Science and Mathematics Education Centre

Teaching and Learning about Acids and Bases in Malaysian Urban and Rural Secondary Schools

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

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Date: 10 JUNE 2013

ABSTRACT

This study investigated the extent to which acids and bases lessons that had been conducted in seven urban and rural schools met the Malaysian secondary school Chemistry curriculum intentions. The present study is distinctive as it is one of the few curriculum evaluation studies that have been conducted to assess the effectiveness of chemistry lessons against the Chemistry curriculum in Malaysia. The motivation to conduct this study was initiated from many reports around the world that described the successes and failures of science lessons to fulfil the intended curriculum – thus, whether or not the chemistry lessons in Malaysian classrooms had realised the Chemistry curriculum intentions was a question. The acids and bases topic was chosen as focus of investigation based on emerging issues about the students' achievements about this topic.

Using the research framework of *intended*, *implemented*, *perceived* and *achieved* curricula, five research questions were generated to guide this study: (1) What are the intentions of the Chemistry curriculum in terms of teaching and learning? (2) How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? (3) What are the urban and rural chemistry students' perceptions about their acids and bases lessons? (4) To what extent are the outcomes from the acids and bases lessons in urban and rural schools different? (5) What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?

This study used the case study as research design. The data were predominantly quantitative and were provided by chemistry teachers and students from urban and rural schools around Melaka Tengah district. Analysis of the Chemistry curriculum official documents and an interview with a representative from the Curriculum Development Division provided insight to answer the first research question. The subsequent research questions were addressed using various instruments: Questionnaire of Enacted Curriculum (responded by 9 teachers and 354 students); modified version of the What Is Happening In This Class? (responded by 260 students); modified version of the Attitude Towards Chemistry Lessons Scales

(responded by 260 students); and Acids-Bases Chemistry Achievement Test (responded by 304 students). The final research question was answered by analysing data given by 247 students who had responded to all instruments. The analysis of their responses resulted in 36 findings. All the instruments used in this study had been assessed in terms of being valid and reliable.

For the first research question the intensions of Chemistry curriculum were that students (1) can attain the intended learning outcomes after the chemistry lessons; (2) have interest to learn chemistry after the lessons; (3) are presented with lessons using thoughtful teaching; and (4) are provided with an experiential learning environment during the lessons. These four intentions of the Chemistry curriculum were successfully identified to varying degrees by both urban and rural students.

In addressing the second research question, the results suggested that there were no differences between the QEC scale means for *Make Connections, Active Learning* and *Use of Laboratory Activities* during acids and bases lessons for both the urban and rural teachers. Nonetheless, the urban chemistry teachers indicated that they were less frequently involved than the rural teachers in the *Use of Traditional Teaching Practices* and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*, but the urban chemistry teachers claimed to have carried out activities related to the *Analyse Information* scale more frequently than the rural chemistry teachers did.

In addressing the third research question, the results suggested that the urban chemistry students preferred less *Investigation* and *Cooperation* than what they actually perceived during the acids and bases lessons whilst feeling satisfied with the level of *Teacher Support*, *Involvement* and *Equity* that they had experienced. On the other hand, the rural chemistry students indicated that they were satisfied with all the scales of the acids and bases learning environment (*Teacher Support*, *Involvement, Investigation, Cooperation* and *Equity*) that they had experienced.

In addressing the fourth research question, two types of findings were presented. For the students' non-cognitive outcomes, the attitudes that the urban chemistry students had developed towards the acids and bases lessons were more positive than what they had desired. Meanwhile, the rural students felt that the attitudes that they had developed during the acids and bases lessons were similar to what they had desired except that they had developed more positive attitudes towards *Liking for Acids-Bases Chemistry Theory Lessons* than what they had desired. In the case of students' cognitive outcomes, both urban and rural students had achieved similar results in the ABCAT after the acids and bases lessons. They had also achieved large improvements in the post-test of the ABCAT over their results in the pre-test.

In addressing the final research question, the findings indicated that the urban chemistry students' achievements in the acids and bases lessons were influenced by their views of the lessons instruction, their perceptions of the learning environment, and their attitudes towards the lessons. Meanwhile, the rural students' achievements in acids and bases lessons were not influenced by any of these factors.

The researcher recommends that future studies should include qualitative methods in order to acquire in-depth understanding of the quantitative results that have been obtained. It is also recommended that larger samples of teachers and rural students be included so that the results are more robust. It is hoped that the findings of this study will benefit all the stakeholders especially curriculum developers, chemistry teachers, and other researchers who are involved in the implementation of acids and bases lessons of the secondary school Chemistry curriculum in Malaysia.

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TABLE OF CONTENTS

DECLARATION	**ii**
ABSTRACT	**iii**
ACKNOWLEDGEMENTS	**vi**
TABLE OF CONTENTS	**vii**
LIST OF TABLES	**xv**
LIST OF FIGURES	**xx**
LIST OF ABBREVIATIONS	**xxiii**
CHAPTER 1 | INTRODUCTION TO THE RESEARCH STUDY	**1**
1.1 Introduction	1
1.2 Background to the Study	1
1.3 The Origin of The Chemistry Curriculum for Secondary School in Malaysia	2
1.4 General Information about Secondary School Chemistry Curriculum	4
1.5 The Status of Chemistry in Malaysian Schools	6
1.5.1 The state of the Chemistry curriculum	6
1.5.2 The state of chemistry teachers	7
1.5.3 The state of students in chemistry	8
1.6 Issues of Teaching and Learning in the Acids and Bases Topic	9
1.7 Rationale of Study	10
1.8 Research Objectives and Research Questions	12
1.9 Significance of the Study	13
1.10 Limitations	13
1.11 Overview of the Thesis	14
1.12 Conclusion	16
CHAPTER 2 | LITERATURE REVIEW	**17**
2.1 Introduction	17

2.2 Theoretical Framework of the Research Study 17
2.2.1 The curriculum domains 17
2.2.2 Adoption, adaption and expansion of curriculum domains 20
2.2.3 Application of curriculum domains in this study 24
2.3 Conceptualisation of Curriculum Evaluation Research 26
2.3.1 Overview of educational evaluation research history 26
2.3.2 Definition and purpose of curriculum evaluation 28
2.3.3 Scope of evaluation 29
2.3.4 Application of curriculum evaluation conceptualisation in this study 31
2.4 Overview of Curriculum Evaluation Research 31
2.4.1 Addressing intentions in curriculum evaluation 31
2.4.2 Addressing implementation in curriculum evaluation 33
2.4.3 Addressing students' perceptions in curriculum evaluation 34
2.4.4 Addressing student outcomes in curriculum evaluation 36
2.4.5 Application of curriculum evaluation components in this study 38
2.5 Previous Research of Curriculum Evaluation in Chemistry and Other Science Subjects 40
2.5.1 Chemistry subject 40
2.5.2 Other science subjects 42
2.6 Conclusion 44

CHAPTER 3 | METHODOLOGY 49
3.1 Introduction 49
3.2 Research Process 49
3.3 Case Study as Research Design 51
3.3.1 Justification on the choice of case study 51
3.3.2 The nature of case study 54
3.3.3 Application of a case study design in this research 55
3.4 Data Sources and a Bounded System 57
3.5 Methods 60
3.5.1 Interviews 61
3.5.2 Questionnaires 62
3.6 Research Questions and Data Collection 64

3.6.1 What are the intentions of the Chemistry curriculum in terms of teaching and learning? 65
3.6.2 How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? 66
3.6.3 What are the urban and rural chemistry students' perceptions about their acids and bases lessons? 68
3.6.4 To what extent are the outcomes from the acids and bases lessons in urban and rural schools different? 69
3.6.5 What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes? 70
3.7 Chronology of Data Collection 70
3.8 Conclusion 71

CHAPTER 4 | DEVELOPMENT OF QUESTIONNAIRES 73
4.1 Introduction 73
4.2 Selected Scales from the Original Sources 73
4.3 Questionnaire of Enacted Curriculum (QEC) 74
4.4 Modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) 78
4.5 Modified version of the What Is Happening In This Class? (WIHIC) 79
4.6 Translation Process of the Modified Version of the ATCLS and the Modified Version of the WIHIC 81
4.7 Trial and Refinement of the Modified Version of the ATCLS and the Modified Version of the WIHIC 82
4.8 Conclusion 84

CHAPTER 5 | DEVELOPMENT OF THE ACHIEVEMENT TEST 85
5.1 Introduction 85
5.2 The Framework of Acids-Bases Chemistry Achievement Test (ABCAT) 85
5.3 The Initial Version 86
5.3.1 Item construction 86
5.3.2 Pilot test of the initial version 90
5.3.3 Analysis of responses and discussion 91

5.4 The Amended Version 92
5.4.1 Item construction 92
5.4.2 Pilot test of the amended version 99
5.4.3 Analysis of responses and discussion 100
5.5 Challenges During the Development Test Items 103
5.6 Conclusion 104

CHAPTER 6 | THE INTENDED CURRICULUM 106
6.1 Introduction 106
6.2 Findings from the Secondary School Chemistry Curriculum 106
6.2.1 The intended impact 106
6.2.2 The intended process 109
6.3 Discussion 116
6.4 Conclusion 120

CHAPTER 7 | THE IMPLEMENTED CURRICULUM 122
7.1 Introduction 122
7.2 Findings from the Teacher Edition of the Questionnaire of the Enacted Curriculum (QEC) 122
7.2.1 Combined results for urban and rural teachers 122
7.2.2 The results for the urban teachers 124
7.2.3 The results for the rural teachers 126
7.2.4 Comparison of results between urban and rural teachers 127
7.3 Findings from the Student Edition of the Questionnaire of Enacted Curriculum (QEC) 129
7.3.1 Combined results for urban and rural students 129
7.3.2 The results for the urban students 132
7.3.3 The results for the rural students 134
7.3.4 Comparison of results between urban and rural students 136
7.4 Discussion 138
7.5 Conclusion 143

CHAPTER 8 | THE PERCEIVED CURRICULUM 144
8.1 Introduction 144

8.2 Findings from the Modified Version of the What is Happening in This Class? (WIHIC) 144
8.2.1 Combined results for urban and rural students 144
8.2.2 The results for the urban students 151
8.2.3 The results for the rural students 155
8.2.4 Comparison of results between urban and rural students 158
8.3 Discussion 160
8.4 Conclusion 162

CHAPTER 9 | THE ACHIEVED CURRICULUM 163
9.1 Introduction 163
9.2 Findings from the Modified Version of the Attitude Towards Chemistry Lesson Scales (ATCLS) 163
9.2.1 Combined results for urban and rural students 163
9.2.2 The results for the urban students 169
9.2.3 The results for the rural students 171
9.2.4 Comparison of results between urban and rural students 174
9.3 Findings from the Acids-Bases Chemistry Achievement Test (ABCAT) 176
9.3.1 Combined results for urban and rural students 177
9.3.2 The results for the urban students 180
9.3.3 The results for the rural students 181
9.3.4 Comparison of results between urban and rural students 182
9.4 Discussion 184
9.4.1 Non-cognitive outcomes 184
9.4.2 Cognitive outcomes 186
9.5 Conclusion 188

CHAPTER 10 | ASSOCIATIONS BETWEEN LESSON INSTRUCTIONS, LEARNING ENVIRONMENT, AND ATTITUDES TOWARDS ACHIEVEMENTS IN ACIDS AND BASES LESSONS 189
10.1 Introduction 189
10.2 Findings from the association between the Student Edition of the Questionnaire of Enacted Curriculum (QEC), the Actual Form of the Modified Version of the Attitudes Towards Chemistry Lessons Scales (ATCLS), and the

Actual Form of the Modified Version of the What Is Happening in This Class? (WIHIC) on the Total Post-test Score of the Acids-Bases Chemistry Achievement Test (ABCAT). 189

10.2.1 Combined results for urban and rural students 189

10.2.2 The results for the urban students 193

10.2.3 The results for the rural students 195

10.3 Discussion 197

10.4 Conclusion 199

CHAPTER 11 | SUMMARY AND CONCLUSION 200

11.1 Introduction 200

11.2 Summary of Thesis 200

11.3 Findings of the Study 207

11.3.1 Research Question #1 - What are the intentions of the Chemistry curriculum in terms of teaching and learning? 207

11.3.2 Research Question #2 - How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? 207

11.3.3 Research Question #3 - What are the urban and rural chemistry students' perceptions about their acids and bases lessons? 209

11.3.4 Research Question #4 - To what extent are the outcomes from the acids and bases lessons in urban and rural schools different? 211

11.3.5 Research Question #5 - What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes? 214

11.4 Implications of the Study 215

11.4.1 Implications of the study for research 215

11.4.2 Implications of the study for teaching 216

11.5 Limitations of the Study 217

11.5.1 Instrument development time 218

11.5.2 Emphasis on quantitative data 219

11.5.3 Access to schools 219

11.5.4 Student and teacher responses 220

11.6 Recommendations for Further Research 221

11.7 Conclusion 223

REFERENCES **225**

APPENDICES (INSIDE CD-ROM)

APPENDIX A: Format of the Semi-Structured Interview with the CDD's Representative 240

APPENDIX B: Interview Transcript with the CDD's Representative 242

APPENDIX C: Questionnaire of Enacted Curriculum (QEC) – *Teacher Edition* 246

APPENDIX D: Questionnaire of Enacted Curriculum (QEC) – *Student Edition* 254

APPENDIX E: Modified of the What Is Happening In This Class? (WIHIC) – *Actual Form* 261

APPENDIX F: Modified of the What Is Happening In This Class? (WIHIC) – *Preferred Form* 269

APPENDIX G: Modified of the Attitude Towards Chemistry Lessons Scales (ATCLS) – *Actual Form* 277

APPENDIX H: Modified of the Attitude Towards Chemistry Lessons Scales (ATCLS) – *Preferred Form* 282

APPENDIX I: Acids-Bases Achievement Test (ABCAT) – *Create Multiple-Choice Items with Free Responses of the Initial Version (English)* 287

APPENDIX J: Acids-Bases Achievement Test (ABCAT) – *Create Multiple-Choice Items with Free Responses of the Initial Version (Malay)* 292

APPENDIX K: Acids-Bases Achievement Test (ABCAT) – *Pilot Test of the Initial Version (English)* 297

APPENDIX L: Acids-Bases Achievement Test (ABCAT) – *Pilot Test of the Initial Version (Malay)* 304

APPENDIX M: Acids-Bases Achievement Test (ABCAT) – *Create Multiple-Choice Items with Free Responses of the Amended Version (Bilingual)* 311

APPENDIX N: Acids-Bases Achievement Test (ABCAT) – *Developing Second Tiers Distracters of the Amended Version (Bilingual)* 326

APPENDIX O: Acids-Bases Achievement Test (ABCAT) – *Pilot Test of the Amended Version (Bilingual)* 334

APPENDIX P: Acids-Bases Achievement Test (ABCAT) – *Pre-Test of the Amended Version* (*Bilingual)* 353

APPENDIX Q: Acids-Bases Achievement Test (ABCAT) – *Post-Test of the Amended Version (Bilingual)* 371

APPENDIX R: Result of the Factor Analysis of the Student Edition of the QEC 389

LIST OF TABLES

Table 1.1 Chemistry topics covered in Form 4 and Form 5.. 5

Table 3.1 The features of experimental and non-experimental research design as described by Merriam (1988)... 51

Table 3.2 Research questions, methods, and data sources used in this research. 65

Table 3.3 Example of two participated chemistry teachers' timetables.................... 67

Table 4.1 Selected scales from the existing questionnaires. 74

Table 4.2 Original and modified instructions in the teacher and student editions of the QEC.. 75

Table 4.3 Description about the QEC scales (in Section B of the teacher and student editions of the questionnaire)... 76

Table 4.4 Description about the modified version of the ATCLS scales.................. 79

Table 4.5 Description about the modified version of the WIHIC scales. 80

Table 4.6 Cronbach's alpha coefficients for the modified version of the ATCLS. ... 83

Table 4.7 Cronbach's alpha coefficients for the modified version of the WIHIC..... 83

Table 5.1 Distribution of the initial version items across the content areas. 90

Table 5.2 The results for the initial version of the ABCAT. 91

Table 5.3 Distribution of the amended version items across the cognitive learning outcomes. 93

Table 5.4 Coverage of the amended version item in terms of Bloom's taxonomy.... 94

Table 5.5 The results for the amended version of the ABCAT. 100

Table 5.6 Items arrangement for the pre-test and the post-test............................... 103

Table 6.1 Acids and bases lesson learning objectives and cognitive learning outcomes. 108

Table 6.2 Specific learning activities suggested for acids and bases topic............. 112

Table 7.1 Average item means for the teacher edition of the QEC for the combination of urban and rural chemistry teachers (N = 9). 123

Table 7.2 Average item means for the teacher edition of the QEC for urban chemistry teachers only (N = 7).. 125

Table 7.3 Average item means for the teacher edition of the QEC for rural chemistry teachers only (N = 2).. 126

Table 7.4 Average item means for the teacher edition of the QEC for urban and rural chemistry teachers ($N_{urban\ teachers} = 7$; $N_{rural\ teachers} = 2$). 127

Table 7.5 Cronbach's alpha coefficients of each scale for the student edition of the QEC for the combination of urban and rural chemistry students (N = 354)........... 129

Table 7.6 Item-scale correlation coefficients of the student edition of the QEC for the combination of urban and rural chemistry students (N = 354). 130

Table 7.7 Average item means, scale means, and standard deviations for the student edition of the QEC for the combination of urban and rural chemistry students (N = 354). 131

Table 7.8 Cronbach's alpha coefficients of each scale for the student edition of the QEC for urban chemistry students only (N = 254). 132

Table 7.9 Average item means, scale means and standard deviations for the student edition of the QEC for urban chemistry students only (N = 254).......................... 133

Table 7.10 Cronbach's alpha coefficients of each scale for the student edition of the QEC for rural chemistry students only (N = 100).. 135

Table 7.11 Average item means, scale means and standard deviations for the student edition of the QEC for rural chemistry students only (N = 100). 135

Table 7.12 Average item means, scale means, standard deviations, effect sizes and *t* values for the student edition of the QEC for urban and rural chemistry students ($N_{urban\ students} = 254$; $N_{rural\ students} = 100$). 137

Table 8.1 Factor loadings for five scales of the modified version of the WIHIC using the individual student as the unit of analysis for the combination of urban and rural chemistry students (N = 260). 146

Table 8.2 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260). 147

Table 8.3 Item-scale correlation coefficients of the actual form of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260). 148

Table 8.4 Item-scale correlation coefficients of the preferred form of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260). 148

Table 8.5 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260). 149

Table 8.6 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the WIHIC for urban chemistry students only (N = 211). 152

Table 8.7 Average item means, scales means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for urban chemistry students only (N = 211). 152

Table 8.8 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the WIHIC for rural chemistry students only (N = 49). 155

Table 8.9 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for rural chemistry students only (N = 49). 156

Table 8.10 Average item means, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for urban and rural chemistry students ($N_{\text{urban students}}$ = 211; $N_{\text{rural students}}$ = 49). 158

Table 9.1 Factor loadings for three scales of the modified version of the ATCLS using the individual student as the unit of analysis for the combination of urban and rural chemistry students (N = 260). 164

Table 9.2 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260). 165

Table 9.3 Item-scale correlation coefficients of the actual form of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260). 166

Table 9.4 Item-scale correlation coefficients of the preferred form of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260). 166

Table 9.5 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260). 167

Table 9.6 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the ATCLS for urban chemistry students only (N = 211). 169

Table 9.7 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for urban chemistry students only (N = 211). 170

Table 9.8 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the ATCLS for rural chemistry students only (N = 49). 172

Table 9.9 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for rural chemistry students only (N = 49). 172

Table 9.10 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for urban and rural chemistry students ($N_{urban\ students}$ = 211; $N_{rural\ students}$ = 49). 175

Table 9.11 The characteristics of ABCAT (N = 304). 178

Table 9.12 Total mean score, standard deviation, effect size and t-test result between pre-test and post-test of the ABCAT for the combination of urban and rural chemistry students (N = 304). 180

Table 9.13 Total mean score, standard deviation, effect size and t-test result between pre-test and post-test of the ABCAT for urban chemistry students only (N = 240). 181

Table 9.14 Total mean score, standard deviation, effect size and t-test result between the pre-test and the post-test of the ABCAT for rural chemistry students only (N = 64). 181

Table 9.15 Total mean score, standard deviation, effect size and t-test result for the pre-test and post-test of the ABCAT for urban and rural chemistry students ($N_{urban\ students}$ = 240; $N_{rural\ students}$ = 64). 182

Table 9.16 Analysis of Covariance (ANCOVA) to compare the effectiveness of acids and bases lesson between urban and rural chemistry students by keeping the pre-test as covariate ($N_{urban\ students}$ = 240; $N_{rural\ students}$ = 64). 183

Table 10.1 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and the total post-test score in the ABCAT for the combination of urban and rural chemistry students (N = 247).. 191

Table 10.2 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and the total post-test score on the ABCAT for urban chemistry students only (N = 199)... 193

Table 10.3 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and total post-test score on the ABCAT for rural chemistry students only (N = 48)... 196

LIST OF FIGURES

Figure 2.1 Relation between Tyler's rationales with the four processes proposed by Kliebard [From Marsh and Stafford (1992, p.6)]. 18

Figure 2.2 Model of theoretical framework for this study. 25

Figure 2.3 Curriculum development model with all feedback lines [From Oliva (2009, p.411)]. 29

Figure 2.4 Relationship between curriculum sub-model and instructional sub-model [From Oliva's (2009, p. 9) concentric model of relationship between curriculum and instructional]. 30

Figure 2.5 Conceptual model of curriculum evaluation for this study. 39

Figure 3.1 General research process [From Anderson and Arsenault (2004, p.28)]. 49

Figure 3.2 Teachers' views concerning the emphasization of Chemistry curriculum issues during their professional development activities. 58

Figure 3.3 Number of urban and rural students who obtained grades A to D in PMR science result. 59

Figure 3.4 Students' perspectives regarding the medium of instruction during chemistry lessons. 60

Figure 3.5 Chronology of the data collection. 71

Figure 5.1 Example of the multiple-choice items with free responses from the initial version (English translation). 87

Figure 5.2 Example of multiple-choice items from the Section A (single tier) and Section B (free response) of the amended version. 95

Figure 7.1 Average item means of the scales in the teacher edition of the QEC for the combination of urban and rural chemistry teachers (N = 9). 124

Figure 7.2 Average item means of the scales in the teacher edition of the QEC for the urban chemistry teachers (N = 7). 125

Figure 7.3 Average item means of the scales in the teacher edition of the QEC for the rural chemistry teachers (N = 2). 126

Figure 7.4 Comparison of the item means obtained per scale from the teacher edition of the QEC for urban and rural chemistry teachers ($N_{urban\ teachers} = 7$; $N_{rural\ teachers} = 2$). 128

Figure 7.5 Average item means of the scales in the student edition of the QEC for the combination of urban and rural chemistry students (N = 354). 131

Figure 7.6 Average item means of the scales in the student edition of the QEC for the urban chemistry students (N = 254). 134

Figure 7.7 Average item means of the scales in the student edition of the QEC for the rural chemistry students (N = 100). 136

Figure 7.8 Comparison of the item means obtained per scale from the student edition of the QEC for urban and rural chemistry students ($N_{urban\ students} = 254$; $N_{rural\ students} = 100$). 137

Figure 8.1 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260). 151

Figure 8.2 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the WIHIC for the urban chemistry students (N = 211). 154

Figure 8.3 Comparison of average item means of scales in the actual and preferred forms of the modified version of the WIHIC for the rural chemistry students (N = 49). 157

Figure 8.4 Comparison of the item means obtained per scale from the modified version of the WIHIC for urban (actual), urban (preferred), rural (actual), and rural (preferred) chemistry students ($N_{urban\ students} = 211$; $N_{rural\ students} = 49$). 159

Figure 9.1 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260). 168

Figure 9.2 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the ATCLS for the urban chemistry students (N = 211). 171

Figure 9.3 Comparison of average item means of scales in the actual and preferred forms of the modified version of the ATCLS for the rural chemistry students (N = 49). 174

Figure 9.4 Comparison of the item means obtained per scale from the modified version of the ATCLS for urban (actual), urban (preferred), rural (actual), and rural (preferred) chemistry students ($N_{urban\ students} = 211$; $N_{rural\ students} = 49$)...................... 176

LIST OF ABBREVIATIONS

CDC	Curriculum Development Centre
CDD	Curriculum Development Division
MOE	Ministry of Education Malaysia
MOSTI	Ministry of Science, Technology and Innovation Malaysia
EPRD	Educational Planning and Research Division
DTCPPM	Department of Town and Country Planning Peninsular Malaysia
STPII	Second National Science and Technology Policy
PPSMI	Teaching and Learning of Science and Mathematics in English [*Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris*]
NSEP	National Science Education Philosophy
KBSM	Integrated Curriculum for Secondary School [*Kurikulum Bersepadu Sekolah Menengah*]
KBSR	Integrated Curriculum for Primary School [*Kurikulum Bersepadu Sekolah Rendah*]
KSSM	Standard Curriculum for Secondary School [*Standard Curriculum for Secondary School*]
PMR	Lower Secondary Assessment [*Penilaian Menengah Rendah*]
SPM	Malaysian Education Certificate [*Sijil Pelajaran Malaysia*]
QEC	Questionnaire of Enacted Curriculum
WIHIC	What Is Happening In This Class?
ATCLS	Attitude Towards Chemistry Lessons Scales
ABCAT	Acids-Bases Chemistry Achievement Test

CHAPTER 1 | INTRODUCTION TO THE RESEARCH STUDY

1.1 Introduction

This study was designed to investigate the extent to which lessons on acids and bases delivered in urban and rural chemistry classrooms had met the intentions of the Chemistry curriculum. In this chapter, the background of the study (Section 1.2), the origin of the Chemistry curriculum for secondary schools in Malaysia (Section 1.3), and the course structure of the secondary school Chemistry curriculum (Section 1.4) are reviewed. The status of the Chemistry curriculum, chemistry teachers, and students' achievement in chemistry in Malaysia (Section 1.5) are described followed by the issues related to teaching and learning of acids and bases topics (Section 1.6) and the rationale for this study (Section 1.7). The research objective and research questions are described (Section 1.8) followed by the significance (Section 1.9) and limitations of this study (Section 1.10). The final section provides an overview of the chapters that comprise the thesis (Section 1.11).

1.2 Background to the Study

As part of the strategies toward realising Malaysia's vision to become an industrialised country by the year 2020 (Sarji, 1997), the government has given greater emphasis for developments in the field of science and technology. Consequently, the Malaysian government has listed nine challenges that should be embarked upon by the community as a whole. One of these challenges, known as the Sixth Challenge, is establishing a scientific and progressive society (Sarji, 1997). This challenge aims to produce innovative and visionary Malaysians who not only become the consumers of science but also are capable to contribute towards the enlightenment of future science knowledge. In order to address this challenge, the Malaysian strategic plans, from the Sixth Malaysia Plan (1990-1995) to the Tenth Malaysia Plan (2011-2015), have concentrated on the developments of various branches of science.

The Ministry of Science, Technology and Innovation Malaysia (MOSTI) has been given the autonomy to carry out this mission through the Second National Science and Technology Policy (STPII). The STPII highlights seven key priority areas (Din & Krishna, 2007): (1) Strengthening research and technological capacity and capability; (2) Promoting commercialisation of research outputs; (3) Developing human resource capacity and capability; (4) Promoting a culture for science, innovation and techno- entrepreneurship; (5) Strengthening institutional frameworks and management for science and technology and monitoring science and technology policy implementation; (6) Ensure widespread diffusion and application of technology, leading to enhanced market-driven R&D to adapt and improve technologies; and (7) Build competence for specialisation in key emerging technologies. It is within the third and fourth key areas that special attention is given to science education in Malaysia.

The involvement of the Ministry of Education Malaysia (MOE) plays an important role to support this agenda through the formulation of the Science and Technology Education Policy that synchronized with the third and fourth key areas of STPII. This educational policy influences the formation of curriculum, pedagogy, assessment, teachers training, facilities, and resources related to science education. In conjunction, a series of planning, formulation and execution of the new school science curriculum has been carried out at the ministry, state and district levels, led by one of the MOE agencies, namely the Curriculum Development Division (CDD), or formerly known as Curriculum Development Centre (CDC) before 2008 (*World data on education. 7th edition, 2010/11*, 2011). This includes the formation of the Integrated Curriculum for Secondary School (KBSM) which is the foundation system for all science subjects in secondary schools including chemistry (Boon, 2008).

1.3 The Origin of The Chemistry Curriculum for Secondary School in Malaysia

The science curriculum was first introduced in 1823 with the establishment of the Raffles Institution in Singapore, which at that time was part of Malaysia (formerly known as Malaya prior to 1963). The pioneer subjects taught were astronomy, mechanics, and basic botany using the syllabuses, textbooks and resources from

England. It is crucial to note that during this period, Malaysia was governed by the British. Under the colonial power, science education was exclusive to upper secondary students from elite classes, mainly families of royalty, Malay rulers, and British officers (Lee, 1992).

The first science curriculum reform occurred when Frederick Daniel, a well-known Science Master, designed a four-year general science course in 1930 that was open to all Malaysian secondary school students. The new science curriculum had gained overwhelming popularity among the schools due to its content being suitable to the local surroundings and was written using comprehensible English language (Min, 1999).

Within a decade after gaining independence from the British in 1957, the newly developed Malaysian government had concentrated attention toward eradicating poverty and redressing the economic imbalance among races (Malays, Chinese, Indian and others). Therefore, a huge amount of resources was channelled towards improvement of science education which was seen as one of the sectors that was potentially capable of generating economic growth.

Under the coordination of the Educational Planning and Research Division (EPRD) within the MOE, a committee consisting of several local and overseas educational experts were formed to amend the previous secondary school science curriculum. The reform involved the adaption and adoption of three British science curricula: the Scottish Integrated Science Syllabus was modified to replace the former General Science Curriculum in lower secondary school and was renamed the Integrated Science Course; the Nuffield Secondary Science was modified to form Modern Science for Malaysian Schools which was intended for upper secondary art stream students; and, the Nuffield “O” Levels Pure Science Syllabi was modified to form Modern Pure Science containing modern biology, modern chemistry, and modern physics subjects which were mainly intended for upper secondary science stream students (Lee, 1992; Lewin, 1975). Swetz and Meerah (1982) reported that the adaptation process of this new science curriculum was challenging in the Malaysian context as the country lacked science facilities, resources and trained educators, while the syllabus itself was taken from a Western country that was far more modern and scientifically advanced. The introduction of modern chemistry during this period became the basis for the formation of the present Chemistry curriculum in Malaysian secondary schools under the KBSM system.

1.4 General Information about Secondary School Chemistry Curriculum

The secondary school Chemistry curriculum is articulated in two official documents: the syllabus and the specifications. The Chemistry curriculum syllabus covers the whole two years chemistry program. It contains the curriculum aims, objectives, brief descriptions of thinking skills and thinking strategies, scientific skills, scientific attitudes and noble values, and the outline of the curriculum content for both Form 4 and Form 5 chemistry classrooms (*Integrated curriculum for secondary schools: Chemistry syllabus*, 2006). Meanwhile, the Chemistry curriculum specifications are divided into two: curriculum specifications for Form 4 (Grade 10) and curriculum specifications for Form 5 (Grade 11). Both Form 4 and Form 5 Chemistry curriculum specifications contain similar components as in the syllabus in terms of aims, objectives, thinking skills and thinking strategies, scientific skills, scientific attitudes and noble values, with the addition of teaching and learning strategies and more details of content knowledge. Nonetheless, each of these specifications are unique in terms of the learning areas to be covered, learning objectives, suggested learning activities, and cognitive learning outcomes (Pheng, Samad, Dawam, Mohammad, Noor, Mat, Arshad, Mohamad, Yamin, Mahasan, & Zaman, 2005).

Typically, the syllabus and curriculum specifications can be obtain from the school administrators or are available for downloading from several websites. The most common website visited for this purpose is http://www.ppk.smkdpk.com managed by the CDD. The chemistry textbooks and chemistry practical books published by MOE have been prepared to correspond with the Chemistry curriculum. The former mainly contains the chemical knowledge, whereas the latter mainly contains the list of related experiments.

Basic schooling in Malaysia comprises 11 years: The students need to attend six years of primary school, Years 1 to 6 (Grade 1 to 6), and five years of secondary school, Forms 1 to 5 (Grade 7 to 11), before they can be accepted to enrol in post-secondary schools such as Form 6 (Grade 12) or at higher institutions. The chemistry subject is mainly offered to Form 4 (Grade 10) and Form 5 (Grade 11) of secondary school students who opt for the science stream. Besides chemistry, the science stream students are also eligible to take two other science subjects, biology and physics. The curriculum for chemistry has been designed to equip students with basic chemistry knowledge that could enable them to pursue formal and informal further education before taking up careers in any field of science and technology in the future. They are one of the cohorts whom the country will rely on to respond to the Sixth Challenge of Vision 2020 as mentioned earlier in this chapter.

Table 1.1 Chemistry topics covered in Form 4 and Form 5.

Theme	Topics	Level
Introducing chemistry.	Introduction to chemistry.	Form 4
Matter around us.	The structure of atom.	Form 4
	Chemical formulae and equations.	Form 4
	Periodic tables of elements.	Form 4
	Chemicals bonds.	Form 4
Interaction between chemicals.	Electrochemistry.	Form 4
	Acids and bases.	Form 4
	Salts.	Form 4
	Carbon compounds.	Form 5
	Oxidation and reduction.	Form 5
	Thermochemistry.	Form 5
	Rate of reaction.	Form 5
Production and management of manufactured chemicals.	Manufactured substance in industry.	Form 4
	Chemicals for consumers.	Form 5

The content knowledge of the Chemistry curriculum is divided into four main themes covering 14 topics to be taught in Form 4 and Form 5. The list starts with the theme - Introducing chemistry - that exposes the students towards the importance of chemistry knowledge and the prospect of careers in the field of chemistry. Under the theme - Matter around us - the curriculum presents the basic concepts of chemistry such as the structure of the atom, formula and chemical equations, the periodic table of elements, and chemical bonds. Within the theme - Interaction between chemicals - learning areas such as electrochemistry, acids and bases, salts, carbon compounds, oxidation and reduction reactions, thermochemistry, and rate of reaction are listed. The final theme - Production and management of manufactured chemicals - exposes students to common chemical substances that are used by industries and consumers. Table 1.1 shows an overview of the themes and topics offered by the Chemistry curriculum.

1.5 The Status of Chemistry in Malaysian Schools

1.5.1 The state of the Chemistry curriculum

The introduction of Teaching and Learning of Science and Mathematics in English was the policy of the former Malaysian Prime Minister, Tun Dr. Mahathir Mohamad which in 2003 brought the Malaysian education system into a new direction. This new policy is known by its Malay acronym, PPSMI. With the enforcement of the policy, the medium of instruction for science and mathematics subjects was supposed to be in English. The aim was simple, to improve the command of English language among the Malaysian students so that they are globally competitive in science and technology. The curriculum of all science subjects including chemistry was revised in 2005 to accommodate this policy. However, PPSMI has become a subject of debate among educators, parents, and politicians, thus, the policy reversal has been announced by the current Malaysian Deputy Prime Minister, Tan Sri Muhyiddin Yassin, starting in 2012 (Haziq, Abdullah, & Isa, 2009). It is coincidental that during the data collection of this study, the instruction of chemistry subject was in the transition period from English to Malay languages.

Recently, the MOE has made an announcement to replace the current secondary schools curriculum that is primarily based on KBSM to a Standard Curriculum for Secondary School (KSSM) by year 2014 (*Pelan strategik interim Kementerian Pelajaran Malaysia 2011-2020 [Ministry of Education Malaysia 2011-2020 interim strategic plan]*, 2012). This change is part of a government campaign to transform the country's education system to be more robust and internationally competitive since the introduction of KBSM in 1989 (Nordin, 1993). Yet, the National Science Education Philosophy (NSEP) that became the fundamental element of the Chemistry curriculum will remain unchanged in KSSM. The transformation to the KSSM was made after almost eight years of KBSM usage.

1.5.2 The state of chemistry teachers

At present, there is no such course offered by the teacher colleges to train teachers in the chemistry education speciality except at the post-graduate level. Instead, the pre-service teachers are trained based on several main teaching areas such as science, economics, arts and others. Within these teaching areas, the pre-service teachers have the options to choose various subject matter as their major and minor subjects. In the case of science teachers, they might be trained to teach chemistry as a major and perhaps biology, physics, and mathematics as a minor. In addition, the teachers are also expected to be well versed in other education subjects such as child psychology, sociology, and pedagogy. Once posted to schools, these graduated teachers might be required to teach any subject even though they may be trained in chemistry or vice versa (Soon, 1997; Zin, 2003) depending on the subject demand. During their teaching service, these teachers may receive continuous support from the MOE to improve their teaching performance through workshops, seminars and others in-service training.

An interview with a CDD representative who holds the position of science curriculum officer indicated that the agency has organised several events as a resource to inform the chemistry teachers about the curriculum intentions, such as: (a) Promotional events and road shows on curriculum; (b) Science and mathematics orientation courses in collaboration with the MOE; (c) Science and mathematics orientation courses in collaboration with State Education Department; (d) Science and mathematics orientation courses in collaboration with District Education Office; and (e) In-house training by senior teachers in their own schools.

Malaysia is a unique country that consists of diverse geographical conditions. This circumstance is one of the factors that influence the growth of a population and socio-economic status at a particular place, thus make it distinct to be either urban or rural areas. The urban and rural areas in this study has been defined in Section 3.4. Generally, the rural schools in Malaysia are still experiencing lower levels of educational resources such as facilities, instructional materials, teacher quality, and teacher supply especially in chemistry than their urban counterparts (Othman & Muijs, 2012). It also reported that many chemistry teachers in the rural areas require assistance in terms of managing and delivering the instruction (Osman, Halim, & Meerah, 2006; Tan, 2007; Tan & Lan, 2011; Zakaria, Daud, & Meerah, 2009). This is might be one of the reasons that many rural schools in Malaysia were claimed could not provide their students with an adequate teaching and learning (*Malaysia economic monitor: Inclusive growth*, 2010), thus creating a big gap of academic achievement between the urban and rural students (Hamzah & Abdullah, 2009; Sukor, Osman, & Abdullah, 2010).

1.5.3 The state of students in chemistry

The students start to be exposed to chemistry knowledge as early as Year 1 (Grade 1) up to Year 6 (Grade 6) during primary school as part of the science subject in the Integrated Curriculum for Primary School (KBSR) system. The chemistry principles at primary school are introduced at a superficial level with the aim of stimulating students' curiosity and developing their interest towards science. The lessons are mainly designed to help students to learn more about themselves and the world around them (*Integrated curriculum for primary schools: Science syllabus*, 2003).

At the lower secondary level, which are from Form 1 (Grade 7) to Form 3 (Grade 9), chemistry is taught as part of the combined science subject. This is a continuation of the KBSR curriculum with the emphasis on developing basic skills for communication and knowledge acquisition. Combined science deals mainly with the basic understanding of scientific principles in relation to life processes and the human environment (Soon, 1997). Typically, the students then are streamed into arts or science classes based on their results of Lower Secondary Assessment (PMR) at the end of Form 3. The chemistry subject is officially taught as a separate subject at the upper secondary school for Form 4 (grade 10) and Form 5 (grade 11) science stream students.

Reports from Trends in International Mathematics and Science Study (TIMSS) indicate that Malaysian student performances in chemistry content area were not consistent across studies conducted in 1999, 2003, and 2007. These studies participated by Form 2 (Grade 8) students from 150 schools involved assessment of various chemistry topics. When Malaysia joined TIMSS in 1999, Malaysian student performances in chemistry was slightly below the international average level which ranked Malaysia at 24th place from 38 participating countries. During this time, only three topics were assessed: classification and composition of matter; chemical properties; and chemical transformations (Martin, Mullis, Gonzalez, Gregory, Smith, Chrostowski, Garden, & O'Connor, 2000).

For TIMSS study in 2003, five chemistry topics were involved in the assessment which covered classification and composition of matter, particulate structure of matter, properties and uses of water, acids and bases, and chemical change. The study found that student performances slightly improved compared to the previous study, with the average scales above the international average benchmark. This had placed Malaysia 16th from 46 participating countries (Martin, Mullis, Gonzalez, & Chrostowski, 2004). However, report for the TIMSS study in 2007 indicated a drop in student performances in chemistry subject in comparison to 2003 results. The chemistry topic involved for assessment during this time was similar to 2003. The students' average scale scores were below the international scale average, and had placed Malaysia at 20th place from 50 participating countries (Martin, Mullis, Foy, Olson, Erberber, Preuschoff, & Galia, 2008).

1.6 Issues of Teaching and Learning in the Acids and Bases Topic

Acids and bases is one of the chemistry topics that has gone through many intense debates and discussions whether in Malaysia or other countries. For some students, acids and bases are considered as a killer topic, others consider it important to be learnt. The issue related to low students' achievement in acids and bases topic have been reported in many countries such as Thailand (Artdej, Ratanaroutai, & Thongpanchang, 2009), Singapore (Tan, Goh, Chia, & Treagust, 2004), Greece (Kousathana, Demerouti, & Tsaparlis, 2005), Taiwan (Lin & Chiu, 2005, 2007), Spain (Calatayud, Barcenas, & Furio-Mas, 2007), and Sweden (Drechsler & Van Driel, 2008).

Sheppard (1997) explained that students' lower grades for the acids and bases topic were caused by deviations of teachers' lessons from the original curriculum objectives leading to insufficient conceptual instruction. In Taiwan, the teacher who planned the acids-bases lessons based on the curriculum guide was found to promote rote learning (Lin & Chiu, 2005) because the teacher over-emphasized instruction in numerical skills while neglecting acids-bases basic properties. In an extended study by Lin and Chiu (2007) using their own developed two tier diagnostic test, they found that one of the reasons for Taiwanese student misconceptions was caused by teachers' improper instruction. Studies conducted in Sweden (Drechsler & Van Driel, 2008) and Spain (Calatayud et al., 2007) also discovered the roots of students' lower achievements in acids and bases originated from inadequacies in teachers' planning and instruction.

In contrast, Powers (2000), Lotfi (2004), and Seyhan and Morgil (2007) recorded increasing students' achievement for the acids-bases topic. These results were from teachers' lesson planning that emphasized meaningful learning. Similarly, the conceptual conflict teaching strategy introduced by Hand and Treagust (1988) as part of acids-bases lesson planning showed active participation by Year 10 students in Australia.

The Malaysian Education Certificate (SPM) is a national examination taken by all students at the end of fifth year of secondary school. The SPM chemistry mainly consists of three papers: the first paper contains multiple-choice questions; the second paper contains short essay questions; and the third paper contains long essay questions. Based on the SPM achievement report in years 2003 and 2004 (*SPM 2003 achievements report*, 2004; *SPM 2004 achievements report*, 2005), particularly in chemistry, the topic of acids and bases was among the topics recorded with low success for the second and third paper. A study conducted a few years later showed similar trends of students' achievement with their level of understanding for the concepts of acids and bases being at the level of moderate and weak (Arshad & Malek, 2010; Theng, 2007).

1.7 Rationale of Study

The motivation to conduct this research was initiated from many reports that described the failures and successes of teachers to carry out what has been intended by the curriculum in many science subjects around the world. It was claimed that the outcomes of curriculum execution might result from varied understanding of science teachers regarding the curriculum intentions. This position can be seen from the different interpretations of science teachers (Roberts, 1982) and biology teachers (Smith & Anderson, 1984) regarding the practicality of curriculum guides for their classroom interactions in terms of utility, time, and focus (Cronin-Jones, 1991). Bekalo and Welford (2000) reported that some Ethiopian's teachers had diverted from the intended curriculum guide to focus only on theory lessons and ignore the investigation activities in the physical science subject. Not fully understanding the Science curriculum guides (Welch, 1979) and Biology curriculum guides (Beyer, Delgado, Davis, & Krajcik, 2009) became a factor for teachers who then disparage the usage of these formal documentations (Ball & Cohen, 1996).

In Malaysia, Ismail (2012) pointed out that science teachers preferred to apply rote teaching and learning practices instead of encouraging students to work together, to share ideas and information freely with each other, or to use modern instruments in the science classroom. He purported that the situation was due to the fact that the teachers were trying to cope with the large amount of material required to be taught to the students by the science curriculum. Osman, Halim and Meerah (2006) reported that the failure of the science curriculum to achieve its objectives was because teachers lacked support in terms of the knowledge and skills required to implement the curriculum. They also suggested continuous evaluation should be done to ensure that the programme's execution meets its objectives. Even though the sciences curriculum has experienced a fast pace of reform since 1967, Lee (1992) found out that the science teachers were still applying didactic and rote teaching and learning process as had happened before the curriculum reform.

As far as this researcher could tell, little or almost no research has been done to evaluate the effectiveness of the Chemistry curriculum in Malaysia. Against the above scene, it is a question to what extent the chemistry classroom in Malaysia was realising the Chemistry curriculum intentions. Due to the time constraint to cover the whole topics as well as to assist the development of instruments, the researcher considered it necessary to narrow down the scope of investigation to one topic. The selection of such topic was expected to fit the typical period of ordinary doctoral study, which was three years length. Since acids and bases topic was one of the topics frequently highlighted as being problematic to be learnt and taught almost everywhere (refer Section 1.6), the researcher decided to choose this topic for further investigation by relating it to the intentions of the Chemistry curriculum. Stern and Roseman (2004) used a similar approach where they had selected one particular learning area, namely matter and energy transformation in ecosystems, in evaluating the Life Science curriculum in United States.

1.8 Research Objectives and Research Questions

In order to address the rationale of this study, the following research objective corresponding to the five research questions are highlighted. Both, the research objective and research questions were crucial in guiding the researcher's focus throughout this study.

Research objective:

To investigate the extent to which the acids and bases lessons delivered in urban and rural chemistry classrooms have met the Chemistry curriculum intentions.

Research questions:

1. What are the intentions of the Chemistry curriculum in terms of teaching and learning?
2. How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?
3. What are the urban and rural chemistry students' perceptions about their acids and bases lessons?
4. To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?
5. What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?

1.9 Significance of the Study

The outcome of this study is intended to benefit the researcher, chemistry teachers, students, and curriculum developers.

Primarily, this study may inform the researcher about the implementations of acids and bases lessons in the chemistry classrooms and its effects upon students' perceptions and achievements in urban and rural schools. It is intended that the outcomes of this study could become a useful reference for other researchers who may conduct similar studies.

The findings of this study may be useful for chemistry teachers who want to reflect upon their teaching strengths and weaknesses when they encounter a particular topic, such as acids and bases, in order to make improvements or strengthen their lesson activities. The results of this study also could provide insights for chemistry teachers regarding their students' perceptions, attitudes, and achievements toward the acids and bases lessons. The teacher can use such information to enlarge their repertoires of lesson evaluations.

The students also are intended to gain benefits from this study. Students could be given the opportunity to express their satisfaction with the learning environment and toward their chemistry lessons. Besides that, the students also can be informed about their achievement in the acids and bases topic.

Finally, the results of this study, which highlight the chemistry classroom situations, can provide insights for curriculum developers to improve the Chemistry curriculum from time to time.

1.10 Limitations

Several limitations had arisen during the implementation of this study. Firstly, this study was initially intended to investigate context-based lessons about acids and bases within the Malaysian Chemistry curriculum (Gilbert, 2006; Pilot & Bulte, 2006). Eventually, this intention was not pursued because the researcher was unsure whether or not the instruction by the chemistry teachers was context-based. Secondly, the acids and bases topic was usually the second last topic in the Form 4 Chemistry scheme of work, which typically was taught between August and October. As such, this study had to be carried out only between these months. Thirdly, access to schools required obtaining permission from several MOE agencies, therefore the researcher had to go through several formal procedures which was time consuming. Fourthly, due to time, distance and financial constraints, only a small number of responses were collected from urban and rural chemistry teachers. Finally, most of the student participants had limited proficiency in English that was an impediment for them to comprehend the statements in the questionnaires and the test that were administered in this study.

1.11 Overview of the Thesis

This thesis is compiled in 11 chapters. The brief descriptions of the remaining chapters are as follows:

- Chapter 2 provides a literature review involving the theoretical framework of the research study (Section 2.2), conceptualisation of the curriculum evaluation research (Section 2.3), overview of curriculum evaluation research (Section 2.4), and previous research of curriculum evaluation in chemistry and other science subjects (Section 2.5).

- Chapter 3 is devoted to the methodology of the study which describes the research process (Section 3.2), the use of a case study as the research design (Section 3.3), the selection of data sources and bounded system (Section 3.4), the methods used (Section 3.5), the data collection (Section 3.6), and the chronology of the data collection (Section 3.7).

- Chapter 4 is set to describe the development of questionnaires that cover issues about the selected scales from the original sources (Section 4.2), development of the Questionnaire of the Enacted Curriculum (QEC) (Section 4.3), development of a modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) (Section 4.4), and development of a modified version of the What Is Happening In This Class? (WIHIC) (Section 4.5). Then, Section 4.6 describes the translation process of the modified version of the ATCLS and the modified version of the WIHIC. Finally, information about the trial and refinement process of the modified version of the ATCLS and the modified version of the WIHIC are mentioned in Section 4.7.

- Chapter 5 addresses the development of the achievement test by encompassing the framework of Acids-Bases Chemistry Achievement Test (ABCAT) (Section 5.2), the development of the initial version (Section 5.3), and the development of the amended version (Section 5.4). The challenges during test development (Section 5.5) also are presented.

- Chapter 6 presents the findings from the analysis of the secondary school Chemistry curriculum (Section 6.2) and its discussion (Section 6.3). The findings address the first research question.

- Chapter 7 presents the results from teacher responses on the QEC (Section 7.2), student responses on QEC (section 7.3), and its discussion findings (Section 7.4). The findings are used to address the second research question.

- Chapter 8 lays out the findings from the modified version of the WIHIC (Section 8.2) and its discussion (Section 8.3). The results of this *perceived* curriculum are used to address the third research question.

- Chapter 9 uncovers the results from the modified version of the ATCLS (Section 9.2) and ABCAT (Section 9.3). The discussions of these non-cognitive and cognitive outcomes are presented in Section 9.4. The findings are designed to address the fourth research question.

- Chapter 10 examines associations between the student responses on the student edition of the QEC, the modified version of the WIHIC and the modified version of the ATCLS on the total post-test score in the ABCAT (Section 10.2). The discussion of these associations are also described (Section 10.3). The results are used to address the final research question.

- Chapter 11 provides the discussion and conclusion of this study by providing a summary of thesis (Section 11.2), the findings of the study (Section 11.3), the implications of the study (Section 11.4), the limitations of the study (Section 11.5), and recommendations for further research (Section 11.6).

1.12 Conclusion

This chapter introduces the research study by providing readers with background information regarding the beginning of the science curriculum in Malaysia until the formation of the secondary school Chemistry curriculum. The status of the acids and bases topic revealed it was problematic to teach and learn not only in Malaysia but also worldwide. Based on the literature review, not many researchers had evaluated the extent to which Chemistry curriculum intentions have been implemented, perceived and achieved in the Malaysian chemistry classroom. Guided by a research objective and five research questions, this research is intended to inform the chemistry teachers, chemistry students, curriculum developers and other researchers in Malaysia and in other countries. The researcher is also aware that several limitations that emerge along the study may have affected the overall outcomes of this research.

CHAPTER 2 | LITERATURE REVIEW

2.1 Introduction

This chapter reviews the research literature that supports the necessity for this study. The theoretical framework of the research study is first discussed (Section 2.2), followed by the conceptualisation of curriculum evaluation research (Section 2.3). An overview of the literature related to the curriculum intention, lesson implementation, students' perceptions of the curriculum, and student learning outcomes is also presented (Section 2.4). Finally, previous research related to curriculum evaluation in chemistry and other science subjects are reviewed (Section 2.5).

2.2 Theoretical Framework of the Research Study

2.2.1 The curriculum domains

Tyler (1950) has proposed four principal questions, known as Tyler's rationale, to address several aspects concerning curriculum issues. These questions are listed as (i) What are the learning purposes that educational institutions attempt to achieve?; (ii) What are the effective learning experiences that are provided in order to achieve this purpose?; (iii) How are learning experiences organized for effective instruction?; and (iv) How can the attainment of the learning purposes be determined? The rationale is probably the first example to draw a systematic guide for educational program investigation. Kliebard (1970) reformulated Tyler's rationale into four familiar processes by which a curriculum is developed. Kliebard described each question of the rationale as, stating objectives, selecting experiences, organizing experiences and evaluating outcomes. We may represent the relation between the rationale and these steps in the form of a flow chart as shown in Figure 2.1.

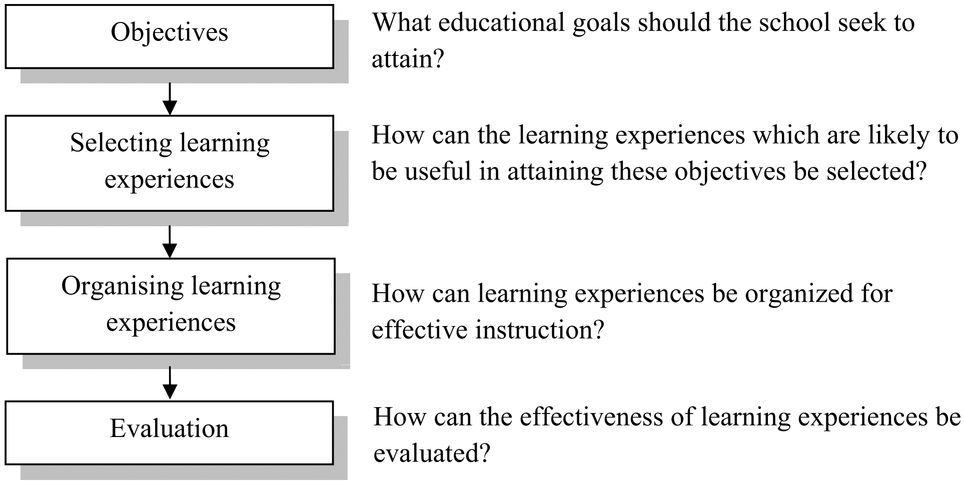

Figure 2.1 Relation between Tyler's rationales with the four processes proposed by Kliebard [From Marsh and Stafford (1992, p.6)].

Goodlad (1979) has proposed that Tyler's rationale had highlighted several fundamental elements of curriculum that feature semantic relations between them which had been addressed disparately before. This was evident from his statement, "Tyler identified at least the major commonplaces of curriculum – the elements about which curriculum developer must make decision(s), on which (the) researcher must focus, and to which theorist must pay attention in formulating their theories and conceptions." (Goodlad, 1979, p.20). He later rephrased the prescriptive questions of the rationale into steps of curriculum planning in order to be more descriptive.

Goodlad and Richter (1966) recommended formal and informal examination of values of all major decision making in the curriculum planning process. The levels of decision making mentioned referred to the societal, institutional, and instructional levels. More than a decade later, Goodlad (1977) developed a model as a result of 18 school studies in Southern California in the United States. The model incorporated all three levels of decision making with five curriculum domains: *ideal, formal, perceived, operational*, and *experienced*. Goodlad, Klein and Tye (1979) claimed the model to be able to systematically and comprehensively answer the inquiries that are commonly encountered in various stages of curriculum activities. Marsh (1986, 2004) admitted that Goodlad's model is relevant to all curriculum planners regardless of their theoretical or philosophical viewpoint.

The first domain, known as the *ideological* or *ideational* or *idealistic* curriculum (Goodlad et al., 1979), represents beliefs of policy makers about how a curriculum-in-use should be like, without taking into account the limited resources and various constraints (Marsh, 1986). The authors described this domain as arising from the ideational work of professional-technical staff at the societal level of decision making under the influence of the political context (Goodlad, 1960, 1979; Goodlad & Richter, 1966). The authors argued that even though the contents will remain intact, some of the methodological elements of this domain are likely to be lost before they reach the students. The content described here refers to the textbooks, workbooks, teachers' guides, and other documents. The authors stated that the domain mainly focused on the process of policymaking and instruction.

