).</td>
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<td>41</td>
<td>Your teacher teaches you through practically showing/doing experiments before the class and explaining you how scientific principle works (demonstration method).</td>
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<td>42</td>
<td>Your teacher facilitates and guides you to learn through prescribed laboratory experimentation (laboratory method).</td>
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<tr>
<td>43</td>
<td>Your teacher facilitates you to explore the scientific phenomenon on your own while working in the laboratory or by asking specific questions under his/her supervision (inquiry method).</td>
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<tr>
<td>44</td>
<td>Your teacher teaches you how to deal with bigger projects and then divides class into groups. Each group is assigned specific part of the project or task to complete within a few days or weeks through cooperating within their group and with other groups so that a whole project gets completed (project method).</td>
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<td>45</td>
<td>Your teacher takes the class or a group to nearby factory/industry to show them how raw material is processed and certain chemical processes take place to produce certain chemicals (observation method).</td>
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<td>46</td>
<td>Your teacher holds a discussion on chemistry related concept with a manageable group of students where participants do not attack on others but patiently listens to others’ viewpoints and present their opinions in order to better understand the topic in hand by looking at it from different angles, the teacher or group leader controls and sums up the discussion fairly (discussion method).</td>
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<td>47</td>
<td>Your teacher introduces a course related problem and helps you to precisely understand and break down the problem and come up with a plan, then you follow your plan to solve the problem, finally the teacher evaluates your effort and findings (problem solving method)</td>
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<tr>
<td>48</td>
<td>Your teacher sometimes teaches certain chemistry related topics (kinetic theory, electrical currents, law of conservation of mass and energy, types of chemical reactions etc) through students’ role-plays (role-play method).</td>
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<td>49</td>
<td>Your teacher focuses on maintaining and memorizing fair-note-books as if it is the all teaching and learning at school (fair-note-book method).</td>
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<td>50</td>
<td>Your teacher <strong>often uses physical punishment</strong>: slapping, beating with a cane/stick etc when someone is not getting the point or understanding academic content.</td>
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<td></td>
<td><strong>Use of audio-visual aids</strong></td>
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<tr>
<td>51</td>
<td>Your teacher uses board and chalks/markers</td>
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<tr>
<td>52</td>
<td>Your teacher uses charts/diagrams.</td>
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<tr>
<td>53</td>
<td>Your teacher uses real things i.e. different elements, compounds and apparatuses.</td>
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<tr>
<td>54</td>
<td>Your teacher uses models of real things e.g. rod-and-ball models of atoms, molecules, bonding; electronic configuration etc.</td>
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</table>
### Part V: Formative Assessment

<table>
<thead>
<tr>
<th>Sr No.</th>
<th>Items/Statements</th>
<th>1</th>
<th>2</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>55</td>
<td>Your teacher uses projectors while teaching (a slide projector, over-head projector, opaque projector).</td>
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<tr>
<td>56</td>
<td>Your teacher uses modern information technology while teaching (computer, multimedia, internet).</td>
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<tr>
<td>57</td>
<td><strong>Activities</strong>&lt;br&gt; You do textbook-reading in the chemistry class.</td>
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<td>58</td>
<td>You do individual tasks during chemistry class.</td>
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<tr>
<td>59</td>
<td>You do group-work during chemistry class.</td>
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<td>60</td>
<td>You give presentations related to chemistry before the class.</td>
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</tbody>
</table>

### Part VI: Course Coverage

<table>
<thead>
<tr>
<th>Course Coverage of Theoretical part</th>
<th>1 0%</th>
<th>2 Up to 25%</th>
<th>3 Up to 50%</th>
<th>4 Up to 75%</th>
<th>5 Up to 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>i) <strong>Chemistry Theory</strong></td>
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<tr>
<td>65</td>
<td>Your teacher covers/will cover the part I (chapter 1 to 10) of the chemistry textbook.</td>
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<tr>
<td>66</td>
<td>Your teacher covers/will cover the part II (chapter 11 to 18) of the chemistry textbook.</td>
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<tr>
<td>67</td>
<td>Your teacher demonstrates the experiments included throughout the textbook.</td>
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<td>ii) <strong>Chemistry Practical Journal</strong></td>
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<tr>
<td>68</td>
<td>Your teacher demonstrates the experiments of Chemistry Practical Journal</td>
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<td>69</td>
<td>You do experiments of Chemistry Practical Journal individually in laboratory under your teacher’s supervision.</td>
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<tr>
<td>70</td>
<td>You do experiments of Chemistry Practical Journal in groups, in laboratory under your teacher’s supervision.</td>
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</table>
APPENDIX B

PERMISSION LETTER FROM IQRA UNIVERSITY

September 12th, 2013

The Director Schools,
Region Hyderabad.

This is to certify that Mr. Muhammad Ilyas Bhutto bearing registration number 022-07-12096 is a bona-fide student of Ph.D offered at IqraUniversity.

To Pursue his research work Mr. Muhammad Ilyas Bhutto requires primary data from grade IX & X class student. You are requested to please facilitate Mr Ilyas Bhutto.

Imtiaz Arif
Director Academics
APPENDIX C

PERMISSION LETTER FROM DIRECTORATE OF SCHOOL EDUCATION

DIRECTORATE OF SCHOOL EDUCATION
HYDERABAD REGION HYDERABAD

No. AO (B&A) / 870, 2013 Hyderabad

Forwarded to the HMs of district Jamshoro that bearer of this letter Mr. Mohammed Ilyas Bhutto is research fellow and he needs some data regarding teachers, students and head teachers for his research purpose. You are requested to facilitate and cooperate him in his educational research endeavor.

Mohammed Akber Memon
Deputy Director

DEPUTY DIRECTOR (FINANCE)
Directorate of School Education
HYDERABAD.
APPENDIX D

HISTOGRAMS OF MULTIPLE LINEAR REGRESSION

General Professional Skills

Five point Likert Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Average Lesson Planning

Five point Likert Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree
EVALUATION OF TEACHING OF CHEMISTRY

Teaching Methods

(Five point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

Audio Visual Aids

(Five point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)
EVALUATION OF TEACHING OF CHEMISTRY

Activities

(Five point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)

Formative Assessment

(Five point Likert Scale: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always)
EVALUATION OF TEACHING OF CHEMISTRY

Chemistry Theory

(Five point Likert Scale: 1=0%, 2=Up to 25%, 3=Up to 50%, 4=Up to 75%, 5=Up to 100%)

Chemistry Practical

(Five point Likert Scale: 1=0%, 2=Up to 25%, 3=Up to 50%, 4=Up to 75%, 5=Up to 100%)
EVALUATION OF TEACHING OF CHEMISTRY

(9 items of MCQs= 9 total marks)

(9 items of Blanks= 9 total marks)
EVALUATION OF TEACHING OF CHEMISTRY

Overall Marks

(18 items of the Test= 18 total marks)