The second domain, the *formal* curriculum (Goodlad et al., 1979), consists of written content of the *ideological* curriculum (such as curriculum guides, syllabus, adopted text, unit of study and other written documents) that have been approved by decision makers at the institutional level (such as state official, school board, or institution personnel) (Goodlad, 1960, 1979; Goodlad & Richter, 1966) and then distributed without any adaptation or alteration. The written documents embedded the expectations of various official bodies such as the education ministry, book publishers, and examination committees (Marsh, 1986) as well as the interest of the community in terms of beliefs, attitudes and other intrinsic values, that were identified by examining the subject matter and the statement of goals.

The next domain, *perceived* curriculum (Goodlad et al., 1979), is also described as the curriculum of the mind as it illustrates the teachers' specific intentions about the classroom instruction (Marsh, 1986). The authors specified that the information about this domain could be sought from both parents and teachers; however, stronger recommendation was made to seek the teachers' perceptions of the formal curricula and what they viewed as reality, as they are the primary sources of data that provide direct insight into the schools.

The fourth domain listed is the *operational* curriculum (Goodlad et al., 1979), drawn from the instructional level of decision making (Goodlad, 1960, 1979; Goodlad & Richter, 1966), assumed that the teachers might hold different perceptions as compared to the actual classrooms. The domain required observation methods by focusing on certain components in order to have reliable measures for obtaining the actual picture of the classroom (Marsh, 1986). This domain is equated to the *perceived* curriculum, as the experiences would be perceived differently among teachers.

The final domain is known as the *experiential* curriculum (Goodlad et al., 1979), measured the students actual experiences during the classroom instruction (Marsh, 1986), thus generating crucial information for the teachers about what should and should not be performed during the instructional level of decision making. Despite its significance, the authors remind the researchers about the difficulty in measuring this domain.

2.2.2 Adoption, adaption and expansion of curriculum domains

Van Den Akker (1998) extended the curricula perspectives proposed by Goodlad and associates (1979) by including an additional domain to describe the curricula activities more comprehensively. Van den Akker described the curricula representations in terms of six domains instead of five as in the original curricula perspectives namely:

(1) The *ideal* curriculum which is the original vision of a curriculum that commonly addresses the basic philosophy, rationale and mission.

(2) The *formal* curriculum consisting of the documents that elaborate the curriculum vision described in the form of a guide.

(3) The *perceived* curriculum which is considered as the curriculum expounded by users especially teachers.

(4) The *operational* curriculum also identified as curriculum-in-action or the enacted curriculum that refers to the actual classroom instructional process directed by previous representations.

(5) The *experiential* curriculum refers to the students' actual learning experiences during the classroom instruction;

(6) The *attained* curriculum, which is an added domain, that refers to the student outcomes of the classroom instruction.

The author describes the proposed representations instructively in order to provide guidance to the evaluator to make exclusive analysis of several aspects of curriculum innovations.

The curricula perspective of Goodlad et al. (1979) that consisted of five domains was adapted by Rosier (1985) who proposed three sequential stages of curriculum instead. The proposed stages claimed to be able to provide a comprehensive picture for the analysis of science curricula. The stages, from the highest to the lowest level, are described as follows:

(1) The *intended* curriculum refers to the level of authority in-charge of defining the curriculum such as the national authority (in a centralized system), school board (in a decentralized system), or in some cases an individual school or individual teacher.

(2) The *translated* curriculum refers to the level of the individual classroom where the teacher translates the *intended* curriculum into sets of learning experiences for their particular group of students.

(3) The *achieved* curriculum refers to the level of achievement of individual students that measures the extent to which the scientific knowledge has been conceptualised by the student.

Rosier (1985) used these curricula stages to search for explanations for Australian students' performance by making comparisons between the national curriculum intentions as well as the students' experiences of the science instruction and students' national examination performance.

In a similar manner, Finegold and Raphael (1988) investigated the achievements of Canadian secondary school students in physics by analysing the relation between the students' results with respect to the physics curricula intentions and the teachers' assessments of students' opportunity to learn. The investigations were carried out through the adoption of Rosier's (1985) conceptual framework, that distinguished three levels of curriculum, the *intended* curriculum, the *translated* curriculum and the *achieved* curriculum.

Treagust (1989) addressed four aspects of curricula that were used to explore the teaching practices of two biology teachers. The teachers were selected from one government school and one private Catholic high school in Perth based on their informed performance which can be considered exemplary and worthy of attention by other teachers and teacher educators. The first aspect, the *intended* curriculum, was referred to in the syllabus, textbooks, teaching focus, and the characteristics of the task set by the teachers. The second aspect, the *implemented* curriculum, was referred to as qualitative and quantitative data from classroom observations. The third is the *perceived* curriculum that referred to the students' responses to learning environment questionnaires and interview questions. The final aspect of attention was the *achieved* curriculum, referred to students' performance obtained from teachers' records, as well as from teachers' and students' interview.

The International Association for the Evaluation of Educational Achievement (IEA) (Rosier & Keeves, 1991) identified three sequential stages, adapted from Rosier (1985) related to three groups of people who are involved in science education, namely the curriculum planner, teachers and students. They believed that there are semantic and logical relationships between these three curriculum stages. The first stage known as the *intended* curriculum was specified by either the centralized system or decentralized system. The *intended* curriculum in the centralized system, such as the national authority, could be identified through the documents produced. On the other hand, the *intended* curriculum in a decentralized system, such as individual school board, teachers committees, or individual teachers, could be identified by seeking the required information from the person in charge of the individual schools. The information acquired might vary between these systems. However, it is possible that the information comprised the content specifications, process objectives, lesson content, lesson topic, general guidelines statements as well as suggestions of teaching methods, time allocation for each topic, textbooks, lessons activities, and teaching aids. The second stage, called the *implemented* curriculum, focused on the issues of individual classrooms, where the teacher interpreted the *intended* curriculum by translating it into sets of learning experiences for their particular students. The translating process could have been directed or guided by the school principal, adviser, pre-service or in-service teacher education programs. The curriculum implementation by the teacher could have involved the use of independent activities or fully structured activities. The third stage, the *achieved* curriculum, measured the changes in the students' scientific knowledge, inquiry skills, attitudes and values. This third stage reflected the effectiveness of the instruction offered in the previous stage.

The National Science Foundation (Suter, 1992) adapted the curriculum model from the International Association for the Evaluation of Educational Achievement (IEA), which was originally designed by Rosier (1985), to address the status of US science and mathematics education in a variety of learning settings and groups. The model claimed to represent the real-world framework. The adapted model illustrated three curriculum components, the *intended* curriculum, *implemented* curriculum, and *attained* curriculum.

Lynch (1997) focused on developing a framework for US beginner teachers to explore science education reform documents and to relate them to practice. The conceptual framework of this research was adopted from the National Science Foundation (Suter, 1992) that used three types of curriculum models: The *intended* curriculum, the *implemented* curriculum and the *attained* curriculum.

Guided by Treagust's (1989) curriculum framework, Hartley (2002) investigated the effectiveness of outreach programs in providing support to both teachers and students in mathematics and physical science. The curriculum framework used by the authors involved the *intended* curriculum, the *implemented* curriculum, the *perceived* curriculum and the *achieved* curriculum.

Osborne, Duschl, and Fairbrother (2002) used 'tripartite' analytical research design to evaluate the new Advanced Subsidiary (AS) course in Science for Public Understanding (SPU) offered by the Alliance for Qualifications and Assessment and developed by the Nuffield Curriculum Centre and the University of York. The tripartite design used in this study referred to the *intended* curriculum, the *implemented* curriculum and the *attained* curriculum. The usage of the tripartite conceptual framework enabled the authors to investigate whether or not each of the suggested course themes was present and how it was integrated in the *implemented* curriculum and *attained* curriculum.

Mills and Treagust (2003) further developed the conceptual framework proposed by IEA (Rosier & Keeves, 1991) and Treagust (1989) to evaluate the effectiveness of two methods of learning, traditional lectures and tutorials, in structural engineering education. The study involved 20 civil engineering students who were in their third year in University of South Australia. The authors defined the evaluation frameworks in terms of the *intended* curriculum, the *implemented* curriculum, *the perceived* curriculum and the *achieved* curriculum.

2.2.3 Application of curriculum domains in this study

The various curriculum representations described in the above literature review originated from the curriculum perspectives of the Goodlad (1977) model. The model can be considered as involving values-oriented studies as it advocates the examination of values and the merit of some object in various levels of decision-making (Stufflebeam & Webster, 1980). The usage of curriculum perspectives varied in terms of its interpretation between authors. This study was conducted within the framework of four curriculum domains as proposed by Treagust (1989), namely *intended* curriculum, *implemented* curriculum, *perceived* curriculum and *achieved* curriculum.

As agreed in many articles, the *intended* curriculum can be described as a formal document that provides information about the lesson contents, instruction guides, learning activities, and lesson goals (Bekalo & Welford, 2000; Finegold & Raphael, 1988; Treagust, 1989; Van den Akker, 1998). Alternatively, the *intended* curriculum also can be defined as a teaching manual for teachers (Ball & Cohen, 1996; Bruce, Bruce, Conrad, & Huang, 1997) providing lessons' goals for students to achieve (Lynch, 1997; Stern & Roseman, 2004). Also known as the *formal* curriculum (Remillard, 2005), it is usually perceived by teachers in terms of curriculum specifications, textbooks, or lesson plans. In the context of this study, the *intended* curriculum referred to the original intentions of the Chemistry curriculum in terms of objectives and curriculum theory with focus on the acids-bases topic as specified in the specifications and syllabus issued by the Malaysian Ministry of Education (*Integrated curriculum for secondary schools: Chemistry syllabus*, 2006; Pheng et al., 2005).

The *implemented* curriculum or also known as the *operational* curriculum (Van den Akker, 1998) or *enacted* curriculum (Longwell-Grice & Letts, 2001; Lynch, 1997; Remillard, 2005). Basically, these terms are used to describe classroom activities and the interactions between teachers and students (Bekalo & Welford, 2000). In relation to this study, the researcher investigated whether or not the urban and rural chemistry teachers had conducted the acids and bases lessons in congruence with the Chemistry curriculum intentions.

Based on related literature reviews, several academics agree that students' experiences of the classroom are different from those of their teachers (Douglas, Sheldon, Lawrence, & Malcolm1980; Suarez, Pías, Membiela, & Dapía, 1998; Wood, Lawrenz, & Haroldson, 2009). Also known as the *experiential* curriculum (Van den Akker, 1998), the *perceived* curriculum refers to the students' actual experiences of the classroom instruction. In the context of this study, the urban and rural chemistry students' learning experiences in the acids and bases lessons were investigated.

The *achieved* curriculum is another outcome of the *implemented* curriculum in this study. Also known as the *attained* curriculum (Lynch, 1997; Van den Akker, 1998), this domain refers to the student outcomes as a result of instruction in acids and bases. For this study, the extent to which the student outcomes produced aligned with the curriculum intentions was investigated.

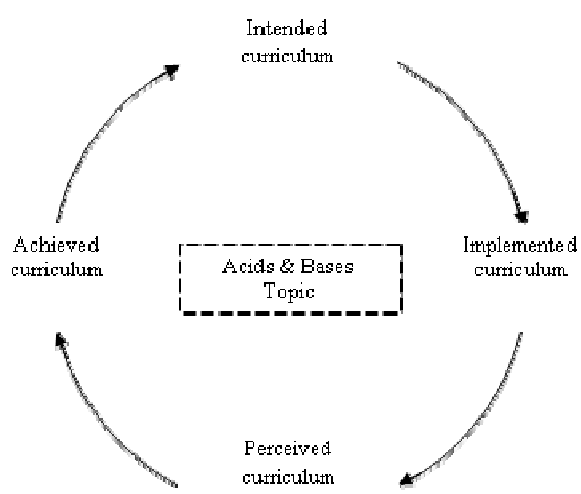

Figure 2.2 Model of theoretical framework for this study.

The interaction between the *intended*, *implemented*, *perceived* and *achieved* curriculum in this study can be represent as in Figure 2.2.

2.3 Conceptualisation of Curriculum Evaluation Research

2.3.1 Overview of educational evaluation research history

Stufflebeam and Shinkfield (1985, p. 15) argued that "No introduction to evaluation as a field of professional practice would be complete without giving some attention to the historical development of the field". Thus, the historical context of educational evaluation research was briefly reviewed in order see how it evolved from the 1920s to the 1970s.

Rossi, Freeman, and Lipsey (1999) claimed that the social evaluation has its roots since the 17th century. However, the revelation of a systematic evaluation in education was not recognized until the 1920; psychometric evaluation represented the leading field when it came to the assessment of an individual or program (Stufflebeam & Shinkfield, 1985). In order to follow the evolution of educational evaluation chronologically, Stufflebeam and Shinkfield (1985) have divided the evolution into five phases: the *pre-Tylerian* period, the *Tylerian* age, the age of *innocence*, the age of *realism* and the age of *professionalism*.

The earliest idea of educational evaluation research has been set forth by Bobbit in 1920, where he described the evaluation practice was being similar to product management (Bobbitt, 1920). Through the metaphor used, Bobbit (1920) implied that the aims act as an end point where he clarified that the final destination of educational practice is to reach its predetermined goals, without concern for the learning process involved. However, a difficulty arises in terms of the nature of the aims or objectives when the concept of product management was applied in educational evaluation (Kliebard, 1970). Thus, a decade after it was put forward, Bobbit's claims were criticised by Dewey (1930). Dewey highlighted the idea that educational objectives should become turning points in the learning process rather than endpoints (Kliebard, 1970). He elaborated that the objectives should inspire a person to foresee the outcomes of learning, thereby influencing him or her to implement appropriate measures to get to that point. Dewey's opinion was widely accepted, and has provided a foundation for the practice of evaluation in later years (Kliebard, 1970).

In the 1930s, Tyler was appointed to head the first educational evaluation project established by the Progressive Education Association (PEA), which was widely known as the Eight-Year Study or Thirty School Study (Stanley, 2009). The goal of this study was to measure the effectiveness of school programs based on the attainment of the intended program objectives (Stanley, 2009; Stufflebeam & Shinkfield, 1985). As a result of Tyler's success in leading this study, he is now known as the father of educational evaluation. This period was called the *Tylerian* age by Stufflebeam and Shinkfield (1985).

From the 1940s to the 1950s, there was no great demand to assess the accountability of the educational system, as people were recovering from the destruction of World War II. Thus, educators were not obligated to evaluate their programs (Stufflebeam & Shinkfield, 1985). This period was known as the age of *innocence* or *social irresponsibility* by Stufflebeam and Shinkfield (1985), and this is where the exertions of evaluation services began.

Stufflebeam and Shinkfield (1985) next introduced the age of *realism*, which occurred between the late 1950s and the early 1970s, and witnessed the boom period in evaluation research (Rossi et al., 1999). This phase marked a new transformation in the field, as the public began to show interest in assessing educational programs. This encouraged the federal government to support the creation of many evaluation committees (Stufflebeam & Shinkfield, 1985).

According to Stufflebeam and Shinkfield (1985), the year 1973 marked the beginning of the age of *professionalism*, where educational services began to be regarded as a prospective profession and speciality field (Rossi et al., 1999). In addition, this field was introduced as a university course and the numbers of publications grew dramatically (Rossi et al., 1999; Stufflebeam & Shinkfield, 1985). The latest transformation of this field is known as *meta-evaluation*; Stufflebeam and Shinkfield (1985) described this as the process of evaluating the evaluation.

This sub-section briefly described the chronology of educational evaluation activities for the past half century before they began to flourish, eventually becoming a professional educational field at present. This evolution is worth acknowledging for comprehending the foundations of curriculum evaluation for this study.

2.3.2 Definition and purpose of curriculum evaluation

Evaluation in general refers to the process of collecting data to judge the performance or merit of a program (Chen, 1990; Rossi et al., 1999). Educational evaluation includes all kinds of evaluation that are related to schools such as evaluation of curriculum, accountability, management, policy, accreditation, grounds, buildings, administration, supervision, personnel, transportation, and others (Oliva, 2009). This study is mainly concerned with the assessment of the curriculum. In many curriculum construction models, curriculum evaluation often located at the end of the model to complete the cycles of curriculum development and implementation (Brady & Kennedy, 2007). An example of curriculum evaluation position in curriculum construction model was provided in Figure 2.3.

Marsh and Stafford (1992) defined curriculum evaluation as a set of procedures, or an independent field of study, or an activity to express the value in a wide range of planning and implementation activities undertaken by teachers, students and other participants (such as staff members, parents, etc.). Cooper (1976) viewed curriculum evaluation as the collection and provision of evidence to make judgement of the feasibility, effectiveness and educational value of curricula. Meanwhile, Goodlad and Richter (1966) connected curriculum evaluation with assessment of learning opportunities in relation to educational objectives, objectives in relation to educational aims, and aims in relation to values.

Posner (2004) described the definitions of curriculum evaluation depending on the perspective from which one views the curriculum. He described three perspectives that contribute to the generation of the definitions. First, for a curriculum that refers to a document such as content outline, scope and sequence or syllabus, curriculum evaluation means a judgement regarding the value or worth of the document. Second, for a curriculum that refers to student experiences, curriculum evaluation might mean a judgement about the worth of the instructional experiences received by the students. Third, for a curriculum that refers to learning objectives, curriculum evaluation might refer to the actual outcomes of the classroom instruction.

Oliva (2009) defined curriculum evaluation as the examination of programs, operations, and curricular outcomes that focuses on the material but not on humans. The activities involve decisions about the programs meeting the curriculum objectives, to determine if the programs are valid, relevant, feasible, have students' interest, as well as in line with the need of students, to check the selection of delivery systems, materials, and resources and to assess the curriculum documentations, such as guides, unit plans and lesson plans.

2.3.3 Scope of evaluation

Beauchamp (1972) described that the primary question of evaluation is concerned with what happens during instruction. According to Oliva (2009), instructional evaluation covers students' achievement, the instructor performances, and the effectiveness of particular approaches or methodologies. Meanwhile, curriculum evaluation goes from beyond the purposes of instructional evaluation into assessment of whether or not the curriculum goals and objectives have been implemented as intended. Therefore, it is inaccurate to consider only the realisation of cognitive, affective, and psychomotor goals of recipients to reflect the effectiveness of the curriculum.

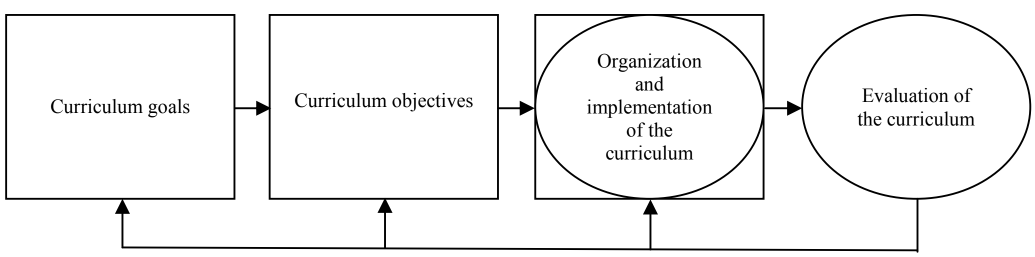

Figure 2.3 Curriculum development model with all feedback lines [From Oliva (2009, p.411)].

Oliva further made a distinct between these two dimensions by representing them in terms of a curriculum sub-model and an instructional sub-model. Based on Figure 2.3, the curriculum sub-model is composed of curriculum goals, curriculum objectives, organization and implementation of the curriculum, and evaluation of the curriculum. In addition, the instructional sub-model is located between organisation and implementation of the curriculum and evaluation of the curriculum of the curriculum sub-model (in Figure 2.3). In short, the instructional sub-model is a subset of the curriculum sub-model as described in Figure 2.4, with curriculum and instruction forming a system (Johnson, 1967).

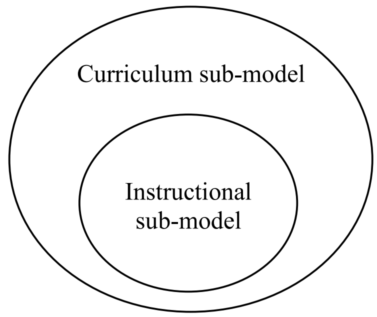

Figure 2.4 Relationship between curriculum sub-model and instructional sub-model [From Oliva's (2009, p. 9) concentric model of relationship between curriculum and instructional].

Oliva suggests that the evaluation process can be focused on the complete model, which covers both the curriculum sub-model and the instructional sub-model, the curriculum sub-model only or the instructional sub-model only. For the evaluation of a single sub-model, either curricula or instructional, he reminds researchers to be aware of the direct and indirect relationship existing between these two sub-models. Curriculum evaluation involves assessment of programs directly, and individual students indirectly, as opposed to instructional evaluation that involves assessment of individual students directly and programs indirectly.

Marsh (1986, 2004) distinguished between curriculum evaluation from other kinds of educational evaluation. Curriculum evaluation involves an assessment of the goals, rationale and structure of a particular curriculum against the context in which interaction between the teacher and students occurs as well as analysis of the students' actual interests, motivation and achievements in the lesson. It is not just an analysis of student outcomes of learning nor is it just an analysis of the teachers' performance of instruction. He also emphasized the importance of considering a plurality of interests of particular groups such as teachers, administrators, students and parents when conducting curriculum evaluation. He stated that curriculum evaluation would not be complete if the only focus is on single dimensions such as the behaviour of students, or an analysis of materials, or the behaviours of a school as a social institution.

2.3.4 Application of curriculum evaluation conceptualisation in this study

Based on the definitions given above, most curricula scholars highlighted the process of making judgments as well as assessment of values as key terms to describe curriculum evaluation. As for this study, curriculum evaluation is referred to as the process of gathering data to make judgments about the operation and outcomes of acids and bases lessons in meeting the intentions of the Chemistry curriculum. This has been done by exploring the gap or discrepancy between what is intended and what is actually took place (Provus, 1972).

For the purposes of this study, the curriculum sub-model as suggested by Oliva (2009) was the focus. Clarification of this focus is crucial in order to avoid confusion between the curriculum evaluation of other educational evaluations, in particular instructional evaluation. Therefore it should be clear that this study is not just an analysis of student outcomes of learning, nor is it just an analysis of the lessons instruction, instead it is assessment of both components (Marsh, 1986, 2004) towards achieving the curriculum objectives.

2.4 Overview of Curriculum Evaluation Research

2.4.1 Addressing intentions in curriculum evaluation

Before curriculum evaluation could be carried out it is crucial for the evaluator to identify the intentions of curriculum. Analysing what is intended by the curriculum could assist the evaluator to ask the right questions about a program and quickly ascertain the key elements of a problem (Chelimsky, 1998). As mentioned in 2.2.3, various official documents such as single worksheets, textbooks, curriculum packages, or other printed documents are the main sources of reference of the *intended* curriculum. This view is supported by McCormick and James (1988) who regarded the curriculum materials as documentary evidence of the intentions that encapsulate, implicitly or explicitly, the components that are desired by the Chemistry curriculum to be implemented in the chemistry classroom. The information is mainly embodied in the curriculum theory.

Curriculum theory is a set of hypotheses that represent the consensus of beliefs and assumptions of curriculum developers and other principal stakeholders that are needed to build the program plans and actions (Weiss, 1997). The theory might be derived from various sources such as previous experience, practice knowledge, intuition, and research. Theory description effectively acts as a blueprint or plan that provides information on how a program should ideally be implemented and how its goals are to be attained (Rossi et al., 1999). Curriculum theory consists mainly of two forms (Rossi et al., 1999): impact theory and process theory. Stake (1967) represented these two theories as intended outcomes and intended transactions, respectively. The impact theory or intended outcomes refer to the expected outcomes produced as a result of the program activities. Meanwhile, the process theory or intended transaction refers to the plan of activities that is undertake to achieve the impact theory or intended outcomes with reference to the stated goals and objectives. These two components are essential in representing the beliefs and assumptions about the causes and effects of the curriculum (Weiss, 1997).

The integral part of impact theory is the stated goals and objectives (Rossi et al., 1999). It is crucial for the evaluator to draw out the educational goals and objectives before carrying out the evaluation process as it will become an indication of educational quality. Each of these terms carry different levels of educational purposes but are interconnected (Davies, 1976; Marsh, 2004). The educational goals are broad and abstract which is hardly quantifiable. As the broad goals are refined and restated as more specific and explicit statements, the extent of the educational intentions that would be attained is possible to measure. This specific statement is referred to as the objectives that contain one or more measurable criteria for success (Davies, 1976; Marsh, 2004; Rossi et al., 1999). The objective is to deal with whatever the stakeholders or teachers want the students to learn. It can be depicted as the “intended educational consequences” or “intended outcomes” of particular courses or units of study (Goodlad & Richter, 1966; Mager, 1962; Posner, 2004).

Many curriculum academicians agree that the existence of strong verbs is the core for a good objective statement. Kirschner et al. (1975) and Mager (1962) referred to the use of action-oriented verbs to describe what the learners are expected to do. Terms such as "to write," "to recite," "to identify," "to differentiate," "to solve," and "to construct," pose an observable and measurable behaviour and are unlikely to load any degree of fuzziness or uncertainty. Meanwhile, Gagne, Briggs and Wager (1988) argued that the action verb is not the most important objective, instead verbs that depict the capability of one to learn are more important. Gagne, Briggs and Wager (1988) argued that the verbs that denote the human capabilities such as "discriminates", "identifies," "classifies," "executes," and "chooses," make the leaners' accomplishment more apparent. The use of measurable behaviour to specify the cognitive learning outcomes or content knowledge can be used as measurement tools of students' achievement (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956).

To explicate the process theory, Rossi, Freeman and Lipsey (1999) recommended two issues. First, they suggest identifying the important educational program functions that must be performed in order to operate as intended. Here, the evaluators are encouraged to view the program functions from the perspectives of the program personnel themselves. Full description of the program function could entail some level of description of the intended activities, components and resources that sustain those activities. Second, there is a need to find how the various functions, activities, and components relate to each other. Here, they suggest representing the linkage as lists, flowcharts, hierarchies or any number of creative forms.

2.4.2 Addressing implementation in curriculum evaluation

A curriculum, however effectively constructed and planned will have limited value if it is not implemented properly (Saylor, Alexander, & Lewis, 1981; Zainuddin, 2010, December). Once implemented, it would be naive to assume that it is carried out as intended. The questions of "how" it is actually carried out and "what" caused the learning effects are crucial questions to be asked by the evaluators involved. Such questions provide indication of curriculum performance more holistically. Therefore, the process of evaluation needs to be conducted to answer these questions.

Evaluation ascertains whether or not the educational program process, activities and operations have been implemented as intended. Whether the assessment is used for formative or summative purposes, the information obtained can be utilised in two ways (Rossi et al., 1999): as quality assurance information or as explanation for the curriculum outcomes. In this study, evaluation of the instructional program was used to explain the curriculum outcomes.

The most favourite technique used by evaluators is direct observation. In fact, King, Morris and Fitz-Gibbon (1987) described this technique as the most credible due to its ability to capture and describe the richness of program implementation through the evaluator's live experiences. However, evaluators have raised two concerns regarding its application in evaluation: the large cost involved in administering (Wolf, 1979) and trespass of participants' privacy and confidentiality (Rossi et al., 1999). According to McCormick (1988), in circumstances where the behaviour cannot be directly observed, occurs infrequently, or issues of privacy and confidentiality are raised, the questionnaire and interview techniques could be used to replace the observation. Questionnaires effectively and speedily obtain information from large numbers of participants. Meanwhile, the interview effectively provides the description of program implementation through face-to-face discussion with an individual or groups of participants (King et al., 1987). Wolf (1979), however, argues that both of these techniques can be less than complete and accurate in capturing everything that actually has taken place during the program implementation.

2.4.3 Addressing students' perceptions in curriculum evaluation

There is no guarantee that successful implementation of a curriculum is viewed similarly by the students and the teacher (Papineau & Kiely, 1996; Rossi et al., 1999). Without proper information of how the students actually perceived the learning, it would be questionable whether or not the learning experiences that were provided were consistent with the curriculum intentions (Rossi et al., 1999; Wolf, 1979).

Chemlisky (1998) asserted that the inclusion of students' learning experiences in educational program evaluation is the hallmark of a credible study. He explains three reasons for this claim. First, the data from students' perceptions counter-balance the management biases that may occur during the evaluation. Second, in the past only a few evaluation studies have considered students' perceptions; consequently, any new findings could lead to new critical information. Finally, any issues related to quality and inadequacies of the program implementation could be highlighted based on the students' experiences towards the learning, thus increasing the sensitivity of the program evaluation.

In order to find out whether the instructional program was delivered as intended, we require information about their learning experiences from the students themselves (Rossi et al., 1999; Wolf, 1979). One effective means is to use a questionnaire. According to Wolf (1979), the application of questionnaires to evaluate the learning situation has been used since 1969 with the development of the College and University Environment Scale (CUES). Wolf noted that the questionnaire was capable of addressing crucial information about the nature of learning experiences of an educational course, program, or curriculum. As a rule of thumb, Wolf suggests two-thirds of students' responses must be obtained for a set of items in order to characterize the aspects of learning situation.

In recent developments, many evaluators have used classroom environment questionnaires to evaluate the learning situation. Suarez, Pias, Membiela & Dapia (1998) stressed that the classroom environment has been considered a promising but neglected source in curriculum evaluation and innovation. The use of classroom environment questionnaires in evaluation studies may produce one of two types of findings. First, when used as independent variables, classroom environment perceptions could predict considerable amounts of variance in cognitive and affective outcomes. Second, when used as dependent variables, classroom environment perceptions could differentiate revealingly and appreciably between groups or schools that actually implemented the curricula (Fraser, 1981). However, McCormick and James (1988) have reminded evaluators that classroom environment questionnaires do not adequately answer certain research questions about students' perceptions in curriculum evaluation.

2.4.4 Addressing student outcomes in curriculum evaluation

After the curriculum has been successfully implemented the impact evaluation or outcome evaluation is performed. The impact evaluation addresses the question of whether or not the educational program has achieved what was set out to accomplish or whether or not any improvements were experienced by the learners (Posavac & Carey, 1997; Rossi et al., 1999). Wolf (1979) stated what is set out to accomplish invariably involves changing the behaviour of learners towards the desired effects. Examples are an improvement of knowledge skills or in problem-solving abilities, changes in attitudes, or any other complex behaviour.

For any improvement in behaviour to take place, there must be a cause that leads to the change. For that reason, many evaluators have recommended that the outcomes evaluation be connected with the implementation evaluation in order to avoid the so-called black-box evaluation. Without data from the process evaluation, the causes that contribute to the success or failure of the educational program are difficult to ascertain making it ineffective in providing information for improvement (Posavac & Carey, 1997; Rossi et al., 1999).

Posavac (1997) has noted that the outcomes of evaluation can have various levels of complexity. The lowest level involves assessing the whether or not the learners have performed as intended. The second level is comparing the performance of those in the program with those not involved. The highest level involves identifying the causes that make the changes in those participating in the educational program.

According to Rossi, Freeman and Lipse (1999), impact evaluation is suitable for an educational program that is mature, well-established, well-structured and well-documented as it provides important information for the decision making related to the program model. However, the impact and efficiency of the program could be difficult to determine if the educational program involves a large number of students. Therefore, the extent to which the program objectives are successfully explicit and relevant to the program recipients or others stakeholders could be the focus of evaluation.

As has been reported extensively in the research literature, the evaluation of outcomes typically relate to the extent to which the pre-specified objectives of the educational program have been achieved. However, Eisner (1994) argued the achievement of the objectives are only one part of the outcomes; instead, the term outcomes covers more broader dimensions. Nixon (1992) has suggested that several dimensions of outcomes that could be used as measure of a curriculum's effectiveness, namely students' achievement, attendance records, pathway of school leavers, patterns of decision that the students make in the classroom and students' attitudes towards the course. There are two types of outcomes that become integral parts of curriculum evaluation: cognitive outcomes and non-cognitive outcomes (McCormick & James, 1988).

Cognitive outcomes refer to students' achievement related the content of a course or segment of the course after it was taught. Eisner (1994) also recognized this as subject-specific outcomes. In order to measure the cognitive outcomes, three types of cognitive assessments have been proposed by McCormick and James (1988). These outcomes are referred to as (1) norm-referenced – comparing one student's to his or her peers, (2) domain-referenced – determination of how well the students have performed in particular objectives or domains, and (3) ipsative – comparison of the students' scores over time. According to McCormick and James (1988), curriculum evaluation is commonly concerned with what the students understand (criterion or domain referencing) instead of comparing students with others students (norm-referencing) so that any problems arising from the lesson can be improved. In addition, Steadman (1976) and Wolf (1979) have suggested that the measurements be done before and after the instruction so that the changes of students' outcomes as result of the curriculum implementation can be determined.

The non-cognitive outcomes refer to students' feelings, emotions, awareness, values, beliefs and attitudes resulting from the lesson implementation. By knowing the outcomes, it is possible to create a more conducive learning environment in order to improve the teacher instruction that might influence the students' attitudes or emotions. Interview and questionnaire techniques can be used to measure this dimension (McCormick & James, 1988). Wolf (1979) has suggested that the measurement of this dimension need not necessarily be done immediately after the lessons have started, but rather later in the implementation. The rationale is first, to avoid the risk of obtaining incorrect information from the students who may be reluctant to respond honestly about their attitudes, feelings and interests. Second, some measure dealing with social relationships should be delayed until the students within the group have been together for a reasonable period.

2.4.5 Application of curriculum evaluation components in this study

In order to reveal the curriculum intentions in this research, several official documents related to the Chemistry curriculum were reviewed in terms of impact theory and process theory. For impact theory, the goals and objective of the Chemistry curriculum, in particular within the acids and bases topic was identified. For the process theory, the proposed teaching and learning activities were highlighted. It is important to clarify both of these theories in order to provide a benchmark for the researcher to measure the extent the objective of acids and bases lessons had been achieved and whether or not the teaching and learning activities had been carried out as required by the Chemistry curriculum.

Using the benchmark from the process theory, the actual implementation of teaching and learning of acids and bases lessons was evaluated. Due to certain limitations (discuss in Section 3.6.2), information about the acids and bases implementation could only be obtained by teachers' responses to a questionnaire. The teacher edition of the Questionnaire of Enacted Curriculum **(**QEC) was developed for this purpose. As the questionnaire was the only source of data for curriculum implementation, the researcher was aware that there were limitations that could not be addressed by the instrument. As a solution, the students' responses were sought using a student edition of the QEC in order to compare the students' views concerning the acids and bases lessons implementation with those of the teachers. Details of both of these editions of the QEC can be found in Section 4.3.

In order to investigate how the students perceived their learning environment during the acids and bases lessons the modified version of the What Is Happening In This Class? (WIHIC) was developed. The development of this questionnaire is presented in Section 4.5. The utilisation of this learning environment questionnaire to assess the *perceived* curriculum in this study was made based on its flexible features as indicated by Fraser (1981).

In order to address student outcomes resulting from the acids and bases lessons, this study considered two elements: students' achievement and students' attitudes. Students' achievement provided description of the students' cognitive outcomes in the acids and bases contents areas. To assess students' achievement, a self-developed standardized achievement test (the complete instrument can be found in Chapter 5) which was called Acids-Bases Chemistry Achievement Test (ABCAT) was used. Meanwhile, the students' attitudes towards the acids and bases lessons provided information about the non-cognitive outcomes consistent with many opinions that suggest that it is one element that could determine a good school curriculum (Aiken & Aiken, 1969; Koballa & Crawley, 1985; Laforgia, 1988). The students' attitudes were assessed using attitudinal scale which was called modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) (the instrument details can be found in Section 4.4) adapted from Cheung (2007, 2009a, 2009b). The results from both cognitive and non-cognitive outcomes were then compared with the benchmark from impact theory.

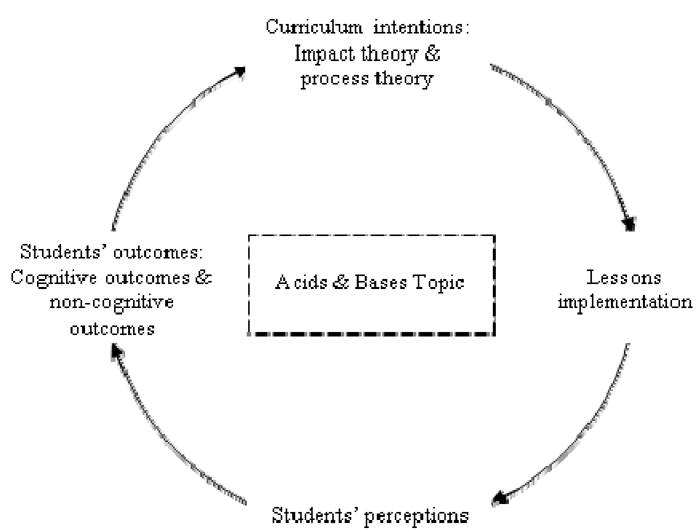

Figure 2.5 Conceptual model of curriculum evaluation for this study.

A conceptual model was drawn based on the interaction of four curriculum representations (Figure 2.5). The rationale for the development of this model was to give a clear picture of the subsequent stages in this study.

2.5 Previous Research of Curriculum Evaluation in Chemistry and Other Science Subjects

2.5.1 Chemistry subject

Examination of the secondary school physical science curriculum in Ethiopia was undertaken by Bekalo and Welford (2000). Their investigation primarily focused on the provision of practical experiences in chemistry and physics lessons. The focus of the investigation was based on their analysis of policy documents as well as curriculum materials. The analysis revealed that the Ethiopian new Education and Training Policy and Sector Strategy intended that the chemistry and physics lessons be taught emphasizing a problem-solving and practical approach as part of classroom activities. To measure the correspondence between the curriculum intention and the experiences that actually took place, the authors had conducted 80 lesson observations on four samples of urban and rural schools. In addition, 40 sessions of observations were also conducted in two primary teacher-training colleges to get an insight into how the students' teachers were trained in practical work. The authors found that the assessment and school practices did not match the curriculum intentions. This meant that the Ethiopian secondary students did not receive the practical experiences as specified in the official documents. Despite this finding, the study did not address the *perceived* and *achieved* curriculum about the students' perceptions and outcomes resulting from the practical work.

The implementation of a new reform-based curriculum adopted for 10th grade chemistry students, namely Living By Chemistry (LBC) was evaluated by Roehrig, Kruse and Kern (2007) in the USA. In this particular study, the authors explored the extent of chemistry teachers' beliefs and knowledge as well as school-level factors that could influence the implementation of inquiry-based instruction as intended by the LBC. The teachers' beliefs were obtained through semi-standardized interviews that were called the Teachers' Beliefs Interview (TBI). The interview also obtained information about the schools' characteristics. A total of 27 chemistry teachers from Ocean Valley, U.S. were observed for six to eight times throughout the school year to examine the implementation of the curriculum. The observation data were triangulated with the data from teachers' interviews and analysis of archive documents. The findings of this study revealed that all of the participating teachers indicated that they had implemented the *intended* curriculum, yet the classroom observations identified a wide range of instructional practices actually took place, mainly traditional, mechanistic, and inquiry. The authors also found that the use of these identified teaching practices during the implementation of LBC was strongly influenced by the teachers' beliefs about teaching and learning, and the presence of a supportive network at their school sites. It was noted that this study mainly focused on process evaluation, thus the students' information in terms of *perceived* and *achieved* curriculum were not identified.

In parallel with the revision of the science curriculum in 2002 carried by the Ministry of Education Malaysia (MOE), Boon (2008) conducted a case study on a chemistry master teacher to ascertain whether or not the teacher applied the thoughtful teaching concept as intended by the Revised Secondary Science Curriculum (RSSC) as he implemented the curriculum. Even though not formally stated, the study had focused investigation on the *implemented* curriculum and *perceived* curriculum, though, the information about the *achieved* curriculum was not covered. In order to seek how the RSSC was manifested in the teacher's classroom, six observations were conducted within a period of 10 months with each lesson covering two periods over 80 minutes. The observations were supported with semi-structured interviews conducted prior to each lesson, and unstructured interviews, conducted with the teachers on every visit. On the others hand, the students' opinions of the thoughtfulness of the teachers' teaching as well as their opinions of the characteristics of thoughtful teachers were sought through group interviews involving five to six students per group. In general, the author found that the major principles of thoughtful teaching and learning given by RSSC were adhered to but not the prescriptive models given in the RSSC documents. It was found that the teacher developed his own thoughtful teaching concepts that the author believed was influenced by the preferences and personal characteristics of the teachers.

2.5.2 Other science subjects

Investigation about the implementation of the Web of Life course in biology classrooms was conducted by Treagust (1989). In this study, the author described the teaching practices of two biology teachers located in two different schools in Western Australia who had used the curriculum. The investigation was organised based on the theoretical framework of *intended*, *implemented*, *perceived* and *achieved* curriculum. The analysis of the syllabus documents revealed that the course required the teachers to provide learning experiences for the students through the text, teacher-led discussions, students-students discussion and laboratory experiments. A series of observations for a period of six weeks and interviews were conducted to ascertain how these two teachers implemented the course. The students' perceptions about the teachers' instruction were sought from all the students using the Classroom Environment Scale questionnaire and by interviewing and observing six particular students in each of the teachers' classrooms. There was no formal assessment recorded in this study to measure the students' achievement in these two classes. However, the author believed that their achievement was satisfactory based on the students' and teachers' feedback during the interviews. This study found that the teaching practices used by both of these teachers could be characterised as whole-class interactive discussion, though each of the teachers used different instructional approaches based on the teachers' personality and teaching philosophy to facilitate the students' understanding. The author suggested the findings could be used as exemplary teaching practices for other teachers.

Osborne, Duschl and Fairbrother (2002) evaluated the new Advanced Subsidiary (AS) course in Science for Public Understanding (SPU) developed by the Nuffield Curriculum Centre and the University of New York. In this study, the authors identified 10 intentions of the SPU course in the official documents. In order to address these intentions, the authors had sought comprehensive data from both teachers and students who took this course between 2001 and 2002. Information about the strategies, difficulties and success that teachers encountered during the implementation of this course was obtained using two teacher questionnaires that were administered to all the teachers, in 29 visits to nine case study schools, as well as by interviewing 19 teachers. In addition, information about the students' responses to this new curriculum and the outcomes of this course were sought by (1) conducting 19 interviews with the students from four schools, (2) administering a questionnaire to 400 students, and (3) analysing 10% of the candidates' 2001 examination papers. The distinct features of this evaluation study were the use of only three curriculum representations in the theoretical framework, namely *intended*, *implemented*, and *achieved* curriculum. Instead of highlighting the *perceived* curriculum as a separate component, the authors treated the data concerning the students' perceptions within the *achieved* curriculum. In this way, the authors considered the students' perceptions as part of the outcomes of the course. At the end of the evaluation, the authors found that the course successfully achieved only two of its intentions: sustain and develop students' enjoyment of and interest in science; and encouraging students to take an informed interest in media reports about issues and events involving science and technology.

Hamzah and Abdullah (2009) conducted an investigation to evaluate the effectiveness of the Teaching and Learning of Science and Mathematics in English (PPSMI) and Computer Technology and Communication initiatives in Malaysian science classrooms. Even though not mentioned directly by the authors, it was recognized that this particular study had used the curriculum representations of *intended*, *implemented*, *perceived* and *achieved* curriculum as their principles of investigation. With the implementation of PPSMI in 2003, the Ministry of Education Malaysia (MOE) required that the medium of instruction for all Science and Mathematics subjects be change from Malay to English. In addition, the implementation of the Computer Technology and Communication initiative in conjunction with the PSSMI was believe to facilitate and smoothen the teaching of Science and Mathematics subjects in English. It was against these intentions that the authors tried to measure the teachers' teaching status and achievements' of students after six years of PPSMI implementation. This study was a large and complex project involving the total of 183 primary and 221 secondary school science teachers as well as 4410 primary students and 4946 secondary students. The investigation involved the development of 13 sets of instruments to be used for observation, survey, and testing methods. In general, the information about the teachers' instruction was collected through observation field notes, referred to as the Teachers Teaching Observation Instrument. The observation data were complemented with two surveys administered to the teachers, namely the Teachers' Self Evaluation Instrument, and the PPSMI Management Instrument. The students' perceptions of the process of instruction were evaluated using the Students' Self Evaluation Instrument. Finally, students' achievement as result of the instruction was determined using nine standard tests, called the Cognitive Level Evaluation Instrument, covering various subjects: science, mathematics, English, additional mathematics, physics and chemistry. Overall, the study highlighted that the PPSMI teachers' teaching status was poor and the level of computer technology usage was average. In terms of students' achievement in the standard tests, the urban students produced better results compared to the rural students in 10 of the 12 subjects tested, except for Physics Paper 1 and Chemistry Paper 1.

The U.S. science education reform documents and standards state that science teachers are intended to use constructivism in their teaching practices. The extent to which this intention was fulfilled was investigated by Savasci and Berlin (2012). The investigation involved a case study of four science teachers from public high schools and private middle schools who students between from Grade 6 to Grade 12. Using two semi-structured interviews, a demographic questionnaire, classroom observations and analysis of classroom documents, information about the science lessons instruction was obtained. Meanwhile, the Classroom Learning Environment Survey (CLES) was administered to all the students taught by these four teachers. The information obtain from this questionnaire was used to understand the students' perceptions towards their science lesson environments. The results showed that although the teachers embraced constructivism, classroom observations did not confirm implementation of these beliefs by three of the four teachers who took part in this study. Besides these findings, no information about student outcomes was reported.

2.6 Conclusion

In the quest to investigate the extent to which the chemistry lessons in Malaysian classrooms had realised the Chemistry curriculum intentions, especially in acids and bases topic, the researcher reviewed the related literature in curriculum evaluation as well as previous evaluation research in chemistry and other science subjects.

The researcher reviewed the literature about theoretical frameworks used in this study.

The literature informed that:

- The four principal questions highlighted in Tyler's rationale were recognized to represent the four levels of curriculum development processes.
- Goodlad (1977) introduced five curriculum domains as guide to examine the values of all major decision making in the curriculum planning process. These curriculum domains are *ideal, formal, perceived, operational, and experiential.*
- The curriculum planners claimed the Goodlad's curriculum domains are able to systematically and comprehensively answer the inquiries that are commonly encountered in various stages of curriculum activities.
- Throughout the years, the Goodlad's curriculum domains were actively adopted, adapted and expanded by various authors depending on their interpretations of these domains.
- Eventually, this study utilised the curriculum representations as defined by Van Den Akker (1998) and Treagust (1989) as the research framework, namely *intended* curriculum, *implemented* curriculum, *perceived* curriculum and *achieved* curriculum.

The researcher reviewed the literature about conceptualisation of curriculum evaluation research.

The literature informed that:

- The educational evaluation research had evolved through five stages from 1920, where it began as psychometric evaluation, until present, where it is regarded as a prospective profession and speciality field. The stages are known as the *pre-Tylerian* period, the *Tylerian* age, the age of *innocence*, the age of *realism* and the age of *professionalism*.
- Curriculum evaluation is one sort of the educational evaluation.
- Various authors defined curriculum evaluation differently, but most of them unanimously highlighted the process of making judgments as well as assessment of values as key terms to describe curriculum evaluation.

- For this study, curriculum evaluation is defined as the process of gathering data to make judgments about the operation and outcomes of acids and bases lessons in meeting the intentions of the Chemistry curriculum.
- The scope of curriculum evaluation goes beyond the assessments of students' achievement, the instructor performances, and the effectiveness of particular approaches, instead it covers whether or not the curriculum goals and objectives have been met as intended.
- This study places the focus of evaluation on student outcomes of learning and the lessons implementation against the intentions of Chemistry Curriculum.

The researcher reviewed the literature about techniques used to address curriculum evaluation research.

The literature informed that:

- The intentions of curriculum commonly embodied in the curriculum theory- a blueprint that provides information on how a program should ideally be implemented and how its goals are to be attained.
- Curriculum theory existed in two forms, impact theory or intended outcomes and process theory or intended transaction.
- Curriculum theory typically could be extracted from the official documents.
- For this study, the goals and objective of the acids and bases topic mentioned in the Chemistry curriculum were extracted to represent the impact theory; meanwhile the teaching and learning methods proposed by the Chemistry curriculum were extracted to represent the process theory. The extent of acids and bases lessons had been achieved and whether or not the teaching and learning activities had been carried out as required by the Chemistry curriculum were determined by these two theories.
- Assessment of lessons implementation ascertains whether or not the educational program process, activities and operations have been implemented as intended.
- There were various techniques suggested to address the lessons implementation: direct observation, questionnaires, and interviews.
- This study utilised the questionnaire technique to elicit information about the lessons implementation where the teachers and students' responses from urban

and rural schools were collected using the Questionnaire of Enacted Curriculum (QEC).

- Assessment of students' perceptions enables the students' learning experiences to be addressed.
- The questionnaire is suggested to be the effective technique to address the students' perceptions.
- This study utilised a questionnaire to sought information about the students' perceptions, namely the modified version of the What Is Happening In This Class? (WIHIC).
- Assessment of student outcomes ascertains whether or not the educational program has achieved what was set out to accomplish or whether or not any improvements were experienced by the learners.
- Two types of student outcomes can be addressed: cognitive outcomes and non-cognitive outcomes.
- An achievement test was suggested to address the student cognitive outcomes; meanwhile, interview and questionnaire techniques were suggested to address the student non-cognitive outcomes.
- For this study, a pre-test and post-test called Acids-Bases Chemistry Achievement Test (ABCAT) was utilised to seek information about the students' progress throughout the acids and bases lessons (cognitive outcome); meanwhile, a questionnaire called the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) was used to sought information about the students' attitudes towards the acids and bases lessons (non-cognitive outcome).

The researcher reviewed the literature about previous research of curriculum evaluation in chemistry and other science subjects.

The literature informed that:

- The evaluation research were found to apply the curriculum representations of *intended* curriculum, *implemented* curriculum, *perceived* curriculum and *achieved* curriculum as their research framework, either explicitly or implicitly.
- There was not much evaluation research was found in chemistry subject as compared to the others science subjects.

- None of the evaluation research in chemistry subject was found to place their focus on acids and bases topic.
- One study was found reporting about the evaluation research on Malaysian secondary school Chemistry curriculum.

In conclusion, this chapter provides a wide range of information from the extant literature related to this study. The review started by exploring the theoretical framework used in this study that covered the origin of curriculum domains or representations towards its adoption, adaptation and expansion by various academics. The reviews than covers the definition, purposes, and scope for conducting curriculum evaluation. Next, the research literature with regard to addressing the curriculum intentions, the implementation of lessons, students' perceptions, and student outcomes are reviewed. The final section provides an overview of previous curriculum evaluation research in chemistry and other science subjects.

CHAPTER 3 | METHODOLOGY

3.1 Introduction

This chapter is divided into six main sections and mainly lays out the methodology used in this study. First, it deals with the four stages of the research process involved in this study (Section 3.2). Second, it states the rationale for this research to use the case study design (Section 3.3). Third, it describes the determination of data sources and the bounded system for the research (Section 3.4). Fourth, it draws the methods used in this research (Section 3.5). Fifth, it describes the collection of data corresponding to the five research questions (Section 3.6). Finally, it lists the chronology of the data collection (Section 3.7).

3.2 Research Process

In general this study was guided by a research process which contains four major stages that are common to all educational research: topic; design and methods; collect, analyse and interpret data; and dissemination. Figure 3.1 illustrates the stages of the research process adopted in this study. Basically, there are four circles that are joined by arrows. Each circle represents a research stage. Meanwhile, the arrows represent the interacting direction of the circles. The whole process is dynamic in nature as the stages interact and impact to each other.

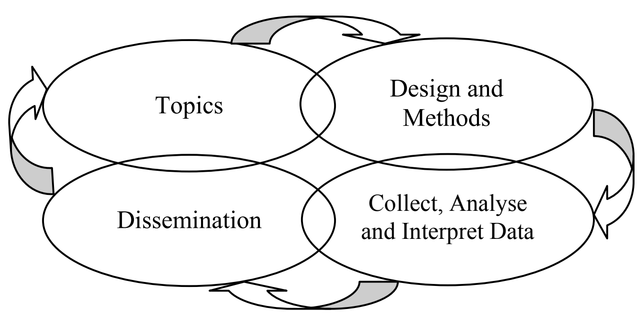

Figure 3.1 General research process [From Anderson and Arsenault (2004, p.28)].

The research process for this study began by identifying the research topic. The selection of the topic was motivated by the researcher's personal interest to evaluate the present Chemistry curriculum which was supported by the literature review. The review unveiled the research problem which led to the development of the research questions. The review of the relevant literature can be found in Chapter 1 and Chapter 2 of this thesis.

The selection of research design and methods for this research was largely influenced by its abilities to answer the research questions. In addition, the selection of methods also took account the accessibility to the participants as well as the method's capacities to gain as much data as possible without affecting the participants' routines. Respectively, Section 3.3 and Section 3.5 justify the use of the research design and the research methods for this study.

This research involved an investigation of a particular topic in chemistry, acids and bases, which typically is taught at the end of the Malaysian school term in Form 4 (Grade 10). For this reason, the researcher had developed a detailed plan covering the research activities that should be done before, during, and after the data collection. In general, the following activities had been carried out: the development of instruments (before the data collection stage); the administration of instruments (during the data collection stage); and data analysis and interpretation (after the data collection stage). These steps were crucial to assure the smoothness of research flow as well to guarantee the data could be collected within the period allocated. The chronology of the data collection is described in Figure 3.5.

The final stages involved reporting the data collected and discussion of the findings when, the researcher's arguments were set forth and supported by relevant theories and literature. The results of the analysis and discussion of the findings are presented in relation to each of the research question from Chapter 6 until Chapter 10 of this thesis.

3.3 Case Study as Research Design

3.3.1 Justification on the choice of case study

Research design is described as a plan of research that guides the researchers' inquiries by clarifying what they are going to test, collect, interpret, analyse and report (Wiersma, 2000). Vaus (2005) equated the research design similar to the blueprint of a building where the researchers need to draft their strategy of work before proceeding with the investigation. This ensured that the investigation could provide usable results (Wiersma, 2000) in order to answer the research questions (de Vaus, 2005).

Table 3.1 The features of experimental and non-experimental research design as described by Merriam (1988).

Experimental Research	Non-experimental Research
Variable of interest can be manipulated.	Not possible to manipulate the cause of behaviour.
To investigate cause-and-effect relationship.	To examine events or phenomena.
Subjects are assigned at random to experimental and control groups.	Subjects too embedded in the phenomenon.

Several types of research design are commonly used by educational researchers. Yin (1989) classified research designs into five types: experimental design; survey design; archival analysis; history design; and case study design. Bryman's (2008) classification of design is slightly different from Yin. He described true experimental design, cross-sectional or survey design, longitudinal design, case study design, and comparative design as the typically used research design. Despite this disagreement, Merriam (1988) classified these designs into two general groups: experimental research; and non-experimental or descriptive research. The distinction between these two groups can be described by three features (Table 3.1). First, the researchers could manipulate the variables of interest in an experimental design, whereas the variables of interest in a non-experimental research are not possible to manipulate as the variables are not easily identified. Secondly, the main goal of experimental research is to investigate the relationship of cause-and-effect; meanwhile the non-experimental research intent to examine and interpret the events or phenomena. Finally, experimental research tends to divide the subjects to form the treatment and control groups via sampling techniques. However, this cannot be done in non-experimental research as the subjects were firmly embedded in the phenomenon.

Based on these features, it is obvious that this research is non-experimental in nature. Further consideration in determining the suitable design for this research took account of the three criteria outlined by Yin (1989) and Bryman (2008): the nature of research questions; ability to control behavioural variables; and whether the inquiry is centred on contemporary events. The consideration of these criteria are important to avoid flaws in answering the research questions that may be caused from the use of unsuitable research designs (Wiersma, 2000).

The nature of the research questions

The first criterion required the researcher to understand each of the stated research questions that he intended to ask. In general, a "what' question might be exploratory or a quantifier in nature (research designs such as experiment, survey, archival analysis, history, or case study can be used to answer these type of questions), or about the prevalence of an event or entity (in which surveys or analysis of archival records designs could possibly use to answer the questions). In addition, "how" and "why" questions could be exploratory, descriptive, or explanatory in nature where case study, experimental or historical designs would be best to answer such questions (Yin, 1989).

Basically, this research was trying to evaluate the effectiveness of acids and bases teaching and learning in meeting the Chemistry curriculum intentions. Four curriculum representations were used to illuminate the theoretical framework of this research: the *intended* curriculum; *implemented* curriculum; *perceived* curriculum; and *achieved* curriculum (Mills & Treagust, 2003; Treagust, 1989; Van den Akker, 1998). In line with the stated purpose and curriculum representations, five research questions were derived as followed: (1) What are the intentions of the Chemistry curriculum in terms of teaching and learning? (2) How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? (3)

What are the urban and rural chemistry students' perceptions about their acids and bases lessons? (4) To what extent are the outcomes from the acids and bases lessons in urban and rural schools different? (5) What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes? All these questions mainly tried to probe and describe the phenomenon of teaching and learning that occurred in acids and bases lessons. Such types of questions have shortlisted this study under three possible research designs: case study, experiments or histories.

The ability to control variables

The second criterion requires the researchers to identify all possible variables involved and to distinguish between independent and dependant variables. Typical experimental designs presume that the actual behavioural events (independent variable) can be accessed and manipulated, and thus, enable them to be controlled directly, precisely and systematically. Moreover, the experimental design deliberately separates the phenomenon from its context (Smith, 1978) so that the attention of the investigation can be put only on the variables of interest (Yin, 1989). Contrarily, for the event where the behaviours of interest cannot possibly manipulated and the boundaries between the phenomenon and context are not clearly apparent, a case study and history designs are the best option (Yin, 1989). In fact, Merriam (1988) stressed that in most educational situations it is not possible to control all the variables of interest.

This research identified teachers' implementation, students' perceptions and student outcomes as the variables of interest. This research was conducted in the natural setting of chemistry classrooms which took place in urban and rural schools. This means that the researcher did not intervene nor was involved in any kind of classroom decision making. The behavioural events (variables) that became the focus of this research were beyond the researcher control and thus were not involved in any manipulation. This criterion enabled the researcher to confirm this study as non-experimental design.

Whether the centre of inquiry is on contemporary events

The third criterion requires the researchers to determine whether the focus of investigation only relies on recorded and physical evidence. Such cases occur when there is no live persons available and the only valid sources are from primary documents, secondary documents, or artefacts. In this situation, a historical design is most appropriate, whereas case study design is applied when the evidences are possible to be collected directly from the sources or persons (Yin, 1989).

This research was dealing directly with chemistry teachers and chemistry students who were involved in acids and bases lessons in 2011. Prior to that, the researcher had reviewed the latest formal documents produced by the Ministry of Education Malaysia (MOE) in order to identify the curriculum intentions in terms of teacher instructions, students' perceptions, and student outcomes. These features revolved around the current events, thus suggested that the case study was the most suitable design for this study.

3.3.2 The nature of a case study

Three criteria described by Yin (1989) and Bryman (2008) in Section 3.3.1 acts as double edge swords where it not only provides a rationale for the researcher to use a case study as design, but also provides descriptions of the features in this study. These features, in parallel with Yin's (1981, p. 59) definition of a case study as, "… an empirical inquiry that attempts to examine: a contemporary phenomenon in its real-life context [when] the boundaries between phenomenon and context are not clearly evident, [and] multiple sources of evidence is used". Based on this definition, the case study can be described as an examination of instance in action (Adelman, Jenkins, & Kemmis, 1976) where it involved real people, real context and real situation. The case study has been built based on this foundation to gain knowledge (Ary, Jacobs, & Razavieh, 2002) or adding existing experiences to understand the real dynamics of situations and people (Stake, 1980). In short, the hallmark of a case study is the significance rather than the frequency (Adelman et al., 1976; Cohen, Manion, & Morrison, 2007). There are two perspectives on how the researcher could perceive the case study: by perceiving the case study as a pre-specified procedure or a methodology (Creswell, 2007; Yin, 1989, 1994) or, contemplating it as a methodology then the case study could be perceived as an object of what to investigate (Adelman et al., 1976; Stake, 1995).

There are several purposes for conducting a case study. Hakim (1987) listed three purposes: to provide preliminary information for a new topic which has never been explored before; to provide a rich detailed description of particular aspects or issues to refine existing knowledge; and to provide a prevailing explanation and ideas to specify the rationale of inclusion or exclusion of variables from the research. Respectively, Yin (1989, 1994) identified these three purposes as specific types of case studies: exploratory case study, descriptive case study, and explanatory case study. Creswell (2008) revealed three others: intrinsic case study- an investigation done with the intention of illuminating a unique or unusual phenomenon; instrumental case study- an investigation of particular phenomenon in order to provides insight into an issue or theme; and collective case study- investigation involves describing and comparing of multiple instrumental cases in order to gain an understanding into an issue or human behaviour. Thomas (2011) added one more purpose to the list which is to evaluative a case study purposely to see how well something is functioning or functioned and to find out what changes have occurred.

3.3.3 Application of a case study design in this research

Considering that the purpose of this research involved complex interactions of different variables (*intended*, *implemented*, *perceived* and *achieved* curriculum) from different sources (urban and rural schools) and different actors (teachers and students), it was important for the researcher to have an organised system of evaluation. For that reason, the case study as a research design or methodology was considered the most suitable to be employed in this research. This perspective of a case study had guided the researcher to systematically answer the research questions as well as organising the work process that included data collection, data analysing, data interpreting, and data reporting. This decision was consistent with Yin (1981) who stated that the case study is a systematic research tool. In conjunction with the purpose of the investigation to see the extent to which the acids and bases lessons meet the Chemistry curriculum intentions in terms of teachers' implementation, students' perceptions, and students' achievement, this study suits well under the evaluative case study.

A multiple-case design was employed in this research requiring the replication of two or more bounded systems (Yin, 1989, 1994). The determination of the case boundary is crucial in order to draw a line between what should and what should not be investigated (Gondo, Amis, & Vardaman, 2010). In the case of this research, the bounded system was referred as the location of schools, whether located within the urban or rural areas. The boundary that distinguishes these two locations is further described in the data sources (Section 3.4). In each bounded system, the researcher was mainly interested to find the extent to which the acids and bases lesson activities were aligned with the Chemistry curriculum intentions.

This study is mainly quantitative. Three methods of data collection were employed: interviews, survey, and test. Through interviews with the representative from the Curriculum Development Division (CDD), the researcher had obtained supporting information regarding the Chemistry curriculum intentions. Three survey instruments were developed to gain information regarding the lessons implementation, students' perceptions and students' non-cognitive outcomes towards the acids and bases lessons, namely, Questionnaire of Enacted Curriculum (QEC), modified version of the What Is Happening In This Class? (WIHIC), and modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS). Meanwhile, the Acids-Bases Chemistry Achievement Test (ABCAT) was developed to seek information related to students' cognitive outcome about the acids and bases lessons.

The responses provided by the participants in this study were not large enough to make the generalisation to the whole population who might be involved in the Chemistry curriculum in Malaysia. However, this study was intended to benefit the participating schools and readers who are interested to know how the acids and bases lesson were implemented, perceived and achieved in conjunction with the Chemistry curriculum and comparing urban and rural schools in one of the districts in Malaysia.

3.4 Data Sources and a Bounded System

The chemistry teachers and Form 4 chemistry students from seven schools were invited to participate in this study. These schools were selected out of 36 secondary schools in the Melaka Tengah district based on their accessibility. These schools can be distinguished in terms of their locations, being urban or rural. These locations became the basis for the bounded systems in this study. The categorisation of the location for each school was provided by the Department of Town and Country Planning Peninsular Malaysia (DTCPPM) using an overlay technique. This technique involved the projection of the schools locations (coordinate obtained from GPS, Google Earth, and Wikimapia) onto the map of the population distribution gathered from the population census in year 2000 (*Senarai sekolah-sekolah negeri Melaka [List of schools in the state of Melaka]*, 2011).

In order to make a school eligible to be classified under the urban category, the school must be determined whether located within the boundary of an urban area. The DTCPPM defined an urban area in terms of five characteristics: has been approved residential; has been populated by at least 10000 people; has 60% of its population aged 15 years old and above working in a non-agriculture sector; has been occupied by at least 50 to 60 people per hectare; has basic facilities such as shops, schools, health centre, public hall, worship houses, post office, police station, bus station, market, and city park (*Senarai sekolah-sekolah negeri Melaka [List of schools in the state of Melaka]*, 2011). On the other hand, schools located outside the urban area are categorised as rural schools.

According to the latest list of the overlay that had been conducted by the DTCPPM, 24 urban schools and 12 rural schools located around Melaka Tengah district were identified. From this number, five urban schools and two rural schools were selected for this research. The participants consisted of nine chemistry teachers and their chemistry students. The number of chemistry students who participated in this study varied in each of the instruments distributed (354 students responded to the student edition of the QEC; 260 students responded to the modified version of the WIHIC; 260 students responded to the modified version of the ATCLS; and 304 students responded to the ABCAT). However, only 247 students were found to provide their responses to all the instruments. The students were composed of different ethnicities, mainly Malay, Chinese, Indian, and others.

Through the teacher edition of the QEC, the urban and rural teachers were asked about their highest qualifications that they currently hold. All teachers indicated had at least a bachelors degree as their highest professional qualification except one urban teacher who had a masters degree. The majority of the teachers had more than five years of service at the current school and had experience in teaching the acids and bases topic.

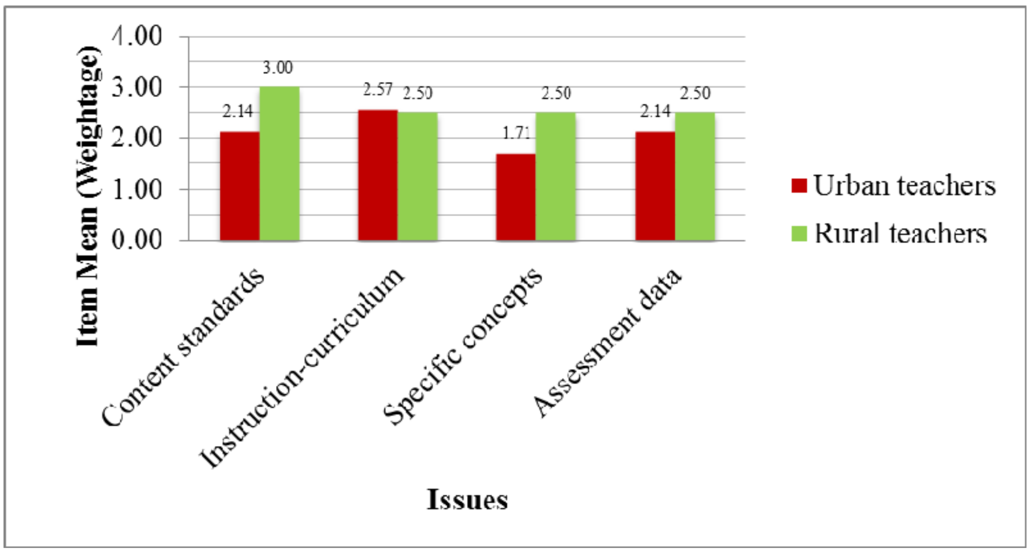

Figure 3.2 Teachers' views concerning the emphasization of Chemistry curriculum issues during their professional development activities.

Both urban and rural teachers then were asked the extent to which they had been exposed to the issues of Chemistry curriculum during their in-service training or in other professional development workshops or courses. The rural teachers indicated they had a better exposure than the urban teachers in terms of three issues: the content standards related to the Chemistry curriculum and how it was used; the specific concepts related to the in-depth study of particular concepts within the chemistry subject; and assessment related to how the results of assessment could be interpreted to be used in chemistry instruction. Meanwhile, both urban and rural teachers indicated that they were moderately informed in terms of instruction related to the alignment of the Chemistry curriculum. On average, both urban and rural teachers had moderate to large exposure to all the issues except that of specific concepts, in which urban teachers only had minor experience. Figure 3.2 represents the teachers' responses about these four issues.

The teachers were asked about the criteria for students to be eligible to enrol in the Chemistry classroom: both urban and rural teachers described their students as selected cohorts where their enrolment to the chemistry course was based on their previous PMR science results. Nevertheless, when the students' achievement were compared to the national norm most urban teachers indicated that their students can be considered at the moderate level; meanwhile the rural teachers indicated their students were between low to mix level of achievement.

In order to gain a brief idea about the state of students' achievement in science, all student participants were asked about their previous results of PMR science via the student edition of the QEC. The urban cohort mainly consisted of students who had grades A to D, while the rural cohort mainly consisted of students who had grades A to C in their PMR science. More half of the students from both cohorts (69.69% for urban students; 56% for rural students) indicated had grade A. In contrast, the lowest PMR science grade was D for urban students (1.97%), and grade C for the rural students (10%). Figure 3.3 represents the urban and rural students PMR science result.

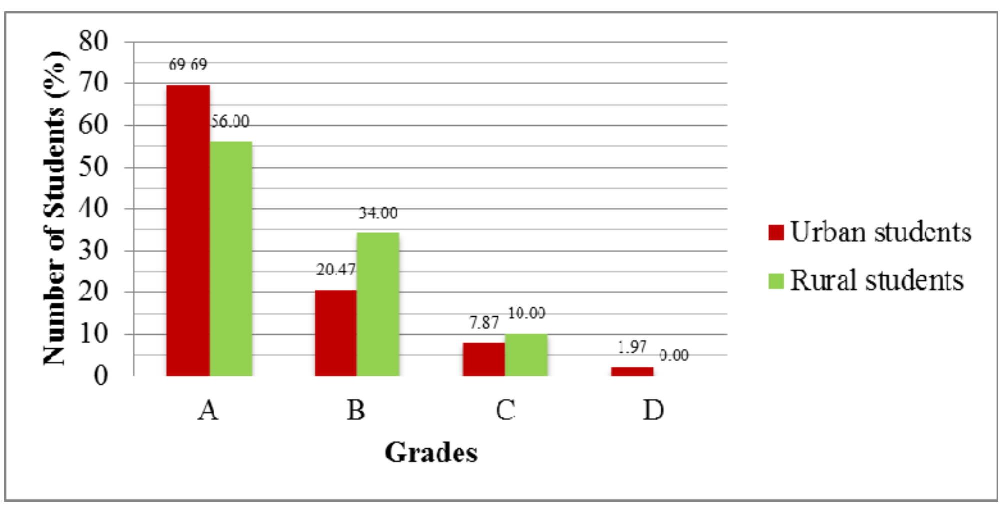

Figure 3.3 Number of urban and rural students who obtained grades A to D in PMR science result.

Teachers' responses to the question asking for the number of chemistry classes taught shows that the urban teachers were in charge of one to five classes consisting of 21 to 30 students per classroom. Meanwhile, the rural teachers were in charge of one to two classes with the number of students in each classroom ranging from 11 to 20. Each urban and rural chemistry classroom had undergone the total of two to three hours chemistry lessons every week with approximately 41 to 50 minutes per session.

When a question asking the medium of instruction used during the chemistry lessons, most urban and rural teachers mentioned that they had used a mixture of English and Malay languages. This situation was confirmed from the responses provided by the majority of the urban (84.65%) and rural (93%) students, described in Figure 3.4.

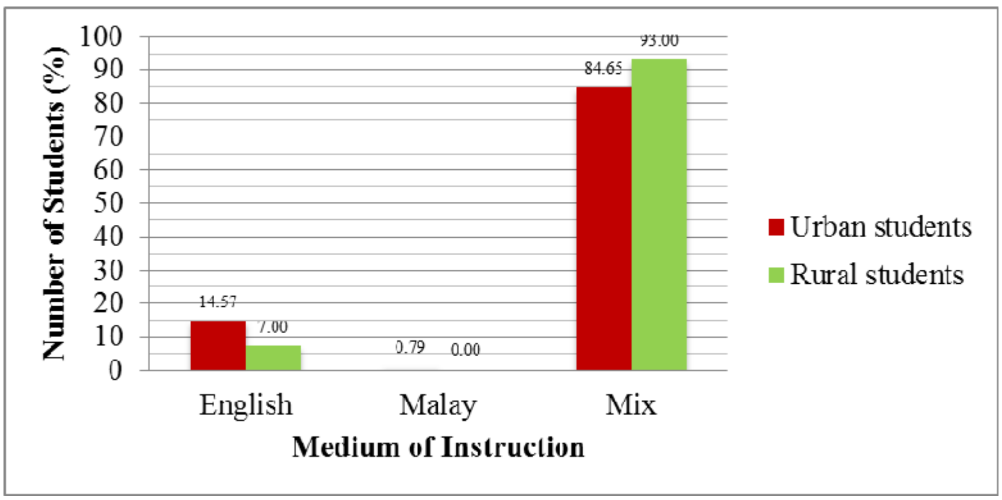

Figure 3.4 Students' perspectives regarding the medium of instruction during chemistry lessons.

3.5 Methods

The use of interviews and questionnaires in this research was chosen based on their potential to evaluate particular aspects of the curriculum as suggested by McCormick and James (1988).

3.5.1 Interviews

The nature of the interviews

The interview is commonly defined as a process which involves interaction of two or more people for a specific purposes associated with some agreed subject matter. The person asking the questions and receiving the answers, known as the interviewer; the person answering the questions, is known as the interviewee (Anderson & Arsenault, 2004; Robson, 2002).

Robson (2002) listed three main types of interviews: Fully structured; semi-structured; and unstructured. The fully structured interview can be identified through fixed wording, pre-determined questions, and firm arrangements of questions. These characteristics are best suited to a highly fixed research design and typically administered alongside with other methods (Robson, 2002). According to Anderson and Arsenault (2004), who called this type of interview a normative interview, the questions asked are straight forward similar to a self-administered questionnaire and the data obtained are easily coded in order to be converted into statistical data.

The characteristics of predetermined questions are also exhibited by the semi-structured interview. Nonetheless, the order and the wording of the questions can be modified according to the situation, and to some extent, the interviewer is allowed to omit or add questions when necessary. This type of interview permits the interviewer to give explanations and clarifications of any ambiguous questions. The versatility of the semi-structured interview enables it to be employed solely or in combination with other methods as part of a flexible research design (Robson, 2002).

The unstructured interview exhibits opposing characteristics from the structured interview. This type of interview does not have pre-determined questions nor have standardized procedures to be carried out. Instead, the interviewer would let the conversation to develop around the area of interest within an informal condition. Anderson and Arsenault (2004) also called this interview a key informant interview where the purpose is to seek deep understanding of particular persons within a situation. This type of interview is commonly employed in a flexible research design.

Besides providing rich and intense information, the interview method enables the researcher to probe further for explanations of the interviewee's answers; this cannot be done using the questionnaire survey method. However, the interview method can have low reliability and interpretation bias due to the lack of standardization technique (Robson, 2002). Furthermore, it is time-consuming to prepare (such as making appointments, obtaining permission, rearranging appointments) and to administer (in which the interviews are varied in length). Anderson and Arsenault (2004) listed several settings where the interviews can be conducted. In the case where one interviewer and one interviewee are involved, face-to-face and phone interviews can be employed. However, if the interview required more than two interviewees, then group interviews or focus groups are recommended.

The application of the interviews in this research

The semi-structured interview or respondent interview was employed in this research. Face-to-face interviews were conducted with the CDD's representative in mid-February 2011. The interview was designed to gain further clarification of the Chemistry curriculum in terms of the intended implementation, intended perceptions, and intended outcomes. In order to cross-reference the data to transcripts of the interview with the CDD's representative, only a single code was used. The particular code is CDD/MOE/16.02.2011, where CDD refers to the interviewee (CDD' representative), MOE refers to the location of interview (Ministry of Education Malaysia), and 16.02.2011 is the date of the interview (16 February 2011). The format of semi-structured interview with the CDD's representative can be found in Appendix A, while the interview transcript can be found in Appendix B.

3.5.2 Questionnaires

The nature of the questionnaires

Merriam (1988) reminded the researchers to distinguished between the questionnaire as a survey design and the questionnaire as a research method. She added that research which embraces a case study as a design can be used as a questionnaire for data gathering.

Anderson and Arsenault (2004) identified eight types of questionnaire items: Fill-in-the-blank or ratio data questions; Multiple choice; Comment-on; List; Likert scale or rating scale; Rank; Dichotomous questions; and Constant sum questions. Cohen, Manion and Morrison (2007) grouped these types of questionnaire items into closed-ended questions and open-ended questions. The close-ended questions are highly structured questions that provide the respondents with a range of response options to choose from. Multiple choice, Likert scale or rating scale, dichotomous questions, and constant sum questions are examples of closed-ended questions. The open-ended questions give freedom for the respondents to elaborate, clarify, and qualify their responses as much as they wish. Fill-in-the-blank or ratio data questions, comment-on, list, and rank are examples of open-ended questions.

Robson (2002) listed three common approaches on how questionnaires can be administered. First is the self-completion questionnaire where the researchers distribute the questionnaire and the respondents fill in the answers by themselves. Second is the face-to-face interview where the researchers ask the respondents a chain of questions, while the researchers completing the questionnaire on behalf of the respondents. Third is the telephone interview where the researcher asks the respondents a chain of questions via phone and the responses are recorded by the researcher. In addition, Anderson and Arsenault (2004) proposed three modes of questionnaire administration and data recording: standard - the questionnaires are distributed and the responses are manually entered into a database; optical scanning - the questionnaires are distributed and the responses are recorded by an optical scanner; electronic questionnaire - the questionnaires are sent via electronic mail (e-mail) and the data may be recorded manually into the database or using specific software.

Questionnaires enable large numbers of questions to be asked to a large number of respondents from many locations with lower cost and in a timely manner (Anderson & Arsenault, 2004). The reliable and valid data generated provide descriptive and inferential statistics as well as correlation information between variables (Adelman et al., 1976; Cohen et al., 2007). Anderson and Arsenault (2004) admitted that the extensive planning and developing of the questionnaires required a lot of time and money, as well as being exposed to the risk of non-response bias (caused from respondents not gives their responses) and response bias (caused from respondent misinterpreting the questions asked).

The application of the questionnaires in this research

Three types of closed-ended questionnaires have been developed to be used in the data collection stage. The first was the QEC that existed in the form of a teacher edition and a student edition. The teacher edition intended to gain information about the lessons' implementation from the views of the teachers. Meanwhile, the student edition intended to obtain information about the lessons' implementation from the perspectives of the students. The second was the modified version of the ATCLS, adapted to measure the students' attitudes towards the acids and bases lessons. The third was the modified version of the WIHIC, used to seek the students' learning environments during the acids and bases lessons.

All questionnaires maintained the application of multiple-choice items and Likert scale items from the original questionnaires. All questionnaires were administered and analysed using standard mode where the copies of questionnaires were distributed to all the participants and the responses were manually entered into the database. The details of the questionnaires developments can be found in Chapter 4.

3.6 Research Questions and Data Collection

This section describes the methods and sources for data collection corresponding to the five research questions of this research. Table 3.2 provides an overview of this section.

Table 3.2 Research questions, methods, and data sources used in this research.

Research Framework	Research Question	Method	Data Source
Intended curriculum	What are the intentions of the Chemistry curriculum in terms of teaching and learning?	Documents analysis	Chemistry curriculum syllabus and specifications.
		Interview	CDD's representative.
Implemented curriculum	How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?	Questionnaire	QEC- teacher edition and student edition.
Perceived curriculum	What are the urban and rural chemistry students' perceptions about their acids and bases lessons?	Questionnaire	Modified version of the WIHIC - actual form and preferred form.
Achieved curriculum	To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?	Questionnaire	Modified version of the ATCLS - actual form and preferred form.
		Test	ABCAT- pre-test and post-test.
	What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?	Correlation	QEC- student edition.
			Modified version of the WIHIC - actual form.
			Modified version of the ATCLS - actual form.
			ABCAT- post-test.

3.6.1 What are the intentions of the Chemistry curriculum in terms of teaching and learning?

The intentions of the Chemistry curriculum were extracted from two main sources: the syllabus and the specifications. Both of these official documents were developed by the CDD with the approval of MOE. The identification of the so called *intended* curriculum would provide the benchmarks in answering the research questions.

In order to shed light on the implicit or ambiguous aspects (Weiss, 1997) of the Chemistry curriculum intentions, a semi-structured interview was conducted with one of the CDD's representatives. Careful attention was placed in terms of ethical issues, questioning techniques and building rapport. The researcher started the interview session by introducing himself while supplying the respondent with the information sheet and consent form. The respondent was briefed about the background of the research (Bryman, 2008) and also was reminded of her right and privacy throughout the session.

In terms of the questioning technique, the researcher started the session with semi-structured questions followed by probing questions based on the respondent's responses (Lodico, Spaulding, & Voegtle, 2006). At the same time, rapport was developed through a conversation-like-situation (Lodico et al., 2006) where the dialogue was not constrained by the structure of questions prepared and the respondent was freely able to express her opinions on related issues without any interruption from the researcher. During the session, the researcher tried his best to become a good listener and also conscious in his attitude in order to avoid being judgemental in his reactions (Lodico et al., 2006). These situations however had extended the session longer than expected. An audio recorder was used to record the interview conversation before it was transcribed and analysed. The results of the analysis in response to the first research question are described in Chapter 6.

3.6.2 How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?

The description on how the acids and bases lesson were actually delivered in urban and rural chemistry classrooms was obtained through the QEC questionnaire. The QEC were adapted from two existing questionnaires, Survey of Enacted Curriculum (Smithson & Blank, 2006) and 2000 National Survey of Science and Mathematics Education Science Questionnaire (Weiss, Pasley, Smith, Banilower, & Heck, 2003). Both of the original questionnaires had demonstrated reasonable standards of validity and reliability.

Instead of using direct observations (Anderson & Arsenault, 2004; Stake, 1995), the researcher decided to use the questionnaire method because it was hard to attend all the participating schools for the acids and bases lessons which typically are delivered almost at the same time in all Form 4 chemistry classrooms between August and September every year (Wong, 2009; *Yearly lesson plan: Chemistry Form 4*, 2011). Table 3.3 shows an example of two participant teachers' timetables in different schools on Tuesday and Monday which were at the same time. Such situations did not support the direct observation to be done, thus the use of questionnaires was considered more practical to cover all schools involved.

Table 3.3 Example of two participated chemistry teachers' timetables.

Monday	Tuesday	Wednesday	Thursday
Teacher A (9.05 am - 10.15 am)		Teacher A (9.05 am - 10.15 am)	Teacher A (9.05 am - 10.15 am)
Teacher B (10.45 am -11.55 am)	Teacher A (11.45 am - 1.00 pm)		Teacher B (12.30pm - 1.40 pm)
	Teacher B (11.55 am - 1.05 pm)		
	Teacher B (1.05 pm - 2.15 pm)		

There were three other rationales for the use of the questionnaire method instead of direct observation in this study: the limited accessibility to certain schools where the schools' administrators would not allow observations to take place for a period of time in their school as they believed this could effect the students' concentration and privacy; as this study was an evaluation in nature, therefore the teachers were unwilling to have their instruction observed directly as they felt uncomfortable that their performances were being rated and assessed; and the schools locations which were far from each other making it difficult to reach the site on time.

The use of a questionnaire to evaluate the *implemented* curriculum was considered as indirect observation and permissible as long the researcher was clear on what was to be find out (McCormick & James, 1988). McCormick and James (1988) added that the use of this method in evaluation research not only provides information regarding occurrence of behaviour, but also provides information on motives, attitudes towards certain events, as well as attitudes, values and beliefs in general. Nonetheless, the researcher was aware of the limitations of this method. By using a questionnaire, the researcher was not able to ask for any clarification nor probe further response from the teachers in order to gain in deeper understanding of their stated behaviours (McCormick & James, 1988).

For this purpose, the teacher edition of the QEC was developed and distributed to all nine urban and rural chemistry teachers to obtain the descriptions of how the acids and bases were actually delivered. The teacher edition of the QEC had been developed concurrently with the student edition of the QEC. Both editions were similar in most aspects including the content of items. Only minor adjustments were made in terms of questionnaire instructions and statements of certain items to suit the different perspectives of the teachers and students. The administration of the QEC took place after the whole acids and bases lessons had been completely delivered in each chemistry classrooms. Section 4.3 described the development of both editions of the QEC. Meanwhile, Chapter 7 described the results of the analysis in response to the second research question. Here, the results of the average item means were used as the basis of comparison.

3.6.3 What are the urban and rural chemistry students' perceptions about their acids and bases lessons?

Data on students' perceptions towards their acids and bases learning environment were obtained through administration of a modified version of the WIHIC. The modified version of the WIHIC existed in terms of the actual form and the preferred form. The former intended to seek the actual perceptions of students concerning their learning environment; meanwhile, the latter intended to seek the desire of students on how their learning environment would be.

The preferred form of the modified version of the WIHIC was administered together with the preferred form of the modified version of the ATCLS and the pre-test of the ABCAT three month prior to the lessons commencement. On the other hand, the actual form of the modified version of the WIHIC was administered together with the actual form of the modified version of the ATCLS and the post-test of the ABCAT a week after the whole lessons were completed. Section 4.5 describes the development of the modified version of the WIHIC and Chapter 8 described the results of the analysis in response to the third research question. The results were reported in forms of average item mean, average item standard deviation, effect size, and *t* values.

3.6.4 To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?

The students' outcomes of this research were described in two ways: the cognitive outcome which provides information on how well the chemistry students had conceptualised the acids and bases lessons throughout the instructions (Fisher & Frey, 2007; Gronlund, 2003; Trice, 2000); and the non-cognitive outcomes which were concerned with the students' feeling (attitudinal domain) towards their acids and bases lessons (McCormick & James, 1988; Yager & McCormack, 1989).

Information regarding the students' cognitive outcomes was obtained through administration of a multiple choice test called ABCAT. Two types of ABCAT had been developed, for a pre-test and post-test. The pre-test had been conducted three months prior to the lessons commencement (together with the preferred forms of the modified version of the ATCLS and the modified version of the WIHIC). The early administration of the ABCAT was to ensure the students started the lesson with similar level of conceptual knowledge (Lodico et al., 2006) as well as to reduce the possibility of the students from memorizing the questions because similar test items were used in the post-test. Meanwhile, the post-test was conducted one week after the completion of all lessons (together with the actual forms of the modified version of the ATCLS and the modified version of the WIHIC) in order to measure the students' achievement resulting from instruction (Finegold & Raphael, 1988; Treagust, 1989). The one week gap given before the administration of the post-test was considered sufficient for the students to do their revisions and to consolidate their memory .

The ABCAT items had been developed according to Cohen et al. (2007) such as containing clear stems, no negative items, only single correct answer, no stem clues, and each of the items were keep separately. The pre-test and post-test contain similar items except that the arrangement of items was shuffled to distinguish between these two tests. Chapter 5 provides a description of the ABCAT development process.

The students' non-cognitive outcomes were measure by the modified version of the ATCLS using the actual and preferred forms. The actual form, intended to seek the students' attitudes after the acids and bases lessons, was administered after the lessons together with the actual form of the modified version of the WIHIC and the post-test of the ABCAT. Meanwhile, the preferred form of the modified version of the ATCLS was used to identify students' desired attitudes towards the acids and bases lessons. The preferred form was administered prior to the lessons together with the preferred form of the modified version of the WIHIC and the pre-test of the ABCAT.

The results of the analysis in response to the fourth research question are described in Chapter 9. The data of the non-cognitive outcomes (reported in Section 9.2) were analysed in terms of average item mean, average item standard deviation, effect size, and t-test. Whereas, the data of the cognitive outcomes (reported in Section 9.3) were analysed in terms of standard deviation, effect size, t-test and Analysis of Covariance (ANCOVA).

3.6.5 What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?

The data from students' responses on the actual forms of the student edition of the QEC, the modified version of the WIHIC, and the modified version of the ATCLS were correlated to the total post-test score in the ABCAT. The rationale for such associations was to examine the students' views of the lessons' instructions, students' learning environment, and students' attitudes and how these contributed to students' achievement of acids and bases lessons. The associations were made for both urban and rural students' data. Chapter 10 described the results of the analysis in response to the fifth research question. Two types of statistical analyses were conducted for this purpose, namely simple correlation and multiple regression.

3.7 Chronology of Data Collection

The chronology of the data collection for this study is summarised in Figure 3.5. All these activities had occurred between February 2011 and November 2011.

Interview the CDD’s representative (February 2011).

↓

Administrations of the preferred form of the modified version of the WIHIC, the preferred form of the modified version of the ATCLS, and the pre-test of the ABCAT (May 2011).

↓

Acids and bases lessons took place (August – October 2011).

↓

Administrations of the teacher edition and the student edition of the QEC (October – November 2011).

↓

Administrations of the actual form of the modified version of the WIHIC, the actual form of the modified version of the ATCLS, and the post-test of the ABCAT (October – November 2011).

Figure 3.5 Chronology of the data collection.

3.8 Conclusion

This chapter has outlined the methodology used in this study. This study was built upon the foundation of a case study design. The data mainly come from nine chemistry teachers and their students from urban and rural schools around Melaka Tengah district. Three questionnaires [Questionnaire of Enacted Curriculum (QEC), the modified version of the What Is Happening In This Class? (WIHIC), and the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS)] and a test [Acids-Bases Chemistry Achievement Test (ABCAT)] were developed and utilised for this purposes. In addition, document analysis and a semi-structured interview with the CDD’s representative were conducted to seek the Chemistry curriculum intentions. Chronologically, the interview with the CDD’s representative and administration of the preferred forms of questionnaires (the modified version of the WIHIC and the modified version of the ATCLS) and the pre-test of the ABCAT were conducted before the acids and bases lessons took place. Meanwhile, the administrations of the actual forms of questionnaires (the modified version of the

WIHIC and the modified version of the ATCLS) and the post-test of the ABCAT were conducted after the acids and bases lessons. The teacher edition and student edition of the QEC also were administered after all the lessons took place.

CHAPTER 4 | DEVELOPMENT OF QUESTIONNAIRES

4.1 Introduction

This chapter describes the development of three questionnaires, namely, the Questionnaire of Enacted Curriculum (QEC) (Section 4.3), the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) (Section 4.4), and the modified version of the What Is Happening In This Class? (WIHIC) (Section 4.5). Respectively, these questionnaires provide information about the activities carried out during the acids and bases lessons, the students' attitudes towards acids and bases lessons, and students' perceptions towards their acids and bases learning environment. The selection of scales from their original sources (Section 4.2) and the translation process of the ATCLS and the modified version of the WIHIC (Section 4.6) are also described. This chapter closes with the report from the trial and refinement process of the modified version of the ATCLS and the modified version of the WIHIC (Section 4.7).

4.2 Selected Scales from the Original Sources

The process began by reviewing the literature to search for existing questionnaires. The selection of suitable ready-made questionnaires needed to consider three main criteria. First, the questionnaires should report high construct validity, indicating that the items should measure what they were supposed to measure. Second, the internal consistency reliability of the scales in each questionnaire reached the acceptable Cronbach's alpha coefficient, where the threshold value must at least 0.60 or greater (Hair, Tatham, Anderson, & Black, 1998). Finally, the scales also were capable of providing information regarding the *implemented* curriculum, the *perceived* curriculum, and the non-cognitive *achieved* curriculum.

Table 4.1 lists 15 selected scales that had been assessed for validity and reliability from four sources. The QEC was constructed with six scales consisting of 26 items. Three of the scales were adapted from the Survey of Enacted Curriculum (Smithson

& Blank, 2006), while three others were adapted from 2000 National Survey of Science and Mathematics Education Science Questionnaire (Weiss et al., 2003). All four scales proposed by Cheung (2007, 2009a, 2009b) in the ATCLS were altered to become the modified version of the ATCLS. The modified version of the WIHIC had adapted five out of the seven original WIHIC scales (Fraser, 1998; Fraser, Fisher, & McRobbie, 1996, April). Each of the questionnaires had undergone the adaptation process separately to suit the specific teaching and learning situation of the acids and bases unit and the medium of instruction in the Malaysian chemistry classroom context (MacLeod & Fraser, 2010).

Table 4.1 Selected scales from the existing questionnaires.

Modified Instrument	Selected Original Scale	Number of Items	Original Instrument
Questionnaire of Enacted Curriculum (QEC)	Analyse Information.	4	Survey of Enacted Curriculum (Smithson & Blank, 2006).
	Make Connections.	3	
	Active Learning.	4	
	Use of Traditional Teaching Practices.	5	2000 National Survey of Science and Mathematics Education Science Questionnaire (Weiss et al., 2003).
	Use of Strategies To Develop Students' Abilities to Communicate.	6	
	Use of Laboratory Activities.	4	
Modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS)	Liking for Chemistry Theory Lessons.	3	Attitude Towards Chemistry Lessons Scale (Cheung, 2007, 2009a, 2009b).
	Liking for Chemistry Laboratory Work.	3	
	Evaluative Beliefs about School Chemistry.	3	
	Behavioural Tendencies to Learn Chemistry.	3	
Modified version of the What Is Happening In This Class? (WIHIC)	Teacher Support.	8	What Is Happening In This Class? (Fraser, 1998; Fraser et al., 1996, April).
	Involvement.	8	
	Investigation.	8	
	Cooperation.	8	
	Equity.	8	

4.3 Questionnaire of Enacted Curriculum (QEC)

As mentioned earlier, there were six scales in the QEC. A review of the literature (Smithson & Blank, 2006; Weiss et al., 2003) showed that the scales were valid and reliable to assess the enacted curriculum. The Cronbach's alpha coefficients reported ranged from 0.71 to 0.83: *Analyse Information* (0.83); *Make Connections* (0.81); *Active Learning* (0.83); *Use of Traditional Teaching Practices* (0.71); *Use of Strategies to Develop Students' Abilities to Communicate Ideas* (0.79); and *Use of Laboratory Activities* (0.80).

These items then were tailored to form two different editions: the teacher edition and the student edition. The teacher edition was used to provide information on how the acids and bases lessons were actually delivered from the viewpoint of the chemistry teachers. The student edition was used to provide information on how the lessons were actually delivered from the viewpoint of the chemistry students. The main alteration was made on the instructions supplied in each edition. A line of "acids and bases lesson/instruction" was added to the instruction statements to make sure that the respondents only referred to the acids and bases lessons when answering the questions. Table 4.2 shows the modified instructions of teacher and student editions.

Table 4.2 Original and modified instructions in the teacher and student editions of the QEC.

Original Instruction	Modified Instruction for Teacher Edition	Modified Instruction for Student Edition
About how often do you do each of the following in your science instruction?	How often do you do each of the following in your acids and bases instruction?	How often does your chemistry teacher do each of the following in your acids and bases instruction?
About how often do students in this science class take part in the following types of activities?	How often do students take part in the following acids and bases lesson activities?	How often do you take part in the following acids and bases lesson activities?
When students in the target class are engaged in laboratory activities, investigations, or experiments as part of science instruction, how much of that time do they:	When students in the target class are engaged in laboratory activities, investigations, or experiments as part of acids and bases instruction, how much of that time do they:	When you are engaged in laboratory activities, investigations, or experiments as part of acids and bases lesson, how often of that activities do you:
When students in the target class collect data or information about science from books, magazines, computers, or other sources (other than laboratory activities), how much of that time do they:	When students in the target class collect data or information about acids and bases lesson from books, magazines, computers, or other sources (other than laboratory activities), how much of that time do they:	When you are collecting data or information about acids and bases lesson from books, magazines, computers, or other sources (other than laboratory activities), how much of that time do you:

Minor adjustments in terms of item statements were also made in order to fit these two categories of respondents. The adjustment covered the change of item structure, American spelling to British spelling (etc. analyze to analyse) and the inclusion of a line of "acids and bases lesson/instruction" to certain item statements. Table 4.3 shows the description and sample items of each scale.

Table 4.3 Description about the QEC scales (in Section B of the teacher and student editions of the questionnaire).

Scale	Description	Item Numbers	Sample Item
Analyse Information (AI)	The extent to which the teacher engaged students in analytical process skills during acids and bases lessons.	21, 23, 24, 26	Analyse and interpret the information or data orally or in writing (teacher edition). Analyse and interpret the information or data orally or in writing (student edition).
Make Connections (MC)	The extent to which the teacher engaged students to make associations from the acids and bases lessons information.	18, 20, 22	Design their own investigation or experiment to solve a scientific question (teacher edition). Design own investigation or experiment to solve a scientific question (student edition).
Active Learning (AL)	The extent to which the teacher engaged students to do investigations, use technology, and utilize chemistry equipment.	16, 17, 19, 25	Do hands-on/laboratory acids and bases lesson activities or investigation (teacher edition) Do hands-on/laboratory acids and bases lesson activities or investigation (student edition).
Use of Traditional Teaching Practices (TT)	The extent to which the teachers use lecture, repetition, reading from textbooks, train-and-drill, and others traditional strategies to teach acids and bases.	1, 8, 9, 11, 13	Introduce content through formal presentations (teacher edition). Teacher introduces content on the blackboard/whiteboard (student edition).
Use of Strategies to Develop Students' Abilities to Communicate Ideas (CI)	The extent to which the teachers encourage students to communicate and give meaning of the information.	2, 3, 4, 5, 6, 7	Pose open-ended questions (teacher edition). Pose questions without a single answer (student edition).
Use of Laboratory Activities (LA)	The extent to which the teachers engaged students in hands-on or laboratory procedures.	10, 15, 12, 14	Follow specific instructions in an activity or investigation (teacher edition). Follow specific instructions in an activity or investigation (student edition).

In the teacher edition of the QEC, Section A (Classroom Description) consisted of seven items, Section B (Instructional Activities in Acids and Bases Lessons) consisted of 26 items, Section C (Professional Development Activities in Chemistry) consisted of five items and Section D (Teacher Characteristics) consisted of four items. In the student edition Section A (Classroom Description) consisted of two items and Section B (Instructional Activities in Acids and Bases Lessons) consisted of 26 items. The teacher and student editions of the QEC can be found in Appendix C and Appendix D, respectively.

Section B of both the teacher and student editions of the QEC were scored using a five-point Likert scale, ranging from Never Take Place (0), Almost Never take Place (1), Sometime Takes Place (2), Almost Always Take Place (3), and Always Take Place (4). Since the items in Section B of the QEC were adapted from two existing questionnaires that have different rating scales, the rating scale of the QEC was standardized for all the scales. Such standardization of operationalisation made the scoring of responses easier and systematic.

Only the student edition of the QEC had gone through the translation process from English to Malay as the researcher assumed that the chemistry teachers already possessed good proficiency in English. The translation was essential to assist the chemistry students who mainly used English as their second language. The process began with translation of the English statements into Malay by the researcher. The Malay translation then was sent to an English language teacher in Malaysia, fluent in both languages, for back translation. The back translation procedure is highly recommended as it is a way to verify the translation of an instrument (Brislin, 1970). As such, the back translation could confirm that the meaning of the Malay language statements were equivalent with the English version. Once the translation and back translation had been validated by the researcher's supervisor, both versions were integrated side-by-side. The English version, which stands as the main statements, was typed by using size 12 of Times New Roman font. This was followed by Malay statements which were typed using size 10 Times New Roman font with italic style.

Finally, the researcher had created the front pages for both teacher and student editions. The front page of both versions contains information such as students' name, and class details, title of the test, consent statement, and researcher details. The researcher had estimated 15 to 20 minutes for the chemistry students to fill the student edition of the QEC, meanwhile, 20 to 25 minutes were estimated for the chemistry teacher to response to the teacher edition of the QEC during the full study.

4.4 Modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS)

Examination of the original ATCLS indicated that all the four scales had been proven valid and reliable in assessing students' attitude toward chemistry lessons in Hong Kong secondary schools (Cheung, 2007, 2009a, 2009b). The reported Cronbach's alpha coefficients tested on those students were as follow: *Liking for Chemistry Theory Lessons* (0.86); L*iking for Chemistry Laboratory Work* (0.84); *Evaluative Beliefs about School Che*mistry (0.76); and *Behavioural Tendencies to Learn Chemistry* (0.76). These scales were adapted into this study in order to investigate the students' attitude towards acids and base lessons.

The modification of the original ATCL was important to get an instrument that could assess the students' non-cognitive achievement towards the acids and bases lessons. The modification process began with the alteration of the statements. Here, the word "chemistry" that exists in the items was replaced with words "acids-bases chemistry". In addition, the original seven-point rating scale labelled as Strongly Disagree, Moderately Disagree, Slightly Disagree, Not Sure, Slightly Agree, Moderately Agree, and Strongly Agree were shorten into five-point rating scale, namely, Strongly Disagree, Disagree, Not Sure, Agree, and Strongly Agree. Each of this rating scale was scored 1, 2, 3, 4, and 5, respectively.

The modification had produced two forms: the actual form and the preferred form. The actual form of the modified version of the ATCLS was built to seek the students' actual attitudes after the acids and bases lesson. On the other hands, the preferred form of the modified version of the ATCLS, which was built upon the basis of actual form framework, intended to seek how the students desired their attitude towards the acids and bases lessons. The word connectors such as "will be" or "would be" were added in the statements to distinguish the preferred form from the actual form. Table 4.4 provides the description of the modified version of the ATCLS scales.

Table 4.4 Description about the modified version of the ATCLS scales.

Scale	Description	Sample Item
Liking for Acids-Bases Chemistry Theory Lessons (TL)	The extent in which the students liked the acids and bases theory lessons implemented in chemistry classroom.	I like acids-bases chemistry more than any other chemistry topic (actual form). I would prefer acids-bases chemistry more than any other chemistry topic. (preferred form).
Liking for Acids-Bases Chemistry Laboratory Work (LW)	The extent in which the students liked the laboratory work of acids and bases lesson.	I like to do acids-bases chemistry experiments (actual form). I would prefer to do acids-bases chemistry experiments (preferred form).
Evaluative Beliefs about Acids-Bases Chemistry (EB)	The extent in which the students beliefs about the importance of acids bases.	Acids-bases chemistry is one of the most important topics for people to study (actual form). Acids-bases chemistry will be one of the most important topics for people to study (preferred form).
Behavioural Tendencies to Learn Acids-Bases Chemistry (BT)	The extent in which the students have tendencies to learn acids and bases lesson.	I like trying to solve new problems in acids-bases chemistry (actual form). I would like solving new problems in acids-bases chemistry (preferred form).

4.5 Modified version of the What Is Happening In This Class? (WIHIC)

Five out of seven WIHIC scales were selected to assess the students' perceptions towards their acids and bases chemistry lessons. Each scale carried eight items. A comparative study conducted by Aldridge, Fraser & Huang (1999) between Australia and Taiwan had shown that the scales were valid and reliable in assessing Western and Asian students' perceptions towards their science classroom. They reported Cronbach's alpha coefficients were as follow: *Teacher Support* (Australia = 0.88, Taiwan = 0.87); *Involvement* (Australia = 0.84, Taiwan = 0.85); *Investigation*

(Australia = 0.88, Taiwan = 0.90); *Cooperation* (Australia = 0.89, Taiwan = 0.87); and *Equity* (Australia = 0.93, Taiwan = 0.90).

Table 4.5 Description about the modified version of the WIHIC scales.

Scale	Description	Sample Item
Teacher Support (TS)	The extent to which the teacher helps, befriends, trusts and is interested in students.	The teacher takes a personal interest in me (actual form). The teacher will take a personal interest in me (preferred form).
Involvement (IN)	The extent to which students have attentive interest, participate in discussion, do additional work and enjoy the acids and bases lesson.	I give my opinion during class discussions (actual form). I will give my opinion during class discussions (preferred form).
Investigation (IG)	The extent to which skills and processes of inquiry and their use in problem solving and investigation are emphasized in acids and bases lesson.	I carry out investigations to answer questions coming from discussions (actual form). I will carry out investigations to answer questions coming from discussions (preferred form).
Cooperation (CO)	The extent to which students cooperate rather than compete with one another on learning acids and bases tasks.	I work with other students on projects in this class (actual form). I will work with other students on projects in this class (preferred form).
Equity(EQ)	The extent to which students are treated equally by the teacher.	I receive the same encouragement from the teacher as other students do (actual form). I will receive the same encouragement from the teacher as other students do (preferred form).

The statements structure of the original WIHIC scales items were maintained in the modified version of the WIHIC. The five-point rating scales of the original WIHIC were applied; however the responses were modified to suit the Malaysian students' interpretation between English and Malays versions. As been acknowledged by many WIHIC investigators, originally there are five alternative response that can be chosen which are 'Almost Never', 'Seldom', 'Sometime', 'Often', and 'Almost Always' (Aldridge, Fraser, & Fisher, 2003; Aldridge et al., 1999; Dorman, 2003; Fraser, 1998). However, the particular responses, 'Almost Never' and 'Seldom' could be interpreted similarly to ‘rarely happen’. A similar case for ‘Often’ and ‘Almost Always’ that would be interpret as ‘frequently happen’. To avoid this confusion the original rating scales were replaced with Never takes place (1), Almost Never takes place (2), Sometimes takes place (3), Almost Always takes place (4), and Always take place (5), respectively.

The modification of the WIHIC had resulted in two forms: the actual form and the preferred form. The actual form of the modified version of the WIHIC was intended to seek the students’ actual perceptions of the acids and bases learning environment. On the other hand, the preferred form of the modified version of the WIHIC was intended to seek the students’ desire toward the acids and bases learning environment. Similar to the modified version of the ATCLS, the word connectors such as “will be” or “would be” were added in the statements to distinguish the preferred form from the actual form for the modified version of the WIHIC. Table 4.5 provides the description of the modified version of the WIHIC scales.

4.6 Translation Process of the Modified Version of the ATCLS and the Modified Version of the WIHIC

Similar procedures done with the student edition of the QEC with regards to the translation and back translation process were also employed in the modified version of the ATCLS and the modified version of the WIHIC. Both forms, actual form and preferred form, were translated by the researcher to the Malay language. The Malay version then was sent for the back translation to make sure there were not distortions of meaning between English and Malay statements. Both translations were revised by researcher’s colleagues for face validity and clarity. The final draft of the actual and preferred forms had integrated the English and Malay version together in each form. Similar to the student edition of the QEC, the English version of the modified version of the ATCLS and the modified version of the WIHIC stand as the main statements which were highlighted with the used of size 12 of Times New Roman font. On the other hands, the Malay version easily spotted by the used of italic Times New roman size 10. The researcher estimated each of the modified version of the ATCLS and the modified version of the WIHIC could be completed within 45 minutes: 10 to 15 minutes for the modified version of the ATCLS; and 25 to 30 minutes for the modified version of the WIHIC. Both actual and preferred forms then were sent for trial.

4.7 Trial and Refinement of the Modified Version of the ATCLS and the Modified Version of the WIHIC

A pilot study is commonly conducted to provide early information, "on where the main research project could fail, where research protocols may not be followed, or whether proposed methods or instruments are inappropriate or too complicated," (van Teijlingen & Hundley, 2001, p.1). Pilot studies of the actual and preferred forms of the modified version of the ATCLS and the modified version of the WIHIC were administered to Form 5 and Form 4 chemistry students. The schools involved for the trials of the actual forms were different from the schools used for the trialled of the preferred forms. The students involved had completed the acids and base unit. Both forms of the modified questionnaires were administered either by the researcher's representatives or by the chemistry teachers themselves, and the responses were returned via mail.

The convenience sampling was used to draw these samples. The actual forms of the modified version of the ATCLS and the modified version of the WIHIC were administered to eight schools. The total of 390 responses (182 males; 208 females) were successfully collected and returned. Similarly, the preferred forms of the modified version of the ATCLS and the modified version of the WIHIC were administered to five schools. The total of 249 responses (68 males; 181 females) was successfully collected. The responses received were entered into the spreadsheet before transferred into the SPPS software.

The responses from the pilot study were analysed in terms of internal consistency reliability of the selected scales. The Cronbach's alpha coefficients of the actual forms for the modified version of the ATCLS ranged from 0.64 to 0.75 and for the modified version of the WIHIC ranged from 0.81 to 0.89. The reliability of the preferred form of the modified version of the ATCLS ranged from 0.64 to 0.76 and for the modified version of the WIHIC ranged from 0.88 to 0.93. In general, the lowest acceptance limit for internal consistency reliability of a scale is set between

0.60 to 0.70 (Hair et al., 1998). Therefore, all values generated from both forms were within the acceptable range as stated in the literature. Table 4.6 and 4.7 list the Cronbach's alpha coefficients for each scale in the modified version of the ATCLS and the modified version of the WIHIC, respectively.

Table 4.6 Cronbach's alpha coefficients for the modified version of the ATCLS.

Scale	Alpha Reliability	
	Actual	Preferred
Liking for Acids-Bases Chemistry Theory Lessons (TL)	0.75	0.76
Liking for Acids-Bases Chemistry Laboratory Work (LW)	0.71	0.71
Evaluation Beliefs about Acids-Bases Chemistry (EB)	0.68	0.76
Behavioural Tendencies to Learn Acids-Bases Chemistry (BT)	0.64	0.64

Table 4.7 Cronbach's alpha coefficients for the modified version of the WIHIC.

Scale	Alpha Reliability	
	Actual	Preferred
Teacher Support (TS)	0.87	0.88
Involvement (IN)	0.81	0.92
Investigation (IG)	0.87	0.93
Cooperation (CO)	0.89	0.91
Equity (EQ)	0.88	0.92

Based on this analysis, only a minor refinement was made in terms of the Malay translation to have the most accurate meaning to the English version. A final item of the modified version of the WIHIC, stated "If you read this item, please circle 5", was added by the researcher on both forms of the modified version of the WIHIC to increase the validity of the students' responses. Both actual and preferred forms of the modified version of the ATCLS and the modified version of the WIHIC were validated by the researcher's supervisor and ready for the full study. The example of these questionnaires can be found as follows: actual form of the modified version of the ATCLS (Appendix G); preferred form of the modified version of the ATCLS (Appendix H); actual form of the modified version of the WIHIC (Appendix E); and preferred form of the modified version of the WIHIC (Appendix F).

4.8 Conclusion

The QEC was mainly developed to address the view of teachers and students toward their acids and lesson activities. Therefore, the 26 items from six scales were adapted from two existing instruments to form the teacher and student editions. Similarly, the total of 12 items from four scales of the original ATCLS were adapted to develop the modified version of the ATCLS, meanwhile 40 items from five scales of original WIHIC were adapted to develop the modified version of the WIHIC. The modified version of the ATCLS was used to assess the students' attitudes towards their acids and bases lessons, meanwhile the modified version of the WIHIC was used to assess the students' perceptions towards the acids and bases learning environment. The modified version of the ATCLS and the modified version of the WIHIC exist in two forms: the actual form and the preferred form. Both forms of the modified version of the ATCLS and the modified version of the WIHIC had been trialled and the analysis showed that the Cronbach's alpha coefficients generated from all scales were within the acceptable range. During the full study, the modified version of the ATCLS and the modified version of the WIHIC forms were administered together with the test instruments (ABCAT), meanwhile QEC were administered separately.

CHAPTER 5 | DEVELOPMENT OF THE ACHIEVEMENT TEST

5.1 Introduction

This chapter outlines the development of the achievements test which is called the Acids-Bases Chemistry Achievement Test (ABCAT). The chapter begins by describing the framework of the ABCAT (Section 5.2), the development of the initial version of the ABCAT (Section 5.3) and the development of the amended version of the ABCAT (Section 5.4). This chapter closes with the description of the challenge faced during the process of test development (Section 5.5).

5.2 The Framework of Acids-Bases Chemistry Achievement Test (ABCAT)

The main purpose of the ABCAT development was to prepare an instrument that could measure the achievements of urban and rural chemistry students resulting from the acids and bases instruction. This was the fourth research objective of this study. The development process was guided by procedures outlined by Cohen et al. (2007).

The ABCAT represents three major characteristics. Firstly, it is a formative test as the results may portray the students' progress in achieving the intended outcomes as well as the effectiveness of the teachers' instruction (Bell & Cowie, 2001) throughout the acids and bases unit. Secondly, ABCAT is a standardized type test where all the participating schools received the same sets of test items that are similar in terms of arrangement and condition (Anderson, 2003). Thirdly, it consists of multiple-choice items which offer a fast and efficient way to analyse large numbers of students' responses (Mandernach, 2003).

Twenty six content areas extracted from the list of cognitive learning outcomes in the Form 4 Chemistry curriculum specifications (Pheng et al., 2005) as well as from Form 4 chemistry textbooks (Neo, Ching, Hong, Wah, & Ahmad, 2005a, 2005b) were used to guide the items' construction. These content areas can be categorised under four main concepts: the characteristics and properties of acids and bases; the strengths of acids and alkalis; the concentration of acids and bases; and neutralisation. The list of the content areas can be found in Table 6.1.

The development of the test had produced two subsequent versions, the initial version and the amended version. The initial version was developed in the early stage of this study with the intention to measure the contextual base of the *intended* curriculum. The development process is reported in Section 5.3. Due to the limitations of the students' low responses on the contextual questions in the Malaysian chemistry curriculum, the results from the pilot study were unable to give an accurate description of the actual students' achievement in the acids and bases topic. The result of this version is discussed in Section 5.3.3. To overcome this issue, an amended version was developed to replace the initial version and was finalised to be used in the following stages of this study. Both of these versions had undergone similar phases, namely test item construction and pilot testing.

5.3 The Initial Version

5.3.1 Item construction

Basically, the test design was retrieved from several sources of literature mainly on the development of two-tier multiple-choice items (Artdej, Ratanaroutai, Coll, & Thongpanchang, 2010; Artdej et al., 2009; Chen, Lin, & Lin, 2002; Dhindsa & Treagust, 2009; Kilic & Saglam, 2009; Treagust, Chandrasegaran, Crowley, Yung, Cheong, & Othman, 2009). Therefore, the procedures for items construction could be viewed in three consecutive stages: create multiple-choice items with free responses; developing second tiers distracters; and constructing the complete test item.

Create multiple-choice items with free responses

Eight multiple-choice items with free responses were created from several sources. Item 1 to 7 were developed by researchers in the Science and Mathematics Education Centre. Meanwhile, item 8 was developed by Chiu (2007). These items were selected based on their congruity with the described content areas as mapped in the specification grid of Table 5.1. The Malay translation was made by the researcher and was validated using the back translation approach (Brislin, 1970). Figure 5.1 shows a few examples of the multiple-choice items with free responses from the initial version. The rest of the initial version items could be found in Appendix I (English translation) and Appendix J (Malay translation).

2. What is a property of citrus fruits like oranges and lemons?

    A. Acidic*
    B. Basic
    C. Neutral

    The reason for my answer is:
    ____
    ____
    ____

4. Baking soda (sodium bicarbonate) added to dough when baking bread causes the bread to rise.

    A. True*
    B. False

    The reason for my answer is:
    ____
    ____
    ____

Figure 5.1 Example of the multiple-choice items with free responses from the initial version (English translation).

Developing second tiers distracters

Both translations were sent to eight schools located in three Malaysian states. The total of 390 complete responses from 196 males and 194 females were received. The responses were coded in terms of similar meaning. The selected codes ranged from number 1 until 4 covering several misconceptions as well as one correct answer. The irrelevant and unanswered responses were coded as zero. The total of 19 distracters was generated from those eight items. The open-ended parts of each item were then replaced with the generated distracters.

For Items 1, only 17.4% out of 390 students gave the most accurate responses for the open-ended part, meanwhile 69.6% students either had left the response part blank or gave wrong answers. The acceptable answer for the open-ended part was: only HCl completely ionised to produce H^+ ions in water. The remaining 13.1% had provided three distracters for this tier: only HCl dissolves in water to produce H^+ ions (2.8%); CH_4 completely ionised to produce more H^+ ions in water than HCl (6.9%); and any substance that contains H atom in the molecular formula is acidic (3.4%).

For item 2, more than half of the students (58.2%) gave the most accurate answer and only 39.5% of the students either had left the response part blank or gave wrong answers. The acceptable answer was: citrus fruits have pH value less than 7. Two distracters were generated from 2.3% students' responses: citrus fruits have harmful and poisonous properties (1.5%); and citrus fruits have pH values greater than 7 (0.8%).

For item 3, most of the students (77.2%) either had left the response part blank or gave wrong answers. Only 3.3% of the students gave the most accurate response: CO_2 gas is produced when the acids react with the sodium bicarbonate. Three distracters had been generated from 19.6% students' responses: H^+ ions are produced when the acids ionise in water (10.8%); the sodium bicarbonate completely reacts with the acids to produce a neutral salt and water (7.0%); and the sodium element in sodium bicarbonate is highly reactive in water (1.8%).

For item 4, 78.8% out of 390 students either had left the response part blank or gave wrong answers. Meanwhile 15.9% of the students gave the most acceptable answer: the sodium bicarbonate decomposes when heated to produce CO_2 gas. The rest (5.3%) had contributed two distracters: OH^- ions are produced when sodium bicarbonate reacts with water in the dough (3.8%); and H^+ ions are produced when sodium bicarbonate reacts with water in the dough (1.5%).

For item 5, 7.5% students out of 390 students responded correctly: the calcium carbonate coating dissolves by reacting with the acidic solution. Meanwhile 68.7% either had left the response part blank or gave wrong answers. Two distracters were generated from 23.9% responses: the calcium carbonate coating completely reacts with the acidic solution to produce a neutral salt and water (18.5%); and the calcium carbonate coating dissolves by reacting with the alkaline solution (5.4%).

For item 6, out of 390 students, only 10.1% gave the correct response: the basic substance neutralises the acidic soils. Meanwhile 54.9% either had left the response part blank or gave wrong answers. The remaining 35.2% of students gave two distracters: the acidic substance changes the pH of soil closer to the ideal pH (32.5%); and the basic substance reduces the soil acidity to pH value greater than 7 (2.7%).

For item 7, only 9.7% gave the most accurate answer and 78.3% either had left the response part blank or gave a distorted answer. The acceptable answer was: the purple cabbage solution can be used to distinguish between the acidic and alkaline solutions. Two distracters were generated from 11.8% responses: the purple cabbage solution can be used to distinguish between the acidic and neutral solutions (9.2%); and the purple cabbage solution is a phenolphthalein indicator (2.6%).

For item 8, 84.4% students either had left the response part blank or gave wrong answers. Only 0.5% students gave the most acceptable response: the concentration of CO_2 in water increases producing more acidic solution. On the other hands, 15.2% of the students had contributed three distracters: the CO_2 gas molecules contain acidic properties (6.4%); the CO_2 gas molecules do not dissolve in water (5.2%); and the water contains a high concentration of H^+ ions (3.6%).

Constructing the complete test item

Three additional items (item 9, 10 and 11) with two tier multiple-choice were also developed by researchers in the Science and Mathematics Education Centre. These additional items were mapped into the specifications grid of Table 5.1.

The test format and layout were considered in this stage. The set consists of six pages including the front page. The front page of the set contains the following information: title of the test, student's fill-in details, instructions for the student, instructions for the teacher, and researcher's information. The test set had been prepared in two translations, Malay and English, which were validated using the back translation approach. Twenty-five to 30 minutes were estimated for the students to complete the test. The scoring system was adopted from Treagust and

Chandrasegaran (2007) where one mark was given for both correct tiers in each item. The complete test can be views in Appendix K for the English version and Appendix L for the Malay version.

Table 5.1 Distribution of the initial version items across the content areas.

Learning Outcome	Item										
	1	2	3	4	5	6	7	8	9	10	11
LO1	X										
LO2				X							X
LO3											
LO4											
LO5			X		X						
LO6											
LO7		X					X				
LO8											
LO9											
LO10											
LO11									X		
LO12										X	
LO13										X	
LO14											
LO15											
LO16								X			
LO17											
LO18											
LO19											
LO20											
LO21											
LO22						X					
LO23											
LO24											
LO25											
LO26											

5.3.2 Pilot test of the initial version

The pilot study was administered to 80 Form 4 chemistry students (36 males, 44 females) from three schools around Selangor, Malaysia. These students had completed at least 10 periods of acids and bases lessons prior the test. Typically, one period of the lesson is equal to 30 minutes. During the test, the students were given the privilege to choose either the English or the Malay sets.

5.3.3 Analysis of responses and discussion

The characteristics of the initial version are summarized in Table 5.2. Two approaches were used to analyse the test results of the initial version: the statistical approach (Osterlind, 1989) was used to quantify the response distributions of each item as well as the reliability of the test; and the judgemental approach (Osterlind, 1989) was used to decide the functionality of items in measuring the criteria set by the Form 4 Chemistry curriculum specifications.

Table 5.2 The results for the initial version of the ABCAT.

Characteristic	Result
Number of items	11
Test time length (minutes)	25 to 30
Minimum/Maximum score	3/10
Total mean score	3.20
Standard deviation	1.43
Alpha reliability	0.15
Difficulty index (range)	Mean = 0.29
0.00 - 0.10	3; 8
0.11 – 0.20	5; 7; 10; 11
0.21 – 0.30	4; 6
0.31 – 0.40	1
0.41 - 0.50	9
0.51 – 0.60	
0.61 – 0.70	
0.71 – 0.80	
0.81 – 0.90	2
0.91 – 1.00	
Discrimination index (range)	Mean = 0.15
0.00 - 0.10	2; 3; 4; 7; 11
0.11 – 0.20	1; 5; 8; 10
0.21 – 0.30	6;
0.31 – 0.40	9
0.41 - 0.50	
0.51 – 0.60	
0.61 – 0.70	
0.71 – 0.80	
0.81 – 0.90	
0.91– 1.00	

For the statistical approach, the students' responses were entered into the spread sheet and cleaned before transferred into Predictive Analytics SoftWare (PASW) software. The responses later were analysed in terms of item analysis (difficulty index and discrimination index), minimum or maximum score, items mean, standard deviation, and Cronbach's alpha coefficient (Artdej et al., 2010; Artdej et al., 2009; Chen et al., 2002; Dhindsa & Treagust, 2009; Kilic & Saglam, 2009; Treagust et al., 2009).

The initial version had recorded students' scores ranging from 3 to 10. Most students only gained rather low scores with a mean 3.20. The test had recorded poor internal consistency reliability with Cronbach's alpha coefficient (0.15) which is in fact lower than the threshold value noted by Nunnally (1978). The low mean values for the difficulty index (0.29) and discrimination index (0.15) indicate that many of the items were considered difficult (Osterlind, 1989) by the students and the items were not efficient to evaluate students' achievement (Popham, 1995), respectively.

The items were sent to three chemistry teachers and one chemistry education lecturer for review. The four respondents suggested that items 3, 4, 5, 7, and 8 covered more depth of content compared to what had been intended by the specifications and textbooks. All the teachers agreed that the items described were rarely exposed to the students during the acids and bases instruction due to these being least highlighted in the examination and most commonly considered as general knowledge. A judgement approach was used at this point to omit all these five items; meanwhile items 1, 2, 6, 9, 10 and 11 were retained. However, the Cronbach's alpha coefficient was still very low (0.19) for the remaining six items. Due to this issue, the researcher revised the test items to form the amended version.

5.4 The Amended Version

5.4.1 Item construction

Similar stages as mentioned in Section 5.3.1 were followed.

Create multiple-choice items with free responses

The total of 23 items was developed in this stage. These items were partitioned into two sections, Section A contained 12 multiple-choice items, whereas Section B contained eight multiple-choice items with free responses and three items of two-tiers multiple-choice.

Table 5.3 Distribution of the amended version items across the cognitive learning outcomes.

Cognitive Learning Outcome	Item																						
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
LO1																		X					
LO2																				X			
LO3	X																						
LO4													X										
LO5												X		X									
LO6																							
LO7		X																	X				
LO8																							
LO9																							
LO10																	X						
LO11																						X	
LO12																							X
LO13																							X
LO14																							
LO15			X																				
LO16											X												
LO17						X										X							
LO18							X																
LO19				X																			
LO20					X																		
LO21																							
LO22																					X		
LO23									X														
LO24								X															
LO25															X								
LO26										X													

Twelve multiple choice items (item A1 to A12) and four multiple-choice items with free responses (item B1 to B4) were drawn from the exercise books (Hong & Ching, 2010; Lew, 2010; Yoon, 2006), revision books (Toon, Leng, & Tin, 2010) and past examination papers (Ishak, 2010). In addition, seven items from Section B, item B5 to B11, were developed by researchers in the Science and Mathematics Education Centre. Three of these items (B8, B10, and B11) were taken from the initial version together with its distracters for the second tiers. The selections of these items were made based on its congruity with the standard content areas of the Form 4 Chemistry curriculum specifications (Pheng et al., 2005) and chemistry textbooks (Neo et al., 2005a, 2005b). A specifications grid (Table 5.3) was built to crosscheck the distributions of items in terms of stated content areas. The items distribution confirmed that almost all of the intended content areas were successfully covered with some items incorporating multiple cognitive learning outcomes.

Table 5.4 Coverage of the amended version item in terms of Bloom's taxonomy.

Item	Remembering	Understanding	Applying	Analysing	Evaluating	Synthesising
A1	X					
A2	X					
A3	X					
A4				X		
A5				X		
A6			X			
A7		X				
A8	X					
A9		X				
A10				X		
A11		X				
A12		X				
B1		X				
B2		X				
B3		X				
B4			X			
B5				X		
B6		X				
B7		X				
B8			X			
B9			X			
B10				X		
B11				X		

The development of these items were also considered the coverage of items across the learning domains of Bloom's taxonomy (Noble, 2004): remembering; understanding; applying; analysing; evaluating; and synthesising. The rationale is to make sure that the test items were aligned with the learning objectives (Airasian & Miranda, 2002) in the Form 4 Chemistry curriculum specifications as well as taking into account the various difficulty levels. Table 5.4 showed the test items were able to cover four of the domains but not evaluating and synthesising.

Section A
Seksyen A

1. An acid displays its properties when it…..
Suatu asid menunjukkan sifat-sifatnya apabila ia…..

    A. ionises in water to produce H^+ ions.*
    mengion dalam air menghasilkan ion-ion H^+.

    B. ionises in propane to produce H^+ ions.
    mengion dalam propana menghasilkan ion-ion H^+.

    C. ionises in water to produce OH^- ions.
    mengion dalam air menghasilkan ion-ion OH^-.

    D. ionises in propane to produce OH^- ions.
    mengion dalam propana menghasilkan ion-ion OH^-.

Section B
Seksyen B

5. Both sulphuric acid and ethanoic acid are strong acids.
Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

    A. True.
    Betul.

    B. False.*
    Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____
____
____

Figure 5.2 Example of multiple-choice items from the Section A (single tier) and Section B (free response) of the amended version.

All 23 items were sent to five experienced chemistry teachers and one chemistry education lecturer for contents validation. The validation involved the match between the items with the specified cognitive learning outcomes (Osterlind, 1989) as well as the depth of the content covered. The items were later translated into Malay and validated using the back translation approach. These two translations were double checked by Dr. A.L. Chandrasegaran who is fluent in both languages. Once approved by the researcher's supervisor, both translations were integrated in a test set. Figure 5.2 shows a few examples of the multiple-choice items from the Section A (single tier) and Section B (free response) of the amended version. The rest of the amended version items could be found in Appendix M.

Developing second tiers distracters

Eleven items of Section B (Appendix N) were sent to five schools in different states in Malaysia. The test was administered by the researcher himself. A total of 260 complete responses from 72 males and 188 females of Form 5 chemistry students were received. These students had completed the acids and bases unit prior to the test.

The free responses of Section B especially item B1, B2, B3, B4, B5, B6, B7, and B9 were coded and filtered. The responses were coded in terms of similar meaning: codes ranged from number 1 until 4 addressed several misconceptions as well as one correct answer. The irrelevant and unanswered responses were coded as zero. A total of 19 distracters with eight correct answers was generated from the open-ended part of these items. The open-ended parts of these items were replaced with the generated distracters. Meanwhile, items B8, B10 and B11 were analysed in terms of frequencies of responses to check the suitability of the ready-made distracters. Eight distracters provided in the second-tier of these items were retained together with three correct answers. The generated distracters were translated into Malay and validated using back translation approach. The translations were double checked by Dr. A.L. Chandrasegaran.

For Items B1, 63.1% of the students gave the most accurate responses for the open-ended part: chemical X could ionise in water to produce OH^- ions. Meanwhile, 23.9% of students either had left the response part blank or gave wrong answers. The remaining 13.1% had contributed to three distracters for this tier: chemical X could ionise in water to produce H^+ ions (5.7%); chemical X could ionise to produce OH^- ions in the absence of water (6.2%); and chemical X is soluble in water (1.2%).

For item B2, more than half of the students (76.9%) gave the most accurate answer and only 7.8% students either had left the response part blank or gave an incorrect answer. The correct answer was: the solution contains a higher concentration of H^+ ions than OH^- ions. Two distracters were generated from 15.5% students' responses: the solution contains a higher concentration of OH^- ions than H^+ ions (10.9%); and the solution contains equal concentrations of H^+ and OH^- ions (4.6%).

For item B3, 34.0% of the students either had left the response part blank or gave incorrect answers. Only 28.9% of students responded correctly: methyl orange turns yellow because there is an excess of alkali in the solution. Three distracters had been generated from 37.3% students' responses: methyl orange turns yellow because neutralisation has occurred (29.6%); methyl orange turns yellow because water and a salt are present in the solution (1.9%); methyl orange turns yellow because there is an excess of acid in the solution (5.8%).

For item B4, almost half of the students (46.6%) either had left the response part blank or gave incorrect answers. Meanwhile 41.5% of the students gave the correct answer: it can measure a fixed volume of solution more accurately. The rest (12%) had contributed two distracters: it is easier to dissolve the solute by shaking (8.5%); and it prevents the solution from splashing out (3.5%).

For item B5, more than half of the students (62.4%) responded correctly, meanwhile 21.0% either had left the response part blank or gave incorrect answers. The most accurate answer given was: sulfuric acid ionises completely in water to produce H^+ ions, while ethanoic acid ionises partially in water to produce H^+ ions. Three distracters were generated from 17% responses: ethanoic acid ionises completely in water to produce H^+ ions, while sulfuric acid ionises partially in water to produce H^+ (2.3%); both acids ionise completely in water to produce H^+ ions (8.1%); and both acids ionise partially in water to produce H^+ ions (6.6%).

For item B6, more than half of the students (52.0 %) gave the correct response: only HCl ionises to produce H^+ ions in water. Meanwhile 16.1% either had left the response part blank or gave incorrect answers. The remaining 31.8% students gave two distracters: CH_4 completely ionises to produce more H^+ ions in water than HCl (15.7%); and any substance that contains H atom in the molecular formula is acidic (16.1%).

For item B7, the majority of the students (90.8%) responded correctly and only 2.4% either had left the response part blank or gave incorrect answers. The correct answer given was: citrus fruits have pH value less than 7. Two distracter was generated from

6.8% responses: citrus fruits have pH values greater than 7 (6.0%); and citrus fruits have pH values equal to 7 (0.8%).

For item B8, only a minority of the students (2.3%) had left the second-tier part blank. On the other hand, 21.9% of students had chosen the correct response: alkalis dissolve grease and oils present in dirt more readily than acids. Most of the students (75.8%) had chosen three distracters: alkalis are soapy and so are able to wash away stains (47.7%); acids are more corrosive than alkalis and so are more effective in removing stains (19.3%); and acids are able to neutralise alkalis present in dirt (8.8%).

For item B9, a majority of the students (67.7%) had given the correct answer for the open-ended part: the basic substance neutralises the acidic soils. Only 12.4% students were recorded left a blank response or gave incorrect answers. The rest of the students (20.0%) had contributed two distracters: a basic substance changes the soil acidity to a pH value greater than 7 (10.4%); and an acidic substance changes the pH of soil closer to the ideal pH (9.6%).

For item B10, more than half of the students (51.6%) had chosen the correct reason whereas only 2.3% had left the second-tier part blank. The accurate answer for the reason is: aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised. The remaining 46.2% of students had chosen three distracters from this tier: potassium hydroxide and ammonia are only partially ionised in water (21.2%); aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula (12.7%); and potassium hydroxide and ammonia ionise completely in water (12.3%).

For item B11, two distracters were chosen by 76.6% responses, higher than the number of students who chosen correct responses (11.9%) which was: the solutions may or may not be highly ionised in aqueous solution. Only 11.5% of the students had left the second-tier part blank. The two distracters chosen were: the solutions contain high concentrations of H^+ or OH^- ions (68.5%); and relatively large amounts of the substances are dissolved in water (8.1%).

Constructing complete test item

Items A1 to A12, items B1 to B7 and B9, and items B8, B10 and B11 were combined in a test set to comprise Section A and Section B (Appendix O). The complete test set consists of 18 pages including the front page. The front page contains information on students' fill-in details, title of the test, consent statement, and researcher details. The general instruction for the test was available on the second page of the set whilst the detailed instructions could be found at the beginning of each section. An English and Malay translation was integrated into the test set. These languages were made easily distinctive through the use of different font styles: Times New Roman size 12 for the English statements, followed by, italic Times New Roman size 10 for the Malay statements. Forty-five minutes (10 to 15 minutes to answer Section A and 25 to 30 minutes to answer Section B) were estimated for students to complete the test.

Items of Section A were scored based on typical multiple-choice items scoring system where one mark was given for each correct response (Ishak, 2010). The scoring system for Section B was adopted from Treagust and Chandrasegaran (2007) where one mark was given for both correct tiers in each item.

5.4.2 Pilot test of the amended version

The test set was sent to four schools located in in different states in Malaysia. The test was administered by the chemistry teachers of each school. The total of 193 Form 5 chemistry students (74 males, 119 females) had sat for this test. The students had completed the acids and bases unit prior the test. The teachers were asked to brief the students before the test and provide continual assistance during the test to make sure the students covered every part of the items. The answer sheets then were collected and returned to the researcher via mail.

5.4.3 Analysis of responses and discussion

The characteristics of amended version are summarized in Table 5.5. The statistical approach (Osterlind, 1989) was used to analyse the response distributions of each item as well as the reliability of the test.

Table 5.5 The results for the amended version of the ABCAT.

Characteristic	Result	
	Section A	Section B
Number of items	12	11
Test time length (minutes)	10 to 15	25 to 30
Minimum/Maximum score	4/12	0/11
Total mean score	7.77	4.96
Standard deviation	2.21	2.34
Alpha reliability	0.58	0.65
Difficulty index (range)	Mean = 0.65	Mean = 0.45
0.00 - 0.10		
0.11 – 0.20		B11
0.21 – 0.30		B3
0.31 – 0.40	A3	B1; B8
0.41 - 0.50	A7; A8	B2; B4; B5; B10
0.51 – 0.60	A4; A11; A12	B6
0.61 – 0.70	A5; A10	B9
0.71 – 0.80	A9	
0.81 – 0.90		
0.91 – 1.00	A1; A2; A6	B7
Discrimination index (range)	Mean = 0.37	Mean = 0.47
0.00 - 0.10	A6	B7; B11
0.11 – 0.20	A2;	
0.21 – 0.30	A1; A4	B8
0.31 – 0.40	A8; A9	B9
0.41 - 0.50	A3; 10	B3
0.51 – 0.60	A5; A7	B1; B4
0.61 – 0.70	A11; A12	B2; B6; B10
0.71 – 0.80		
0.81 – 0.90		B5
0.91 – 1.00		

For the statistical approach, the students' responses were entered into the spread sheet and cleaned before transferred into PASW software. The responses later were analysed in terms of item analysis (difficulty index and discrimination index), minimum or maximum score, items mean, standard deviation, and Cronbach's alpha coefficient (Artdej et al., 2010; Artdej et al., 2009; Chen et al., 2002; Dhindsa & Treagust, 2009; Kilic & Saglam, 2009; Treagust et al., 2009).

The analysis of Section A and Section B were done separately as presented in Table 5.5 as each section was slightly different in terms of the test formats. The results showed that there was a large gap between the lowest and the highest scores for both sections, which ranged from 4 to 12 for Section A and from 0 to 11 for Section B. Most of the students did relatively well in Section A (mean score = 7.77 out of 12) compared with Section B (mean score = 4.96 out of 11). The Cronbach's alpha coefficient for Section B was slightly higher than Section A with coefficient values of 0.65 and 0.58, respectively. Both reliability coefficients are above the threshold value noted by Nunnally (1978) and considerably acceptable based on the criterion reported by Artdej, Ratanaroutai and Thongpanchang (2009).

Popham (1995) has described items with difficulty indices between 0.00-0.20, 0.21-0.80 and 0.81-1.00 are considered difficult, moderate and easy, respectively. Briefly, the mean of difficulty index for Section A (0.65) and Section B (0.45) suggest both sections mainly consist of moderately difficult items. This phenomenon was confirmed via detailed inspection of Table 5.5 which revealed nine out of 12 items in Section A had indices ranging from 0.39 to 0.76, while the remaining three items were considered easy (indices above 0.91). Similarly, nine out of 11 items in Section B have moderate level of difficulty, while only one item for each difficult and easy levels. The wide range of difficulty indices (Odom & Barrow, 1995) reported in this test provide the potential to reach more students with a wide range of abilities (Taylor & Nolen, 2005).

In terms of the discrimination index, Section A had recorded values ranged from 0.10 to 0.67 (discrimination indices mean of 0.37), while Section B had recorded values ranged from 0.06 to 0.81(discrimination indices mean of 0.47). According to Othman, Treagust and Chadrasegaran (2008), attention should be given to the indices below than 0.20. On top of that, Baker's (2001) classification of discriminant index could provides a description regarding the quality of an item: above 0.30 (good);

between 0.10 to 0.30 (fair); and below 0.10 (poor). Four items was identified required attention: item A2, A6, B7, and B11 with discrimination indices 0.17, 0.10, 0.06, and 0.10, respectively. Osterlind (1989) however asserted that the low discrimination indices do not necessarily indicate bad items, instead show more students had succeeded in achieving the objectives set by the test items if supported by high difficulty indices. Items A2, A6, and B7 more likely represented the situation where the difficulty indices were above 0.91. Only item B11, with difficulty index 0.10, was considered insufficient to meet this criterion, fitting the classification of poor quality item claimed by Baker (2001). Further reviews from the chemistry teachers revealed that the B11 item was hardly understood by the students and the concept highlighted was less emphasized during the lessons. Therefore, item B11 was omitted. In addition, items in Section A only required minor adjustments in terms of the stem statements and the options given which covers the correct answer and distracters.

The integration of English and Malay translations into the test in the second version was proven more practical in a way that assisted students who may lack proficiency in English by only referring the translations followed in every statement. In addition, it was more economical where only one test set was prepared instead of two sets for each student, as occurred in the initial version.

To finalise the development of the test, the pre-test and post-test sets were created. Both sets used same items but with a different order of arrangement. The decision to use this method was made based on the guidelines proposed by Cohen, et al. (2007) which stated that the items drawn for the pre-test and the post-test should have similar content and difficulty. To avoid confusion, similar items arrangement during the pilot study was used in the post-test. On the other hand, the items were systematically re-arranged for the pre-test as shown in Table 5.6. A sample of the pre-study and the post-study sets can be obtained in Appendix P and Appendix Q, respectively.

Table 5.6 Items arrangement for the pre-test and the post-test.

Pre-test Item		Post-test Item
A12	=	A1
A6	=	A2
A7	=	A3
A5	=	A4
A8	=	A5
A4	=	A6
A9	=	A7
A3	=	A8
A10	=	A9
A2	=	A10
A11	=	A11
A1	=	A12
B10	=	B1
B5	=	B2
B6	=	B3
B4	=	B4
B7	=	B5
B3	=	B6
B8	=	B7
B2	=	B8
B9	=	B9
B1	=	B10

5.5 Challenges During the Development Test Items

The main challenge faced by the researcher during the study was the blank or incorrect answers left by the students in many items. Despite the test being distributed to many students, the number of responses collected was below the researchers' expectation. This situation was true especially during the second stage (developing second tiers distracters) of item construction and the pilot study phases of both initial and amended versions. There are four possible reasons that could explain this situation. First, the students might confuse and be unfamiliar with the test format used in the ABCAT. Typically, the schools' assessments were represented in forms of multiple-choice items or essays. Instead, the ABCAT's items were presented in terms of multiple-choice with free response and two-tier multiple-choice. This situation may have caused the students to hesitate to give their answers. Secondly, some teachers were found not to have covered certain learning areas during the acids and bases lessons. The researcher's observations during the development of the amended version and informal interviews with some of the teachers had confirmed this situation. The teachers had placed their excuse on the limited lesson periods and the exclusion of the particular content areas from the examination. This information explained why students had a poor responses towards the initial version, thus failing to meet the standard of a good test. A lack preparation to sit for the test might also suggest the students' limited responses. Preliminary briefings as well as continual assistance from the teachers and researchers during administration of amended version seemed to improve the students' response rates as compared to the initial version. The final reason relates to the students' proficiency in English. It was assumed that during the initial version, the students were not given the choice to select the Malay version as most of the responses received by the researcher were the English version. Those students possibly faced difficulty in understanding the statements given and directly affected their ability to give responses. In order to cater this problem, both languages were integrated in the amended version set side-by-side. Each statement was arranged in way that the English version still stands as the main statement followed by the Malay's translation. The researcher felt this strategy was more practical to improve the students' understanding towards the items as well as being more economical.

5.6 Conclusion

The pilot study of the initial version showed a poor test items [Cronbach's alpha coefficient = 0.15; Difficulty indices: 0.00-0.90; Discrimination indices: 0.00-0.40]. Despite several items believed to be faulty were removed, the Cronbach's alpha coefficient only increase slightly to 0.19. The strength and weakness of the initial version was used to guide the development of amended version.

The pilot study of amended version revealed satisfactory findings about the ABCAT in both Section A and [Cronbach's alpha coefficient = 0.58; Difficulty indices: 0.39-0.96; Discrimination indices: 0.10-0.67] and Section B [Cronbach's alpha coefficient = 0.65; Difficulty indices: 0.12-0.94; Discrimination indices: 0.06-0.81]. Based on this result, all the items in both sections were retained except for item B11. Each item was validated by experienced chemistry teachers and a chemistry education lecturer as well as been mapped in the specifications grid.

The data from the pilot study will provide crucial information to the researchers in the evaluation of the alignment between the students' achievement and the expected cognitive learning outcomes (Gronlund, 2003) as intended by the Chemistry curriculum in the next and final stage of the study. In relation to that, the students' achievement in this test will countercheck the effectiveness of the teacher implementation with regard to the cognitive outcomes (Hummel, 1997).

The development of ABCAT phase took the longest time in this research. More than six months had been spent to develop the initial version and another six months to revise and produce the amended version.

CHAPTER 6 | THE INTENDED CURRICULUM

6.1 Introduction

This chapter outlines the findings from the analysis of the Chemistry curriculum documents in order to address the first research question: What are the intentions of the Chemistry curriculum in terms of teaching and learning? The discussion of these findings is found at the end of this chapter.

6.2 Findings from the Secondary School Chemistry Curriculum

The researcher found that some statements printed in the Chemistry curriculum were somehow quite general in a way that could be applied to serve any science subject in secondary school. A cross check with other curriculum documents such as chemistry, biology, physics, as well as modern science subjects confirmed that all of the science subjects shared similar statements regarding the following components: aims; objectives; thinking skills and thinking strategies; scientific skills; scientific attitudes and noble values; teaching and learning strategies; and content organisation. Due to that reason, it was important for the researcher to interpret the embedded intentions contained in the Chemistry curriculum from the viewpoint of chemistry as a subject. Consequently, these Chemistry curriculum documents were analysed in terms of the intended impact and the intended process.

6.2.1 The intended impact

The students be able to attain the intended cognitive learning outcomes after the chemistry lessons

In general, the Chemistry curriculum aimed to produce students who were knowledgeable in both theories and practices that would enable them to solve problems and make decision in everyday life related to chemistry. This aim was shaped by correspondence with the National Science Education Philosophy (NSEP) which included the following statement: “In consonance with the National Education Philosophy, science education in Malaysia nurtures a Science and Technology Culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency” (Pheng et al., 2005, p.ix).

Within each of the Chemistry curriculum themes (refer Table 1.1), two types of goals were identified. The first one was referred to the overall goals of the theme; meanwhile the second one was referred to the topic goals. In the case of this study, the acids and bases topic was the second topic under the theme of interaction between chemicals. The goal for this theme was to provide the chemistry students with the basic understanding of chemical reactions that caused chemical changes to substances, the interaction of matter that produces new substances and causes energy change, and application of chemical reactions in industries. Basically, the goal for acids and bases topic was the refinement from the theme goal where it was intended to provide the chemistry students with basis understanding of acids and bases and its applications (*Integrated curriculum for secondary schools: Chemistry syllabus*, 2006)

The acids and bases topic consisted of seven learning areas: the meaning of acids and bases; the role of water in the formation of hydroxonium ions; characteristics of acids and alkalis; strong acids and weak acids; strong alkali and weak alkalis; molarity; and neutralisation. These learning areas were distributed over four learning objectives. The learning objectives were stated as follow: analysing characteristics and properties of acids and bases; synthesising the concepts of strong acids, weak acids, strong alkalis and weak alkalis; analysing concentration of acids and alkalis; and analysing neutralisation.

All four learning objectives had 26 cognitive learning outcomes to be mastered by students at the end of the acids and bases lessons: five in the first learning objective; eight in the second learning objective; seven in the third learning objective; and six in the fourth learning objectives. Table 6.1 lists all the learning objectives and cognitive learning outcomes for the acids and bases topic in the Chemistry curriculum.

Table 6.1 Acids and bases lesson learning objectives and cognitive learning outcomes.

Learning Objectives	Cognitive Learning Outcomes (LO) A student is able to:	
Analysing characteristics and properties of acids and bases.	LO1	State the meaning of acid, base and alkali.
	LO2	State uses of acids, bases, alkalis in daily life.
	LO3	Explain the role of water in the formation of H^+ ions to show the properties of acids.
	LO4	Explain the role of water in the formation of OH^- ions to show the properties of alkalis.
	LO5	Describe chemical properties of acids and alkalis.
Synthesising the concepts of strong acids, weak acids, strong alkalis and weak alkalis.	LO6	State the uses of a pH scale.
	LO7	Relate pH value with acidic or alkaline properties of a substance.
	LO8	Relate concentration of H^+ ions with pH value.
	LO9	Relate concentration of OH^- ions with pH value.
	LO10	Relate strong or weak acid with degree of dissociation.
	LO11	Relate strong or weak alkali with degree of dissociation.
	LO12	Conceptualise qualitatively strong and weak acids.
	LO13	Conceptualise qualitatively strong and weak alkalis.
Analysing concentration of acids and alkalis.	LO14	State the meaning of concentration.
	LO15	State the meaning of molarity.
	LO16	State the relationship between the number of moles with molarity and volume of a solution.
	LO17	Describe methods for preparing standard solutions.
	LO18	Describe the preparation of solution a solution with a specified concentration using dilution method.
	LO19	Relate pH value with molarity of acid and alkali.
	LO20	Solve numerical problems involving molarity of acids and alkalis.
Analysing neutralisation.	LO21	Explain the meaning of neutralisation.
	LO22	Explain the application of neutralisation in daily life.
	LO23	Write equations for neutralisation reactions.
	LO24	Describe acids-bases titration.
	LO25	Determine the end point of titration during neutralisation.
	LO26	Solve numerical problems involving neutralisation reactions to calculate either concentration or volume of solutions.

The cognitive learning outcomes were specified under the column of "Learning Outcomes" and were presented in the form of measurable behavioural terms such as, "state the meaning…", "describe the preparation..", and "explain the application…". During the planning of teaching and learning, the teachers were reminded, "…to *adhere the curriculum since the summative assessment will be based on the learning outcomes in the curriculum specifications by the Malaysian Assessment Syndicate at the end of the full course. Their achievements in this summative assessment may have high stakes for the students and the teachers too!"* (CDD/MOE/16.02.2011). In addition, the Chemistry curriculum had advised the teachers to organise the classroom activities that could cover multiple cognitive learning outcomes and had advised them to avoid achieving each of the cognitive learning outcomes separately. Besides that, the teachers also were informed that it was not necessary to follow the order of the cognitive learning outcomes as listed in the curriculum.

Finding 1: The Chemistry curriculum intended that students be able to attain the intended cognitive learning outcomes after the chemistry lessons.

The students have interest to learn chemistry after the lessons

Even though the Chemistry curriculum seemed to place the cognitive learning outcomes in the spotlight more frequently, the curriculum also took account of the non-cognitive or affective outcomes as a result of the lessons. Here, the Chemistry curriculum intended the students to have a higher degree of interest towards chemistry after the lessons. This intention was stated indirectly as a product of the suggested teaching and learning strategies. This intention was evident where the documents encouraged the chemistry teachers to include different activities in their lesson planning in order to boost the students' interest towards the subjects.

The existence of this intention was supported by the CDD's representative through the following statement: "*After each chemistry lesson, it is expected that students will achieve the intended learning outcomes, be motivated with the student centred activities... have fun, excitement and accept the challenges involved through solving the tasks or problems given by the teachers or peers through good working etiquette*" (CDD/MOE/16.02.2011).

Finding 2: The Chemistry curriculum intended that the students have interest to learn chemistry after the lessons.

6.2.2 The intended process

The lessons are to be carried out using thoughtful teaching

The Chemistry curriculum proposed several thoughtful instructional strategies for teachers to plan and carry out effective chemistry lessons. It was up to the teachers' decisions to choose the most suitable instructional strategies for their lessons by considering the following criteria: curriculum content; students' abilities; students' multiple intelligences; and the availability of resources and facilities. The brief descriptions of the teaching and learning approaches proposed by the Chemistry curriculum are as follows (Pheng et al., 2005):

(a) Inquiry-discovery: In order to apply this approach, the chemistry teachers were recommended to consider lesson activities such as information seeking, inquiring, and investigating that would assist the students in building their own learning experiences. Through such activities, the students were intended to generate their own concepts and principles.

(b) Constructivism: The main characteristic of this approach was for students to put in their own efforts in order to construct their understanding. In this regard, the chemistry teachers were recommended to prepare tasks that would enable the chemistry students to construct their own conceptualisations towards the chemistry concepts and principles by relating them with their prior knowledge. The Chemistry curriculum suggested activities such as cooperation, ideas sharing, and reflective learning to be part of the constructivist approach.

(c) Science, technology and society: Throughout the lessons, the Chemistry curriculum recommended the teachers to integrate the mastery of chemistry knowledge together with the elements of science and technology and their impact on the society. Lesson activities such as investigation and discussion were the suitable platforms to embed this principle.

(d) Contextual learning: The Chemistry curriculum highlighted that this approach was mainly aimed to provide opportunities for the students to relate their knowledge with their own daily experiences. Through this approach, the Chemistry curriculum intended the students to acknowledge the relevance of chemistry to their lives. Investigation activity was suggested to be carried out for this approach.

(e) Mastery learning: The learning objectives were an essential component of the Chemistry curriculum. Through this approach, the Chemistry curriculum suggested that the lessons could be planned to provide the chemistry students with adequate opportunities and at the correct pace to acquire and master the learning objectives. The incorporation of remedial and enrichment activities during the teaching-learning process were suggested to accomplish this intention.

Corresponding to the suggested teaching and learning approaches, the Chemistry curriculum had specified several classroom activities that could be engaged in during the teaching and learning process. These activities were as follows:

(a) Experiments: Experimenting was a typical lesson activity suggested in the Chemistry curriculum. Within this method, the curriculum intended the chemistry teachers to guide their students through proper experimenting procedures to discover specific chemistry concepts and principles. During the implementation, the teachers were reminded to integrate all skills, namely, thinking skills, scientific skills, and manipulative skills. In addition, chemistry teachers were encouraged to provide students with opportunities to design their own experiments.

(b) Discussions: The Chemistry curriculum stated that this method could promote the exchange of ideas among students regarding certain chemistry issues. Such activity was suggested to take place before, during, or after an activity. For teachers, the Chemistry curriculum specified their roles as facilitators who provoked discussion by raising questions that could stimulate thinking and getting students to express themselves.

(c) Simulations: The Chemistry curriculum proposed this method to be applied in chemistry lessons to assist students in understanding certain chemistry concepts or principles by conducting activities that could resemble the real situation. Here, the students were able to visualise or analogise the learnt concepts towards something with which they were familiar. Role-plays, games, and models were suggested as parts of the simulation activities.

(d) Projects: The Chemistry curriculum suggested this method be carried out by individuals or groups of students towards achieving certain learning objectives. Through this activity, students' skills such as problem-solving skills, time management skills, and independent learning skills were expected to be developed. It was suggested that the project's products be presented in the classroom in the form of reports, artefacts or other kinds of presentations. However, the teachers were encouraged to plan this method properly as it could consume time or lesson periods to be completed.

(e) Visit and use of external resources: The Chemistry curriculum mentioned that the learning of chemistry lessons could be enhanced by being conducted outside the school's perimeter or could be an organised partnership with various organisations. Such activities were hoped to boost students' interest towards chemistry as well as to make the lessons more meaningful and effective. To optimise the impact of this method, the Chemistry curriculum had asked the teacher to plan this activity carefully. The teachers could involve the students in the planning process of the visit, assign specific educational tasks during the visit, and arrange a post-visit discussion after the visit. These steps would develop the students' skills to select, analyse and evaluate.

(f) Use of technology: For the Chemistry curriculum the use of technology in chemistry lessons was viewed as encouraging meaningful, effective, as well as interesting ways of learning. The utilisation of various sources of technology such as television, radio, video, calculators, computer, educational software and the internet in the teaching and learning process were highly encouraged. The application of computer simulations and animations were recommended to assist the students' understanding in exploring abstract or difficult scientific concepts. The Chemistry curriculum believed this method could optimise the achievement of the cognitive learning outcomes.

Table 6.2 Specific learning activities suggested for acids and bases topic.

Learning Activities	Learning Objective			
	1	2	3	4
Discussion	√	√	√	
Experiment	√√		√	
Computer simulation	√	√		
Hands-on			√√	√
Write equations	√			√
Calculation			√√	√
Collect and interpret data				√
Mind mapping		√		
Unspecified activities	√	√√		

Under the acids and bases topic, specific teaching and learning activities were suggested in the column "Suggested Learning Activities". Content analysis of the column identified nine groups of suggested classroom activities over the four learning objectives (Table 6.2). Eight activities were explicitly specified; meanwhile, only one was implicitly specified.

The first activity was discussion which was highlighted thrice, each in learning objective 1 (analysing characteristics and properties of acids and bases), learning objective 2 (synthesising the concepts of strong acids, weak acids, strong alkalis and weak alkalis), and learning objective 3 (analysing concentration of acids and alkalis). The activity covered the development of students' abilities to communicate ideas regarding the basic concepts of acids and bases, the relationship of pH values with degree of acidity and alkalinity, and the concepts of concentration of acids and alkalis.

The second activity was the experiment which was proposed to be carried out in learning objective 1 and learning objective 3. Two out of three of the activities were suggested to be done in learning objective 1, focusing investigation on the roles of water in the formation of hydrogen and hydroxide ions. Only one experiment activity was suggested in learning objective 3 to focus on the relationship between pH values with the molarity of a few diluted solutions of an acid and alkali.

The third activity was the use of computer simulations as modelling tools to show students the formation of hydroxonium and hydroxide ions in the presence of water (learning objective 1) and the dissociation of varied strength acids and alkalis (learning objective 2). Only two of such activities were suggested in both objectives.

The fourth activity was hands-on- mentioned thrice, twice in learning objective 3, and once in learning objective 4. This activity focused on giving the students experiences to prepare solutions with different concentration and to conduct neutralisation using a computer interface to determine the end point.

The fifth activity was writing equations which was mentioned once in each learning objective 1 and learning objective 4. This activity required students to comprehend the equation involving acids, alkalis, and neutralisation reactions.

The sixth activity was the calculation, mentioned twice in learning objective 3 and once in learning objective 4. The focus was to engage the students in problem solving activities involving numerical problem of unit conversion, molarity, and neutralisation reactions.

The seventh activity was collecting and interpreting data, mentioned only once in learning objective 4. The activity was intended to engage students in analysing information on neutralisation and its application in daily life.

The eighth activity was the mind map construction. The activity involved the students to build their own conceptual regarding different strength of acids and alkalis, as mentioned once in learning objective 2.

The final grouping consisted of unspecified classroom activities. For this activity, chemistry teachers to use their own creativity to create their own lessons activities with regards to chemical properties of acids and alkalis and to measure the pH values of solutions. It was mentioned thrice: once in learning objective 1 and twice in learning objective 2.

 # Finding 3: The Chemistry curriculum intended that the lessons are to be carried out using thoughtful teaching.

The students are provided with an experiential learning environment during the lessons

In order to achieve the listed cognitive learning outcomes regardless of the topics, the Chemistry curriculum advocated that the chemistry classroom, "should be organised to provide opportunities for the students to apply thinking skills in conceptualisation, problem solving and decision-making [through] active teaching and learning process" (Pheng et al., 2005, p.4). This statement was further clarified by the CDD's representative through the following statements, **"***The activities must be seen as relevant to the student so that they are engaged in the activities and felt that they have learnt and achieved at least some knowledge and understanding of chemistry. The teachers must be able to provide opportunities for students to experience the chemistry concepts and principles in an articulated manner"* (CDD/MOE/16.02.2011).

The statements above described the intention of the Chemistry curriculum to create experiential learning environment for the students through the implementation of thoughtful teaching. The Chemistry curriculum highlighted that the roles of teachers in thoughtful teaching should not be confined to being an information provider, instead to act as knowledge presenters, experts, or facilitators. The roles of teachers with regards to this intention were explained further by the CDD's representative as follow (CDD/MOE/16.02.2011):

> *Researcher: How does the CDD intend the interactions between the teacher-students to take place during the chemistry lesson?*
> *CDD's representative: Encourage teachers to always plan student-centred lessons and most of the time the teacher act as the facilitator. Where possible the students decide the depth of the objectives and the type of activities involved.*
> *Researcher: Why emphasise student-centred learning?*
> *CDD's representative: To give students the opportunity to experience what they want to know and study… thus, giving the students the autonomy, confidence, interest and perseverance in what they are doing… and the real feeling of being a scientist, researcher or investigator.*

According to the Chemistry curriculum, the teachers' tasks in the experiential learning environment were to challenge their students with higher order questions and problems and be required to solve problems utilising their creativity and critical thinking. The teachers were encouraged to provide ample opportunities for the students to take part in scientific investigations through hands-on activities and experimentations. These activities were intended to inculcate scientific skills such as to observe, ask questions, formulate and test hypotheses, analyse, interpret data, report and evaluate findings to the students.

 # Finding 4: The Chemistry curriculum intended that the students are provided with an experiential learning environment during the lessons.

6.3 Discussion

The first intention involved the attainment of cognitive learning outcomes as specified by the Chemistry curriculum in every topic, in the case of this study acids and bases topic. The Chemistry curriculum had listed the cognitive learning outcomes in detail. It was written using action-oriented verbs such as "to state," "to explain," "to describe," "to relate," "to conceptualise" and others. Not only that, the verbs were organised according to the increasing hierarchy of the Bloom's cognitive domains (Bloom et al., 1956). The use of such verbs suited what had been described by Kirschner Associates (1975) and Mager (1962) as good and explicit objectives. The extent to what the students had attained the cognitive outcomes in acids and bases lessons was assessed using the Acids-Bases Chemistry Achievement Test (ABCAT). The item in ABCAT had been composed according to the specified cognitive learning outcomes of acids and bases topic. The development of the ABCAT is covered in Chapter 5, meanwhile the findings of the student achievements as resulting from the acids and bases lessons are laid out in Table 9.13 for urban chemistry students and Table 9.14 for rural chemistry students. Both urban and rural chemistry students had indicated satisfying attainment of the overall intended learning outcomes based on the large improvements of results from the pre-test to the post-test of the ABCAT (large effect size between the results of the pre-test and the post-test of the ABCAT).

The second intention was concerned with elevating students' interests towards chemistry lessons. However, an analysis of the Chemistry curriculum documents could not identify much detail about this intention. Instead, student interest was mentioned indirectly believing that it would play a role in influencing the students' achievement. The interview with the CDD's representative had supported the existence of this component as a product of students' experiential learning environment. Therefore, the improvement of students' attitudes towards chemistry lesson was considered as part of the Chemistry curriculum intentions. In the context of this study, the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) was used to gather information about the attitudes of urban and rural chemistry students towards the acids and bases lessons. The results are presented in Figure 9.2 for urban chemistry students and Figure 9.3 for rural chemistry students. The urban chemistry students indicated that they had high interest towards *Liking for Acids-Bases Chemistry Laboratory Work*. Meanwhile, the rural chemistry students indicated that they had high interest towards *Liking for Acids-Bases Chemistry Laboratory Work* and *Evaluative Beliefs about Acids-Bases Chemistry*. The encouraging attitude towards these scales were evidenced by the item means of the actual scales of the modified version of the ATCLS located between 4 (Agree) to 5 (Strongly Agree). Other scales were only recorded low interest, yet positive by the urban and rural students [the item means of the actual scales of the modified version of the ATCLS located between 3 (Not Sure) to 4 (Agree)].

The intention to move away from the traditional, rote and dull teaching strategies had always been the focus of Malaysian education system since the adaption of the Nuffield "O" Levels Pure Science Syllabi about 40 years ago (Lee, 1992; Lewin, 1975). Therefore, the third intention had encouraged chemistry teachers to carry out thoughtful teaching strategies during the chemistry lessons. In general, five teaching and learning approaches and six classroom activities had been suggested with nine specific activities proposed for the acids and bases lessons. Despite the comprehensive suggestions of the thoughtful teaching strategies, either in general or within the acids and bases topic, it was crucial to know that the Chemistry curriculum did not restrain the chemistry teachers to abide by any of these ideas. Instead, the chemistry teachers were allowed to alter the suggested activities when necessary or to bring forth their own innovative and effective classroom activities as long it could gear up towards experiential learning for the students. This was evidence from one of the suggested classroom activities that implicitly required the teachers to use their own creativity to deliver the lessons in learning objectives 1 and learning objective 2 (refer Table 6.2). In order to measure this intention in the context of acids and bases lessons in the urban and rural chemistry classrooms, the teacher edition of the Questionnaire of Enacted Curriculum (QEC) was administered.

The results for the urban and rural chemistry teachers are presented in Figures 7.2 and 7.3, respectively. The urban chemistry teachers had poorly implemented the *Analyse Information, Make Connections, Active Learning, Use of Strategies to Develop Students' Attitudes to Communicate Ideas* and *Use of Laboratory Activities* during the acids and bases lessons as evident by item means of the teacher edition of the QEC located between 2 (Sometimes) and 3 (Almost Always). Similarly, the rural chemistry teachers also had poorly implemented the thoughtful teaching practices during the acids and bases lessons, except for the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*. Instead, the acids and bases lessons in both urban and rural chemistry classrooms were been dominated by the *Use of Traditional Teaching Practices* [item mean of the teacher edition of the QEC between 3 (Almost Always) and 4 (Always)].

In relation to the third intention, the fourth intention was concerned with the Chemistry curriculum vision to provide an experiential learning environment to the students. This was deemed parallel to one of the specific initiatives mentioned in the STPII to transform from the passive examination oriented and rote learning approach to being actively engaged in hands-on and minds-on activities oriented approach (Din & Krishna, 2007; Zainuddin, 2010, December, p.5). As described by Tan (1991), the instructional strategies of the Malaysian science curriculum basically centralised on student-centred, problem-solving and activity-oriented. It was clear that the Chemistry curriculum did provide the platform for different learning experiences and supported the teachers' lesson planning. All of these were to make the chemistry lessons meaningful and attractive which would lead to the improvement of students' achievement (Osman et al., 2006). The order of the classroom activities was organised in correspondence with the cognitive domain hierarchy of the cognitive learning outcomes. This was consonant with what had been described by Johnson (1967) that learning experiences are not a random series of items, but instead are structured ones. The assessment of this intention during acids and bases lessons involved the use of the modified version of the What Is Happening In This Class? (WIHIC). Respectively, the results of urban and rural students are presented in Figures 8.2 and 8.3. Both urban and rural chemistry students indicated that they had perceived the *Cooperation* quite high [item means of the scales of the modified version of the actual form WIHIC being located between 4

(Almost Always) to 5 (Always)] during the acids and bases lessons. Meanwhile, both urban and rural students indicated that they had weak perceptions of other scales, yet they were positively perceived during the acids and bases lessons [item means of the scales of the modified version of the actual form WIHIC being located between 3 (Sometimes) to 4 (Almost Always)].

It was found that the Chemistry curriculum shared similar statements on the following components with other science subjects: aims; objectives; thinking skills and thinking strategies; scientific skills; scientific attitudes and noble values; teaching and learning strategies; and content organisation. This situation was called, 'curriculum frameworks' where a group of related subjects, in the case of this study chemistry, biology, physics, modern science, fit together according to a pre-determined set of criteria to appropriately cover an area of study (Marsh, 2004). Western Australia (Andrich, 2009) and the Northern Territory (*NT curriculum framework*, 2009), both are a state and territory in Australia, were examples using the curriculum frameworks with a similar set of criteria for values, skills, and assessments were applied across eight subjects from Kindergarten to Year 10: arts, English, health and physical education, languages other than English, mathematics, science, society and environment, and technology and enterprise.

It was obvious that the Chemistry curriculum had placed equal weight on the content as well as the lessons' organisation. According to Hamilton (1976), such emphasis exhibits a common concern for the 'what' and 'how' of the curriculum. For the content, the Chemistry curriculum had addressed in detail the learning objectives and cognitive learning outcomes that should be achieved by the students at the end of chemistry lessons. In terms of the lessons' organisation, the Chemistry curriculum had laid out the teaching and learning strategies that could be implemented to achieve the learning objectives, referred to as the cognitive learning outcomes in this study.

Overall, the Chemistry curriculum prepared by the Ministry of Education Malaysia (MOE) had fulfilled the criteria described by Bal and Cohen (1996) and Remillard (2005) as a good curriculum guide. This was admitted by Soon (1997) who mentioned that the Chemistry curriculum had been comprehensively prepared towards equipping students with adequate chemical background to cope with everyday life and also to prepare them for tertiary academic studies or technical courses for those who would be inclined to work in science and technology field.

6.4 Conclusion

The explication of curriculum theory (impact theory and process theory) from the official documents (the specifications and the syllabus) with support from the explanation of the CDD representative had successfully the researcher concluded that there were four intentions in the Chemistry curriculum. The Chemistry curriculum intended that (1) students be able to attain the intended learning outcomes after the chemistry lessons; (2) the students have interest to learn chemistry after the lessons; (3) the lessons are to be carried out using thoughtful teaching; and (4) the students are provided with an experiential learning environment during the lessons. The identification of these intentions had provided an answer to address the first research question, “What are the intentions of the Chemistry curriculum in terms of teaching and learning?”, and thus, act as benchmarks to measure the effectiveness of acids and bases lessons to ascertain whether or not they had met the Chemistry curriculum intentions. For the first intention of the Chemistry curriculum referred to above, both urban and rural chemistry students in this study indicated that had satisfactorily attained the overall intended learning outcomes. For the second intention of the Chemistry curriculum, the urban chemistry students indicated that they had high interest only towards *Liking for Acids-Bases Chemistry Laboratory Work* (mean of 4.07); meanwhile, the rural chemistry students indicated that they had high interest only towards *Liking for Acids-Bases Chemistry Laboratory Work* (mean of 4.19) and *Evaluative Beliefs about Acids-Bases Chemistry* (mean of 4.18). For the third intention of the Chemistry curriculum, both urban and rural chemistry teachers indicated that the *Use of Traditional Teaching Practices* (means of 3.09 and 3.40, respectively) dominated their acids and bases lessons. Nonetheless, the rural chemistry teachers also indicated to have largely carried out teaching practices that involved the *Use of Strategies to Develop Students’ Attitudes to Communicate Ideas* (mean of 3.33) during the acids and bases lessons. For the fourth intention of the Chemistry curriculum, both urban and rural chemistry students indicated that they had only weakly perceived the experiential learning environment during the acids and bases lessons except for the relatively high cooperation between the students (means of *Cooperation* scale - 4.23 for urban chemistry students and 4.26 for rural chemistry students).

CHAPTER 7 | THE IMPLEMENTED CURRICULUM

7.1 Introduction

This chapter addresses the second research question: How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? Results from the teacher edition of Questionnaire of Enacted Curriculum (QEC) (Section 7.2) presented an analysis of the classroom activities from the view of the chemistry teachers. Meanwhile, results from the student edition of the QEC (Section 7.3) provided supporting information from the view of the chemistry students. The findings are discussed at the end of the chapter (Section 7.4).

7.2 Findings from the Teacher Edition of the Questionnaire of the Enacted Curriculum (QEC)

7.2.1 Combined results for urban and rural teachers

The data had been gathered from nine chemistry teachers from urban and rural schools around Melaka Tengah district. It was the researcher's intentions to collect more responses from other teachers; however, the limited funds restrained the researcher from travelling to more distant schools. A typical Malaysian school might have one or two chemistry teachers available, and sometimes none depending on the number of students enrolled in the subject. This meant the researcher would need to go to more schools in order to obtain more teachers' responses. Besides that, as this study required the data from both teachers and students to address the inquiries with regards to the *implemented*, *perceived* and *achieved* curriculum, the data collection process would become more difficult, thus, the time available only allowed the researcher to collect data from these nine teachers and their classes.

Due to the small sample size of teachers (N = 9) factor analysis and reliabilities could not be determined using the Predictive Analytics SoftWare (PASW) software. Therefore, the average item mean for urban and rural teachers' responses and the deviation of average item means between urban and rural teachers were computed manually using the spreadsheet (Microsoft Excel) software. The average item mean can be determined by dividing the scale means with the number of items in the scale. The identification of average item mean enabled the comparison between scales that had different numbers of items.

The results from the analysis of the average item means for the combined group of urban and rural teachers are shown in Table 7.1. The item means for all scales exceeded 2 (Sometimes) suggesting the positive implementations of all described teaching practices during the acids and bases lessons.

Table 7.1 Average item means for the teacher edition of the QEC for the combination of urban and rural chemistry teachers (N = 9).

Scale	Average Item Mean[a]
Analyse Information (AI)	2.33
Make Connections (MC)	2.44
Active Learning (AL)	2.44
Use of Traditional Teaching Practices (TT)	3.16
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.98
Use of Laboratory Activities (LA)	2.94

[a] Average item mean = Scale mean divided by the number of items in that scale.

The urban and rural teachers indicated that they had carried out the *Use of Traditional Teaching Practices* (3.16) most frequently. The teaching practices that involved the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* and the *Use of Laboratory Activities* were implemented a relatively similar amount as indicated by item means of 2.98 and 2.94, respectively. *Make Connections* and *Active Learning* scales were generally implemented sometimes with each scale having an item mean of 2.44. The urban and rural teachers claimed to carry out the *Analyse Information* (2.33) the least frequently during the acids and bases lessons. Figure 7.1 describes the implementation of the described teaching practices in the acids and bases lessons for the combined urban and rural teachers' responses.

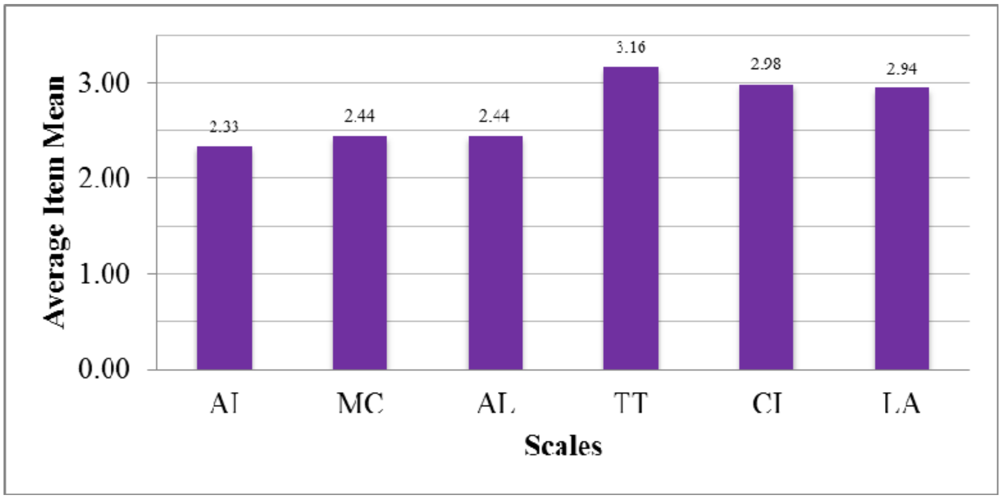

Figure 7.1 Average item means of the scales in the teacher edition of the QEC for the combination of urban and rural chemistry teachers (N = 9).

 # Finding 5: The validity and reliability for the six scales of the teacher edition of the QEC that was used this study could not be determined due to the small sample size of the teachers. However, reports about the original instruments indicated that all the replicated scales had demonstrated good internal consistency reliability, with the Cronbach's alpha coefficient being 0.71 or above for each of the scales (Smithson & Blank, 2006; Weiss et al., 2003).

7.2.2 The results for the urban teachers

Seven urban chemistry teachers from five schools provided their responses on the teacher edition of the QEC. Their responses were collated on six scales with the item means ranging from 2.39 to 3.09 (Table 7.2). These values exceeded 2 (Sometimes) which suggested positive implementations of the described teaching practices during the acids and bases lessons.

Table 7.2 shows the urban teachers had *Use of Traditional Teaching Practices* (3.09) the most frequently in the acids and bases lessons. The *Use of Laboratory Activities* and the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* were positively carried out with item means of 2.96 and 2.88, respectively. Two other teaching practices, namely *Make Connections* and *Active Learning*, had item means of 2.43 each. The urban teachers indicated that the application of *Analyse*

Information (2.39) was the least frequently used. Figure 7.2 graphically represents the implementation of the described teaching practices by the urban teachers.

Table 7.2 Average item means for the teacher edition of the QEC for urban chemistry teachers only (N = 7).

Scale	Average Item Mean[a]
Analyse Information (AI)	2.39
Make Connections (MC)	2.43
Active Learning (AL)	2.43
Use of Traditional Teaching Practices (TT)	3.09
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.88
Use of Laboratory Activities (LA)	2.96

[a] Average item mean = Scale mean divided by the number of items in that scale.

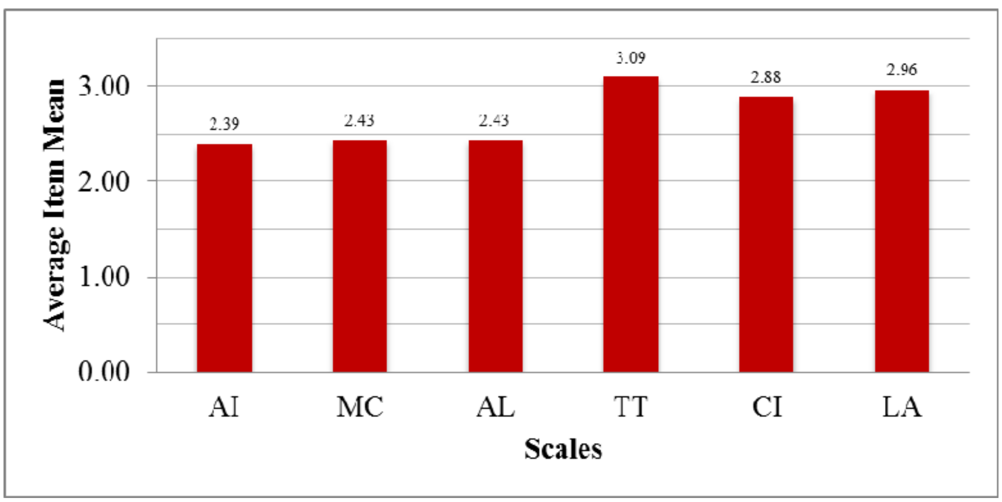

Figure 7.2 Average item means of the scales in the teacher edition of the QEC for the urban chemistry teachers (N = 7).

 # Finding 6: The urban chemistry teachers indicated that they had carried out all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. The *Use of Traditional Teaching Practices* (TT) was claimed to be the most frequent, while the use of *Analyse Information* (AI) in the teaching practice was implemented the least.

7.2.3 The results for the rural teachers

Table 7.3 lists the item means of the QEC scales based on the responses given by two chemistry teachers from rural category schools. The item means across six scales, ranged from 2.13 to 3.40, were above 2 (Sometimes) suggesting positive implementation of the described teaching practices.

Table 7.3 Average item means for the teacher edition of the QEC for rural chemistry teachers only (N = 2).

Scale	Average Item Mean[a]
Analyse Information (AI)	2.13
Make Connections (MC)	2.50
Active Learning (AL)	2.50
Use of Traditional Teaching Practices (TT)	3.40
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	3.33
Use of Laboratory Activities (LA)	2.88

[a] Average item mean = Scale mean divided by the number of items in that scale.

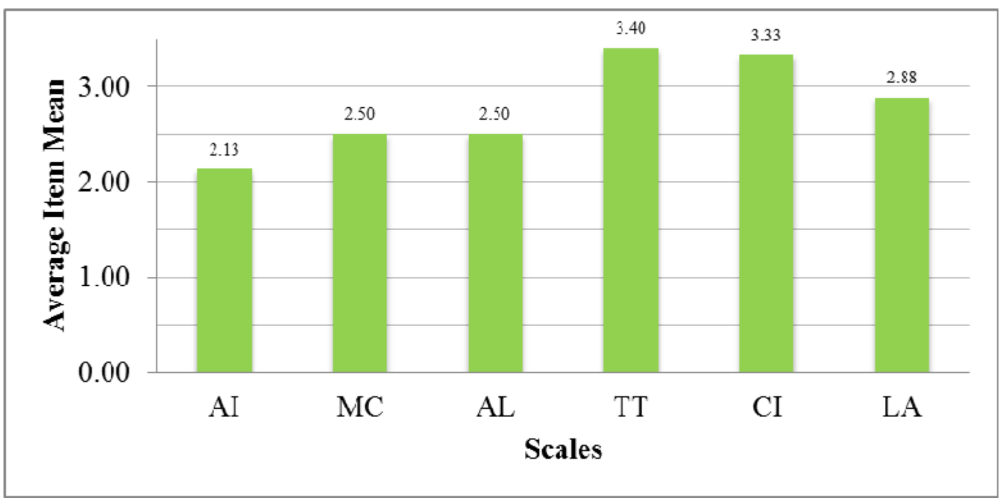

Figure 7.3 Average item means of the scales in the teacher edition of the QEC for the rural chemistry teachers (N = 2).

The most frequent teaching practice carried out by the rural teachers was the *Use of Traditional Teaching Practices* (3.40), followed by the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (3.33). The *Use of Laboratory Activities* by the rural teachers during the acids and bases lessons was positive with the item mean of 2.88. Two other teaching practices namely, *Make Connections* and *Active Learning,* had item means of 2.50 each. The lowest item mean (2.13) was scored for the teaching practice that involved *Analyse Information*. Figure 7.3 graphically represents the execution of the specified teaching practices by the rural teachers.

 # Finding 7: The rural chemistry teachers indicated that they had carried out all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons with the most frequently used practice being *Use of Traditional Teaching Practices* (TT), while the *Analyse Information* (AI) teaching practice was implemented the least.

7.2.4 Comparison of results between urban and rural teachers

For comparison of teaching practices between urban and rural teachers, the data from Table 7.2 and Table 7.3 were combined to form Table 7.4. The deviation of average item means between urban and rural teachers for all six scales ranged from 0.07 to 0.45.

Table 7.4 Average item means for the teacher edition of the QEC for urban and rural chemistry teachers ($N_{urban\ teachers} = 7$; $N_{rural\ teachers} = 2$).

Scale	Average Item Mean[a]		
	Urban	Rural	Deviation
Analyse Information (AI)	2.39	2.13	0.26
Make Connections (MC)	2.43	2.50	0.07
Active Learning (AL)	2.43	2.50	0.07
Use of Traditional Teaching Practices (TT)	3.09	3.40	0.31
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.88	3.33	0.45
Use of Laboratory Activities (LA)	2.96	2.88	0.08

[a] Average item mean = Scale mean divided by the number of items in that scale.

Using the item mean as the basis of comparison, three teaching practices of the urban and rural teachers were identified to be carried out at relatively similar frequencies, namely *Make Connections* (difference by 0.07), *Active Learning* (difference by 0.07), and *Use of Laboratory Activities* (difference by 0.08). However, the rural teachers indicated to *Use of Traditional Teaching Practices* and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* more frequently than the urban teachers did as shown by larger item mean differences between the urban and rural teachers for these scales, namely 0.31 and 0.45, respectively. Meanwhile, the item mean difference of 0.26 indicated that the urban teachers had carried out the *Analyse Information* more frequently than the rural teachers. Figure 7.4 illustrates the comparison of teaching practices between urban and rural chemistry teachers.

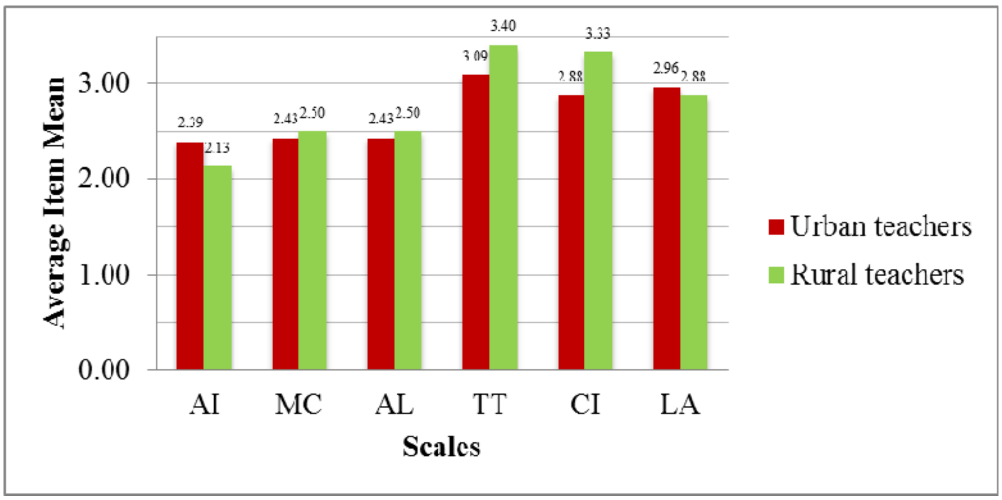

Figure 7.4 Comparison of the item means obtained per scale from the teacher edition of the QEC for urban and rural chemistry teachers ($N_{urban\ teachers} = 7$; $N_{rural\ teachers} = 2$).

 # Finding 8: There were no differences between the urban and rural teachers for the implementation of *Make Connections* (MC), *Active Learning* (AL) and *Use of Laboratory Activities* (LA) during the acids and bases lessons. Nonetheless, the urban chemistry teachers indicated to *Use of Traditional Teaching Practices* (TT) and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (CI) less frequently, but claimed to carry out the *Analyse Information* (AI) activity more frequently than the rural chemistry teachers did.

7.3 Findings from the Student Edition of the Questionnaire of Enacted Curriculum (QEC)

7.3.1 Combined results for urban and rural students

As mentioned in Section 4.3, all the scales that form the teacher edition were replicated to form the student edition of the QEC. The replication of these scales enabled the comparison between the teachers and students' responses with regard to the teaching practices that had been carried out during the acids and bases lessons. The total of 354 chemistry students from all participating urban and rural schools had provided their responses on the student edition. Due to the large participation of students, it was possible to carry out several analyses to determine validity and reliability, namely, internal consistency reliability and mean correlation with other scales. In addition, analyses of item mean, scale mean, average standard deviation, effect size and t-test were done using urban and rural chemistry students as the unit of analysis. Nonetheless, the factor analysis to determine the construct validity of the student edition of the QEC was not shown here as the result does not supported the six-scale structures of the teacher edition of the QEC. The result of the factor analysis (Appendix R) indicated that only four scales were generated where many of the items did not load in its original scale, instead dispersed on the four scales. Therefore, the six-scale structure of the teacher edition of the QEC was kept throughout the analyses.

Table 7.5 Cronbach's alpha coefficients of each scale for the student edition of the QEC for the combination of urban and rural chemistry students (N = 354).

Scale	No. of Items	Alpha Reliability
Analyse Information (AI)	4	0.82
Make Connections (MC)	3	0.58
Active Learning (AL)	4	0.58
Use of Traditional Teaching Practices (TT)	5	0.61
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	6	0.77
Use of Laboratory Activities (LA)	4	0.78

Table 7.5 shows the internal consistency reliability of each scale of the student edition of the QEC with Cronbach's alpha coefficients ranging from 0.58 to 0.82. Three scales, namely *Analyse Information*, *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*, and *Use of Laboratory Activities* had coefficients above 0.70, suggesting a good internal consistency reliability between items for each scale (Kim, Crasco, Smithson, & Blank, 2001). However, *Make Connections, Active Learning* and *Use of Traditional Teaching Practices* had relatively low internal consistency reliability with Cronbach's alpha coefficients of 0.58, 0.58 and 0.61, respectively (Kim et al., 2001).

Table 7.6 Item-scale correlation coefficients of the student edition of the QEC for the combination of urban and rural chemistry students (N = 354).

Scale	AI	MC	AL	TT	CI	LA
Analyse Information (AI)	-	0.73**	0.63**	0.50**	0.44**	0.55**
Make Connections (MC)		-	0.63**	0.50**	0.45**	0.56**
Active Learning (AL)			-	0.50**	0.46**	0.57**
Use of Traditional Teaching Practices (TT)				-	0.54**	0.62**
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)					-	0.44**
Use of Laboratory Activities (LA)						-
Mean correlation with other scales	0.57	0.57	0.56	0.53	0.47	0.55

** Correlation is significant at the 0.01 level (2-tailed).

To determine the extent to which the scales were unrelated to each other, the discriminant validity was measured by obtaining the mean correlation of each scale with the other scales (Lehmann, 1988) as shown in Table 7.6. The mean correlation with other scales ranged from 0.47 to 0.57, suggesting a low to medium degree of correlation between scales, thus, supporting the existence of discriminant validity in this student edition.

Table 7.7 shows item means for all scales, ranged from 2.47 to 3.23, were above the value of 2 (Sometimes) which suggested positive engagement of urban and rural students in those described teaching practices. The students indicated that had participated in the *Use of Laboratory Activities* the most frequent with the item mean of 3.23. The *Use of Traditional Teaching Practices* was also positively engaged by the students (3.08). This was followed by students' engagement in the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (2.86). The students' responses also indicated that they had positive engagement in the *Analyse Information* and *Make Connections* with item means of 2.56 and 2.51, respectively. The teaching practice that involved *Active Learning* was the least engaged in by the students (2.47). Figure 7.5 graphically represents the item means for each of the scales.

Table 7.7 Average item means, scale means, and standard deviations for the student edition of the QEC for the combination of urban and rural chemistry students (N = 354).

Scale	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation
Analyse Information (AI)	2.56	10.26	0.77
Make Connections (MC)	2.51	7.54	0.67
Active Learning (AL)	2.47	9.89	0.74
Use of Traditional Teaching Practices (TT)	3.08	15.39	0.55
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.86	17.14	0.64
Use of Laboratory Activities (LA)	3.23	12.94	0.62

[a] Average item mean = Scale mean divided by the number of items in that scale.

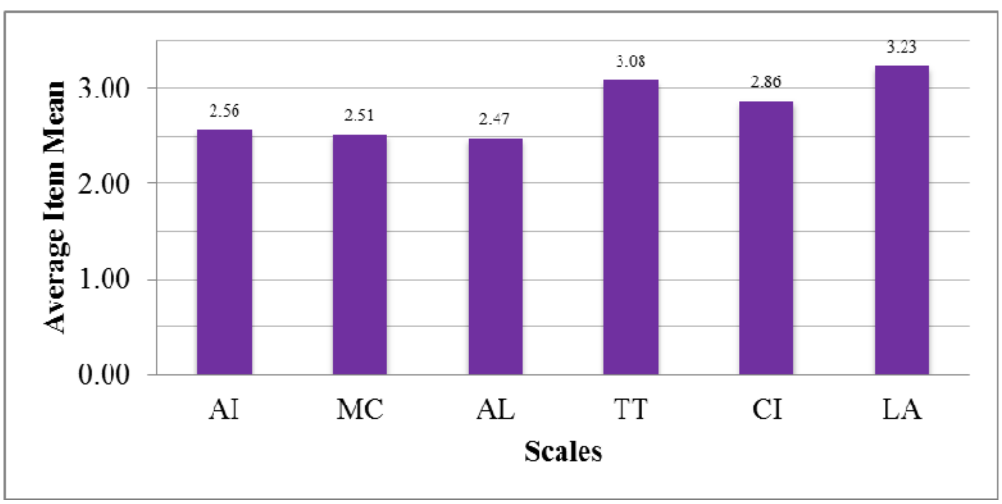

Figure 7.5 Average item means of the scales in the student edition of the QEC for the combination of urban and rural chemistry students (N = 354).

Table 7.7 shows that the scale means ranged from 7.54 for the *Make Connections* to 17.14 for the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*. The average item standard deviation, representing the distribution of students' responses across the items of each scale, was the largest for *Analyse Information* (0.77) and the lowest for *Use of Traditional Teaching Practices* (0.55).

 # Finding 9: The student edition of the QEC demonstrated moderate reliability with only three scales having Cronbach's alpha coefficients above 0.70. Nonetheless, the student edition of the QEC showed satisfactory discriminant validity on all six scales for the combination of urban and rural chemistry students of this study.

7.3.2 The results for the urban students

The total of 254 chemistry students from the urban category schools had provided their responses on the student edition of the QEC. Table 7.8 shows that Cronbach's alpha coefficients for all scales ranged from 0.58 to 0.82.

Table 7.8 Cronbach's alpha coefficients of each scale for the student edition of the QEC for urban chemistry students only (N = 254).

Scale	No. of Items	Alpha Reliability
Analyse Information (AI)	4	0.82
Make Connections (MC)	3	0.61
Active Learning (AL)	4	0.60
Use of Traditional Teaching Practices (TT)	5	0.58
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	6	0.76
Use of Laboratory Activities (LA)	4	0.79

Three scales, namely *Analyse Information*, *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*, and *Use of Laboratory Activities*, had good internal consistency reliability with Cronbach's alpha coefficients being above 0.70 (Kim et al., 2001). Meanwhile, the Cronbach's alpha coefficients for *Make Connections*

(0.61), *Active Learning* (0.60) and *Use of Traditional Teaching Practices* (0.58) indicated low internal consistency reliability (Kim et al., 2001).

Table 7.9 Average item means, scale means and standard deviations for the student edition of the QEC for urban chemistry students only (N = 254).

Scale	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation
Analyse Information (AI)	2.55	10.20	0.76
Make Connections (MC)	2.50	7.49	0.67
Active Learning (AL)	2.43	9.73	0.76
Use of Traditional Teaching Practices (TT)	3.00	15.02	0.54
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.81	16.89	0.62
Use of Laboratory Activities (LA)	3.23	12.91	0.63

[a] Average item mean = Scale mean divided by the number of items in that scale.

Table 7.9 shows that the item means were above 2 (Sometimes), suggesting that the urban students had positively engaged in all the described teaching practices. The urban students showed that they had most engagement in the *Use of Laboratory Activities* (3.23) followed by the *Use of Traditional Teaching Practices* (3.00). The item mean of 2.81 indicated positive engagement of urban students to *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*. The urban students also indicated positive engagement in *Analyse Information* and *Make Connections* with the item means of 2.55 and 2.50, respectively. The urban students were positively engaged in *Active Learning* with an item mean of 2.43. Figure 7.6 shows the item mean responses by the urban students.

Table 7.9 shows the average item standard deviation recorded for the *Analyse Information* and *Active Learning* with values of 0.76 each, both of which had the largest distribution of students' responses, while the *Use of Traditional Teaching Practices* had the lowest distribution of students' responses (0.54).

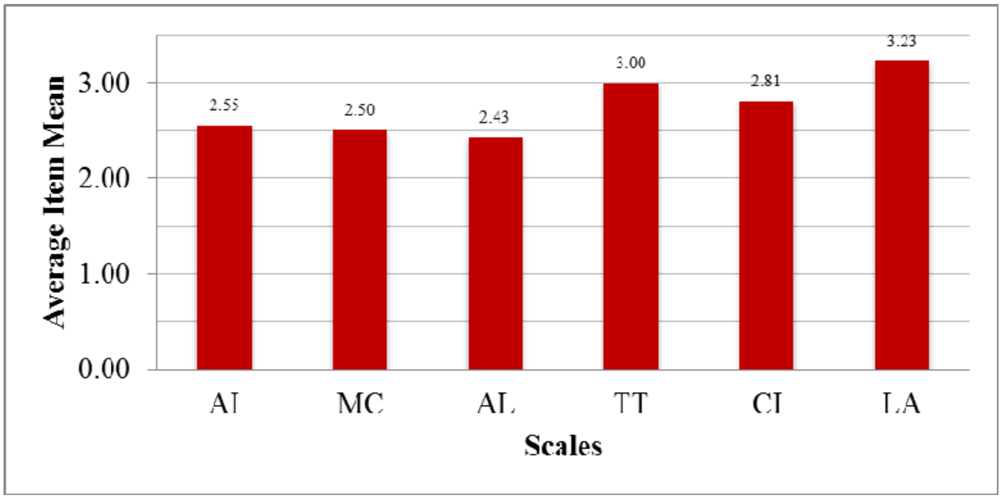

Figure 7.6 Average item means of the scales in the student edition of the QEC for the urban chemistry students (N = 254).

 # Finding 10: The urban chemistry students claimed that they had been engaged in all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. They claimed they had participated in the *Use of Laboratory Activities* (LA) the most frequently, while they were least engaged in lesson activities that involved *Active Learning* (AL).

7.3.3 The results for the rural students

The total of 100 chemistry students from rural category schools had responded to the student edition of the QEC. Table 7.10 shows the internal consistency reliability for each scale of the student edition of the QEC as responded by these students.

Table 7.10 shows good internal consistency reliability for three scales namely *Analyse Information*, *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*, and *Use of Laboratory Activities* with the Cronbach's alpha coefficients were above 0.70 (Kim et al., 2001). Meanwhile, the *Use of Traditional Teaching Practices* had recorded acceptable internal consistency reliability with a coefficient of 0.64 (Kim et al., 2001). Two teaching practices, namely *Make Connections* and *Active Learning* indicated low internal consistency reliability with each having a Cronbach's alpha coefficient of 0.54.

Table 7.10 Cronbach's alpha coefficients of each scale for the student edition of the QEC for rural chemistry students only (N = 100).

Scale	No. of Items	Alpha Reliability
Analyse Information (AI)	4	0.81
Make Connections (MC)	3	0.54
Active Learning (AL)	4	0.54
Use of Traditional Teaching Practices (TT)	5	0.64
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	6	0.79
Use of Laboratory Activities (LA)	4	0.75

Table 7.11 Average item means, scale means and standard deviations for the student edition of the QEC for rural chemistry students only (N = 100).

Scale	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation
Analyse Information (AI)	2.60	10.41	0.78
Make Connections (MC)	2.55	7.66	0.67
Active Learning (AL)	2.57	10.29	0.68
Use of Traditional Teaching Practices (TT)	3.26	16.31	0.55
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	2.97	17.79	0.67
Use of Laboratory Activities (LA)	3.25	13.00	0.61

[a] Average item mean = Scale mean divided by the number of items in that scale.

Table 7.11 suggests the rural students had positive engagement with all the described teaching practices as indicated by the average item means which ranged from 2.55 to 3.26. Their responses indicated that they had engaged in relatively equal amount for *Use of Traditional Teaching Practices* and *Use of Laboratory Activities* (item mean of 3.26 and 3.25, respectively). This was followed by the students' positive participation in the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (2.97). The rural students indicated two teaching practices, namely *Analyse Information* (2.60) and *Active Learning* (2.57) in which they were positively engaged. The students had claimed to take part in the *Make Connections* (2.55) the least frequently. Figure 7.7 represents the item means based on the rural students' responses.

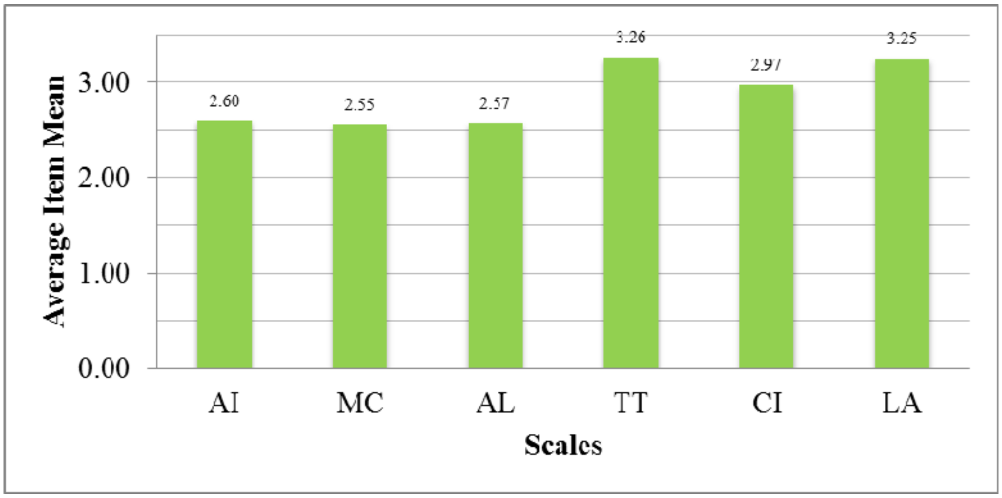

Figure 7.7 Average item means of the scales in the student edition of the QEC for the rural chemistry students (N = 100).

Table 7.11 shows the average standard deviations ranged from 0.55 to 0.78, where the *Use of Traditional Teaching Practices* had the smallest students' distribution responses while the *Analyse Information* had the largest distribution of responses.

 # Finding 11: The rural chemistry students claimed that they had been engaged in all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. They claimed they had participated in the *Use of Traditional Teaching Practices* (TT) and *Use of Laboratory Activities* (LA) the most frequently. Meanwhile, the students claimed they had been least engaged in the *Make Connections* (MC) activities.

7.3.4 Comparison of results between urban and rural students

Table 7.12 shows the comparisons of item mean, effect size, and independent samples t-test between urban and rural chemistry students for their responses on the QEC. This table combines the data from Tables 7.9 and 7.11.

Table 7.12 Average item means, scale means, standard deviations, effect sizes and *t* values for the student edition of the QEC for urban and rural chemistry students ($N_{urban\ students}$ = 254; $N_{rural\ students}$ = 100).

Scale	Students	Average Item Mean[a]	Difference	
			Effect Size (Eta^2)	*t* values
Analyse Information (AI)	Urban Rural	2.55 2.60	0.06	-0.59
Make Connections (MC)	Urban Rural	2.50 2.55	0.07	-0.73
Active Learning (AL)	Urban Rural	2.43 2.57	0.19	-1.62*
Use of Traditional Teaching Practices (TT)	Urban Rural	3.00 3.26	0.48	-4.05**
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	Urban Rural	2.81 2.97	0.25	-2.01*
Use of Laboratory Activities (LA)	Urban Rural	3.23 3.25	0.03	-0.29

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

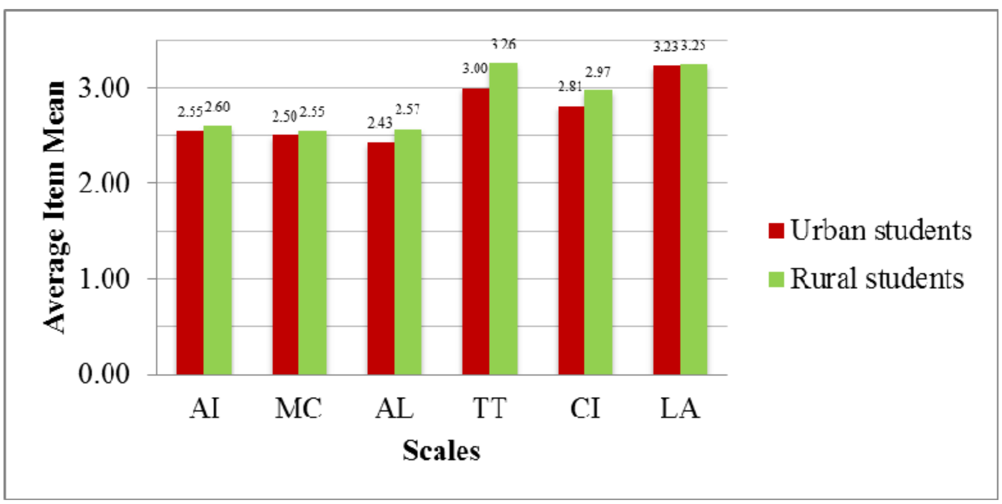

Figure 7.8 Comparison of the item means obtained per scale from the student edition of the QEC for urban and rural chemistry students ($N_{urban\ students}$ = 254; $N_{rural\ students}$ = 100).

The comparison of item means (Table 7.12) indicated that the urban students significantly had statistically significant lesser engagements in *Use of Traditional Teaching Practices* and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* than the rural students did (effect size of 0.48 and 0.25, respectively). On the other hand, the difference between the urban and rural students for their engagement in *Active Learning* was statistically significant, but the effect size suggests it to be of little educational importance (effect size of 0.19). Only small differences between the urban and rural students were recorded for their engagement in *Analyse Information* (effect size 0.06), *Make Connections* (effect size 0.07), and *Use of Laboratory Activities* (effect size 0.03), and these differences were not statistically significant. Figure 7.8 represents the comparison of item means between urban and rural students.

 # Finding 12: There were no differences between the urban and rural students in their level of engagement in *Analyse Information* (AI), *Make Connections* (MC), *Active Learning* (AL) and *Use of Laboratory Activities* (LA) during the acids and bases lessons. However, the urban students claimed that they were engaged to a lower extent in *Use of Traditional Teaching Practices* (TT) and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (CI) than the rural students were.

7.4 Discussion

The assessments of validity and reliability of teacher edition of the QEC cannot be done due to the low number of chemistry teachers who participated in this study. However, the assessments of student edition of the QEC indicated that the Cronbach's alpha coefficients (Table 7.5) for three scales were above 0.70 except for *Make Connections, Active Learning* and *Use of Traditional Teaching Practices* which recorded Cronbach's alpha coefficients below the threshold value of 0.62 (Kim et al., 2001). The lower Cronbach's alpha coefficients of these scales were not surprising because the items that formed the scales were adapted from the surveys (Smithson & Blank, 2006; Weiss et al., 2003) that originally intended to seek the responses from teachers and not students. This meant that the students might possibly have interpreted some of the items in those three scales differently from the teachers, thus, reducing the internal consistency reliability. The result from the factor analysis of the student edition of QEC (Appendix R) supported this explanation where only four scales were generated instead of six-scale scales as in the teacher edition of QEC. Overall, the reliability of the student edition of the QEC was somewhat moderate. In addition, the low to medium degree of correlation between scales

(Table 7.6) supported the existence of discriminant validity in the student edition of the QEC.

Tables 7.2 and 7.3 showed that each group of urban and rural chemistry teachers, respectively, had scored the *Use of Traditional Teaching Practices* the highest. This suggested that the teachers from these two areas similarly indicated that they were more likely to apply the lecture style, repetition, reading from textbooks, train-and-drill, and others didactic strategies during the acids and bases instruction. On the other hand, *Analyse Information* had the lowest item mean as scored by the urban and rural chemistry teachers. This suggested that these teachers had least carried out the teaching practices that engaged students in analytical process skills during acids and bases lessons as compared to other described teaching practices.

When these two teaching practices were compared between the urban and rural teachers (Table 7.4), the urban teachers had indicated lower item means for the *Use of Traditional Teaching Practices*, but higher item means for the *Analyse Information* than the rural teachers. These suggested that the urban teachers had carried out the traditional teaching practices to a lesser extent than the rural teachers did, but they implemented the analytical process skill lessons activities more frequently than their rural counterpart did. The largest deviation of responses between the urban and rural teachers was on the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* where the rural teachers indicated encouraging their students to communicate and give meaning to the information in the acids and bases lessons more frequently than the urban teachers did. The remaining teaching practices were carried out in a relatively similar amount between urban and rural teachers as indicated by the small deviation of item means. These teaching practices were *Make Connections* (the extent to which the teacher engaged students to make associations of the information from acids and bases lessons), *Active Learning* (the extent to which the teacher engaged students to do investigation activities), and *Use of Laboratory Activities* (the extent to which the teachers engaged students in laboratory procedures).

The high frequency of traditional teaching practices by the urban and rural chemistry teachers in this study as compared to others teaching practices during the acids and bases lessons was no different to what had been reported in many other Malaysian science classrooms over the past three decades (Swetz & Meerah, 1982; Zin, 2003; Zin & Lewin, 1993). The possible explanation to this issue was that these chemistry teachers probably were more inclined to teach the lessons towards preparing the students for the following year public examination, Malaysian Education Certificate (SPM), thereby they did not place so much emphasis on the thoughtful teaching practices intended by the Chemistry curriculum. Whatever the assumption was, further research should explore this issue in-depth to discover the actual factors that hindered these chemistry teachers from implementing the described thoughtful teaching practices more frequently.

Both urban and rural students (Table 7.9 and Table 7.11) had scored the *Use of Laboratory Activities* among the highest. This situation suggested that both urban and rural students had viewed their engagements with laboratory procedures the most frequent. On the contrary, the urban students indicated that their engagement in investigation activities (*Active Learning)* was the lowest as compared to other teaching practices. Similarly, the rural students indicated that they were least involved in making associations of the information from acids and bases lessons *(Make Connections)*. When these three scales were compared between the urban and rural students (Table 7.12), the differences were not statistically significant, meaning the urban chemistry students had engaged in a similar amount of laboratory activities, investigation and making connections of acids and bases information as the rural chemistry students did. Instead, the data showed that the urban students were significantly less engaged than the rural students in the teaching practices that involved lecture teaching style (*Use of Traditional Teaching Practices*) and communicating the acids and bases information (*Use of Strategies to Develop Students' Attitudes to Communicate Ideas*).

The teachers and students from the urban schools (Table 7.2 and Table 7.9, respectively) viewed four teaching practices had taken placed in relatively similar amounts, namely making associations of the information from acids and bases lessons (*Make Connections*), investigation (*Active Learning*), lecture teaching style (*Use of Traditional Teaching Practices*), and communicating the information of acids and bases lessons (*Use of Strategies to Develop Students' Attitudes to*

Communicate Ideas). Meanwhile, the urban students claimed to engage in the hands-on or laboratory procedures (*Use of Laboratory Activities*) and analytical process skill (*Analyse Information*) higher than the urban teachers' claimed.

Meanwhile, the teachers and students from the rural schools (Table 7.3 and Table 7.11, respectively) had similar views about the amount of making associations of the information from acids and bases lessons (*Make Connections*) and investigations (*Active Learning)* that had taken place. However, the rural teachers and rural students had opposing views about the amount of remaining teaching practices that took place. The rural teachers claimed they had carried out the lecture teaching style (*Use of Traditional Teaching Practices*) and communicating the information of acids and bases lessons (*Use of Strategies to Develop Students' Attitudes to Communicate Ideas*) more than was claimed by the rural students. On the other hand, the rural teachers claimed to carry out less teaching practices that involved laboratory procedures (*Use of Laboratory Activities*) and analytical process skill (*Analyse Information*) than what the students' reported.

The findings showed there were no congruities in responses between the teachers and students with regards to the acids and bases teaching practices either in urban or rural schools. However, the congruity had been found in each students' and teacher's responses between the urban and rural schools. This situation is consistent with several reported studies (Osborne et al., 2002; Wood et al., 2009) which described there were indeed conflicts of views between the teachers and students about the classroom activities; however, students' views and teachers' views across schools were similar.

In relation, the high engagements in the *Use of Laboratory Activities* as claimed by the students obviously contradicted to the *Use of Traditional Teaching Practices* claimed by the teachers. One possible explanation was that the students might have viewed the teachers' practical demonstration as part of their engagement in the laboratories procedures, thus, influencing their judgements to give highly positive ratings to the *Use of Laboratory Activities* scale. This explanation was supported by the item means of *Active Learning* that were scored among the lowest by the urban and rural chemistry students, suggesting the extent to which the students were engaged to do investigations was unlikely to occur as frequently as other scales. If this was the case, it might be similar to what Bekalo and Welford (2000) had described that actually teachers' demonstrations had taken place and not the hands-on practical procedures. The application either of these teaching practices, hands-on investigations or teachers' demonstrations would have different influences on students' learning (Fogleman, McNeill, & Krajcik, 2011). Whatever, it was still unclear to the researcher what had caused this obvious contradiction, thus, further research requires the inclusion of observation of teaching methods in order to confirm this matter.

The rural students had scored the *Use of Traditional Teaching Practices* significantly higher than the urban students had suggesting that these rural students had engaged in rote learning more frequently than the urban students did. Similar responses were obtained for the rural chemistry teachers compared to the urban chemistry teachers. This situation seems to respond to the findings of Osman, Halim and Meerah (2006) that chemistry teachers in rural areas had expressed greater need for assistance in administering the instructional facilities and equipment as compared to the teachers from urban areas.

Overall, both urban and rural chemistry respondents (teachers and students) agreed that all the described teaching practices in the QEC were present during the acids and bases lessons despite some disagreements of views about the amount that the teaching practices were carried out. This result suggested that the components of thoughtful teaching practices (*Analyse Information; Make Connections; Active Learning; Use of Strategies to Develop Students' Abilities to Communicate Ideas;* and *Use of Laboratory Activities*) did exist during the acids and bases lessons in both urban and rural chemistry classrooms. However, the amount of these thoughtful components being implemented was minimal as the teachers had indicated that the passive lecture method (*Use of Traditional Teaching Practices)* had dominated the lessons most of the time. The finding somewhat concurred with the finding reported by Boon (2008) who found that the major principles of thoughtful instruction were applied by a chemistry teacher but not the prescriptive models given by the official documents. The situation was not something new, as many evaluation experts had described that the discrepancy between the curriculum intentions and process were common. Instead, the extent to which the curriculum was delivered as intended to the students was a pivotal question asked by many evaluators (Rossi et al., 1999; Saylor et al., 1981; Zainuddin, 2010, December).

7.5 Conclusion

This chapter presented the findings from the teacher and student editions of the QEC to address the second research question, “How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?” To answer the research question, the teacher edition was administered to the urban and rural chemistry teachers to obtain theirs views about the described teaching practices that had been carried out during their acids and bases lessons. The results suggested the thoughtful teaching had taken place, though the use of passive lecture-style instruction had dominated throughout the acids and bases instructions especially in the rural chemistry classrooms.

CHAPTER 8 | THE PERCEIVED CURRICULUM

8.1 Introduction

This chapter lays out the findings obtained from the modified version of the What Is Happening In This Class? (WIHIC) in order to address the third research question: What are the urban and rural chemistry students' perceptions about their acids and bases lessons? The discussion of the findings is made at the end of the chapter.

8.2 Findings from the Modified Version of the What is Happening in This Class? (WIHIC)

As pointed out in Section 4.5, the modified version of the WIHIC, which existed in terms of actual and preferred forms, was composed of 41 items with response ratings ranging from 1 (Never) to 5 (Always). This questionnaire had been administered in two consecutive periods. The actual form, intended to seek the students' actual perceptions towards their acids and bases learning environment, was administered a week after the lessons. Whereas, the preferred form, intended to seek how the students would prefer their acids and bases learning environment, was administered three months prior the lessons' commencement.

8.2.1 Combined results for urban and rural students

Initially, the total of 363 responses for the actual forms and 334 responses for the preferred forms had been gathered from Form 4 chemistry students of the participating schools. The preferred form had recorded a lesser returning rate due to the absenteeism of many students who were involved in a sporting event which was held simultaneously in all secondary schools around the state during the administration of the data collection. From these numbers, only 305 students had completed both actual and preferred forms. In order to ensure the accuracy of the data obtained, the students were further filtered by item 41 which stated, "If you read this item, please circle 5". The process of responses elimination in each form was done manually removing those who had responded other than 5 (Always) for this particular item. As a result, 45 students were dropped from the responses list making 260 for the total number of students. Should be noted that this particular item was not included in any statistical analysis done throughout this study.

The 40 items of the actual and preferred forms of the modified version of the WIHIC were subjected to factor analysis to extract any flawed items that should be removed. Before the analysis was done, the data were assessed to determine their suitability for factor analysis. Inspection of the data had shown that both forms had adequate ratio of subjects to item with 6.5 to 1 (Costello & Osborne, 2005), displayed many correlation matrix coefficients above 0.3, and also statistical significance ($p < 0.05$) for Bartlett's Test of Sphericity. In addition, the Kaiser-Meyer-Oklin values for the actual and preferred forms had exceeded the recommended value of 0.6 with 0.89 and 0.92, respectively.

All 40 items of the actual and preferred forms had undergone multiple factor analysis to identify the finest factor structure (Costello & Osborne, 2005) that posed the following characteristics: factor loading more than 0.30, no or few item cross-loadings, and no factors with fewer than three items were displayed in the table. The extraction method used was principal component analysis and the type of rotation technique was oblimin with Kaiser Normalization. Table 8.1 describes the factor structure of the actual and preferred forms of the modified version of the WIHIC.

The principal components analysis for both forms had generated five components with eigenvalues more than 1, ranging from 1.52 to 13.53 for the actual form, and 1.69 to 11.92 for the preferred form (Table 8.1). The percentage of variance for the actual scales ranged from 3.79% to 33.83% giving the total of 59.62%. Meanwhile, the percentage of variance for the preferred scales ranged from 4.22% to 29.80%, giving the total of 54.31%. The factor loading of 40 items showed replication of the five original dimensions of the WIHIC (Fraser, 1998; Fraser et al., 1996, April): *Teacher Support*; *Involvement*; *Investigation*; *Cooperation*; and *Equity*.

Table 8.1 Factor loadings for five scales of the modified version of the WIHIC using the individual student as the unit of analysis for the combination of urban and rural chemistry students (N = 260).

Item no.	Teacher Support (TS)		Involvement (IN)		Investigation (IG)		Cooperation (CO)		Equity (EQ)	
	Actual	Preferred	Actual	Preferred	Actual	Preferred	Actual	Preferred	Actual	Preferred
1	.61	.56								
2	.70	-								
3	.66	.78								
4	.68	.54								
5	.69	.58								
6	.63	.66								
7	.58	.72								
8	-	-								
9			.49	.61						
10			.67	.78						
11			.43	-						
12			.66	.64						
13			.61	.54						
14			.71	.72						
15			.54	.47						
16			-	.59						
17					.68	.50				
18					.55	.45				
19					.82	.69				
20				.53	.49	-				
21					.75	.84				
22					.78	.85				
23					.82	.82				
24					.70	.69				
25							.75	.75		
26							.72	.75		
27							.82	.81		
28							.84	.73		
29							.82	.65		
30							.86	.82		
31							.85	.76		
32							.54	.54		
33									.59	.45
34									.66	.64
35									.80	.63
36									.56	.70
37									.67	.80
38									.77	.73
39									.71	.43
40									.74	.45
% Variance	33.83	5.44	3.99	29.80	6.70	4.83	11.31	10.02	3.79	4.22
Eigenvalue	13.53	2.18	1.60	11.92	2.68	1.93	4.52	4.01	1.52	1.69

The amount of variance was 59.62% (Actual form) and 54.31% (Preferred form).
The sample consisted of 260 form 4 chemistry students in 13 classes in Melaka Tengah district.
Factor loadings less than 0.4 have been omitted.

As a rule of thumb, only items that had factor loadings at least 0.40 or above were retained in Table 8.1. Items with a factor loading less than 0.40 were excluded which suggested faulty items (Aldridge, Bell, & Fraser, 2009; Lian, Wong, & Der-Thanq, 2006). Inspection on the factor loading found that five items did not load in any scale indicating that these items had generated values below than 0.40. These items were item 2 (preferred), item 8 (actual) and (preferred), item 11 (preferred), and item 16 (actual). Meanwhile, item 20 (preferred) did not load in its original scale, instead loading in the *Involvement*. Therefore, item 2, item 8, item 11, item 16, and item 20 of both forms were dropped, which left remaining 35 items of the modified version of the WIHIC (excluded item 41) for further analysis.

The internal consistency reliability of the modified version of the WIHIC for the actual and preferred forms had been determined by measuring the Cronbach's alpha coefficient. Table 8.2 displays the results of internal consistency reliability analysis.

Table 8.2 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260).

Scale	No. of Items	Alpha Reliability	
		Actual	Preferred
Teacher Support (TS)	6	0.84	0.80
Involvement (IN)	6	0.85	0.80
Investigation (IG)	7	0.89	0.88
Cooperation (CO)	8	0.92	0.89
Equity (EQ)	8	0.92	0.87

As shown in Table 8.2, the Cronbach's alpha had recorded coefficients ranged from 0.84 to 0.92 for the actual scales and 0.80 to 0.89 for the preferred scales. The coefficients for all the scales exceeded the minimum threshold value, that is 0.6, as recommended by Hair, Anderson, Tatham, and Black (1998). These results showed that both the actual and preferred scales of the modified version of the WIHIC had demonstrated good internal consistency reliability and indicated that all items within each scale were measuring the same construct.

In order to determine the extent to which the scales were unrelated to each other, the discriminant validity was measured by obtaining the mean correlation of each scale with the other scales (Lehmann, 1988) in each actual and preferred form were assessed as shown in Table 8.3 and Table 8.4.

Table 8.3 Item-scale correlation coefficients of the actual form of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260).

Scale	TS	IN	IG	CO	EQ
Teacher Support (TS)	-	0.56**	0.45**	0.31**	0.66**
Involvement (IN)		-	0.61**	0.27**	0.55**
Investigation (IG)			-	0.21**	0.44**
Cooperation (CO)				-	0.50**
Equity (EQ)					-
Mean correlation with other scales	0.50	0.50	0.43	0.32	0.54

** Correlation is significant at the 0.01 level (2-tailed).

Table 8.4 Item-scale correlation coefficients of the preferred form of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260).

Scale	TS	IN	IG	CO	EQ
Teacher Support (TS)	-	0.49**	0.48**	0.31**	0.50**
Involvement (IN)		-	0.53**	0.32**	0.47**
Investigation (IG)			-	0.29**	0.41**
Cooperation (CO)				-	0.58**
Equity (EQ)					-
Mean correlation with other scales	0.44	0.45	0.43	0.38	0.49

** Correlation is significant at the 0.01 level (2-tailed).

Table 8.3 shows the mean correlation with other scales for the actual form ranged from 0.32 to 0.54. A similar analysis was conducted on the preferred form (Table 8.4) which showed the values of mean correlation with other scales ranged from 0.38 to 0.49. These values can be regarded as small enough to suggest that each scale of the actual and preferred forms of the modified version of the WIHIC has adequate discriminant validity (Koul, 2003).

One of the foci of this study was to investigate the students' perceptions towards their acids and bases learning environment in order to address the *perceived* curriculum. The usage of learning environment instruments for this purpose was supported by Fraser (1981). The data gathered from both forms were analysed in terms of average item mean, average item standard deviation, effect size, and t-test for each scale.

The average item mean was used to facilitate the comparison of scores between scales as each scale had a different number of items - *Teacher Support* (6 items), *Involvement* (6 items), *Investigation* (7 items), *Cooperation* (8 items), and *Equity* (8 items). The average item mean was obtained by dividing the scale mean with the numbers of items in that scale. As this research involved the administrations of the actual and preferred forms on the same samples, a paired samples t-test was used for each scale to determine whether there was any significance difference of scores between what the students had actually perceived and what the students had preferred from their acids and base learning environment (Pallant, 2007). This analysis was done by comparing the mean scores of the actual scales with mean scores of the preferred scales. The significant difference information alone would not be enough without knowing the magnitude of the difference (Thompson, 1999). Therefore, the effect size was calculated by using Cohen's *d* effect size calculator which was developed by Becker (2000).

Table 8.5 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference	
					Effect Size (Eta^2)	*t* values
Teacher Support (TS)	Actual Preferred	3.54 3.49	21.25 20.95	0.67 0.64	0.08	1.15
Involvement (IN)	Actual Preferred	3.17 3.15	19.00 18.91	0.72 0.70	0.02	0.32
Investigation (IG)	Actual Preferred	3.26 3.11	22.80 21.74	0.77 0.77	0.20	3.09**
Cooperation (CO)	Actual Preferred	4.24 4.07	33.88 32.53	0.65 0.66	0.26	3.65**
Equity (EQ)	Actual Preferred	3.78 3.76	30.27 30.09	0.77 0.68	0.03	0.46

[a] Average item mean = Scale mean divided by the number of items in that scale.
**p* < 0.05, ***p* < 0.01

Table 8.5 shows that the average item means for all scales in the actual form exceeded 3 (Sometimes), suggested the students had positive perceptions towards their acids and bases learning environment (Fraser, 1998). Taken together, both urban and rural students had the highest perception of *Cooperation* (4.24). Meanwhile, *Equity* was perceived as the second most positive with item mean of 3.78. This was followed by *Teacher Support* and *Investigation*, with item means of 3.54, for the former, and 3.26, for the latter. The urban and rural students perceived the least *Involvement* (3.17).

The average item standard deviations for all the scales were above 0.70 except *Teacher Support* (0.67) and *Cooperation* (0.65) scales. *Equity* and *Investigation* had the largest standard deviation (0.77) which represented the widest distribution of students' responses across items within the scales. This was followed closely by *Involvement* (0.72).

The item means above 3 (Sometimes) displayed by all scales in the preferred form (Table 8.5) suggested the students had positive preference towards acids and bases learning environment. The urban and rural students preferred *Investigation* (3.11) and *Involvement* the least (3.15). In contrast, *Cooperation* (4.07) was the most desired by the students. The *Equity* (3.76) and *Teacher Support* (3.49) scales were perceived positively.

The scale means of the preferred format ranged from 18.91 for the *Involvement* to 32.53 for the *Cooperation*. In addition, the *Teacher Support* had indicated the smallest distribution of students' responses within the scale, which was represented by the average standard deviation value of 0.64. Meanwhile, the widest dispersion of students' responses was represented by the *Investigation* scale with the average standard deviation of 0.77.

When the actual and preferred forms were compared (Table 8.5), it was found that the students preferred lower *Investigation* and *Cooperation* than what they had perceived in the acids and bases lessons. The differences between the actual and preferred scores for these two scales were statistically significant ($p < 0.01$) with effect sizes of 0.20 and 0.26, respectively. For *Teacher Support*, *Involvement*, and

Equity, there were only small differences between the actual and preferred scores (effect size 0.08, 0.02, and 0.03, respectively), and these differences were not statistically significant. Figure 8.1 shows the comparisons of the students' actual perceptions with their prefer perceptions towards the acids and bases learning environment.

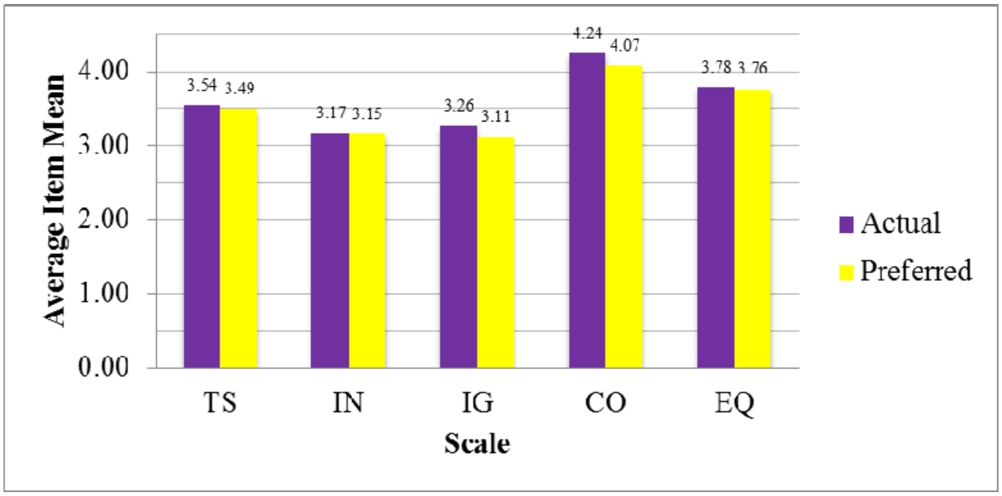

Figure 8.1 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the WIHIC for the combination of urban and rural chemistry students (N = 260).

Finding 13: Both the actual and preferred forms of the modified version of the WIHIC displayed satisfactory factorial validity, reliability and discriminant validity on all five scales for the combination of urban and rural chemistry students in this study.

8.2.2 The results for the urban students

Table 8.6 shows the Cronbach's alpha coefficients of the actual and preferred forms involving 211 Form 4 chemistry students from urban category schools. A quick look of the table had shown slightly higher coefficients in actual scales as compared to the preferred scales. All scales in both forms had displayed Cronbach's alpha coefficients above 0.80 except for *Teacher Support* of the preferred version with a coefficient of 0.78. Nonetheless, all the Cronbach's alpha coefficients had exceed the 0.60 minimum value which suggested good internal consistency reliability of scales in both forms (Hair et al., 1998).

Table 8.6 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the WIHIC for urban chemistry students only (N = 211).

Scale	No. of Items	Alpha Reliability	
		Actual	Preferred
Teacher Support (TS)	6	0.83	0.78
Involvement (IN)	6	0.85	0.80
Investigation (IG)	7	0.89	0.87
Cooperation (CO)	8	0.92	0.89
Equity (EQ)	8	0.92	0.86

The lowest Cronbach's alpha coefficient for actual format was recorded by *Teacher Support* with value of 0.83. In addition, two scales namely *Cooperation* and *Equity* had the highest coefficients with values of 0.92 each. For the preferred version, the *Cooperation* with coefficient of 0.89 had the highest value of Cronbach's alpha; meanwhile, the lowest value was the *Teacher Support* with the coefficient of 0.78.

Table 8.7 Average item means, scales means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for urban chemistry students only (N = 211).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference	
					Effect Size (Eta^2)	*t* values
Teacher Support (TS)	Actual Preferred	3.55 3.49	21.29 20.91	0.68 0.63	0.10	1.32
Involvement (IN)	Actual Preferred	3.14 3.12	18.85 18.73	0.72 0.69	0.03	0.40
Investigation (IG)	Actual Preferred	3.22 3.07	22.50 21.51	0.78 0.76	0.19	2.69**
Cooperation (CO)	Actual Preferred	4.23 4.03	33.84 32.20	0.67 0.66	0.31	4.01**
Equity (EQ)	Actual Preferred	3.77 3.71	30.12 29.68	0.80 0.68	0.07	1.00

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

Table 8.7 summarises the findings from the analyses of average item mean, average item standard deviation, paired samples t-test, and effect size of each scale in both actual and preferred forms. The analyses had used the urban chemistry students as the unit of analysis.

The item means recorded in the actual form (Table 8.7) suggested that all scales were positively perceived by the urban students with responses ranging from 3 (Sometimes) to 5 (Always) during the acids and bases lessons. The urban students perceived *Cooperation* (4.23) the most positively. The item mean of 3.77 indicated that the urban students perceived the *Equity* was positive. The perception towards *Teacher Support* (3.55) also was present along the lessons, followed by *Investigation* (3.22). The *Involvement* scale with item mean of 3.14 was felt the least positive.

The highest inconsistency of urban students' responses across the items was detected in the *Equity* scale. This was evident by the large average item standard deviation generated (0.80) as compared to other scales. In contrast, the average standard deviation recorded by *Cooperation* (0.67) had indicated moderate variation of urban students' responses.

The item mean of the preferred form (Table 8.7) showed that the *Cooperation* (4.03) was the most desired by the urban students during the acids and bases lessons. The *Equity* with item mean of 3.71 was prefer the second. This was followed by the students' preference towards the *Teacher Support* (3.49). However, the urban students indicated that the *Involvement (*3.12) and *Investigation* (3.07) were the least desired to take place during the acids and bases lessons.

The most obvious disagreements across items as responded by the urban students was in the *Investigation* (average standard deviation of 0.76). On the contrary, the *Teacher Support* noted being more consistent of urban students' responses with the average item standard deviation of 0.63. The remaining three scales, namely *Involvement*, *Equity*, and *Cooperation*, had recorded average item standard deviations of 0.69, 0.68 and 0.66, respectively.

The comparisons of the actual and preferred forms (Table 8.7) indicated that the urban students had perceived the *Investigation* and *Cooperation* more than what they had preferred. These were evident from the low to medium effect sizes recorded on these two scales (0.19 for the former and 0.31 for the latter), and these differences were statistically significant ($p < 0.01$). Meanwhile, there were relatively small differences between actual and preferred scores for *Teacher Support, Involvement*, and *Equity* (effect size 0.10, 0.03 and 0.07, respectively) and these differences were not statistically significant. Figure 8.2 presents the differences between the actual and the preferred scores as responded by the urban chemistry students.

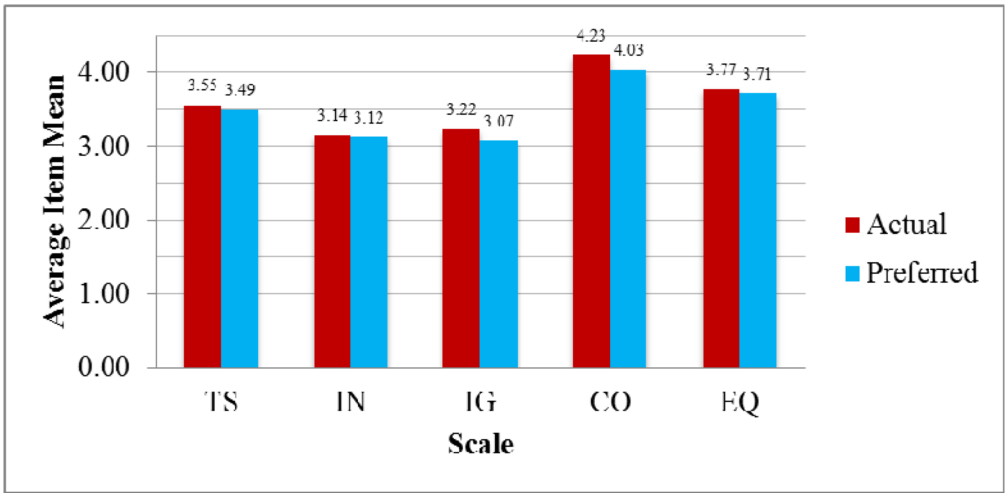

Figure 8.2 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the WIHIC for the urban chemistry students (N = 211).

 # Finding 14: The urban chemistry students indicated positive perceptions of the acids and bases learning environment (item means for all scales were above 3-Sometimes) with *Cooperation* (CO) being perceived the most frequent, while *Involvement* (IN) the least.

 # Finding 15: The urban chemistry students preferred less *Investigation* (IG) and *Cooperation* (CO) than what they actually perceived during the acids and bases lessons. Meanwhile, the urban chemistry students expressed satisfaction about the level of *Teacher Support* (TS), *Involvement* (IN) and *Equity* (EQ) that they had perceived.

8.2.3 The results for the rural students

A total of 49 students from the rural category schools had completed both actual and preferred forms of the modified version of the WIHIC. Table 8.8 summarises the Cronbach's alpha coefficients for each scale of both forms. All scales showed coefficients more than 0.80. The high coefficients recorded across the scales indicated that the rural students had consistently perceived the items in each of scales.

Table 8.8 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the WIHIC for rural chemistry students only (N = 49).

Scale	No. of Items	Alpha Reliability	
		Actual	Preferred
Teacher Support (TS)	6	0.85	0.86
Involvement (IN)	6	0.84	0.84
Investigation (IG)	7	0.88	0.90
Cooperation (CO)	8	0.91	0.91
Equity (EQ)	8	0.88	0.86

The Cronbach's alpha coefficients for actual form ranged from 0.84 for *Involvement* to 0.91 for *Cooperation*. The *Teacher Support* (0.85) and *Involvement* (0.84) scales had relatively similar internal consistency reliability. Similarly, the *Investigation* and *Equity* scales had coefficients of 0.88 each. The preferred version recorded similar ranged of reliability coefficients (from 0.84 to 0.91) with the lowest coefficient was recorded by *Involvement* and the highest coefficient was recorded by *Cooperation*. The *Investigation* scale had recorded a Cronbach's alpha coefficient of 0.90 while the *Teacher Support* and *Equity* scales had similar levels of reliability (0.86).

Using the rural chemistry students as the unit of analysis, Table 8.9 summarises the findings of average item means, average item standard deviations, effect sizes and *t* values of each scale in both actual and preferred forms.

The actual form of the modified version of the WIHIC (Table 8.9) had showed that *Cooperation* (4.26) was the most perceived by the rural students during the acids and bases lessons. The existence of *Equity* was perceived the second as indicated by the item mean of 3.86. *Teacher Support* (3.51) and *Investigation* (3.44) were perceived relatively the same. However, the rural students felt *Involvement (*3.27) was the least perceived as compared to other scales.

Table 8.9 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for rural chemistry students only (N = 49).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference: Effect Size (Eta^2)	Difference: *t* values
Teacher Support (TS)	Actual Preferred	3.51 3.52	21.08 21.14	0.66 0.70	0.02	-0.10
Involvement (IN)	Actual Preferred	3.27 3.28	19.63 19.69	0.68 0.74	0.01	-0.10
Investigation (IG)	Actual Preferred	3.44 3.25	24.10 22.76	0.71 0.81	0.25	1.50
Cooperation (CO)	Actual Preferred	4.26 4.24	34.04 33.94	0.60 0.59	0.02	0.12
Equity (EQ)	Actual Preferred	3.86 3.98	30.90 31.86	0.61 0.62	0.20	-1.22

[a] Average item mean = Scale mean divided by the number of items in that scale.
$^{*}p < 0.05$, $^{**}p < 0.01$

The *Investigation* gained the widest distribution of students' responses with average item standard deviations of 0.71. Respectively, the *Involvement*, *Teacher Support*, and *Equity* scales had scored 0.68, 0.66, and 0.61 for the average item standard deviation. The rural students seemed to be more consistent in answering the items within the *Cooperation* scale as compared to other scales (average item standard deviation 0.60).

The preferred form in Table 8.9 shows that *Investigation* (3.25) and *Involvement* (3.28) were desired to take places the least by the rural students during the acids and bases lessons. In contrast, *Cooperation* (4.24) was preferred the most, followed by *Equity* (3.98). The rural students also expressed positive preference in terms of *Teacher Support* (3.52).

The scale means for the preferred form ranged from 19.69 for *Involvement* to 33.94 for *Cooperation*. The average item standard deviation of the preferred form shows that *Investigation* (0.81) had the widest responses distribution across its items followed by *Involvement* (0.74), *Teacher Support* (0.70), *Equity* (0.62) and *Cooperation* (0.59).

The comparison of item means between the actual and preferred forms (Table 8.9) showed small to medium differences were detected only on two scales. The rural students indicated that they desired less *Investigation* (effect size 0.25) during acids and bases lessons. Meanwhile, the students expressed their desire to see more *Equity* (effect size 0.20) present in the lessons. Despite the relatively small to medium differences between the actual and prefer scores on these two scales, none of them were statistically significant. Three other scales, namely *Teacher Support* (effect size 0.02), *Involvement* (effect size 0.01), and *Cooperation* (effect size 0.02) had relatively small differences between the actual and preferred scores, and these differences also were not statistically significant. Figure 8.3 presents the differences between the actual and the preferred scores as responded by the rural chemistry students.

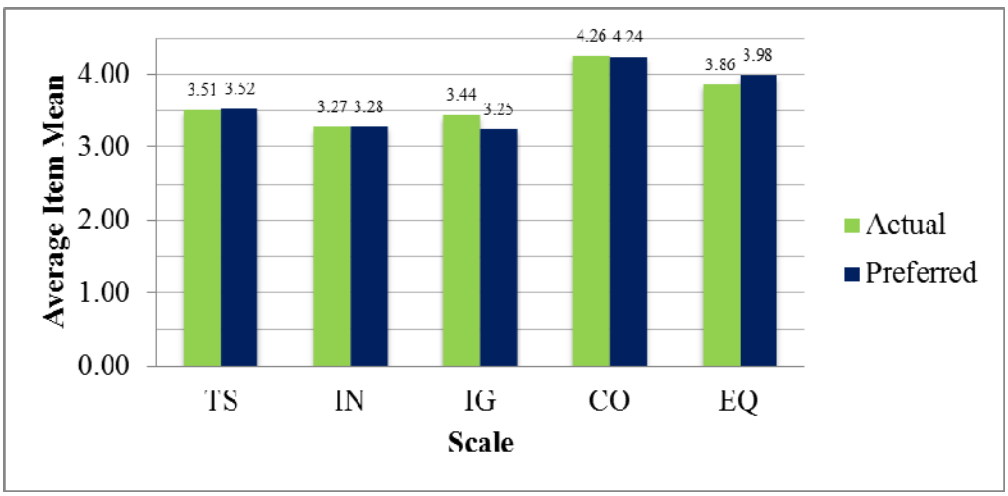

Figure 8.3 Comparison of average item means of scales in the actual and preferred forms of the modified version of the WIHIC for the rural chemistry students (N = 49).

 # Finding 16: The rural chemistry students had positive perceptions of the acids and bases learning environment (item means for all scales were above 3-Sometimes). The rural students perceived *Cooperation* (CO) the most frequent, while the *Involvement* (IN) was experienced the least during the lessons.

 # Finding 17: The rural chemistry students were satisfied with the level of *Teacher Support* (TS), *Involvement* (IN), *Investigation* (IG), *Cooperation* (CO) and *Equity* (EQ) that they had perceived during the acids and bases lessons.

8.2.4 Comparison of results between urban and rural students

Table 8.10 shows the comparisons of average item mean, effect size, and *t* values between urban and rural chemistry students in terms of the actual and preferred forms. The data of the urban chemistry students were taken from Table 8.7, meanwhile, the data of the rural chemistry students were taken from Table 8.9. These two tables were joined to form Table 8.10 to ease the comparisons and graphically represents in Figure 8.4.

Table 8.10 Average item means, effect sizes and *t* values for the actual and preferred forms of the modified version of the WIHIC for urban and rural chemistry students ($N_{urban\ students}$ = 211; $N_{rural\ students}$ = 49).

Scale	School	Average Item Mean[a]		Difference			
				Effect Size (Eta^2)		*t* values	
		Actual	Preferred	Actual	Preferred	Actual	Preferred
Teacher Support (TS)	Urban Rural	3.55 3.51	3.49 3.52	0.04	0.05	0.33	-0.38
Involvement (IN)	Urban Rural	3.14 3.27	3.12 3.28	0.14	0.18	-1.15	-1.46
Investigation (IG)	Urban Rural	3.22 3.44	3.07 3.25	0.24	0.18	-1.89	-1.46
Cooperation (CO)	Urban Rural	4.23 4.26	4.03 4.24	0.03	0.26	-0.24	-2.10*
Equity (EQ)	Urban Rural	3.77 3.86	3.71 3.98	0.10	0.32	-0.79	-2.57*

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

Using the item mean as the basis of comparisons, the urban students had perceived less *Involvement* (effect size 0.14) and *Investigation* (effect size 0.24) than the rural students. Negligible differences were found between the urban and rural students' perceptions for *Teacher Support*, *Cooperation*, and *Equity* (effect size of 0.04, 0.03 and 0.10, respectively). However, none of these differences between urban and rural students was statistically significant for the actual form of the modified version of the WIHIC.

For the preferred form, the urban students desired lesser *Involvement* (effect size 0.18), *Investigation* (effect size 0.18), *Cooperation* (effect size 0.26) and *Equity* (effect size 0.32) than the rural students. The only area that the urban students indicated slightly lower preference than the rural students was *Teacher Support* with effect size of 0.05. However, the independent samples t-test indicated only *Cooperation* and *Equity* were statistically significant ($p < 0.05$) for the preferred form of the modified version of the WIHIC between urban and rural students in favour of the rural students.

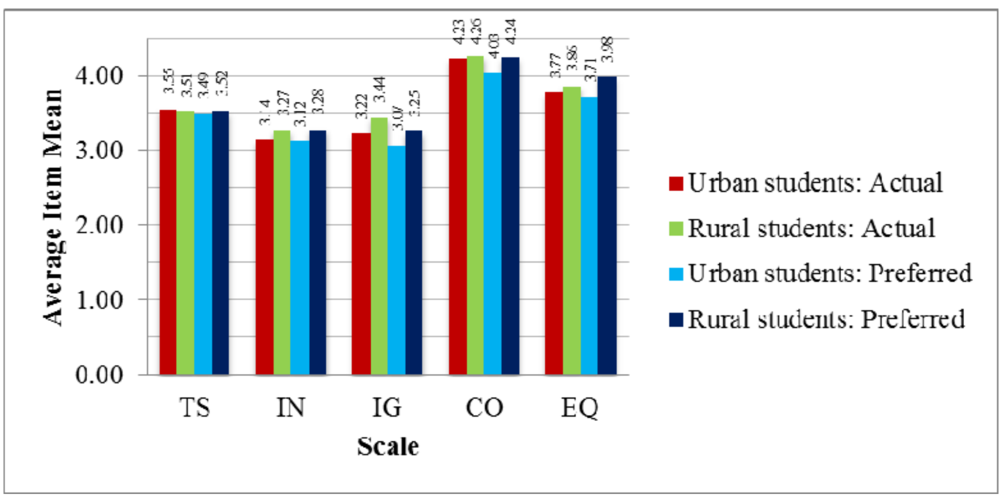

Figure 8.4 Comparison of the item means obtained per scale from the modified version of the WIHIC for urban (actual), urban (preferred), rural (actual), and rural (preferred) chemistry students ($N_{urban\ students} = 211$; $N_{rural\ students} = 49$).

 # Finding 18: There were no perception differences between urban and rural chemistry students for all the scales of the actual modified version of the WIHIC, namely *Teacher Support* (TS), *Involvement* (IN), *Investigation* (IG), *Cooperation* (CO) and *Equity* (EQ) during the acids and bases lessons.

 # Finding 19: The urban students preferred lesser *Cooperation* (CO) and *Equity* (EQ) to take place during the lessons compared to the rural students. However, the urban students' preferences towards *Teacher Support* (TS), *Involvement* (IN) and *Investigation* (IG) were not significantly different to the rural students.

8.3 Discussion

The development of the modified version of the WIHIC for this study purpose had been proven valid and reliable. The factor analysis on both forms of the modified version of the WIHIC showed a satisfactorily factorial validity where it successfully replicated the five original scales of the WIHIC with factor loadings above 0.40 (Table 8.1). The reliability also was very good with Cronbach's alpha coefficients being 0.80 or above for the scales on both forms (Table 8.2). The mean correlation with other scales ranged from 0.32 to 0.54, for the actual form (Table 8.3), and from 0.38 to 0.49, for the preferred form (Table 8.4) suggesting that each scale of the actual and preferred forms of the modified version of the WIHIC has adequate discriminant validity, but tends to overlap. However, the factor analysis supports the independence of factor scores on the five scales (Koul, 2003). All these qualities featured by the modified version of the WIHIC fitted the description of a good questionnaire as mentioned by Aldridge, Bell and Fraser (2009) and by Lian, Wong and Der-Thanq (2006). As a consequence, the modified version of the WIHIC showed evidence that it was suitable to be used in Malaysian chemistry classroom contexts.

Both urban and rural chemistry students (Table 8.7 and Table 8.9, respectively) had scored *Cooperation* the most positive. This result suggests that the students from each of these two areas were most likely to collaborate with one another in completing the acids and bases tasks. On the contrary, the item mean for *Involvement* was scored the lowest by the urban and rural chemistry students, thus, giving an impression that they had perceived the least participation of acids and bases discussion as compared to other WIHIC dimensions. The findings of this study where the students perceived working collaboratively the most positive and participation in the lessons discussions or activities the least positive were consistent with the findings reported by Suarez, Pias, Membiela and Dapia (1998) who had conducted a study to investigate science students' perceptions towards the implementations of an innovative curriculum project.

When the actual and preferred scales of the modified version of the WIHIC were compared, the rural chemistry students had expressed satisfactions on all the dimensions of acids and bases learning environment (Table 8.9). However, the urban chemistry students had scored the preferred forms of *Investigation* and *Cooperation* lower than the actual versions (Table 8.7). The findings suggested that the urban chemistry students desired lesser activities that required them to find things out for themselves and wanted fewer activities that required them to collaborate during the acids and bases lessons. From the researcher's point of view, the low preferences of urban chemistry students towards the *Investigation* and *Cooperation* might be due to the students already being accustomed to the closed-ended learning cultures that had been long practiced by the chemistry teachers. This rationale was supported by the finding from the urban teachers' responses on the Questionnaire of Enacted Curriculum (QEC) which claimed to use the traditional teaching methods most frequently (Table 7.2). As the teachers tried to apply any teaching practices that required the students to be self-directed and collaborate to find answers for particular issues, the students might have felt uncomfortable. Therefore, it might be typical for these students wishing for their teachers to provide them with the answers instead of working harder to find the answers for themselves. A similar situation was reported by Swetz and Meerah (1982) for Malaysian physics students three decades ago. However, the finding of *Investigation* in this study, for either urban or rural chemistry students, was different to the perceptions of Israelis urban and suburban chemistry students who preferred to have more frequent of the probing activities (Hofstein & Lazarowitz, 1986).

No differences for the actual scales of the modified version of the WIHIC between the urban and rural students (Table 8.10) suggested that both of these cohorts had similar perceptions of the actual acids and bases learning environment. Likewise, the preferred scales of the modified version of the WIHIC indicated that there were no item mean differences between the urban and rural students except for C*ooperation* and *Equity* which was scored higher by the rural chemistry students (Table 8.10). Respectively, these two exceptional scale values suggested that the rural students had a higher desire to participate in collaborative activities and required more equality in teachers' treatment as compared to the urban students.

Overall, both urban and rural chemistry students felt satisfied with the acids and bases learning environment that they had perceived, and both urban and rural students generally experienced the same amount about their learning environment. The finding where students were satisfied with their acids and bases learning environment could be influenced by the students' expectations that they had brought upon when responding to a preferred form of the modified version of the WIHIC prior the lessons' commencement. The expectation of these students might be learnt from their familiarity and experiences on how the teachers had behaved in the previous topic lessons. They would naturally expect their teachers to behave similarly and their experiences would not be much different from the other lessons. As this expectation was becoming true during the acid and bases instructions, it explains why the students' responses on the actual form of the modified version of the WIHIC conducted after the lessons were congruent with their preceding responses. Rop (1999) also derived to similar explanation where he found that the student participants in his study were satisfied towards their school chemistry experiences.

8.4 Conclusion

This chapter provided the findings obtained from the modified version of the WIHIC. The questionnaire was administered to both urban and rural chemistry students to ascertain their perceptions about the acids and bases learning environment. The findings are intended to provide a response for the third research question, "What are the urban and rural chemistry students' perceptions about their acids and bases lessons?" The results suggested that the urban chemistry students preferred less *Investigation* and *Cooperation* than what they actually perceived during the acids and bases lessons whilst feeling satisfied with the level of *Teacher Support*, *Involvement* and *Equity* that they had experienced. On the other hand, the rural chemistry students indicated that they were satisfied with all the scales of the acids and bases learning environment (*Teacher Support*, *Involvement*, *Investigation*, *Cooperation* and *Equity*) that they had experienced.

CHAPTER 9 | THE ACHIEVED CURRICULUM

9.1 Introduction

This chapter mainly presents the findings from the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) (Section 9.2) and Acids-Bases Chemistry Achievement Test (ABCAT) (Section 9.3). The information obtained was used to address the fourth research question: To what extent are the outcomes from the acids and bases lessons in urban and rural schools different? The chapter ends with a discussion of the findings (Section 9.4).

9.2 Findings from the Modified Version of the Attitude Towards Chemistry Lesson Scales (ATCLS)

As mentioned in Section 4.4, the modified version of the ATCLS existed in two versions: the actual and preferred forms. Both forms were composed of 12 items with rating responses ranging from Strongly Disagree (1), Disagree (2), Not Sure (3), Agree (4), and Strongly Agree (5). The preferred form, intended to seek the students' preferred attitudes towards the acids and bases lessons, was administered three months prior to the commencement of lessons together with the preferred form of the modified version of the What Is Happening In This Class? (WIHIC) and the pre-test of the ABCAT. Meanwhile, the actual form, intended to seek the students' actual attitudes towards the acids and bases lessons, together with the actual form of the modified version of the WIHIC and the post-test of the ABCAT, was administered a week after completion of the lessons. A total of 260 Form 4 chemistry students (211 urban and 49 rural) had completed both versions of the modified version of the ATCLS.

9.2.1 Combined results for urban and rural students

Responses to both the actual and preferred forms of the modified version of the ATCLS were subjected to analyses of factor structure and internal consistency reliability to determine the validity and reliability of its factor structure. Prior to that, the assessment of suitability for factor analysis had confirmed the factorability of both forms: ratio of subjects to items was 21.7:1; displayed many correlation matrix coefficients above 0.3; Bartlett's Test of Sphericity was statistical significant ($p < 0.05$); and Kaiser-Meyer-Oklin values exceeded the recommended value of 0.6 for both the actual form (0.88) and the preferred form (0.82).

Using the principal component analysis as the extraction method and oblimin with Kaiser Normalization as the rotation technique, the factor analysis of both forms were conducted to determine the finest factor structure (Costello & Osborne, 2005): factor loadings more than 0.30, no or few item cross-loadings, and no factors with fewer than three items were displayed in the table. Table 9.1 shows the factor loadings of the 12 items for the actual and preferred forms.

Table 9.1 Factor loadings for three scales of the modified version of the ATCLS using the individual student as the unit of analysis for the combination of urban and rural chemistry students (N = 260).

Item No.	Liking for Acids-Bases Chemistry Laboratory Work (LW)		Liking for Acids-Bases Chemistry Theory Lessons (TL)		Evaluative Beliefs about Acids-Bases Chemistry (EB)	
	Actual	Preferred	Actual	Preferred	Actual	Preferred
6	0.84	0.85				
7	0.77	0.69				
10	0.79	0.69				
12	0.58	0.58				
1			0.87	0.88		
2			0.61	0.63		
4			0.87	0.62		
5		0.41	0.70			
3					0.80	0.71
8					0.85	0.81
9			0.46			0.65
11					0.59	0.54
% Variance	43.16	34.10	11.06	9.36	9.09	10.56
Eigenvalue	5.18	4.09	1.33	1.12	1.09	1.27

The amount of variance was 63.31% (Actual form) and 54.02% (Preferred form).

The 12 items had loaded in three components with the actual form generated percentage of variances ranging from 9.09% to 43.16% and the eigenvalues ranging from 1.09 to 5.18. Meanwhile, the preferred form generated the percentage of variances, which ranged from 9.36% to 34.10% with eigenvalues ranging from 1.12

to 4.09. This was the finest factor structure with all items loaded by values above 0.40.

The three-scales of the questionnaire generated in this study were different from the original four-scales of the ATCLS generated by Cheung (2007). Further examination of the factor loading of each item found that item 5 and item 9 were not loaded in parallel between the actual and preferred forms. Therefore, these items were omitted from further analyses. The remaining items were distributed in three scales: items 6, 7, 10, and 12 were in *Liking for Acids-Bases Chemistry Laboratory Work*; items 1, 2, and 4 were in *Liking for Acids-Bases Chemistry Theory Lessons*; and items 3, 8, and 11 were in *Evaluative Beliefs about Acids-Bases Chemistry*.

Table 9.2 Cronbach's alpha coefficients of each scale for the actual and the preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260).

Scale	No. of Items	Alpha Reliability	
		Actual	Preferred
Liking for Acids-Bases Chemistry Laboratory Work (LW)	4	0.80	0.72
Liking for Acids-Bases Chemistry Theory Lessons (TL)	3	0.82	0.67
Evaluative Beliefs about Acids-Bases Chemistry (EB)	3	0.74	0.64

The internal consistency reliability of the modified version of the ATCLS was measured using Cronbach's alpha coefficient (Table 9.2). The internal consistency reliability of the actual scales was higher than the preferred scales. The Cronbach's alpha coefficients for the actual scales ranged from 0.74 to 0.82, while the preferred scales ranged from 0.64 to 0.72. All values were considered acceptable according to Hair, Anderson, Tatham, and Black (1998) who proposed the minimum threshold value of 0.60.

In order to determine the extent to which the scales were unrelated to each other, the discriminant validity was measured by obtaining the mean correlation of each scale with the other scales (Lehmann, 1988). The mean correlation with others scales for the actual form (Table 9.3) ranged from 0.50 to 0.54. The mean correlation with others scales for the preferred form (Table 9.4) ranged from 0.40 to 0.45. These values can be regarded as small enough to suggest that each scale of the actual and preferred forms of the modified version of the ATCLS has sufficient discriminant validity (Dalgety, Coll, & Jones, 2003).

Table 9.3 Item-scale correlation coefficients of the actual form of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260).

Scale	LW	TL	EB
Liking for Acids-Bases Chemistry Laboratory Work (LW)	-	0.54**	0.54**
Liking for Acids-Bases Chemistry Theory Lessons (TL)		-	0.46**
Evaluative Beliefs about Acids-Bases Chemistry (EB)			-
Mean correlation with other scales	0.54	0.50	0.50

** Correlation is significant at the 0.01 level (2-tailed).

Table 9.4 Item-scale correlation coefficients of the preferred form of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260).

Scale	LW	TL	EB
Liking for Acids-Bases Chemistry Laboratory Work (LW)	-	0.46**	0.43**
Liking for Acids-Bases Chemistry Theory Lessons (TL)		-	0.37**
Evaluative Beliefs about Acids-Bases Chemistry (EB)			-
Mean correlation with other scales	0.45	0.42	0.40

** Correlation is significant at the 0.01 level (2-tailed).

In order to seek the students' attitudes towards acids and bases lessons, the data of the modified version of the ATCLS from both forms were analysed to determine the average item mean, average item standard deviation, effect size, and *t* values. The item means enable comparisons of scores between scales because each scale was composed of a different number of items. The average standard deviation was used to determine the distribution of students' responses in each scale. The t-test was used to determine whether there were any significant differences of responses between the actual and preferred forms (paired samples t-test) or between the urban and rural chemistry students (independent samples t-test). In addition, the effect size determined the magnitude of the differences.

Table 9.5 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference: Effect Size (Eta^2)	Difference: *t* values
Liking for Acids-Bases Chemistry Laboratory Work (LW)	Actual	4.10	15.93	0.66	0.17	2.34*
	Preferred	3.98	16.38	0.66		
Liking for Acids-Bases Chemistry Theory Lessons (TL)	Actual	3.57	10.16	0.76	0.26	3.64**
	Preferred	3.39	10.71	0.66		
Evaluative Beliefs about Acids-Bases Chemistry (EB)	Actual	4.03	11.86	0.67	0.11	1.59
	Preferred	3.95	12.08	0.66		

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

Table 9.5 shows that the item means of the actual scales ranged from 3.57 to 4.10. These values were above 3 (Not Sure) suggesting that the combined sample of urban and rural students had positive attitudes towards the acids and bases lessons. The students indicated *Liking for Acids-Bases Chemistry Laboratory Work* followed by their positive *Evaluative Beliefs about Acids-Bases Chemistry*. The item mean was 4.10 for the former scale and 4.03 for the latter scale. Meanwhile, the students' *Liking for Acids-Bases Chemistry Theory Lessons* was somewhat positive as indicated by an item mean of 3.57

The average item standard deviation had shown values ranging from 0.66 to 0.76 with the *Liking for Acids-Bases Chemistry Theory Lessons* having the largest distribution of students' responses as compared to the other scales.

The item means of the preferred form ranged from 3.39 to 3.98 (Table 9.5), exceeding the score of 3 (Not Sure), suggesting that the urban and rural students had positive desires towards liking the acids and bases lessons. The students indicated that they had the highest preferences towards *Liking for Acids-Bases Chemistry Laboratory Work* (3.98) and *Evaluative Beliefs about Acids-Bases Chemistry* (3.95). The item mean of 3.39 indicated the students had a positive preference for *Liking for Acids-Bases Chemistry Theory Lessons.*

The scale means of the preferred form ranged from 10.71 to 16.38. The average item standard deviations for all scales had recorded similar distributions of students' responses with value of 0.66 each.

When the item means between the actual and preferred scales were compared (Table 9.5), the urban and rural students' *Liking for Acids-Bases Chemistry Laboratory Work* and *Liking for Acids-Bases Chemistry Theory Lessons* were higher than what they had desired. On the other hand, the difference between actual and preferred scores for *Evaluative Beliefs about Acids-Bases Chemistry* was relatively small (effect size 0.11). Of the three scales, *Liking for Acids-Bases Chemistry Laboratory Work* (effect size 0.17) and *Liking for Acids-Bases Chemistry Theory Lessons* (effect size 0.26) showed statistically significant differences between the actual and preferred scores. Figure 9.1 graphically represents the comparisons of average item means between the actual and preferred scales for the combination of urban and rural chemistry students.

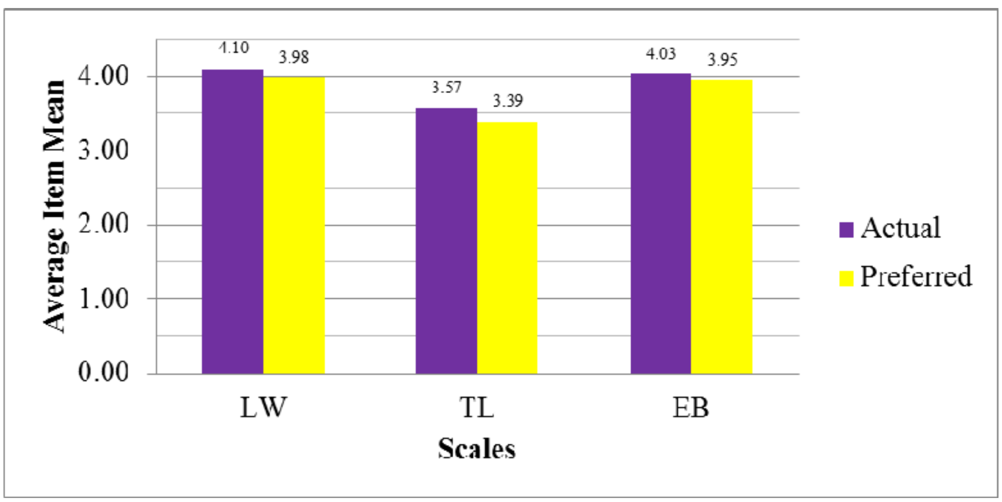

Figure 9.1 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the ATCLS for the combination of urban and rural chemistry students (N = 260).

Finding 20: Factor analysis on the actual and preferred forms of the modified version of the ATCLS using the combination of urban and rural chemistry students in this study supported a three-scale structure (with the items from *Behavioural Tendencies to Learn Chemistry* being distributed evenly to others scales) rather than the *a priori* four-scale structure of the original ATCLS. The three-scale structure on both forms displayed satisfactory reliability and discriminant validity.

9.2.2 The results for the urban students

The total of 211 urban chemistry students had provided their responses on the actual and preferred forms of the modified version of the ATCLS. Table 9.6 shows Cronbach's alpha coefficients derived from these students.

Table 9.6 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the ATCLS for urban chemistry students only (N = 211).

Scale	No. of Items	Alpha Reliability	
		Actual	Preferred
Liking for Acids-Bases Chemistry Laboratory Work (LW)	4	0.77	0.69
Liking for Acids-Bases Chemistry Theory Lessons (TL)	3	0.79	0.60
Evaluative Beliefs about Acids-Bases Chemistry (EB)	3	0.71	0.61

Table 9.6 shows that the actual scales had acceptable internal consistency reliability with the lowest coefficient recorded being 0.71 for *Evaluative Beliefs about Acids-Bases Chemistry,* and the highest coefficient was 0.79 for *Liking for Acids-Bases Chemistry Theory Lessons*. Meanwhile, the preferred scales had shown acceptable internal consistency reliability with Cronbach's alpha coefficients ranging from 0.60 (*Liking for Acids-Bases Chemistry Theory Lessons*) to 0.69 (*Liking for Acids-Bases Chemistry Laboratory Work*).

The actual scales of the modified version of the ATCLS (Table 9.7) had recorded item means somewhere between 3 (Not Sure) to 4 (Agree) suggesting that the urban students' attitudes towards acids and bases lesson were positive. The urban students had the most *Liking for Acids-Bases Chemistry Laboratory Work* (4.07), followed by their positive *Evaluative Beliefs about Acids-Bases Chemistry* (3.99). The urban students however, indicated the least *Liking for Acids-Bases Chemistry Theory Lessons* (3.48), but the attitudes were still positive.

Table 9.7 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for urban chemistry students only (N = 211).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference: Effect Size (Eta^2)	Difference: *t* values
Liking for Acids-Bases Chemistry Laboratory Work (LW)	Actual	4.07	15.79	0.63	0.20	2.36*
	Preferred	3.95	16.29	0.64		
Liking for Acids-Bases Chemistry Theory Lessons (TL)	Actual	3.48	9.99	0.73	0.23	2.90**
	Preferred	3.33	10.45	0.62		
Evaluative Beliefs about Acids-Bases Chemistry (EB)	Actual	3.99	11.68	0.67	0.15	1.96*
	Preferred	3.89	11.98	0.65		

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

The average item standard deviations of the actual scales had shown that the largest students' responses was on the *Liking for Acids-Bases Chemistry Theory Lessons* (0.73) followed by the *Evaluative Beliefs about Acids-Bases Chemistry* (0.67) and *Liking for Acids-Bases Chemistry Laboratory Work* (0.63).

Table 9.7 shows that the urban students had positive desires towards liking acids and bases lessons as indicated by the item means which ranged from 3.33 to 3.95. The lowest item mean of 3.33 indicated that the students had the least desires towards *Liking for Acids-Bases Chemistry Theory Lessons.* However, the urban students had expressed their desires towards *Liking for Acids-Bases Chemistry Laboratory Work* and *Evaluative Beliefs about Acids-Bases Chemistry,* as evidenced from the high item means of 3.95 and 3.89, respectively.

The average item standard deviations for all scales were relatively similar, ranging from 0.62 to 0.65, suggesting that the students' responses across the items were fairly dispersed in each scale.

Table 9.7 shows comparisons of item means between the actual and preferred scales. The urban students felt their *Liking for Acids-Bases Chemistry Laboratory Work*, *Liking for Acids-Bases Chemistry Theory Lessons* and *Evaluative Beliefs about*

Acids-Bases Chemistry were higher than what they had desired. These scales had effect sizes of 0.20, 0.23 and 0.15, respectively. The differences between the actual and preferred scores of all the scales were small to medium and statistically significant. Figure 9.2 graphically represents the comparisons of average item means between the actual and preferred scales for the urban chemistry students.

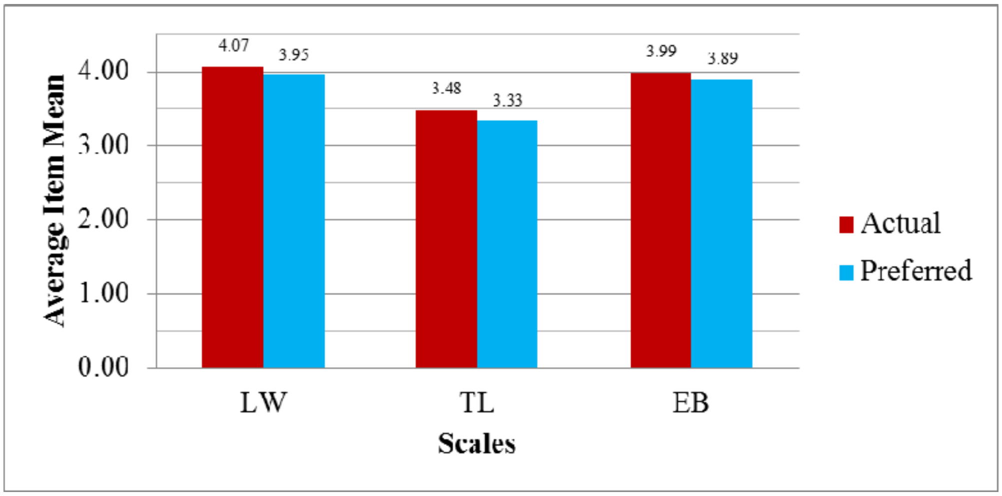

Figure 9.2 Comparison of average item means of the scales in the actual and preferred forms of the modified version of the ATCLS for the urban chemistry students (N = 211).

 # Finding 21: The urban chemistry students had positive attitudes towards all dimensions of the modified version of the ATCLS (item means for all scales were above 3 - Not Sure); *Liking for Acids-Bases Chemistry Laboratory Work* (LW) were the highest, while *Liking for Acids-Bases Chemistry Theory Lessons* (TL) were the lowest.

 # Finding 22: The urban chemistry students had higher *Liking for Acids-Bases Chemistry Laboratory Work* (LW), *Liking for Acids-Bases Chemistry Theory Lessons* (TL) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) than what they had desired.

9.2.3 The results for the rural students

Table 9.8 shows the internal consistency reliability of the actual and preferred scales for the responses from 49 rural chemistry students.

Table 9.8 Cronbach's alpha coefficients of each scale for the actual and preferred forms of the modified version of the ATCLS for rural chemistry students only (N = 49).

Scale	No. of Item	Alpha Reliability	
		Actual	Preferred
Liking for Acids-Bases Chemistry Laboratory Work (LW)	4	0.88	0.84
Liking for Acids-Bases Chemistry Theory Lessons (TL)	3	0.89	0.82
Evaluative Beliefs about Acids-Bases Chemistry (EB)	3	0.87	0.73

The actual form showed very good internal consistency reliability across the scales with Cronbach's alpha coefficients ranging from 0.87 for *Evaluative Beliefs about Acids-Bases Chemistry* to 0.89 for *Liking for Acids-Bases Chemistry Theory Lessons*. Similarly, the preferred scales also indicated good internal consistency reliability where the minimum score was recorded for *Evaluative Beliefs about Acids-Bases Chemistry* (0.73) and the maximum score was recorded for *Liking for Acids-Bases Chemistry Laboratory Work* (0.84).

Table 9.9 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for rural chemistry students only (N = 49).

Scale	Form	Average Item Mean[a]	Scale Mean	Average Item Standard Deviation	Difference	
					Effect Size (Eta^2)	*t* values
Liking for Acids-Bases Chemistry Laboratory Work (LW)	Actual	4.19	16.53	0.75	0.08	0.50
	Preferred	4.13	16.76	0.69		
Liking for Acids-Bases Chemistry Theory Lessons (TL)	Actual	3.94	10.92	0.80	0.38	2.26*
	Preferred	3.64	11.82	0.79		
Evaluative Beliefs about Acids-Bases Chemistry (EB)	Actual	4.18	12.61	0.68	0.04	-0.23
	Preferred	4.20	12.53	0.64		

[a] Average item mean = Scale mean divided by the number of items in that scale.
*p < 0.05, **p < 0.01

The item means of the actual scales exceeded 3 (Not Sure) suggesting the rural students had positive attitudes towards the acids and bases lessons (Table 9.9). The rural students indicated to have the highest level of *Liking for Acids-Bases Chemistry Laboratory Work* and *Evaluative Beliefs about Acids-Bases Chemistry*, where the item means of these two scales were relatively similar (4.19 and 4.18, respectively). Not far behind was their *Liking for Acids-Bases Chemistry Theory Lessons* with the item mean of 3.94.

The average item standard deviations varied across the three scales. The *Liking for Acids-Bases Chemistry Theory Lessons* had the greatest distribution of students' responses with the average item standard deviation of 0.80, while the *Evaluative Beliefs about Acids-Bases Chemistry* had the lowest distribution of students' responses with the average item standard deviation of 0.68.

Table 9.9 also shows that the item means for the preferred scales ranged from 3.64 to 4.20 suggesting that the rural students had positive desires towards liking acids and bases lessons. The rural students indicated very high preferences in terms of *Liking for Acids-Bases Chemistry Laboratory Work* and *Evaluative Beliefs about Acids-Bases Chemistry* with item means of 4.13 and 4.20, respectively. The rural students also expressed positive preferences towards *Liking for Acids-Bases Chemistry Theory Lessons* (3.64), but this was the least desired compared to the other two scales.

The average item standard deviations of the preferred scales indicated that the *Liking for Acids-Bases Chemistry Theory Lessons* (0.79) had the most variation in students' responses, followed by *Liking for Acids-Bases Chemistry Laboratory Work* (0.69) and *Evaluative Beliefs about Acids-Bases Chemistry* (0.64).

Table 9.9 shows that the effect sizes between the actual and preferred scores were small for two scales, namely *Liking for Acids-Bases Chemistry Laboratory Work* (effect size 0.08) and *Evaluative Beliefs about Acids-Bases Chemistry* (effect size 0.04), and these differences were not statistically significant. Meanwhile, the rural students indicated that their *Liking for Acids-Bases Chemistry Theory Lessons* (effect size 0.38) were higher than what they had desired. The paired t-test analysis results showed that this difference was statistically significant ($p < 0.05$). Figure 9.3 graphically represents the comparisons of average item means between the actual and preferred scales for the rural chemistry students.

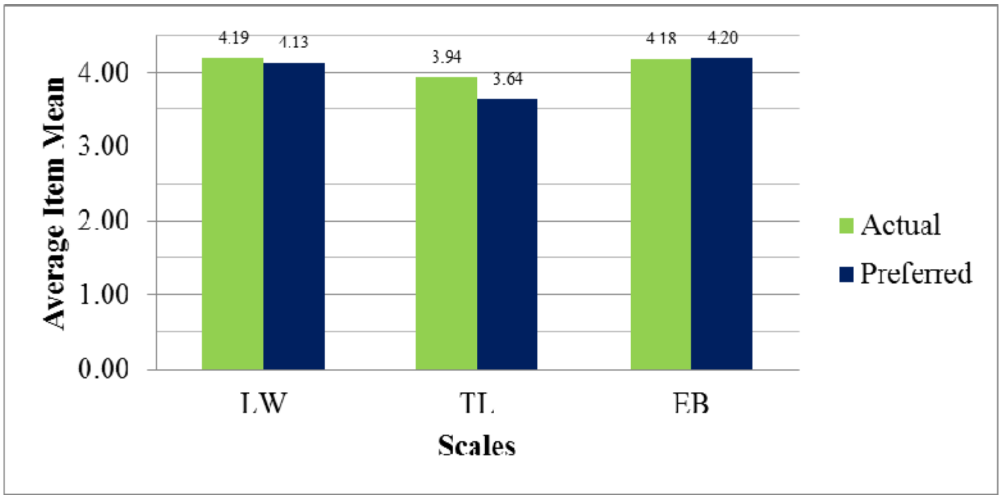

Figure 9.3 Comparison of average item means of scales in the actual and preferred forms of the modified version of the ATCLS for the rural chemistry students (N = 49).

Finding 23: The rural chemistry students had positive attitudes towards all dimensions of the modified version of the ATCLS (item means for all scales were above 3 - Not Sure). The students indicated that their *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) were the highest, while their *Liking for Acids-Bases Chemistry Theory* (TL) were the lowest.

Finding 24: The rural chemistry students showed higher *Liking for Acids-Bases Chemistry Theory Lessons* (TL) than what they had desired. Meanwhile, the rural chemistry students were satisfied with their level of *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) similar to what they presently held.

9.2.4 Comparison of results between urban and rural students

The data from both urban (Table 9.7) and rural (Table 9.9) students were compared and the results are shown in Table 9.10.

Table 9.10 Average item means, scale means, standard deviations, effect sizes and *t* values for the actual and preferred forms of the modified version of the ATCLS for urban and rural chemistry students ($N_{urban\ students} = 211$; $N_{rural\ students} = 49$).

Scale	Students	Average Item Mean[a]		Difference			
				Effect Size (Eta^2)		*t* values	
		Actual	Preferred	Actual	Preferred	Actual	Preferred
Liking for Acids-Bases Chemistry Laboratory Work (LW)	Urban	4.07	3.95	0.14	0.22	-1.11	-1.79
	Rural	4.19	4.13				
Liking for Acids-Bases Chemistry Theory Lessons (TL)	Urban	3.48	3.33	0.48	0.37	-3.88**	-3.00**
	Rural	3.94	3.64				
Evaluative Beliefs about Acids-Bases Chemistry (EB)	Urban	3.99	3.89	0.22	0.37	-1.74	-3.01**
	Rural	4.18	4.20				

[a] Average item mean = Scale mean divided by the number of items in that scale.
*$p < 0.05$, **$p < 0.01$

In general, the urban students had lower attitudes towards acids and bases lessons compared to their rural counterparts (Table 9.10). This was indicated by the large effect sizes in all the actual scales: *Liking for Acids-Bases Chemistry Laboratory Work* (effect size 0.14); *Liking for Acids-Bases Chemistry Theory Lessons* (effect size 0.48); and *Evaluative Beliefs about Acids-Bases Chemistry* (effect size 0.22). Nonetheless, only *Liking for Acids-Bases Chemistry Theory Lessons* showed a statistically significant difference ($p < 0.01$) between the urban and rural students.

Table 9.10 shows small to medium effect sizes between urban and rural students for all the preferred scales. Nonetheless, the independent samples t-test analysis showed only the preferred scales of *Liking for Acids-Bases Chemistry Theory Lessons* as well as *Evaluative Beliefs about Acids-Bases Chemistry* had significant differences between urban and rural students ($p < 0.01$). Both of these scales had a similar effect size of 0.37. Meanwhile, no significant differences between urban and rural students were found for *Liking for Acids-Bases Chemistry Laboratory Work*. Figure 9.4 graphically represents these comparisons.

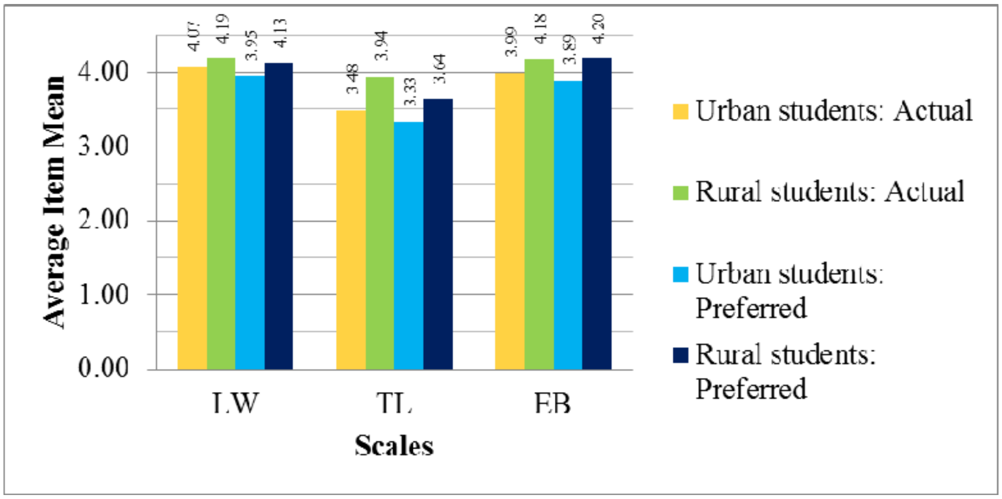

Figure 9.4 Comparison of the item means obtained per scale from the modified version of the ATCLS for urban (actual), urban (preferred), rural (actual), and rural (preferred) chemistry students ($N_{urban\ students} = 211$; $N_{rural\ students} = 49$).

\# **Finding 25:** The urban and rural chemistry students possessed similar *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB). However, the rural students were more *Liking for Acids-Bases Chemistry Theory Lessons* (TL) than the urban students.

\# **Finding 26:** The urban and rural students had similar preferences towards *Liking for Acids-Bases Chemistry Laboratory Work* (LW). Nonetheless, the rural chemistry students had higher preferences towards *Liking for Acids-Bases Chemistry Theory Lessons* (TL) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) compared to the urban students.

9.3 Findings from the Acids-Bases Chemistry Achievement Test (ABCAT)

The ABCAT was used to ascertain the students' cognitive achievement in acids and bases lessons. The instrument which consists of 22 items (12 items from Section A - single tier multiple choice; and 10 items from Section B - two tiers multiple choice) had been carefully developed based on the cognitive learning outcomes of the acids and bases topic provided by the Chemistry curriculum. The ABCAT was administered as a pre-test and a post-test. The details of the development process can be found in Chapter 5. Due to the different characteristics between Section A and Section B, the analysis to determine validity and reliability had been done separately for each pre-test and post-test. Nonetheless, the total mean score from these two sections was used to compare the students' achievement between pre- and post-results as well as between the urban and rural cohorts.

9.3.1 Combined results for urban and rural students

The total of 304 chemistry students (240 urban and 64 rural students) had given their responses on the pre-test and post-test. The students had spent between 30 to 45 minutes for each test. Table 9.11 shows the characteristics of the ABCAT with regards to minimum and maximum score, mean score, standard deviation, Cronbach's alpha coefficient, and item analysis (difficulty and discrimination indices).

The result of the pre-test showed large differences between the students' minimum and maximum scores in both sections, with values of 0 to 11 for Section A, and 0 to 8 for Section B. Similarly, large differences were also found in both sections in the post-test with scores of 3 to 12 for Section A, and 0 to 9 for Section B. When these minimum-maximum scores were compared across the tests, it was found the score difference in Section A decreased from the pre-test (11 points difference) to the post-test (9 points difference), but it was not the case for Section B which indicated relatively similar score differences for the pre-test (8 points difference) and the post-test (9 points difference). The mean score of the pre-test was 5.43 for Section A and 2.77 for Section B. The post-test result showed an improvement from the pre-test in both sections, with the item mean of Section A having improved to 7.90, while the Section B item mean had improved to almost double (4.04) from the pre-test.

The standard deviation of the pre-test showed lower variation of students' responses in Section B (1.67) as compared to Section A (1.98). Meanwhile, the standard deviation in the post-test recorded relatively similar variation of students' responses in Section A (1.91) and Section B (1.99). Both the pre-test and the post-test recorded somewhat low values of Cronbach's alpha coefficients. The Cronbach's alpha coefficients for the pre-test (0.41) and the post-test (0.42) of Section A were relatively similar. Meanwhile, the Cronbach's alpha coefficients for Section B improved slightly from the pre-test (0.44) to the post-test (0.54), but were still low.

Table 9.11 The characteristics of ABCAT (N = 304).

Characteristics	Pre-test		Post-test	
	Section A	Section B	Section A	Section B
Number of items	12	10	12	10
Maximum possible score	12	10	12	10
Minimum/Maximum score	0/11	0/8	3/12	0/9
Mean score	5.43	2.77	7.90	4.04
Standard deviation	1.98	1.67	1.91	1.99
Alpha reliability	0.41	0.44	0.42	0.54
Difficulty index (range)	Mean = 0.45	Mean = 0.28	Mean = 0.66	Mean = 0.41
0.00 - 0.10		B3		
0.11 – 0.20	A8	B1; B4; B5; B10		B3
0.21 – 0.30	A7; A10	B2		B8; B10
0.31 – 0.40	A3; A4	B6; B8; B9	A3	B1; B4
0.41 - 0.50	A1; A5; A11; A12		A4; A7; A8; A11	B2; B5; B6; B9
0.51 – 0.60			A10	
0.61 – 0.70	A9		A12	
0.71 – 0.80		B7	A5; A9	
0.81 – 0.90	A2; A6		A1	B7
0.91 – 1.00			A2; A6	
Discrimination index (range)	Mean = 0.35	Mean = 0.33	Mean = 0.31	Mean = 0.43
0.00 - 0.10			A2	
0.11 – 0.20		B3; B10	A6	B3
0.21 – 0.30	A2; A3; A6; A7; A8; A10	B1	A1; A4; A8	B7
0.31 – 0.40	A1; A4; A12	B2; B4; B5; B6; B9	A3; A5; A9; A11	B6; B8
0.41 - 0.50	A11	B7; B8	A7; A10; A12	B10
0.51 – 0.60	A5; A9			B1; B2; B4; B9
0.61 – 0.70				B5
0.71 – 0.80				
0.81 – 0.90				
0.91 – 1.00				

The difficulty indices between 0.00-0.20, 0.21-0.80 and 0.81-1.00 are considered difficult, moderate and easy, respectively (Popham, 1995). The difficulty index means of the pre-test in Section A (0.45) and Section B (0.28) suggested that most of the items that comprised these two sections were moderately hard. In detail, six pre-test items had indexes below 0.20 suggesting that the students had considered those items difficult. Meanwhile, 14 pre-test items were considered moderately hard, while only two items were seen as easy. Similarly, the difficulty index means of the post-test items for Section A (0.66) and Section B (0.41) were also considered to be mildly difficult by the students. Detailed analysis revealed that only one item was conceived hard (index below than 0.2) and four items were considered easy (indexes above 0.8). The students considered the remaining items had moderate difficulty (0.20-0.80).

In order to obtain the discrimination index, 27% of the high achievers and 27% of the low achievers from the total of 304 chemistry students were selected for this analysis. Therefore, 82 high achieving students and 82 low achieving students were selected from the combined urban and rural schools. For reference, the quality of an item is considered to be good if the index is above 0.30; fair if the index ranges between 0.10 to 0.30; and poor if the index is below 0.10 (Baker, 2001). Overall, the means of the discrimination index in both Section A (0.35 in pre-test; and 0.31 in post-test) and Section B (0.33 in pre-test; and 0.43 in post-test) across the tests suggested that the ABCAT contained effective items. Inspection of Table 9.11 revealed an item from Section A of the post-test, namely A2, had a discrimination index value of 0.06 which is literally below the threshold value (0.10). Osterlind (1989) however asserted that the low discrimination index does not necessarily indicate a low quality item, instead shows that more students have succeeded in achieving the objective set by the test item if supported by high difficulty index. Inspection on the difficulty index indicated that item A2 had an index of 0.96, which exactly represented the situation described by Osterlind (1989). Therefore, item A2 was retained.

Table 9.12 shows the total mean score made up of Section A and Section B, standard deviation, and difference (effect size and *t* value) for comparison between pre-test and post-test for 304 chemistry students.

Table 9.12 Total mean score, standard deviation, effect size and t-test result between pre-test and post-test of the ABCAT for the combination of urban and rural chemistry students (N = 304).

Test	Total Mean Score	Standard Deviation	Difference	
			Effect Size (Eta^2)	*t* values
Pre	8.20	3.05	1.18	-16.81**
Post	11.94	3.28		

*$p < 0.05$, **$p < 0.01$

Overall, there was an improvement in students' achievement after the lessons. This was evidenced by the increase of the total mean scores from the pre-test (8.20) to the post-test (11.94). A slightly higher standard deviation was recorded in the post-test (3.28) as compared to the pre-test (3.05) suggesting more variation of students' scores were found in the post-test. Analysis of the effect size had generated a score of 1.18 suggesting that a large difference was found between the total mean score of the pre-test and total mean score of the post-test. Paired sample t-test analysis had confirmed that the difference was statistically significant ($p < 0.01$).

 # Finding 27: Section A and Section B of the post-test of the ABCAT indicated low internal consistency reliability for the combination of urban and rural chemistry students. Nonetheless, the difficulty index suggested that most of the items from both sections were of moderate difficulty. The discrimination index suggested that the items from both sections were effective in differentiating the high achieving students from the lower achieving students.

9.3.2 The results for the urban students

Table 9.13 shows the total mean score made up of Section A and Section B, standard deviation, and difference (effect size and t value) for comparison between the pre-test and the post-test for the 240 urban chemistry students.

Table 9.13 shows an increase of the total mean scores of the urban students from the pre-test (7.78) to the post-test (11.92). The increment suggested that the urban students' achievements improved as a result of the acids and bases lessons. The effect size of 1.35 indicated the difference of total mean scores between the pre-test and the post-test was large and statistically significant ($p < 0.01$). In addition, the standard deviation values suggested the post-test (3.29) had more variation in students' scores compared to the pre-test (2.82).

Table 9.13 Total mean score, standard deviation, effect size and t-test result between pre-test and post-test of the ABCAT for urban chemistry students only (N = 240).

Test	Total Mean Score	Standard Deviation	Difference	
			Effect Size (Eta^2)	*t* values
Pre	7.78	2.82	1.35	-17.19**
Post	11.92	3.29		

*$p < 0.05$, **$p < 0.01$

Finding 28: There was large improvement in urban chemistry students' achievement as a result of the acids and bases lessons.

9.3.3 The results for the rural students

Table 9.14 shows the total mean score made of Section A and Section B, standard deviation, effect size, and t value for comparison of the pre-test and the post-test generated from the responses of 64 rural students.

Table 9.14 Total mean score, standard deviation, effect size and t-test result between the pre-test and the post-test of the ABCAT for rural chemistry students only (N = 64).

Test	Total Mean Score	Standard Deviation	Difference	
			Effect Size (Eta^2)	*t* values
Pre	9.78	3.39	0.68	-4.41**
Post	12.05	3.29		

*$p < 0.05$, **$p < 0.01$

The table 9.14 shows an increase in the total mean scores from the pre-test (9.78) to the post-test (12.05). The results suggested improvement of rural students' achievement after the acids and bases lessons. The difference of total mean scores between the pre-test and the post-test was large (effect size 0.68) and statistically significant (p < 0.01). The analysis of standard deviation indicated the distribution of students' scores was larger in the pre-test (3.39) as compared to the post-test (3.29).

Finding 29: There was large improvement in rural chemistry students' achievement as a result of the acids and bases lessons.

9.3.4 Comparison of results between urban and rural students

The achievements of urban and rural chemistry students with regards to the acids and bases lessons were compared. For this purpose, the urban students' achievements (Table 9.13) and rural students' achievement (Table 9.14) on the ABCAT were combined to produce Table 9.15.

Table 9.15 Total mean score, standard deviation, effect size and t-test result for the pre-test and post-test of the ABCAT for urban and rural chemistry students ($N_{urban\ students}$ = 240; $N_{rural\ students}$ = 64).

Test	Total Mean Score		Standard Deviation		Effect Size (Eta^2)	*t* values
	Urban	Rural	Urban	Rural		
Pre	7.78	9.78	2.82	3.39	0.64	-4.35**
Post	11.92	12.05	3.29	3.29	0.04	-0.28

*p < 0.05, **p < 0.01

Table 9.15 shows the comparison of total mean scores between the urban and rural chemistry students for the pre-test. The rural students (9.78) indicated a higher total mean score as compared to the urban students (7.78). The difference between the urban and rural students was large (effect size 0.64) and statistically significant.

Table 9.15 also shows the comparison of total mean scores between the urban and the rural chemistry students for the post-test. The total mean scores between these cohorts recorded a negligible difference (effect size 0.04) with 11.92 gained by the urban students, while 12.05 gained by the rural students. The t-test analysis indicated that the difference was not statistically significant.

Since this study had used the student participants from their existing classrooms (non-randomized sampling), therefore the students' achievements on the pre-test between these cohorts (urban and rural) cannot be assumed equivalent and were exposed to error of variance (Dimitrov & Rumrill, 2003). Therefore, the data were subjected to one-way Analysis of Covariance (ANCOVA) that could help to control the pre-existing differences between the urban and rural chemistry students. In order to do this analysis, the urban and rural chemistry students were assigned as the independent variables, meanwhile the post-test scores were assigned as the dependent variable. The scores from the pre-test were loaded as the covariate. Table 9.16 presents the results of the ANCOVA.

Table 9.16 Analysis of Covariance (ANCOVA) to compare the effectiveness of acids and bases lesson between urban and rural chemistry students by keeping the pre-test as covariate ($N_{urban\ students} = 240$; $N_{rural\ students} = 64$).

Source	Sum of Square	*df*	Mean Square	F	Sig.	Partial Eta Squared
Covariates (Pre-test)	211.05	1	211.05	20.79	0.00**	0.07
Main effect (Region)	9.06	1	9.06	0.89	0.35	0.00
Error	3056.14	301	10.15			

*$p < 0.05$, **$p < 0.01$

Assessment on normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of ANCOVA which was done prior to the analysis had confirmed there were no violation any of these assumptions. Based on the results shown in Table 9.16, no significant difference existed between the urban and rural chemistry students in terms of their post-test scores with the magnitude of difference being small. This result suggested that both urban and rural chemistry students had similar achievement after the acids and bases lessons. However, there was significant ($p < 0.01$) relationship between the covariate and the post-test which explained 7% of the variance in the dependent variable, suggesting that the pre-test scores had 7% of influence towards the students' post-test scores.

 # Finding 30: Both urban and rural students had similar levels of achievement as a result of the acids and bases lessons.

9.4 Discussion

9.4.1 Non-cognitive outcomes

The three-scale structure of the modified version of the ATCLS was produced as a result of the multiple factor analysis to gain the finest structure as suggested by Costello and Osborne (2005). While the three-scale structure generated in this study was different from the original four-scale ATCLS developed by Cheung (2007), it had displayed factorial validity with factor loadings of at least 0.41 for all items in both forms (Table 9.1). The reliability of all scales were good as evidenced from the Cronbach's alpha coefficients which ranged from 0.74 to 0.82 for the actual scales, and 0.64 to 0.72 for the preferred scales (Table 9.2). The mean correlation with other scales ranged from 0.50 to 0.54 for the actual form (Table 9.3), and from 0.40 to 0.45 for the preferred form (Table 9.4), indicating the discriminant validity values for both forms were satisfactory (Dalgety et al., 2003).

Both urban and rural students had scored the *Liking for Acids-Bases Chemistry Laboratory Work* the highest (Table 9.7 and Table 9.9, respectively). The responses suggested that the urban and rural students were highly enthusiastic when they were involved in the acids and bases practical work. At the same time, the *Liking for Acids-Bases Chemistry Theory Lessons* was scored the lowest by both cohorts suggesting they had the lowest interest in learning the acids and bases theory in comparison with the other two scales. The urban and rural chemistry students' attitudes towards laboratory work could be explained by their views on the engagement of the laboratory procedures as indicated by the *Use of Laboratory Activities* in Table 7.9 (urban students) and Table 7.11 (rural students). In fact, many investigations have reported that students' engagement in laboratory procedures could eventually promote the students' interests towards chemistry (Osborne & Collins, 2001). Meanwhile, the urban and rural chemistry students' attitudes toward the theory lessons could be due to the domination of a passive lectures style (*Use of Traditional Teaching Practices*) carried out during acids and bases instructions as claimed by the urban (Table 7.2) and rural (Table 7.3) chemistry teachers in the Questionnaire of Enacted Curriculum (QEC). Many studies did report that the implementation of such teacher-centred approaches hardly promotes the students' attitudes to learn the theory in comparison with the implementation of active teaching practices (Osborne & Collins, 2001).

Both urban and rural chemistry students (Table 9.7 and Table 9.9, respectively) showed lower item means for their preferences towards *Liking for Acids-Bases Chemistry Theory Lessons* compared to the actual form. This situation suggested that the urban and rural chemistry students were more enthusiastic towards the acids and bases theory lessons compared to what they had previously desired. One possible explanation to the lower desire of the urban and rural chemistry students towards the acids and bases theory might be initiated from the administration of the preferred form of the modified version of the ATCLS prior the lessons commencement. As the urban and rural students were still not being exposed to the acids and bases lessons during the administration of the preferred form, the students might have been confused and were not sure in determining their preferences of attitudes towards the lessons theory. A similar explanation also applied for *Liking for Acids-Bases Chemistry Laboratory Work* where the urban students were detected to have higher attitudes towards the chemistry practical work compared to what they had previously desired.

By studying the changes of students' attitudes before and after the lessons, rural students indicated no change in item means for *Evaluative Beliefs about Acids-Bases Chemistry* (Table 9.9). This suggested that the rural chemistry teachers' instructions did not make any progress in advocating the importance of acids and bases towards the students' beliefs despite two cognitive learning outcomes being devoted to giving exposure to students about the uses of acids, alkalis and neutralisation in their daily life. This was one of the major issues faced by many Malaysian chemistry teachers. It was typical for the teachers to prepare the students for the final year examination of Form 4 or SPM at end of Form 5. As the teachers rushed to complete the syllabus before the examination started, it seemed that the teachers probably opted to minimise their focus on those two cognitive learning outcomes. By doing that, the teachers have more time to emphasize other important cognitive learning outcomes which were considered more valuable for the examination. For the *Liking for Acids-Bases Chemistry Theory Lessons*, the data suggested that both urban and rural students' interests towards the acids and bases theory had improved after the lessons.

Meanwhile, the *Liking for Acids-Bases Chemistry Laboratory Work* suggested that only the urban students showed significant improvement of interest towards the acids and bases laboratory as a result of the lessons.

Table 9.10 shows that the rural students had higher item means for the actual form of *Liking for Acids-Bases Chemistry Theory Lessons* compared to the urban students. This result suggested that the rural students were more likely to be enthusiastic about the acids and bases theory lessons compared to their urban counterparts. The rural students also had scored larger item means for their preferences towards *Liking for Acids-Bases Chemistry Theory Lessons* and *Evaluative Beliefs about Acids-Bases Chemistry* than the urban students. These results suggested that the rural students had greater interest in the acids and bases theory lessons and the importance of acids and bases lessons prior to the lessons commencement than the urban students did.

Overall, the urban chemistry students' attitudes towards the acids and bases lessons were higher than what they had desired, whereas the rural students felt the attitudes that they had developed during the acids and bases lessons were similar to what they had desired.

9.4.2 Cognitive outcomes

The low Cronbach's alpha coefficients in Section A (0.42) and Section B (0.54) of the post-test did not necessarily indicated low quality tests (Table 9.11). Instead, the low Cronbach's alpha coefficients suggested that each section consisted of items that assessed different cognitive learning outcomes (Adams & Wieman, 2011). The difficulty indices for post-test items ranged from 0.31 to 1.00 for Section A and 0.11 to 0.90 for Section B. The varied difficulty indices in this test were consonant to the work of Popham (1995) who mentioned that a good test should be composed of items that consider various students' ability. In addition, the means of the discrimination index in both sections of the post-test (Section A was 0.31 and Section B was 0.43) was above 0.30 suggesting the test contained appropriate items.

Examination of the pre-test results for the urban and rural chemistry students (Table 9.13 and Table 9.14, respectively) revealed that these students had relatively high item means. These scores suggested that the students already had a fair level of prior-knowledge regarding acids and bases. Despite the fact that chemistry as a subject was only introduced starting in Form 4, an examination of the Science curriculum for primary school (*Integrated curriculum for primary schools: Science syllabus*, 2003) revealed that elementary acids and bases concepts had been introduced to Year 5 (Grade 5) students and the concepts were continued to be explored in the following years up to Form 3 (Grade 9). This information could explain why the students already had some prior knowledge about the acids and bases before commencing this unit.

Nevertheless, both urban and rural students showed an increase in scores from the pre-test to the post-test (Table 9.13 and Table 9.14, respectively). The increased scores suggest that both urban and rural students' achievements towards acids and bases lessons improved because of the lessons.

Comparison between the urban and rural students in Table 9.15 using the independent samples t-test indicated that the rural students had higher pre-test mean scores than the urban students and the difference was statistically significant. This suggested that the rural students had higher prior knowledge of acids and bases than their urban counterparts before the commencement of lessons. On this basis, the comparison of post-test scores between the urban and rural students using the regular method (independent samples t-test analysis) would not be fair as each of these cohorts started with different level of prior knowledge. By using the Analysis of Covariance (ANCOVA) the pre-existing difference between the urban and rural students could be controlled. The ANCOVA results (Table 9.16) showed that the difference of post-test scores between urban and rural students was small and this difference was not statistically significant after controlling for the pre-test scores. This suggested that both urban and rural students had equal improvement of achievements as a result of the acids and bases lessons.

Overall, both urban and rural chemistry students had shown an improvement in achievement after the acids and bases lessons, and both urban and rural chemistry students displayed equal amounts of improvement. This finding somewhat concurred with the findings from Hamzah and Abdullah (2009) who found there were no significant differences in cognitive achievements between urban and rural secondary students for the chemistry paper 1 (multiple choice questions paper) in Malaysia.

9.5 Conclusion

Two types of instruments are presented in this chapter, namely the modified versions of the ATCLS and ABCAT. The former was used to seek the students' non-cognitive outcomes with regards to their attitudes towards acids and bases lessons; meanwhile the latter was used to seek the students' achievement in acids bases lessons which represented their cognitive outcomes. The findings provide an answer to the fourth research question, "To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?" Both the validity and reliability of these instruments (modified version of the ATCLS and ABCAT) had already been determined. For the students' non-cognitive outcomes, the attitudes that the urban chemistry students had developed towards the acids and bases lessons were more positive than what they had desired. Meanwhile, the rural students felt that the attitudes that they had developed during the acids and bases lessons were similar to what they had desired except that they had developed higher *Liking for Acids-Bases Chemistry Theory Lessons* than what they had desired. In the case of students' cognitive outcomes, both urban and rural students had achieved similar results in the ABCAT after the acids and bases lessons. They had also achieved large improvements in the post-test of the ABCAT over their results in the pre-test.

CHAPTER 10 | ASSOCIATIONS BETWEEN LESSON INSTRUCTIONS, LEARNING ENVIRONMENT, AND ATTITUDES TOWARDS ACHIEVEMENTS IN ACIDS AND BASES LESSONS

10.1 Introduction

This chapter presents the findings of the fifth research question: What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes? For this purpose, the data generated from the questionnaires, namely the student edition of the Questionnaire of Enacted Curriculum (QEC), the actual form of the modified version of the What Is Happening In This Class? (WIHIC), and the actual form of the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) were correlated with the total post-test score of the Acids-Bases Chemistry Achievement Test (ABCAT). The discussion of the findings is covered at the end of the chapter.

10.2 Findings from the association between the Student Edition of the Questionnaire of Enacted Curriculum (QEC), the Actual Form of the Modified Version of the Attitudes Towards Chemistry Lessons Scales (ATCLS), and the Actual Form of the Modified Version of the What Is Happening in This Class? (WIHIC) on the Total Post-test Score of the Acids-Bases Chemistry Achievement Test (ABCAT).

10.2.1 Combined results for urban and rural students

Since there were inconsistencies in the numbers of students who had responded to the student edition of the QEC, the actual form of the modified version of the WIHIC, the actual form of the modified version of the ATCLS, and the ABCAT it was not possible to compute the correlations between these raw data sources. As a solution, these students were sorted to find those who had provided responses to all the questionnaires and the test. As a result, a total of 247 chemistry students were found who matched across all of the instruments. From this number, 199 students were from urban schools and 48 were from rural schools. This number exceeded the minimum sample size suggested by Tabachnik and Fidell (2007) based on the formula $N > 50 + 8m$, where 'm' refers to the number of independent variables or predictors. In the case of this study, the independent variable refers to the scales in each of the questionnaires. For example, the value of 'm' could be represented by all six scales of the QEC (student edition), thus, resulting the equation of $50 + 8(6) = 98$. The result of this equation indicated that the minimum sample size, N, to enable the analysis of the association between the scales of QEC and the students' post-test score is 98.

The average item means from the scales of the questionnaires and the student's total post-test score in the ABCAT were combined in the same Predictive Analytics SoftWare (PASW) file to facilitate the computation process. Two types of analyses were conducted for this purpose, namely simple correlation (r) and multiple regression (R^2). The simple correlation analysis provided information about bivariate associations that exist between the students' achievement in acids and bases lessons with an individual dimension of the students' views of classroom instruction, students' perceptions of the learning environment, and students' attitudes. In relation, the strength of association was determined based on the guideline suggested by Cohen (1988): weak if the r value is between 0.10 and 0.29; moderate if the r value is between 0.30 and 0.49; and strong if the r value is between 0.50 and 1.0. Meanwhile, the multiple regression analysis had given more detailed information about the influence of each set of the correlated questionnaire scales on students' achievement. As the multiple correlation was determined to be statistically significant, the standardised regression coefficient (β) was analysed to acquire how much variance of each of the questionnaire scales had contributed to the significant correlations with the students' achievement (Pallant, 2007).

These two analyses required each scale of the questionnaires to be loaded as independent variables, while the students' post-test scores of the ABCAT were loaded as the dependent variable in the PASW software. Table 10.1 presents the results of these analyses. Preliminary inspection of the data outputs between each set of the scales of the questionnaires and the students' post-test score in the ABCAT indicated no violation of normality, linearity, multicollinearity and homoscedasticity assumptions, thus suggesting the suitability of multiple regression analysis to be used for each of the associations.

Table 10.1 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and the total post-test score in the ABCAT for the combination of urban and rural chemistry students (N = 247).

Scale	ABCAT (Total Post-Test Score)		
	r	β	t
Student edition of the Questionnaire of Enacted Curriculum (QEC)			
Analyse Information (AI)	0.10	0.01	0.10
Make Connections (MC)	0.07	-0.09	-0.86
Active Learning (AL)	0.14*	0.09	0.98
Use of Traditional Teaching Practices (TT)	0.19**	0.19	2.14*
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	0.08	-0.05	-0.63
Use of Laboratory Activities (LA)	0.14*	0.04	0.40
Multiple regression (R^2)		0.04	
Actual form of the modified version of the What Is Happening in This Class? (WIHIC)			
Teacher Support (TS)	0.14*	-0.04	-0.42
Involvement (IN)	0.25**	0.27	3.12**
Investigation (IG)	0.12*	-0.06	-0.73
Cooperation (CO)	0.08	0.00	0.02
Equity (EQ)	0.17**	0.07	0.70
Multiple regression (R^2)		0.07**	
Actual form of the modified version of the Attitudes Towards Chemistry Lessons Scales (ATCLS)			
Liking for Acids-Bases Chemistry Laboratory Work (LW)	-0.02	-0.21	-2.59*
Liking for Acids-Bases Chemistry Theory Lessons (TL)	0.18**	0.25	3.24**
Evaluative Beliefs about Acids-Bases Chemistry (EB)	0.11*	0.11	1.40
Multiple regression (R^2)		0.06**	

$*p < 0.05$ $**p < 0.01$

The relationship between the students' views of the acids and bases lessons instruction and the students' achievements is presented in Table 10.1. The simple correlation analysis showed that a statistically significant but weak association existed between the students' post-test score on the ABCAT and the three scales of the student edition of QEC, namely *Active Learning* (0.14), *Use of Traditional Teaching Practices* (0.19), and *Use of Laboratory Activities* (0.14). The standardised regression coefficient indicated that one scale of the student edition of the QEC, namely *Use of Traditional Teaching Practices* (0.19) had uniquely contributed to the variance of students' achievement ($p < 0.05$). Yet, the contribution of the student edition of the QEC to the ABCAT score could not be accounted for, as the multiple regression of 0.04 was not significant.

The next relationship presented in Table 10.1 was between the students' perceptions of the acids and bases learning environment and their achievement. The simple correlation between the students' post-test score on the ABCAT and the four scales of the modified actual version of the WIHIC, namely *Teacher Support*, *Involvement*, *Investigation*, and *Equity* were significant. The coefficients ranged from 0.12 to 0.25 suggesting that they all had weak correlations with each other. The multiple regression between the students' post-test score on the ABCAT and the set of scales in the modified version of the actual version of the WIHIC was 0.07 and the value was statistically significant ($p < 0.01$). As the multiple regression was statistically significant, examination of the standardised regression coefficient revealed only one actual scale of the modified version of the WIHIC, namely *Involvement* (0.27) had made a unique contribution to the students' achievement ($p < 0.01$).

Table 10.1 also presents the relationship between the students' attitudes towards the acids and bases lessons and their achievement. The simple correlation indicated that there were associations between two scales of the modified version of the actual form of the ATCLS (*Liking for Acids-Bases Chemistry Theory Lessons* and *Evaluative Beliefs about Acids-Bases Chemistry*) and the students' post-test score on the ABCAT, and these associations were statistically significant. However, the correlations were weak as indicated by values of 0.18 and 0.11, respectively. The multiple regression between the students' achievement and the set of the set of scales of the modified version of the actual form of the ATCLS was significant ($p<0.01$) with a coefficient of 0.06. From the set of scales of the modified version of the actual form of the ATCLS, the *Liking for Acids-Bases Chemistry Theory Lessons* ($\beta = 0.25$) had made the largest unique contribution although the *Liking for Acids-Bases Chemistry Laboratory Work* ($\beta = 0.21$) also made a significant contribution to the variance of the students' achievement.

10.2.2 The results for the urban students

The 199 chemistry students from the urban schools had provided their responses to all the questionnaires and the achievement test. The data from these urban students were analysed using the simple correlation and multiple regression. Table 10.2 shows the results of the analyses.

Table 10.2 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and the total post-test score on the ABCAT for urban chemistry students only (N = 199).

Scale	ABCAT (Total Post-Test Score)		
	r	β	t
Student edition of the Questionnaire of Enacted Curriculum (QEC)			
Analyse Information (AI)	0.10	0.05	0.44
Make Connections (MC)	0.04	-0.18	-1.60
Active Learning (AL)	0.15*	0.16	1.56
Use of Traditional Teaching Practices (TT)	0.20**	0.23	2.42*
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	0.02	-0.14	-1.57
Use of Laboratory Activities (LA)	0.14*	0.05	0.49
Multiple regression (R^2)		0.07*	
Actual form of the modified version of the What Is Happening in This Class? (WIHIC)			
Teacher Support (TS)	0.18**	0.03	0.30
Involvement (IN)	0.27**	0.27	2.77**
Investigation (IG)	0.12*	-0.07	-0.80
Cooperation (CO)	0.09	0.02	0.31
Equity (EQ)	0.18**	0.03	0.26
Multiple regression (R^2)		0.08**	
Actual form of the modified version of the Attitudes Towards Chemistry Lessons Scales (ATCLS)			
Liking for Acids-Bases Chemistry Laboratory Work (LW)	0.00	-0.16	-1.85
Liking for Acids-Bases Chemistry Theory Lessons (TL)	0.20**	0.24	2.88**
Evaluative Beliefs about Acids-Bases Chemistry (EB)	0.12*	0.09	1.18
Multiple regression (R^2)		0.06**	

*$p < 0.05$ **$p < 0.01$

The relationship between the urban chemistry students' views of the acids and bases lessons instruction and their achievement is shown in Table 10.2. The simple correlation showed that three scales of the student edition of the QEC, namely *Active Learning*, *Use of Traditional Teaching Practices*, and *Use of Laboratory Activities* had significant associations with the urban students' post-test score on the ABCAT. The coefficients between these there scales were 0.15, 0.20 and 0.14, respectively, with all of these values indicating a weak relationship. The multiple regression was 0.07 and was statistically significant ($p < 0.05$) between the urban students' achievement and the set of the scales of the student edition of the QEC. Of the set of the scales of the student edition of the QEC, only the *Use of Traditional Teaching Practices* with a standardised regression coefficient of 0.23 uniquely explained the variance in the urban students' achievement ($p < 0.05$).

The relationship between the urban chemistry students' perceptions of the acids and bases learning environment and their achievement is shown in Table 10.2. The simple correlation showed that significant associations existed between the urban students' post-test score on the ABCAT and the four scales (*Teacher Support*, *Involvement*, *Investigation*, and *Equity*) of the modified version of the actual form of the WIHIC. However, the strengths of the relationship were weak as indicated by the coefficients that ranged from 0.12 to 0.27. The multiple regression between the set of scales of the modified version of the actual form of the WIHIC and the urban students' total post-test score on the ABCAT was statistically significant ($p < 0.01$) with a coefficient of 0.08. While the multiple regression was statistically significant, the analysis of the standardised regression coefficient indicated that only *Involvement* with a coefficient of 0.27 was the sole significant contributor ($p < 0.01$) to the urban students' achievement.

Table 10.2 presents the relationship between the urban chemistry students' attitudes towards the acids and bases lessons and their achievement. Only two actual scales of the modified version of the ATCLS were significantly associated with the urban students' post-test score on the ABCAT as indicated by the simple correlations. These scales were *Liking for Acids-Bases Chemistry Theory Lessons* (0.20) and *Evaluative Beliefs about Acids-Bases Chemistry* (0.12) where the coefficients suggested weak relationships. The multiple regression between the set of scales of the modified version of the actual form of the ATCLS and the urban students' achievement was 0.06 was statistically significant ($p < 0.01$). From the three scales of the modified version of the actual form of the ATCLS, only *Liking for Acids-*

Bases Chemistry Theory Lessons ($\beta = 0.24$) was a significant ($p < 0.01$) contributor to the urban students' achievement.

 # Finding 31: There was positive but relatively weak relationship between the urban chemistry students' achievement and their views of the acids and bases lessons instructions [especially *Use of Traditional Teaching Practices* (TT)].

 # Finding 32: There was positive but relatively weak relationship between the urban chemistry students' achievement and their perceptions of the acids and bases learning environment [especially *Involvement* (IN)].

 # Finding 33: There was positive but relatively weak relationship between the urban chemistry students' achievement and their attitudes towards the acids and bases lessons [especially *Liking for Acids-Bases Chemistry Theory Lessons* (TL)].

10.2.3 The results for the rural students

The 48 chemistry students from the rural category of schools had provided their responses to the questionnaires and the test. Similar to the urban chemistry students, the simple correlation and multiple regression analyses were used to find the relationships between the students' views of the lessons instruction, students' perceptions of the learning environment, and students' attitudes towards the lessons on the students' achievement. Table 10.3 presents these results.

Table 10.3 presents the relationship between the rural chemistry students' views of the acids and bases lessons instruction and their achievement. The simple correlation showed a significant association ($p < 0.05$) between the rural students' achievements with one scale of the student edition of the QEC, namely *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (0.28) with a weak relationship. The multiple regression between the set of scales of the student edition of the QEC and the rural students' achievement was 0.12, but this value was insignificant. Since the multiple regression was not statistically significant, the standardised regression coefficient was not examined.

The relationship between the rural chemistry students' achievement and their perceptions towards the acids and bases learning environment is presented in Table 10.3. The simple correlation coefficient indicated no association between any scale of the modified version of the actual form of the WIHIC and the rural students' achievement. The multiple regression coefficient was 0.10, but the value was not statistically significant. In relation to no significant values of the multiple regression, the standardised regression coefficient was not examined.

Table 10.3 Associations between the scales of the QEC (student edition), the actual form of the modified version of the ATCLS, the actual form of the modified version of the WIHIC and total post-test score on the ABCAT for rural chemistry students only (N = 48).

Scale	ABCAT (Total Post-Test Score)		
	r	β	t
Student edition of the Questionnaire of Enacted Curriculum (QEC)			
Analyse Information (AI)	0.08	-0.21	-0.89
Make Connections (MC)	0.19	0.25	1.13
Active Learning (AL)	0.06	-0.10	-0.49
Use of Traditional Teaching Practices (TT)	0.15	-0.09	-0.37
Use of Strategies to Develop Students' Attitudes to Communicate Ideas (CI)	0.28*	0.33	1.75
Use of Laboratory Activities (LA)	0.14	0.11	0.46
Multiple regression (R^2)		0.12	
Actual form of the modified version of the What Is Happening in This Class? (WIHIC)			
Teacher Support (TS)	-0.06	-0.31	-1.56
Involvement (IN)	0.19	0.32	1.47
Investigation (IG)	0.11	0.01	0.06
Cooperation (CO)	0.01	-0.14	-0.76
Equity (EQ)	0.10	0.16	0.74
Multiple regression (R^2)		0.10	
Actual form of the modified version of the Attitudes Towards Chemistry Lessons Scales (ATCLS)			
Liking for Acids-Bases Chemistry Laboratory Work (LW)	-0.11	-0.58	-2.31*
Liking for Acids-Bases Chemistry Theory Lessons (TL)	0.14	0.33	1.72
Evaluative Beliefs about Acids-Bases Chemistry (EB)	0.06	0.32	1.36
Multiple regression (R^2)		0.13	

*$p < 0.05$ **$p < 0.01$

Table 10.3 indicates the relationship between the rural chemistry students' attitudes towards the acids and bases lessons and their achievement. The simple correlation showed no association between all the scales of the modified version of the actual form of the ATCLS and the rural students' achievement. The multiple regression analysis showed a coefficient of 0.13 and it was not significant. Due to this reason, there was no need to take account of the standardised regression coefficient despite one scale of the modified version of the actual form of the ATCLS, namely *Liking for Acids-Bases Chemistry Laboratory Work* to have uniquely contributed to the variance of the rural students' achievement.

 # Finding 34: No relationship was observed between the rural chemistry students' achievement and their views of the acids and bases lessons instruction.

 # Finding 35: No relationship was observed between the rural chemistry students' achievement and their perceptions of the acids and bases learning environment.

 # Finding 36: No relationship was observed between the rural chemistry students' achievement and their attitudes towards the acids and bases lessons.

10.3 Discussion

Analysis of correlation between the student edition of the QEC and the total post-test score on the ABCAT suggested that the relationship between the students' views of the acids and bases lessons instruction and their achievement existed only for urban chemistry students (Table 10.2). The urban chemistry students associated their accomplishment after the acids and bases lessons with their engagement in the passive lecture style, train-and-drill, and other traditional teaching practices (*Use of Traditional Teaching Practices*) during the lessons. This finding is congruent to what had be found by Talib, Luan, Azhar and Abdullah (2009) through interviews of 25 Malaysian students, who obtained grades A1 and A2 in chemistry, physics and biology subjects in the SPM examination. The interviews revealed that the students believed their engagements in repetition and recalling learning activities had helped them to be successful in those subjects.

Analysis of the correlations between the actual form of the modified version of the WIHIC and the total post-test score on the ABCAT suggested there was association between the urban chemistry students' perceptions of the acids and bases learning environment, especially *Involvement*, and their achievement (Table 10.2). Despite the urban chemistry students perceiving *Involvement* as the least frequent during the acids and bases lessons (Table 8.7), it appears that the students' participation in the acids and bases discussions was the most influential component of their learning environment towards their achievement. This finding suggests that the urban chemistry teachers should give more opportunity to the students to be involved in discussion activities, as there was evidence that it improved the students' learning. In general, the association between the urban students' perceptions of the learning environment and their cognitive outcomes in this study was consistent with other investigations of science subjects (Fraser & Kahle, 2007; Fraser, Walberg, Welch, & Hattie, 1987; Suarez et al., 1998).

Analysis of the correlations between the actual form of the modified version of the ATCLS and the total post-test score on the ABCAT suggested the existence of a relationship between the urban chemistry students' attitudes towards the acids and bases lessons and their achievement (Table 10.2). This finding was consistent with the interview findings obtained by Talib, Luan, Azhar and Abdullah (2009) with 25 Malaysian students who received high marks in SPM for the subjects of chemistry, biology, and physics. In the Talib et al. interviews, the students had claimed their success in those science subjects was influenced by their interest for both science and learning of science. Such relationship between the students' attitudes and their cognitive achievement in chemistry were also observed in Greece (Salta & Tzougraki, 2004) and the UK (Osborne & Collins, 2001).

The researcher believed that no relationships were observed between students' achievement and their (1) views of the acids and bases lessons instruction, (2) perceptions of the acids and bases learning environment and (3) attitudes towards the acids and bases lessons for the rural chemistry students (Table 10.3) probably because of the small number of students who had responded to all the instruments.

It could also be said that the urban chemistry students' achievement in the acids and bases lessons was influenced by their views of the lessons instruction, their perceptions of the learning environment, and their attitudes towards the lessons.

Meanwhile, the rural students' achievement in acids and bases lessons was not influenced by any of these factors.

10.4 Conclusion

The findings of this chapter were designed to address the final research question, "What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?" Using simple correlations and multiple regression analyses, three pairs of associations were made between the students' views of the lessons instruction, students' perceptions of the learning environment, and students' attitudes towards the lessons had on the students' achievement in acids and bases lessons. To do the analyses, the scales of the (1) student edition of the actual form of the QEC, (2) actual form of the modified version of the WIHIC, and (3) actual form of the modified version of the ATCLS were loaded as independent variables; meanwhile, the students' total post-test score on the ABCAT was loaded as the dependent variable. The findings indicated that the urban chemistry students' achievements in the acids and bases lessons were influenced by their views of the lessons instruction, their perceptions of the learning environment, and their attitudes towards the lessons. Meanwhile, the rural students' achievements in acids and bases lessons were not influenced by any of these factors.

CHAPTER 11 | SUMMARY AND CONCLUSION

11.1 Introduction

This chapter is designed to discuss and conclude the findings that are presented from Chapter 6 to Chapter 10 corresponding to the five research questions. This chapter begins with the summary of the thesis (Section 11.2) and findings of the study (Section 11.3). Next, the implications of the study (Section 11.4) and its limitations (Section 11.5) are discussed. This chapter closes with the recommendations for further research (Section 11.6) and thesis conclusion (Section 11.7).

11.2 Summary of Thesis

Chapter 1 overviews the background of the study, the origin of the Chemistry curriculum for secondary school in Malaysia and general information about the secondary school Chemistry curriculum. The overview describes the important role of the Chemistry curriculum in paving the way to realise the country's vision to produce a competent human capital in the field of chemistry. Nonetheless, since the Chemistry curriculum was last revised in 2005, only a few studies had been conducted to evaluate the effectiveness of the Chemistry curriculum. Based on the evidence found through the reviewed literature concerning the status of acids and bases topic in Malaysia and worldwide, it was decided to use this topic as the medium for further investigation within the conceptual framework of the *intended*, *implemented*, *perceived* and *achieved* curriculum.

Chapter 1 continues with the statements of the research objective and the five research questions used to guide this study. The research objective was set to evaluate the extent to which the acids and bases lessons delivered in urban and rural chemistry classrooms had met the Chemistry curriculum intentions. Meanwhile, the research questions in this study were organised corresponding to the conceptual frameworks of the *intended*, *implemented*, *perceived* and *achieved* curriculum: (1) What are the intentions of the Chemistry curriculum in terms of teaching and learning? (2) How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms? (3) What are the urban and rural chemistry students' perceptions about their acids and bases lessons? (4) To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?, and (5) What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes? This research was anticipated to benefit the researchers, chemistry teachers, chemistry students, and curriculum developers. An overview of the limitations that could affect the outcomes of this study are also described.

Chapter 2 provides an overview of the literature related to this study. The overview on the theoretical framework indicated there were actually several curriculum domains or representations proposed by various academicians. The overview of the theoretical framework started by tracing back the origin of the curriculum domains as suggested by Goodlad, Klein and Tye (1979). The overview then continued to understand how these domains were adopted, adapted and expanded over the years by various educationists. Indeed, several experts had highlighted various terms to represent a domain, yet it was still referred to by the same entity. From the overviews, four curriculum representations suggested by Treagust (1989) were used to form the backbone of this study, namely the *intended*, *implemented*, *perceived* and *achieved* curriculum.

Chapter 2 continues with conceptualisation of the curriculum evaluation research. The chapter begins by reviewing the history of educational evaluation research. The review then describes the definition, purpose and scope for conducting curriculum evaluation. Here, the researcher had defined the curriculum evaluation for this study as the process of gathering data to make judgments about the operation and outcomes of acids and bases lessons in meeting the intentions of Malaysian Chemistry curriculum.

Chapter 2 also explores the related literature about the four curriculum representations. The review of the literature had addressed useful information about the explications of the curriculum intentions, lessons implementation, students' perceptions, and students' outcomes. The review had provided clear descriptions on why those components of curriculum representations should be extracted, how they could be extracted, and what instruments could be used to extract them. In addition, a conceptual model was drawn to represent the interactions of these curriculum components. This chapter ends by providing some past examples of curriculum evaluation research in chemistry and others science subjects.

Chapter 3 concentrates on the methodology used in this study. This chapter contains eight major sections outlining the researcher's work plan and the process of data collection. The chapter begins by describing the four stages of the research process on which this study had been built upon. This is followed by the explanation of the nature of the design and the rationale for using a case study as the research design. The following section provides information about the sources of data for this study, which came from nine schools around Melaka Tengah district. In this study context, each of these schools was contained within the bounded system, referred to as urban or rural areas. This research is quantitative in nature where questionnaires and tests were used exclusively to answer most of the research questions. Nonetheless, a semi-structured interview had been conducted with a representative of the Curriculum Development Division (CDD) merely to clarify the implicit intentions of the Chemistry curriculum. Included in this chapter are the details on how the data were collected during the study. The final section describes the chronology of the data collection.

Chapter 4 explains the developments of three questionnaires: the Questionnaire of Enacted Curriculum (QEC), the modified version of the Attitude Towards Chemistry Lessons Scales (ATCLS) and the modified version of the What Is Happening In This Class? (WIHIC). The developments of these questionnaires were crucial to provide instruments that could collect data about the *implemented* curriculum, *perceived* curriculum and non-cognitive outcome that were used in later stage of this study.

Chapter 5 outlines the development of a test called the Acids-Bases Chemistry Achievement Test (ABCAT). Subsequently, two versions of the ABCAT were produced, namely the initial version and the amended version. Due to the limitations of the former test, the latter test was produced and used to measure the students' achievement in acids and bases in the subsequent stages of this study. The results of these two versions were analysed in terms of item analysis (difficulty index and discrimination index), minimum or maximum score, item mean, standard deviation, and Cronbach's alpha coefficient. The result from the pilot study of the amended version showed that it satisfied all the characteristics required for a good test instrument and satisfied the level of the content of this topic that was taught in the Malaysian chemistry classrooms.

Chapter 6 attempts to address the first research question, "What are the intentions of the Chemistry curriculum in terms of teaching and learning?" Two documents produced by the CDD, namely the Chemistry curriculum syllabus and the Chemistry curriculum specifications were reviewed. The identified intentions from the documents reviewed were further clarified through a semi-structured interview with a CDD's representative that was conducted in the early stage of this study. Four intentions of the Chemistry curriculum were identified. The Chemistry curriculum intended that (1) students be able to attain the intended learning outcomes after the chemistry lessons; (2) the students have interest to learn chemistry after the lessons; (3) the lessons are to be carried out using thoughtful teaching; and (4) the students are provided with an experiential learning environment during the lessons. The information was a useful indicator to measure the extent to which the acids and bases lessons were effectively meeting the Chemistry curriculum intentions. For the first intention of the Chemistry curriculum referred to above, both urban and rural chemistry students in this study indicated that had satisfactorily attained the overall intended learning outcomes. For the second intention of the Chemistry curriculum, the urban chemistry students indicated that they had high interest only towards *Liking for Acids-Bases Chemistry Laboratory Work* (mean of 4.07); meanwhile, the rural chemistry students indicated that they had high interest only towards *Liking for Acids-Bases Chemistry Laboratory Work* (mean of 4.19) and *Evaluative Beliefs about Acids-Bases Chemistry* (mean of 4.18). For the third intention of the Chemistry curriculum, both urban and rural chemistry teachers indicated that the *Use of Traditional Teaching Practices* (means of 3.09 and 3.40, respectively) dominated their acids and bases lessons. Nonetheless, the rural chemistry teachers also indicated to have largely carried out teaching practices that involved the *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (mean of 3.33) during the acids and bases lessons. For the fourth intention of the Chemistry curriculum, both urban and rural chemistry students indicated that they had only weakly perceived the experiential learning environment during the acids and bases lessons except for the relatively high cooperation between the students (means of *Cooperation* scale - 4.23 for urban chemistry students and 4.26 for rural chemistry students).

Chapter 7 summarises the findings of the teaching practices used by nine chemistry teachers (seven urban teachers and two rural teachers) during the acids and bases lessons. Their responses were collected using the teacher edition of the QEC. In addition, the responses from 354 chemistry students (254 urban students and 100 rural students) were collected using the student edition of the QEC to support the teachers' responses. Due to the low number of participant teachers, the validity and reliability of the teacher edition of the QEC could not be determined with certainty. In addition, the analysis of the average item mean of the teachers' responses was computed manually using the a Microsoft Excel spreadsheet based on its adopted original scales. The large number of students' responses enabled the validity and reliability of the student edition of QEC to be determined. In addition, analyses of item mean, scale mean, average standard deviation, effect size and t-test were performed using the urban and rural chemistry students as unit of analysis. The data are presented in tables and graphs for easy comparison and discussion. The findings were used to address the second research question, "How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?" The results suggested that there were no differences between the QEC scale means for *Make Connections, Active Learning* and *Use of Laboratory Activities* during acids and bases lessons for both the urban and rural teachers. Nonetheless, the urban chemistry teachers indicated that they were less frequently involved than the rural teachers in the *Use of Traditional Teaching Practices* and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas*, but the urban chemistry teachers claimed to have carried out activities related to the *Analyse Information* scale more frequently than the rural chemistry teachers did.

Chapter 8 presents the findings from the modified version of the WIHIC. From the total responses received, only 260 chemistry students (consist of 211 urban and 49 rural students) had completed both the actual and preferred forms of the WIHIC. In order to determine the validity and reliability of the modified version of the WIHIC for both forms, several analyses were performed like determining the factor structure, internal consistency reliability and discriminant validity of the instrument. Using the urban and rural chemistry students as the unit of analysis, item mean, scale mean, average standard deviation, effect size and t-test analyses were done. The findings were used to address the third research question, "What are the urban and rural chemistry students' perceptions about their acids and bases lessons?" The results suggested that the urban chemistry students preferred less *Investigation* and *Cooperation* than what they actually perceived during the acids and bases lessons whilst feeling satisfied with the level of *Teacher Support*, *Involvement* and *Equity* that they had experienced. On the other hand, the rural chemistry students indicated that they were satisfied with all the scales of the acids and bases learning environment (*Teacher Support*, *Involvement, Investigation, Cooperation* and *Equity*) that they had experienced.

Chapter 9 discusses the findings related to fourth research question, "To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?" Two types of data were highlighted here, namely the students' non-cognitive outcomes and students' cognitive outcomes. The students' non-cognitive outcomes was sought using the modified version of the ATCLS to find the students' attitudes towards the acids and bases lessons and it was administered in both the actual and preferred forms. The students' responses on both forms of the modified version of the ATCLS were analysed to determine the average item mean, scale mean, average item standard deviation, effects size and t-test results. Meanwhile, the students' cognitive outcomes was sought using the pre-test and post-test of the ABCAT to assess the achievement of urban and rural chemistry students in the acids and bases lessons. The students' responses on the ABCAT were analysed to determine the total mean score, effect size, t-test results and ANCOVA results. Both the validity and reliability of these instruments (modified version of the ATCLS and ABCAT) had already been determined. For the students' non-cognitive outcomes, the attitudes that the urban chemistry students had developed towards the acids and bases lessons were more positive than what they had desired. Meanwhile, the rural students felt that the attitudes that they had developed during the acids and bases lessons were similar to what they had desired except that they had developed more positive attitudes towards *Liking for Acids-Bases Chemistry Theory Lessons* than what they had desired. In the case of students' cognitive outcomes, both urban and rural students had achieved similar results in the ABCAT after the acids and bases lessons. They had also achieved large improvements in the post-test of the ABCAT over their results in the pre-test.

Chapter 10 addresses the fifth research question, "What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?" Two types of analyses were conducted using the Predictive Analytics SoftWare (PASW) software, namely simple correlation (r) and multiple regression (R^2) to explore the relationships. The 247 chemistry students (199 urban students; 48 rural students) had provided their responses to all the instruments, namely the student edition of the QEC, the actual form of the modified version of the WIHIC, the actual form of the modified version of the ATCLS, and the ABCAT.

As indicated by the fifth research question, Chapter 10 explores three pairs of relationships for the urban and rural chemistry students. The first relationship was between the students' views of the lessons instruction and their achievement. For this purpose, the scales from the student edition of the QEC were loaded as the independent variable and the students' total post-test score on the ABCAT was loaded as the dependent variable. The second relationship involved the relationship between the students' perceptions of the acids and bases learning environment and their achievement. In this relationship, the scales from the actual form of the modified version of the WIHIC were loaded as the independent variables while the students' total post-test score on the ABCAT was loaded as the dependent variable. The final relationship was between the students' attitudes towards the acids and bases lessons and their achievement. Here, the scales from the actual form of the modified version of the ATCLS were set to be the independent variable and the students' total-post-test score on the ABCAT was set to be the dependent variable. The findings indicated that the urban chemistry students' achievements in the acids and bases lessons were influenced by their views of the lessons instruction, their perceptions of the learning environment, and their attitudes towards the lessons. Meanwhile, the rural students' achievements in acids and bases lessons were not influenced by any of these factors.

11.3 Findings of the Study

11.3.1 Research Question #1 - What are the intentions of the Chemistry curriculum in terms of teaching and learning?

As shown in Chapter 6, the analysis of the Chemistry curriculum documents supported with an interview of a CDD representative had led to the identification of four intentions:

- The Chemistry curriculum intended that students be able to attain the intended cognitive learning outcomes after the chemistry lessons (see Section 6.2.1).
- The Chemistry curriculum intended that the students have interest to learn chemistry after the lessons (see Section 6.2.1).
- The Chemistry curriculum intended that the lessons are to be carried out using thoughtful teaching (see Section 6.2.2).
- The Chemistry curriculum intended that the students are provided with an experiential learning environment during the lessons (see Section 6.2.2).

11.3.2 Research Question #2 - How are the acids and bases lessons actually conducted by teachers in urban and rural chemistry classrooms?

As shown in Chapter 7, the development of the QEC mainly aimed to gather information about the teaching practices of acids and bases lessons. Two types of QEC were used in this study, the teacher edition and student edition. The teacher edition was administered to the teachers to ascertain their views on how frequently they had carried out the described teaching practices. Meanwhile, the student edition was administered to the students to find out their views about the extent to which they had been engaged in the described teaching practices. Nine chemistry teachers and 354 chemistry students had provided their responses to the teacher edition and student edition, respectively. The examination of the validity and reliability of both versions of the QEC are described as follows:

- The validity and reliability for the six scales of the teacher edition of the QEC that was used this study could not be determined due to the small sample size of the teachers. However, reports about the original instruments indicated that all the replicated scales had demonstrated good internal consistency reliability, with the Cronbach's alpha coefficient being 0.71 or above for each of the scales (Smithson & Blank, 2006; Weiss et al., 2003) (see Section 7.2.1).
- The student edition of the QEC demonstrated moderate reliability with only three scales having Cronbach's alpha coefficients above 0.70. Nonetheless, the student edition of the QEC showed satisfactory discriminant validity on all six scales for the combination of urban and rural chemistry students of this study (see Section 7.3.1).

The urban schools were represented by seven chemistry teachers and 254 chemistry students. Meanwhile, two chemistry teachers and 100 chemistry students represented the rural schools. The analysis of average item mean was performed on both the teacher edition and student edition of the QEC. The key findings from the analysis are as follows:

- The urban chemistry teachers indicated that they had carried out all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. The *Use of Traditional Teaching Practices* (TT) was claimed to be the most frequent, while the use of *Analyse Information* (AI) in the teaching practice was implemented the least (see Section 7.2.2).
- The rural chemistry teachers indicated that they had carried out all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons with the most frequently used practice being *Use of Traditional Teaching Practices* (TT), while the *Analyse Information* (AI) teaching practice was implemented the least (see Section 7.2.3).
- There were no differences between the urban and rural teachers for the implementation of *Make Connections* (MC), *Active Learning* (AL) and *Use of Laboratory Activities* (LA) during the acids and bases lessons. Nonetheless, the urban chemistry teachers indicated to *Use of Traditional Teaching*

Practices (TT) and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (CI) less frequently, but claimed to carry out the *Analyse Information* (AI) activity more frequently than the rural chemistry teachers did (see Section 7.2.4).

- The urban chemistry students claimed that they had been engaged in all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. They claimed they had participated in the *Use of Laboratory Activities* (LA) the most frequently, while they were least engaged in lesson activities that involved *Active Learning* (AL) (see Section 7.3.2).
- The rural chemistry students claimed that they had been engaged in all the described teaching practices (item mean exceeded 2-Sometimes) during the acids and bases lessons. They claimed they had participated in the *Use of Traditional Teaching Practices* (TT) and *Use of Laboratory Activities* (LA) the most frequently. Meanwhile, the students claimed they had been least engaged in the *Make Connections* (MC) activities (see Section 7.3.3).
- There were no differences between the urban and rural students in their level of engagement in *Analyse Information* (AI), *Make Connections* (MC), *Active Learning* (AL) and *Use of Laboratory Activities* (LA) during the acids and bases lessons. However, the urban students claimed that they were engaged to a lower extent in *Use of Traditional Teaching Practices* (TT) and *Use of Strategies to Develop Students' Attitudes to Communicate Ideas* (CI) than the rural students were (see Section 7.3.4).

11.3.3 Research Question #3 - What are the urban and rural chemistry students' perceptions about their acids and bases lessons?

As shown in Chapter 8, the modified version of the WIHIC was developed in order to gather information regarding the students' perceptions of the acids and bases learning environment. Using 260 chemistry students from urban and rural schools, the validity and reliability of the instrument were evaluated revealing the following results:

- Both the actual and preferred forms of the modified version of the WIHIC displayed satisfactory factorial validity, reliability and discriminant validity on all five scales for the combination of urban and rural chemistry students in this study (see Section 8.2.1).

The analyses of average item mean, average item standard deviation, effect size, and t-test were performed on both the actual form and the preferred forms of the modified version of the WIHIC. The analyses which had involved 211 urban and 49 rural chemistry students, revealed the following findings:

- The urban chemistry students indicated positive perceptions of the acids and bases learning environment (item means for all scales were above 3-Sometimes) with *Cooperation* (CO) being perceived the most frequent, while *Involvement* (IN) the least (see Section 8.2.2).
- The rural chemistry students had positive perceptions of the acids and bases learning environment (item means for all scales were above 3-Sometimes). The rural students perceived *Cooperation* (CO) the most frequent, while the *Involvement* (IN) was experienced the least during the lessons (see Section 8.2.3).
- The urban chemistry students preferred less *Investigation* (IG) and *Cooperation* (CO) than what they actually perceived during the acids and bases lessons. Meanwhile, the urban chemistry students expressed satisfaction about the level of *Teacher Support* (TS), *Involvement* (IN) and *Equity* (EQ) that they had perceived (see Section 8.2.2).
- The rural chemistry students were satisfied with the level of *Teacher Support* (TS), *Involvement* (IN), *Investigation* (IG), *Cooperation* (CO) and *Equity* (EQ) that they had perceived during the acids and bases lessons (see Section 8.2.3).
- There were no perception differences between urban and rural chemistry students for all the scales of the actual modified version of the WIHIC, namely *Teacher Support* (TS), *Involvement* (IN), *Investigation* (IG), *Cooperation* (CO) and *Equity* (EQ) during the acids and bases lessons (see Section 8.2.4).

- The urban students preferred lesser *Cooperation* (CO) and *Equity* (EQ) to take place during the lessons compared to the rural students. However, the urban students' preferences towards *Teacher Support* (TS), *Involvement* (IN) and *Investigation* (IG) were not significantly different to the rural students (see Section 8.2.4).

11.3.4 Research Question #4 - To what extent are the outcomes from the acids and bases lessons in urban and rural schools different?

In order to address this research question as shown in Chapter 9, two types of findings were obtained: non-cognitive outcomes and cognitive outcomes. The non-cognitive outcomes referred to the data obtained regarding the students' attitudes towards the acids and bases lessons. Meanwhile, the cognitive outcome referred to the students' achievement in the acids and bases lessons examinations.

Non-cognitive outcomes

The modified version of the ATCLS was developed to assess the students' attitudes towards the acids and bases lessons. The evaluation of validity and reliability of this instrument had involved 260 chemistry students from urban and rural schools. The findings are as follows:

- Factor analysis on the actual and preferred forms of the modified version of the ATCLS using the combination of urban and rural chemistry students in this study supported a three-scale structure (with the items from *Behavioural Tendencies to Learn Chemistry* being distributed evenly to others scales) rather than the *a priori* four-scale structure of the original ATCLS. The three-scale structure on both forms displayed satisfactory reliability and discriminant validity (see Section 9.2.1).

Analysis of responses to both the actual form and the preferred form of the modified version of the ATCLS was performed to obtain the average item mean, average item standard deviation, effect size, and t-test results. The analyses had involved 211 urban and 49 rural chemistry students. The key findings from these analyses are as follows:

- The urban chemistry students had positive attitudes towards all dimensions of the modified version of the ATCLS (item means for all scales were above 3 - Not Sure); *Liking for Acids-Bases Chemistry Laboratory Work* (LW) were the highest, while *Liking for Acids-Bases Chemistry Theory Lessons* (TL) were the lowest (see Section 9.2.2).
- The rural chemistry students had positive attitudes towards all dimensions of the modified version of the ATCLS (item means for all scales were above 3 - Not Sure). The students indicated that their *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) were the highest, while their *Liking for Acids-Bases Chemistry Theory* (TL) were the lowest (see Section 9.2.3).
- The urban chemistry students had higher *Liking for Acids-Bases Chemistry Laboratory Work* (LW), *Liking for Acids-Bases Chemistry Theory Lessons* (TL) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) than what they had desired (see Section 9.2.2).
- The rural chemistry students showed higher *Liking for Acids-Bases Chemistry Theory Lessons* (TL) than what they had desired. Meanwhile, the rural chemistry students were satisfied with their level of *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) similar to what they presently held (see Section 9.2.3).
- The urban and rural chemistry students possessed similar *Liking for Acids-Bases Chemistry Laboratory Work* (LW) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB). However, the rural students were more *Liking for Acids-Bases Chemistry Theory Lessons* (TL) than the urban students (see Section 9.2.4).
- The urban and rural students had similar preferences towards *Liking for Acids-Bases Chemistry Laboratory Work* (LW). Nonetheless, the rural chemistry students had higher preferences towards *Liking for Acids-Bases Chemistry Theory Lessons* (TL) and *Evaluative Beliefs about Acids-Bases Chemistry* (EB) compared to the urban students (see Section 9.2.4).

Cognitive outcomes

In order to address the students' achievement resulting from the acids and bases lessons, the 22-item ABCAT was developed. The reliability and the validity of the test, which was composed of two sections, had been evaluated using 304 chemistry students from the urban and rural schools. The findings are as follows:

- Section A and Section B of the post-test of the ABCAT indicated low internal consistency reliability for the combination of urban and rural chemistry students. Nonetheless, the difficulty index suggested that most of the items from both sections were of moderate difficulty. The discrimination index suggested that the items from both sections were effective in differentiating the high achieving students from the lower achieving students (see Section 9.3.1).

In order to compare the achievement of urban and rural chemistry students (240 and 64 students, respectively), analyses of total mean scores, standard deviation, effect size and t-test were performed on the pre-test and the post-test of ABCAT. The findings of the analyses are presented as follows:

- There was large improvement in urban chemistry students' achievement as a result of the acids and bases lessons (see Section 9.3.2).
- There was large improvement in rural chemistry students' achievement as a result of the acids and bases lessons (see Section 9.3.3).
- Both urban and rural students had similar levels of achievement as a result of the acids and bases lessons (see Section 9.3.4).

11.3.5 Research Question #5 - What are the relationships between urban and rural students' achievement and students' views of the instruction in acids and bases, students' learning environment, and students' attitudes?

As shown in Chapter 10, simple correlation and multiple regression analyses were performed out to determine the relative strength of the associations between the students' total post-test score on the ABCAT with three others independent factors. These independent variables were (1) students' views on the acids and bases lessons instruction, (2) students' perceptions of the acids and base learning environment, and (3) students' attitudes towards the acids and bases lessons. The analyses revealed the following findings:

- There was positive but weak relationship between the urban chemistry students' achievement and their views of the acids and bases lessons instructions [especially *Use of Traditional Teaching Practices* (TT)] (see Section 10.2.2).
- No relationship was observed between the rural chemistry students' achievement and their views of the acids and bases lessons instruction (see Section 10.2.3).
- There was positive but weak relationship between the urban chemistry students' achievement and their perceptions of the acids and bases learning environment [especially *Involvement* (IN)] (see Section 10.2.2).
- No relationship was observed between the rural chemistry students' achievement and their perceptions of the acids and bases learning environment (see Section 10.2.3).
- There was positive but relatively weak relationship between the urban chemistry students' achievement and their attitudes towards the acids and bases lessons [especially *Liking for Acids-Bases Chemistry Theory Lessons* (TL)] (see Section 10.2.2).
- No relationship was observed between the rural chemistry students' achievement and their attitudes towards the acids and bases lessons (see Section 10.2.3).

11.4 Implications of the Study

As far as the researcher's knowledge is concerned, no evaluation research has been conducted to investigate the effectiveness of acids and bases lessons in the Malaysian Secondary school Chemistry curriculum. Therefore, this study has made a distinctive contribution to the field of curriculum evaluation in general and to the Malaysian Chemistry curriculum in particular. The study has two levels of implications: the first is for research and the second is for teaching.

11.4.1 Implications of the study for research

All the instruments (the modified version of the WIHIC, the modified version of the ATCLS and the ABCAT), except the QEC, had been exclusively examined in terms of validity and reliability for use in this study. Other researchers or evaluators can utilise one or all of these instruments to obtain valuable information that can be used for teaching reflections as well as for monitoring students' perceptions of their learning environments, students' attitudes and students' achievement in the acids and bases lessons within Malaysian chemistry classrooms context.

This study that has used the theoretical framework of the *intended*, *implemented*, *perceived* and *achieved* curriculum in evaluating the extent of acids and bases lessons delivered in urban and rural chemistry classrooms has, only to some extent, met the Chemistry curriculum intentions. The use of such a theoretical framework in assessing the acids and bases lessons provided holistic information in terms of lesson implementation, students' perceptions, and students' outcomes. As implication, the findings from this study could serve as an example to evaluate the effectiveness of other chemistry topics against the Chemistry curriculum intentions. By doing so, would give a description of the strength and weakness in the teaching of every chemistry topic in the Malaysian Form 4 and 5 Chemistry curriculum. This information could then be used by curriculum developers as baseline data in improving the future Chemistry curriculum in Malaysia.

11.4.2 Implications of the study for teaching

It is interesting to note that the responses from the urban and rural teachers concerning their teaching practices during the acids and bases lessons (Sections 7.2.2 and 7.2.3) indicated the domination of the use of passive lecture-style instruction that had taken place especially in the rural chemistry classrooms. Many researchers agree that the use of traditional teaching practices has always been associated with dull, passive, and boring teaching practices (Goodrum, 2004). Such teaching practices obviously contradicted what was intended in the Chemistry curriculum that emphasises thoughtful teaching. This study provides a platform for the chemistry teachers who had participated in this study to reflect on the extent to which their teaching practices have deviated from the intentions of the Chemistry curriculum. Doing so may encourage the teachers to realise the need to revise their teaching practices in acids and bases lessons in order to meet the requirements of the curriculum intentions. In addition, the findings also provide crucial feedback to the Malaysian Ministry of Education (MOE) for the need to organise supporting training or workshop sessions for the teachers in in order to improve their teaching skills to comply with the intentions of Chemistry curriculum.

Many researchers had shown that students' cognitive achievement is indeed influenced by the teachers' teachings practices (Talib et al., 2009), the students' learning environments (Allen, 2003) and the students' attitudes (Osborne & Collins, 2001; Salta & Tzougraki, 2004). In the case of this study, all these associations did exist in the urban chemistry classrooms. These findings suggest that the chemistry teachers should consider improving their teaching practices, improving the students' learning environment, as well as elevating the students' attitudes in order to improve their students' achievement. These associations suggest that if the chemistry teachers intend to improve the achievement of their students in acids and bases lessons, they should ensure that the factors that have been found to be empirically linked to their achievement should be enhanced. In fact, other chemistry teachers who may wish to improve their students' achievement in acids and bases lessons should exploit all of these factors.

It is obvious that the present study is distinctive as it is one of the few curriculum evaluation studies that have been conducted to assess the effectiveness of chemistry lessons against the Chemistry curriculum in Malaysia. In addition, the findings of this study are unique as it is only focus on one topic, namely acids and bases, while the previous evaluation studies were quite general and not specific on any topic. The identification of Chemistry curriculum intentions in this study gives the teachers a series of benchmarks that they should aware in implementing the acids and bases lessons. These benchmarks might be seemingly common, though, it has rarely been given great emphasis during chemistry lessons. This claim was evident by the implementation of the passive lecture method that dominated the acids and bases instruction in both urban and rural classrooms observed in this study. As a result, it was not surprising to find similar trends of perceptions, attitudes and cognitive achievement by these two cohorts. These findings might only be the tip of the iceberg. Such ways of instruction could possibly implicate other chemistry topics and be repeated in future years, thus providing impact toward the succession or failure of the Chemistry curriculum as a whole. Therefore, the findings of this study have contributed some meaningful information to those who are directly or indirectly involved in the development and implementation of the Chemistry curriculum. Effective intervention programs should be planned to enhance the application of thoughtful teaching and learning of the acids and bases topic in particular and chemistry as a subject in general.

11.5 Limitations of the Study

Given that this study was the pioneer in evaluating the effectiveness of acids and bases lessons in meeting the Malaysian Chemistry curriculum intentions using the theoretical framework of the *intended*, *implemented*, *perceived* and *achieved* curriculum, it is not surprising that this research has limitations in terms of its scope and other aspects. The researcher had identified several limitations that could influence the overall investigation and outcomes of this study. It should be noted that the findings from this study are applicable to the cases of urban and rural chemistry classrooms from around the Melaka Tengah district only. Therefore, the findings may not be valid to be generalized to others classrooms outside this district.

11.5.1 Instrument development time

In this study, a lot of time and energy was committed to develop, refine, and trial-test numerous instruments to address the various research questions. The most time spent was in the development of the pre-test and post-test of the ABCAT that was used to monitor the students' achievement throughout the acids and bases lessons. The main challenge faced by the researcher was the undependable students' information about their responses during the trialling of the ABCAT. In the initial plan, the researcher had planned to conduct a context-based investigation of acids and base lessons against the Chemistry curriculum intentions based on the given theoretical framework of the *intended*, *implemented*, *perceived* and *achieved* curriculum (Gilbert, 2006; Pilot & Bulte, 2006). For that purpose, the initial version of the ABCAT consisting of 11 items of two-tier multiple-choices items had been developed, refined and trial-tested in the target schools. Surprisingly, the data collected from the trial-test showed very poor student performances with many of the items left incomplete, which affected the reliability of the test. An urgent solution was decided in which the data collected from the initial test was not pursued as the results did not contribute to the thread of the thesis. An amended version of the ABCAT then was developed to replace the previous test that was also trial-tested. The development details and the trial results for the initial version as well as the amended version were reported in Chapter 5. In addition, since the researcher had personally developed both versions of ABCAT, limitations could had arisen in terms of bias towards it success.

The issue of time was also the main factor that limited the researcher's efforts to validate the QEC. Since the utilisation of the QEC in this study was decided later after the trial-testing the modified version of the WIHIC, the modified version of the ATCLS, and the amended version of the ABCAT, the researcher had missed the opportunity to trial-test the QEC. The situation became critical since the researcher needed to conduct the data collection before the school term ended as the acids and bases topic was taught around August to October.

11.5.2 Emphasis on quantitative data

The present study was predominantly quantitative. Initially, the researcher was supposed to conduct a series of observations and interviews during the data collection stage. Considering the researcher's financial constraints because of the expenses that had been incurred for the development and trial-tests of the modified version of the WIHIC, the modified version of the ATCLS, and the ABCAT, the decision was made after discussions between the researcher and his supervisor to replace the observation component with the teacher and student editions of the QEC. The replacement however did not change the original purpose to seek information about the *implemented* curriculum.

Another reason why this study was unable to include any qualitative components was due to the fact that the researcher had spent a lot of time to develop and validate a wide range of instruments such as modified version of the WIHIC, the modified version of the ATCLS and the ABCAT. The researcher had taken almost one year to prepare those instruments. Due to the absence of qualitative components to address the curriculum implementation as well as to support information obtained from the quantitative data, the researcher acknowledged that the overall values of this study were affected. Besides that, the lack of qualitative data consequently had limited the researcher to draw the exact causal conclusion. If time and resources permitted, the inclusion of qualitative components (observations and interviews) for a similar study in the future would be preferable.

11.5.3 Access to schools

The policy of the MOE required all researchers to obtain approval before accessing the Malaysian schools. The researcher had gone through several formal procedures before he conducted the pilot study and full study in the target schools. Prior to obtaining access to the schools, a letter requesting permission to do so was written to the MOE. Following that, approval from the state education department and the district education department was sought before the researcher could made appointments with the principals of the schools. All these procedures consumed a lot of time. Unfortunately, this process did not guarantee access to the schools. Several schools had denied the presence of the researcher and did not allow the researcher to administer any of the instruments. Among the reasons given were that the presence of researcher could cause disturbance in the teaching and learning flow and the student needs to prepare for the final year examination.

11.5.4 Student and teacher responses

There were occasions where the data collected were imperfect in some respects due to the reason that the researcher had not administered the instruments personally. The students may have taken for granted when responding to the instruments especially when they knew that their responses would not be included in any assessment marks. This meant the students would give their responses without reading the instructions and the items carefully. As the researcher was aware of this situation, 45 students were eliminated based on the responses they had provided to item 41 of the modified version of the WIHIC, which stated, “If you read this item, please circle 5” (Section 8.2.1). Another possibility was that the students might provide fake responses in order to please the teachers who administered the instruments on behalf of the researcher.

The numbers of students who provided their response varied for each of the instruments. A total of 254 urban chemistry student and 100 rural chemistry students had provided their responses for the student edition of the QEC. For the modified version of the WIHIC and modified version of the ATCLS, 211 urban and 49 rural chemistry students had provided their responses. Meanwhile, 240 urban and 64 rural chemistry students sat for the ABCAT. When these students were cross-checked between these instruments, only 199 urban and 48 rural chemistry students were found to be matched. These numbers showed the urban students were of a reasonable size but the number of rural students was relatively small. The low sample size of the rural students made it difficult to draw unequivocal conclusions from the comparisons between those two cohorts.

Similarly, the small number of responses gathered from the urban and rural chemistry teachers could also have affected the reliability and structure validity of the teacher edition of the QEC. It was the researcher’s intention to collect more responses from other chemistry teachers during the data collection. However, the limited time and funds restrained the researcher from travelling to further schools to collect responses from more teachers.

Language barrier was one of the obstacles for the chemistry students to understand the statements of instructions and items in the questionnaires and the test. Despite the Teaching and Learning of Science and Mathematics in English (PPSMI) policy still being enforced during the administration of this study, meaning the official medium of instruction was supposed to be in English, not all the students had a good command of English. The actual medium of instruction involved mixing of English and Malay languages (Lan & Tan, 2008). Therefore, the development of the instruments had to take account of this issue by placing both English and Malay statements side-by-side in order to assist students to understand the instructions and items.

Students may not have had enough prior experience or maturity that may have led the chemistry students from the urban and rural schools to give distorted responses about what they would have liked to happen in the acids and bases lessons. As this was the first time these students had encountered acids and bases lessons, the students might be confused what the preferred situation should be like, and this affected their responses on the preferred form of the questionnaires. As a consequence the comparison of the actual and preferred scales for the modified version of the WIHIC and the modified version of the ATCLS produced very small differences.

11.6 Recommendations for Further Research

Despite the limitations addressed above, this study provides some possible new directions to assess the effectiveness of chemistry lessons against the Chemistry curriculum intentions. The evaluation of the effectiveness of acids and bases lessons for this study is only a starting point. The researcher considers that it is necessary for future similar research to accommodate the strengths and weaknesses of this study to improve the research findings.

As noted in the methodology section, this research used a case study design that enabled an in-depth understanding of how the acids and bases lessons were carried out, what were the students' perceptions of the learning environment, and what were the outcomes as a result of the lessons. However, this study lacked qualitative data that could provide more detailed information. Therefore, the researcher highly recommends the inclusion of qualitative components for future research. It is also suggested that the observations and interview findings could be used as the main data to describe the *implemented* curriculum and to provide supporting information about the *perceived* and *achieved* curriculum.

The teacher and student editions of the QEC had been used in this study to replace the qualitative components in gaining the information about the *implemented* curriculum. The utilisation of both editions had missed the validation process due to the limitations mentioned above. Since, the scales of the QEC were adopted from two original questionnaires that were developed from Western contexts (refer Section 4.3), therefore, the issue whether it was valid to be used in a Malaysian context is the main concern. For that reason, the researcher recommends future research to a conduct proper cross-validation exercise as well as a reliability check for the use of the QEC in the Malaysian contexts in order to increase the qualities of robustness and dependability.

This study administered the preferred forms of the modified version of the WIHIC and ATCLS three months prior to the commencement of the acids and bases lessons, meanwhile the actual forms were administered a week after the lessons. The researcher suspected that the insignificant differences between the actual and preferred scores of those questionnaires were due to the students' lack of experience or maturity in determining their desired opinions towards their learning environment and attitudes. For future research, the researcher recommends that the preferred forms be administered after the lessons, while the actual forms be administered a week later (Fraser, 2000). This may enable the students to make comparison between what actually had taken place and what they would like to see to be improved in terms of the learning environment and their attitudes.

Almost one third of the time of this study had been spent in developing, refining and trial-testing the ABCAT. The purpose of its development was to obtain information about the students' achievement in acids and bases concepts, which was part of the *achieved* curriculum. Since a lot of valuable time was spent for this process, the researcher recommends future research to use the ready-made standardised assessments that could fulfil a similar purpose. Such approach not only saves time but also energy and money.

As mentioned in the limitations section, in this study, different numbers of students responded to the different instruments due to the problems of students being absent or providing incomplete responses. These students were deleted resulting in only 199 urban chemistry students and 48 rural chemistry students who had provided their responses in all the instruments. These numbers were then used in the correlations analyses to answer the final research question. Therefore, the researcher recommends synchronising the number of students responding to every instrument in future research in order to facilitate the analysis of comparisons and correlations.

This study only involved the participation of the teachers and students who came from the urban and rural chemistry classrooms around the Melaka Tengah district in Malaysia. As such, the findings cannot be generalized to all Malaysian schools. Therefore, it is recommended that similar studies could be conducted using larger sample sizes and including chemistry classrooms outside the district.

Finally, the researcher recommends similar investigations could be conducted on other topics in the Chemistry curriculum. Such effort combined with the findings of this study could provide baseline data for the improvement of the Malaysian secondary school Chemistry curriculum.

11.7 Conclusion

This final chapter summarises the entire thesis, particularly the findings. Chapter 1 introduced the background of the study; Chapter 2 reviewed the related research literature; Chapter 3 outlined the methodology used in this study; Chapters 4 and 5 describes the developments of instruments used in this study; and Chapters 6 to 10 presented the findings and discussions. There are 36 findings drawn across five research questions (4, 8, 7, 11 and 6 findings were derived that addressed research questions 1, 2, 3, 4 and 5, respectively). This final chapter also discusses the implications and limitations resulting from this study. The chapter concludes with some recommendations for further research. This study hopes to benefit all the stakeholders involved in the implementation of acids and bases lessons in the secondary school Chemistry curriculum in Malaysia, particularly curriculum developers, chemistry teachers, and other researchers.

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APPENDIX A: Format of the Semi-Structured Interview with the CDD's Representative

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Curtin University

INTERVIEW FORMAT FOR THE INTENDED CURRICULUM

Part A- Personal background

1. What is your name?
2. What is your role in the CDD?

Part B- The Curriculum Development Division (CDD) intentions

1. How does the CDD intend the chemistry teachers to implement or manage the chemistry lessons? / Why?
2. How does the CDD intend the students to have their experiences after each of the chemistry lesson? / Why?
3. How does the CDD intend the students to have their achievements after each of the chemistry lesson? / Why?
4. How does the CDD intend the interactions between the teacher-students to take place during the chemistry lesson? / Why?
5. In what way do the CDD intentions have been informed to the chemistry teachers? / How well?

Part C- Chemistry Curriculum in Malaysian context

1. What does the Chemistry Curriculum actually refer to in the Malaysian education context? / What actually does the Chemistry Curriculum represent?
2. How important is the Chemistry Curriculum to chemistry teachers? / Why?
3. What is the basis of the development of the Malaysian Chemistry Curriculum?
4. Who was involved in the development of the Chemistry Curriculum?

APPENDIX B: Interview Transcript with the CDD's Representative

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CDD/MOE/16.02.2011

Interviewer: Ph.D. student from Science and Mathematics Education Centre, Curtin University, Perth, Australia.

Interviewee: Curriculum Officer responsible for the Chemistry Curriculum Form 4 and 5 in Curriculum Development Division, Ministry of Education, Malaysia.

Interview Setting: Interview conducted in interviewee's office located at Curriculum Development Division, Ministry of Education, Putrajaya, Malaysia. The interview was conducted at 3.00 PM on 16 February 2011 (Wednesday).

(Start of Interview)

Interviewer: How does the CDD intend the chemistry teachers to implement the chemistry lessons?

Interviewee: Teachers are encourage to employ a variety of approaches such as inquiry discovery, constructivism, contextual learning, mastery learning, science, technology and society or other approaches when planning for the lessons T & L (teaching and learning) methods. Teachers may use various methods such as experiments, discussions, simulations, projects, field trips and visits with the use of technology where applicable… In the curriculum, the teaching-learning methods suggested are stated under the column "Suggested Learning Activities."

Interviewer: How does the CDD intend the students to have their experiences after each of the chemistry lesson, for example in term of students' attitudes and perceptions towards the lesson?

Interviewee: After each chemistry lesson, it is expected that students will achieve the intended learning outcomes, be motivated with the student centred activities... have fun, excitement and accept the challenges involved through solving the tasks or problems given by the teachers or peers through good working etiquette. The activities must be seen as relevant to the student so that they are engaged in the activities and felt that they have learnt and achieved at least some knowledge and understanding of chemistry. The teachers must be able to provide opportunities for students to experience the chemistry concepts and principles in an articulated manner.

Interviewer: How does the CDD intend the students to have their achievements after each of the chemistry lesson?

Interviewee: During the lessons, the teacher will be giving good constructive questions, from low to high order thinking questions, to build the students' understanding on the scientific concepts or principles for the lesson. At the end of the lesson, teacher will give a task to the students as formative assessment in order to get feedback on the students' achievements for that lesson. The feedback will be used by the teacher to take improve the students' achievement.

Interviewer: How does the CDD intend the interactions between the teacher-students to take place during the chemistry lesson?

Interviewee: Encourage teachers to always plan students-centred lessons and most of the time the teacher act as the facilitator. Where possible the students decide the depth of the objectives and the type of activities involved.

Interviewer: Why emphasise student-centred learning?

Interviewee: To give students the opportunity to experience what they want to know and study… thus, giving the students the autonomy, confidence, interest and perseverance in what they are doing… and the real feeling of being a scientist, researcher or investigator.

Interviewer: In what way do the CDD intentions have been informed to the chemistry teachers?

Interviewee: The chemistry teachers have been informed through promotional events on curriculum, science and mathematics orientation courses in collaboration with MOE, State Education Department, or District Education Office, and in house training by senior teachers in their own schools

Interviewer: How well the CDD intentions have been informed to the chemistry teachers?

Interviewee: CDD monitoring shows that the impact is very little, since the courses were done through the cascading model causing the dilution factors in the training process.

Interviewer: What actually does the Chemistry Curriculum represent?

Interviewee: Chemistry curriculum specifications which represents the whole year study programs in secondary schools.

Interviewer: How important is the Chemistry Curriculum to chemistry teachers?

Interviewee: It is compulsory for teachers to adhere to the curriculum since the summative assessment will be based on the learning outcomes in the curriculum specifications by the Malaysian Assessment Syndicate at the end of the full course. Their achievements in this summative assessment may have high stakes for the students and the teachers too!

Interviewer: What is the basis of the development of the Malaysian Chemistry Curriculum?

Interviewee: The developments of Chemistry Curriculum are based on the National Philosophy of Education and National Science Education Philosophy.

Interviewer: Who was involved in the development of the Chemistry Curriculum?

Interviewee: MOE's curriculum officers, professional bodies, industries representatives, universities lecturers, expert teachers and experience teachers.

(End of Interview)

APPENDIX C: Questionnaire of Enacted Curriculum (QEC) – *Teacher Edition*

Science & Mathematics Education Centre (SMEC)

QUESTIONNAIRE OF ENACTED CURRICULUM

Teacher Edition
Chemistry
Acids & Bases Lessons

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the acids and bases lesson curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. This information can be used to assist Malaysian acids and bases lesson teachers like yourself in making acids and bases lesson lessons of the Form 4 acids and bases lesson curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your identity will be kept **confidential** and **anonymous** throughout this study.

If you have any inquiries regarding the procedures or require further information, do not hesitate to contact me at +614 5057 8984 or e-mail me at muhdibrahim83@gmail.com. Alternatively you can contact my supervisor Professor David Treagust at +618 9266 7924 or d.f.treagust@curtin.edu.au.

Your participation in this research is highly appreciated and valuable. Thank you very much!

(Note: Your personal information will be kept personal.)

Name:___________________________ School: _______________________

Email:___________________________ Phone: ________________________

Instructions for Teacher

For all questions about classroom practices, please refer only to activities in the acids and bases lesson class that you teach. If you teach more than one acids and bases lesson class, select the first class that you teach each week. If you teach a split class (i.e., the class is split into more than one group for acids and bases lesson instruction) select only one group to describe as the target class.

Please read each question and the possible responses carefully, and then mark your response by filling in the appropriate circle to indicate your response. A pen or pencil may be used to complete the survey.

SECTION A: CLASSROOM DESCRIPTION

1. How many different chemistry classes do you currently teach?

   ① ② ③ ④ ⑤
   (Number of classes taught)

2. How many students are in the target chemistry class?

   ① 10 or fewer
   ② 11 to 20
   ③ 21 to 30
   ④ 31 to 40
   ⑤ 41 or more

3. During a typical week, approximately how many hours will the target class spend in chemistry instruction?

   ① ② ③ ④ ⑤ ⑥
   (Number of instructional hours)

4. What is the average length of each class period for the target chemistry class?

   ① Not applicable
   ② 20 to 30 minutes
   ③ 31 to 40 minutes
   ④ 41 to 50 minutes
   ⑤ More than 50 minutes.

5. What is the achievement level of most of the students in the target chemistry class, compared to national norms?

   ① High achievement levels.
   ② Average achievement levels.
   ③ Low achievement levels.
   ④ Mixed achievement levels.

6.	What is the medium of instruction in the target chemistry class?	① English language	② Malay language	③ Mix of languages.	④ Others: ______________

7.	How the students were place in the target chemistry class?	① Ability or prior achievement.	② Limited English proficiency.	③ Teacher recommendation.	④ Parent request.	⑤ Student decision.	⑥ No one factor more than another.

SECTION B: INSTRUCTIONAL ACTIVITIES IN ACIDS AND BASES LESSONS

How often do you do each of the following in your acids and bases instruction?		**Never** takes place	**Almost Never** takes place	**Sometimes** takes place	**Almost Always** takes place	**Always** takes place
1.	Introduce content through formal presentations.	⓪	①	②	③	④
2.	Pose open-ended questions.	⓪	①	②	③	④
3.	Engage the whole class in discussions.	⓪	①	②	③	④
4.	Require students to supply evidence to support their claims.	⓪	①	②	③	④
5.	Ask students to explain concepts to one another.	⓪	①	②	③	④
6.	Ask students to consider alternative explanations.	⓪	①	②	③	④

7.	Help students see connections between acids and bases lesson with other disciplines.	⓪	①	②	③	④
8.	Assign acids and bases lesson homework.	⓪	①	②	③	④

How often do students take part in the following acids and bases lesson activities?		**Never** takes place	**Almost Never** takes place	**Sometimes** takes place	**Almost Always** takes place	**Always** takes place
9.	Listen and take notes during presentation by teacher.	⓪	①	②	③	④
10.	Work in groups.	⓪	①	②	③	④
11.	Read from a chemistry textbook in class.	⓪	①	②	③	④
12.	Follow specific instructions in an activity or investigation.	⓪	①	②	③	④
13.	Answer textbook or worksheet questions.	⓪	①	②	③	④
14.	Record, represent, and/or analyse data.	⓪	①	②	③	④
15.	Do hands-on/laboratory acids and bases lesson activities or investigation.	⓪	①	②	③	④
16.	Collect data (other than laboratory activities).	⓪	①	②	③	④

17. Use computers, calculators, or other educational technology to learn acids and bases.	⓪	①	②	③	④

When students in the target class are engaged in laboratory activities, investigations, or experiments as part of acids and bases instruction, how much of that time do they:	**Never** takes place	**Almost Never** takes place	**Sometimes** takes place	**Almost Always** takes place	**Always** takes place
18. Make educated guesses, predictions, or hypotheses.	⓪	①	②	③	④
19. Use acids and bases lesson equipment or measuring tools.	⓪	①	②	③	④
20. Collect data.	⓪	①	②	③	④
21. Analyse and interpret acids and bases data.	⓪	①	②	③	④
22. Design their own investigation or experiment to solve a scientific question.	⓪	①	②	③	④

When students in the target class collect data or information about acids and bases lesson from books, magazines, computers, or other sources (other than laboratory activities), how much of that time do they:	**Never** takes place	**Almost Never** takes place	**Sometimes** takes place	**Almost Always** takes place	**Always** takes place
23. Make a prediction based on the data.	⓪	①	②	③	④
24. Analyse and interpret the information or data orally or in writing.	⓪	①	②	③	④

25.	Use of laboratory instruments connected to computer (e.g., Computer Based Lab).	⓪	①	②	③	④
26.	Display and analyse data.	⓪	①	②	③	④

SECTION C: PROFESSIONAL DEVELOPMENT ACTIVITIES IN CHEMISTRY

Did your professional development activities (e.g., in service training/ workshop/ course) refer to the following issues?		**None**	**Minor**	**Moderate**	**Major**
1.	State chemistry content standards (e.g., what they are and how they are used).	⓪	①	②	③
2.	Alignment of chemistry instruction to curriculum.	⓪	①	②	③
3.	In-depth study of chemistry or specific concepts within chemistry (e.g., acids and bases lesson).	⓪	①	②	③
4.	State or district chemistry assessment (e.g., preparing, understanding, or interpreting assessment data).	⓪	①	②	③
5.	Interpretation of assessment data for use in chemistry instruction.	⓪	①	②	③

SECTION D: TEACHER CHARACTERISTICS

1.	Please indicate your gender.	Female ①	Male ②			
		Less than 1 year	1 – 5 years	6 – 10 years	11 – 15 years	More than 15 years
2.	How many years have you taught acids and bases lesson prior to this year?	①	②	③	④	⑤
3.	How long have you been assigned to teach at your current school?	①	②	③	④	⑤
4.	What is the highest degree you hold?	Does not apply ①	Bachelor ②	Master ③	Ph.D. ④	Other ⑤

Questionnaire End.

Thank You!

APPENDIX D: Questionnaire of Enacted Curriculum (QEC) – ***Student Edition***

Science & Mathematics Education Centre (SMEC)

QUESTIONNAIRE OF ENACTED CURRICULUM
SOAL SELIDIK PERLAKSANAAN KURIKULUM

Student Edition
Edisi Pelajar

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: _____________________________

Instruction to student: This survey is **bilingual**. Please read each question and the possible responses carefully. **Mark** your response by filling in the appropriate **circle**. A pen or pencil may be used to complete the survey.
Arahan kepada pelajar: *Soal selidik ini adalah dalam* ***dwibahasa****. Sila baca setiap soalan dan pilihan respon yang diberikan dengan teliti.* ***Tandakan*** *pilihan anda dengan mengisi bahagian dalam* ***bulatan*** *yang berkenaan. Pen atau pensil boleh digunakan untuk melengkapkan soal selidik ini.*

SECTION A: CLASSROOM DESCRIPTION
SEKSYEN A: MAKLUMAT KELAS

1. What is your PMR science result?
   Apakah keputusan sains PMR anda?

   ① A ④ D
   ② B ⑤ E
   ③ C

2. What is the medium of teaching and learning in your chemistry class?
   Apakah medium pengajaran dan pembelajaran di dalam kelas kimia anda?

   ① English language *Bahasa Inggeris*
   ② Malay language *Bahasa Malaysia*
   ③ Mix of languages *Campuran bahasa*
   ④ Others: ______________ *Lain-lain:* ______________

SECTION B: INSTRUCTIONAL ACTIVITIES IN ACIDS AND BASES LESSONS
SEKSYEN B: AKTIVITI PENGAJARAN DALAM PELAJARAN ASID DAN BES

How often your chemistry teacher do each of the following in your acids and bases instruction? ***Berapa kerap guru kimia anda melakukan setiap aktiviti pengajaran asid dan bes berikut?***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir*** *Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
1. Teacher introduces content on the blackboard/whiteboard. *Guru memperkenalkan kandungan di atas papan hitam/papan putih.*	⓪	①	②	③	④

2.	Pose questions without a single answer. *Menanyakan soalan yang tidak hanya mempunyai satu jawapan sahaja.*	⓪	①	②	③	④
3.	Engage the whole class in discussions. *Melibatkan seluruh kelas di dalam perbincangan.*	⓪	①	②	③	④
4.	Require students to supply evidence to support their claims. *Memerlukan pelajar untuk menyediakan bukti bagi menyokong hujah mereka.*	⓪	①	②	③	④
5.	Ask students to explain concepts to one another. *Meminta pelajar untuk menerangkan konsep antara satu sama lain.*	⓪	①	②	③	④
6.	Ask students to consider alternative explanations. *Meminta pelajar menimbangkan penjelasan alternatif.*	⓪	①	②	③	④
7.	Help students see connections between acids and bases lesson with other disciplines. *Membantu pelajar membuat hubungan atara pelajaran asid dan bes dengan pelajaran lain.*	⓪	①	②	③	④
8.	Assign acids and bases lesson homework. *Menugaskan pelajaran asid dan bes sebagai kerja rumah.*	⓪	①	②	③	④

How often do you take part in the following acids and bases lesson activities? ***Berapa kerap anda turut serta dalam aktiviti pelajaran asid dan bes berikut?***	**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
9. Listen and take notes during presentation by teacher. *Mendengar dan mengambil nota semasa guru mengajar.*	⓪	①	②	③	④
10. Work in groups. *Bekerja di dalam kumpulan.*	⓪	①	②	③	④
11. Read about acids and bases from a chemistry textbook in class. *Membaca mengenai asid dan bes daripda buku teks kimia di dalam kelas.*	⓪	①	②	③	④
12. Follow specific instructions in an activity or investigation. *Mengikut arahan khusus di dalam suatu aktiviti atau penyiasatan.*	⓪	①	②	③	④
13. Answer textbook or worksheet questions. *Menjawab soalan-soalan buku teks atau lembaran kerja.*	⓪	①	②	③	④
14. Record, represent, and/or analyse data. *Merekod, mempersembahkan, dan/atau menganalisa data.*	⓪	①	②	③	④
15. Do hands-on/laboratory acids and bases lesson activities or investigation. *Melakukan aktiviti praktikal/aktiviti makmal atau penyiasatan bagi pelajaran asid dan bes.*	⓪	①	②	③	④

16. Collect data (other than laboratory activities).
Mengutip data (selain daripada aktiviti makmal).

⓪ ① ② ③ ④

17. Use computers, calculators, or other educational technology to learn acids and bases.
Menggunakan komputer, kalkulator, atau teknologi pendidikan lain untuk mempelajari asid dan bes.

⓪ ① ② ③ ④

When you are engaged in laboratory activities, investigations, or experiments as part of acids and bases lesson, how often of that activities do you: ***Apabila anda turut serta di dalam aktiviti makmal, penyiasatan, atau eksperimen dalam pelajaran asid dan bes, berapa kerap anda menjalankan aktiviti berikut:***	**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
18. Make educated guesses, predictions, or hypotheses. *Melakukan tekaan bijak, ramalan, atau hipotesis.*	⓪	①	②	③	④
19. Use acids and bases equipment or measuring tools. *Menggunakan kelengkapan atau alat sukatan asid dan bes.*	⓪	①	②	③	④
20. Collect data. *Mengutip data.*	⓪	①	②	③	④
21. Analyse and interpret acids and bases data. *Menganalisa dan menterjemahkan data asid dan bes.*	⓪	①	②	③	④
22. Design own investigation or experiment to solve a scientific question. *Mereka bentuk penyiasatan sendiri untuk menyelesaikan persoalan saintifik.*	⓪	①	②	③	④

When you are collecting data or information about acids and bases lesson from books, magazines, computers, or other sources (other than laboratory activities), how much of that time do you: ***Apabila anda mengutip data atau maklumat mengenai pelajaran asid dan bes daripada buku, majalah, komputer, atau daripada sumber lain (selain daripada aktiviti makmal), berapa banyak masa anda:***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir*** *Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
23. Make a prediction based on the data. *Membuat ramalan berdasarkan data.*	⓪	①	②	③	④
24. Analyse and interpret the information or data orally or in writing. *Menganalisa dan menterjemahkan maklumat atau data secara lisan atau bertulis.*	⓪	①	②	③	④
25. Use of laboratory instruments connected to computer (e.g., Computer Based Lab). *Menggunakan alatan makmal yang disambung kepada komputer (Contohnya, Makmal Berasaskan Komputer).*	⓪	①	②	③	④
26. Display and analyse data. *Mempamer dan menganalisa data.*	⓪	①	②	③	④

Questionnaire End.
Soal Selidik Tamat.

Thank You!
Terima Kasih!

APPENDIX E: Modified of the What Is Happening In This Class? (WIHIC) –

Actual Form

Curtin University

Science & Mathematics Education Centre (SMEC)

WHAT IS HAPPENING IN THIS CLASS?
APA YANG BERLAKU DALAM KELAS INI?

Actual Form
Borang Sebenar

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: _________________

Form/*Tingkatan*:______________ School/*Sekolah*: ______________________________

Information for Students
Maklumat untuk Pelajar

1. This questionnaire is **bilingual**.
   Soal selidik ini adalah dalam ***dwibahasa.***

2. This questionnaire consists of 41 items to describe your perceptions toward chemistry lesson practices. Decide **how often** for each of the practices takes place making use of the options provided. Draw a **circle** around the particular number of your choice to indicate your response.
   Soal selidik ini mengandungi 41 item bagi menggambarkan persepsi anda terhadap amalan pembelajaran kimia. Tentukan ***berapa kerap*** *amalan tersebut berlaku menggunakan skala yang disediakan.* ***Bulatkan*** *pada nombor pilihan anda bagi menentukan respon anda.*

3. Answer **all** questions. **Thirty minutes** are allocated for this questionnaire.
   Jawab ***semua*** *soalan.* ***Tiga puluh minit*** *diperuntukkan untuk soal selidik ini.*

4. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
   Sesetengah pernyataan dalam soal selidik ini hampir sama dengan pernyataan yang lain. Jangan risau berkenaan ini. Berikan sahaja pendapat anda bagi semua pernyataan. Tiada jawapan 'betul' atau 'salah'. Hanya pendapat anda yang diperlukan.

Instruction: Decide **how often** for each of the practices takes place making use of the options below:
Arahan: *Tentukan* ***berapa kerap*** *amalan tersebut berlaku menggunakan skala skala bawah:*

1	if the practice/*sekiranya amalan tersebut*	**Never** takes place/***Tidak*** *berlaku.*
2	if the practice/*sekiranya amalan tersebut*	**Almost Never** takes place/***Hampir Tidak*** *berlaku.*
3	if the practice/*sekiranya amalan tersebut*	**Sometimes** takes place/***Kadang-kadang*** *berlaku.*
4	if the practice/*sekiranya amalan tersebut*	**Almost Always** takes place/***Hampir Selalu*** *berlaku.*
5	if the practice/*sekiranya amalan tersebut*	**Always** takes place/***Selalu*** *berlaku.*

Draw a **circle** around the particular number of your choice to indicate your response.
Bulatkan *pada nombor pilihan anda bagi menentukan respon anda*.

Items/*Item*		**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir Tidak*** *berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
1	The teacher takes a personal interest in me. *Guru memberi perhatian kepada saya.*	1	2	3	4	5
2	The teacher goes out of his/her way to help me. *Guru berusaha sedaya upaya untuk menolong saya.*	1	2	3	4	5
3	The teacher considers my feelings. *Guru mengambil kira perasaan saya.*	1	2	3	4	5
4	The teacher helps me when I have trouble with the work. *Guru menolong saya apabila saya menghadapi masalah dalam kerja saya*.	1	2	3	4	5
5	The teacher talks with me. *Guru bercakap-cakap dengan saya.*	1	2	3	4	5
6	The teacher is interested in my problems. *Guru berminat dengan masalah-masalah saya.*	1	2	3	4	5
7	The teacher moves about the class to talk with me. *Guru berusaha sedaya upaya untuk bercakap dengan saya.*	1	2	3	4	5
8	The teacher's questions help me to understand. *Soalan-soalan guru membantu saya untuk faham.*	1	2	3	4	5
9	I discuss ideas in class. *Saya berbincang idea-idea di dalam kelas.*	1	2	3	4	5
10	I give my opinion during class discussions. *Saya memberikan pendapat saya semasa perbincangan kelas.*	1	2	3	4	5
11	The teacher asks me questions. *Guru menyoal saya soalan.*	1	2	3	4	5
12	My ideas and suggestions are used during classroom discussions. *Idea–idea dan pendapat-pendapat saya digunakan semasa perbincangan kelas.*	1	2	3	4	5
13	I ask the teacher questions. *Saya bertanya soalan kepada guru.*	1	2	3	4	5

	Items/***Item***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir Tidak*** *berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
14	I explain my ideas to other students. *Saya menerangkan idea-idea saya kepada pelajar lain.*	1	2	3	4	5
15	Students discuss with me how to go about solving problems. *Pelajar-pelajar lain berbincang dengan saya untuk mencari penyelesaian sesuatu masalah.*	1	2	3	4	5
16	I am asked to explain how I solve problems. *Saya diminta untuk menerangkan bagaimana saya menyelesaikan masalah-masalah.*	1	2	3	4	5
17	I carry out investigations to test my ideas. *Saya mengendalikan penyiasatan untuk menguji idea-idea saya.*	1	2	3	4	5
18	I am asked to think about the evidence for statements. *Saya diminta berfikir untuk membuktikan sesuatu pernyataan.*	1	2	3	4	5
19	I carry out investigations to answer questions coming from discussions. *Saya menjalankan penyiasatan untuk menjawab soalan-soalan daripada perbincangan.*	1	2	3	4	5
20	I explain the meaning of statements, diagrams and graphs. *Saya menerangkan maksud pernyataan, gambarajah, dan graf.*	1	2	3	4	5
21	I carry out investigations to answer questions which puzzle me. *Saya menjalankan penyiasatan untuk menjawab soalan-soalan yang membinggungkan saya.*	1	2	3	4	5
22	I carry out investigations to answer the teacher's questions. *Saya menjalankan penyiasatan untuk menjawab soalan-soalan guru.*	1	2	3	4	5
23	I find out answers to questions by doing investigations. *Saya memperolehi sesuatu jawapan bagi soalan-soalan melalui penyiasatan.*	1	2	3	4	5

	Items/***Item***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir Tidak*** *berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
24	I solve problems by using information obtained from my own investigations. *Saya menyelesaikan masalah-masalah dengan menggunakan maklumat yang diperolehi daripada penyiasatan saya.*	1	2	3	4	5
25	I cooperate with other students when doing assignment work. *Saya berkerjasama dengan pelajar-pelajar lain apabila melakukan sesuatu tugasan.*	1	2	3	4	5
26	I share my books and resources with other students when doing assignments. *Saya berkongsi buku dan sumber-sumber lain dengan pelajar-pelajar lain semasa membuat tugasan.*	1	2	3	4	5
27	When I work in groups in this class, there is teamwork. *Semasa saya bekerja secara berkumpulan di dalam kelas, wujudnya kerjasama berpasukan.*	1	2	3	4	5
28	I work with other students on projects in this class. *Saya menjalankan tugas dengan pelajar lain bagi sesuatu projek di dalam kelas.*	1	2	3	4	5
29	I learn from other students in this class. *Saya belajar daripada pelajar-pelajar lain di dalam kelas ini.*	1	2	3	4	5
30	I work with other students in this class. *Saya melakukan tugas bersama-sama pelajar lain dalam kelas ini.*	1	2	3	4	5
31	I cooperate with other students on class activities. *Saya bekerjasama dengan pelajar-pelajar lain untuk menjalankan aktiviti-aktiviti kelas.*	1	2	3	4	5

	Items/***Item***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir Tidak*** *berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
32	Students work with me to achieve class goals. *Pelajar-pelajar lain melakukan tugas bersama saya bagi mencapai matlamat kelas.*	1	2	3	4	5
33	The teacher gives as much attention to my questions as to other students' questions. *Guru memberikan sepenuh perhatian kepada soalan-soalan saya sepertimana pelajar-pelajar lain.*	1	2	3	4	5
34	I get the same amount of help from the teacher as do other students. *Saya memperolehi bantuan yang sama daripada guru sepertimana pelajar-pelajar lain.*	1	2	3	4	5
35	I have the same amount of say in this class as other students. *Saya mempunyai peluang yang sama banyak untuk berkata-kata di dalam kelas ini.*	1	2	3	4	5
36	I am treated the same as other students in this class. *Saya dilayan sama seperti pelajar-pelajar lain dalam kelas ini.*	1	2	3	4	5
37	I receive the same encouragement from the teacher as other students do. *Saya mendapat galakan daripada guru sama seperti pelajar-pelajar lain.*	1	2	3	4	5
38	I get the same opportunity to contribute to class discussions as other students. *Saya dapat menyumbang kepada perbincangan kelas sama seperti pelajar-pelajar lain.*	1	2	3	4	5
39	My work receives as much praise as other students' work. *Kerja saya mendapat pujian sama seperti pelajar-pelajar lain.*	1	2	3	4	5

Items/*Item*		**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir Tidak*** *berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
40	I get the same opportunity to contribute to answer questions as other students. *Saya mendapat peluang menjawab soalan-soalan sama seperti pelajar-pelajar lain*.	1	2	3	4	5
41	If you read this item, please circle 5. *Sekiranya anda membaca item ini, sila bulatkan 5.*	1	2	3	4	5

Questionnaire End.
Soal Selidik Tamat.

Thank You!
Terima Kasih!

APPENDIX F: Modified of the What Is Happening In This Class? (WIHIC) –

Preferred Form

Science & Mathematics Education Centre (SMEC)

WHAT IS HAPPENING IN THIS CLASS?
APA YANG BERLAKU DALAM KELAS INI?

Preferred Form
Borang Harapan

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: _____________________________

Information for Students
Maklumat untuk Pelajar

1. This questionnaire is **bilingual**.
Soal selidik ini adalah dalam ***dwibahasa.***

2. This questionnaire consists of 41 items to describe your **preferred** perceptions toward chemistry lesson practices. Decide the **frequency** for each of the practices you **prefer** in terms of the scale provided. Draw a **circle** around the particular number of your choice to indicate your response.
Soal selidik ini mengandungi 41 item bagi menggambarkan persepsi ***harapan*** *anda terhadap amalan pembelajaran kimia. Tentukan* ***kekerapan*** *amalan tersebut yang anda* ***harapkan*** *berlaku berdasarkan skala yang disediakan.* ***Bulatkan*** *pada nombor pilihan anda bagi menentukan respon anda.*

3. Answer **all** questions. **Thirty minutes** are allocated for this questionnaire.
Jawab ***semua*** *soalan.* ***Tiga puluh minit*** *diperuntukkan untuk soal selidik ini.*

4. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
Sesetengah pernyataan dalam soal selidik ini hampir sama dengan pernyataan yang lain. Jangan risau berkenaan ini. Berikan sahaja pendapat anda bagi semua pernyataan. Tiada jawapan 'betul' atau 'salah'. Hanya pendapat anda yang diperlukan.

Instruction: Decide the **frequency** for each of the practices you prefer in terms of the scale below:
Arahan: *Tentukan* ***kekerapan*** *amalan tersebut yang anda harapkan berlaku berdasarkan skala di bawah:*

1	if the practice/*sekiranya amalan tersebut*	**Never** takes place/***Tidak*** *berlaku.*
2	if the practice/*sekiranya amalan tersebut*	**Almost Never** takes place/***Hampir Tidak*** *berlaku.*
3	if the practice/*sekiranya amalan tersebut*	**Sometimes** takes place/***Kadang-kadang*** *berlaku.*
4	if the practice/*sekiranya amalan tersebut*	**Almost Always** takes place/***Hampir Selalu*** *berlaku.*
5	if the practice/*sekiranya amalan tersebut*	**Always** takes place/***Selalu*** *berlaku.*

Draw a **circle** around the particular number of your choice to indicate your response.
Bulatkan *pada nombor pilihan anda bagi menentukan respon anda*.

	Items/***Item***	**Never** takes place/ ***Tidak*** *berlaku*	**Almost Never** takes place/ ***Hampir*** *Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang*** *berlaku*	**Almost Always** takes place/ ***Hampir Selalu*** *berlaku*	**Always** takes place/ ***Selalu*** *berlaku*
1	The teacher will take a personal interest in me. *Guru akan memberi perhatian kepada saya.*	1	2	3	4	5
2	The teacher will go out of his/her way to help me. *Guru akan berusaha sedaya upaya untuk menolong saya.*	1	2	3	4	5
3	The teacher will consider my feelings. *Guru akan mengambil kira perasaan saya.*	1	2	3	4	5
4	The teacher will help me when I have trouble with the work. *Guru akan menolong saya apabila saya menghadapi masalah dalam kerja saya.*	1	2	3	4	5
5	The teacher will talk to me. *Guru akan bercakap-cakap dengan saya.*	1	2	3	4	5
6	The teacher will be interested in my problems. *Guru akan berminat dengan masalah-masalah saya.*	1	2	3	4	5
7	The teacher will move about the class to talk with me. *Guru akan berusaha sedaya upaya untuk bercakap dengan saya.*	1	2	3	4	5
8	The teacher's questions will help me to understand. *Soalan-soalan guru akan membantu saya untuk faham.*	1	2	3	4	5
9	I will discuss ideas in class. *Saya akan berbincang idea-idea di dalam kelas.*	1	2	3	4	5
10	I will give my opinion during class discussions. *Saya akan memberikan pendapat saya semasa perbincangan kelas.*	1	2	3	4	5
11	The teacher will ask me questions. *Guru akan menyoal saya soalan.*	1	2	3	4	5

	Items/*Item*	**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
12	My ideas and suggestions will be used during classroom discussions. *Idea–idea dan pendapat-pendapat saya akan digunakan semasa perbincangan kelas.*	1	2	3	4	5
13	I will ask the teacher questions. *Saya akan bertanya soalan kepada guru.*	1	2	3	4	5
14	I will explain my ideas to other students. *Saya akan menerangkan idea-idea saya kepada pelajar lain.*	1	2	3	4	5
15	Students will discuss with me how to go about solving problems. *Pelajar-pelajar lain akan berbincang dengan saya untuk mencari penyelesaian sesuatu masalah.*	1	2	3	4	5
16	I will be asked to explain how I solve problems. *Saya akan diminta untuk menerangkan bagaimana saya menyelesaikan masalah-masalah.*	1	2	3	4	5
17	I will carry out investigations to test my ideas. *Saya akan mengendalikan penyiasatan untuk menguji idea-idea saya.*	1	2	3	4	5
18	I will be asked to think about the evidence for statements. *Saya akan diminta berfikir untuk membuktikan sesuatu pernyataan.*	1	2	3	4	5
19	I will carry out investigations to answer questions coming from discussions. *Saya akan menjalankan penyiasatan untuk menjawab soalan-soalan daripada perbincangan.*	1	2	3	4	5
20	I will explain the meaning of statements, diagrams and graphs. *Saya akan menerangkan maksud pernyataan, gambarajah, dan graf.*	1	2	3	4	5

Items/*Item*		**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
21	I will carry out investigations to answer questions which puzzle me. *Saya akan menjalankan penyiasatan untuk menjawab soalan-soalan yang membinggungkan saya.*	1	2	3	4	5
22	I will carry out investigations to answer the teacher's questions. *Saya akan menjalankan penyiasatan untuk menjawab soalan-soalan guru.*	1	2	3	4	5
23	I will find out answers to questions by doing investigations. *Saya akan memperolehi sesuatu jawapan bagi soalan-soalan melalui penyiasatan.*	1	2	3	4	5
24	I will solve problems by using information obtained from my own investigations. *Saya akan menyelesaikan masalah-masalah dengan menggunakan maklumat yang diperolehi daripada penyiasatan saya.*	1	2	3	4	5
25	I will cooperate with other students when doing assignment work. *Saya akan berkerjasama dengan pelajar-pelajar lain apabila melakukan sesuatu tugasan.*	1	2	3	4	5
26	I will share my books and resources with other students when doing assignments. *Saya akan berkongsi buku dan sumber-sumber lain dengan pelajar-pelajar lain semasa membuat tugasan.*	1	2	3	4	5
27	When I work in groups in this class, there will be teamwork. *Semasa saya bekerja secara berkumpulan di dalam kelas, akan wujudnya kerjasama berpasukan.*	1	2	3	4	5
28	I will work with other students on projects in this class. *Saya akan menjalankan tugas dengan pelajar lain bagi sesuatu projek di dalam kelas.*	1	2	3	4	5

	Items/*Item*	**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
29	I will learn from other students in this class. *Saya akan belajar daripada pelajar-pelajar lain di dalam kelas ini.*	1	2	3	4	5
30	I will work with other students in this class. *Saya akan melakukan tugas bersama-sama pelajar lain dalam kelas ini.*	1	2	3	4	5
31	I will cooperate with other students on class activities. *Saya akan bekerjasama dengan pelajar-pelajar lain untuk menjalankan aktiviti-aktiviti kelas.*	1	2	3	4	5
32	Students will work with me to achieve class goals. *Pelajar-pelajar lain akan melakukan tugas bersama saya bagi mencapai matlamat kelas.*	1	2	3	4	5
33	The teacher will give as much attention to my questions as to other students' questions. *Guru akan memberikan sepenuh perhatian kepada soalan-soalan saya sepertimana pelajar-pelajar lain.*	1	2	3	4	5
34	I will get the same amount of help from the teacher as do other students. *Saya akan memperolehi bantuan yang sama daripada guru sepertimana pelajar-pelajar lain.*	1	2	3	4	5
35	I will have the same amount of say in this class as other students. *Saya akan mempunyai peluang yang sama banyak untuk berkata-kata di dalam kelas ini.*	1	2	3	4	5
36	I will be treated the same as other students in this class. *Saya akan dilayan sama seperti pelajar-pelajar lain dalam kelas ini.*	1	2	3	4	5

	Items/*Item*	**Never** takes place/ ***Tidak** berlaku*	**Almost Never** takes place/ ***Hampir** Tidak berlaku*	**Sometimes** takes place/ ***Kadang-kadang** berlaku*	**Almost Always** takes place/ ***Hampir Selalu** berlaku*	**Always** takes place/ ***Selalu** berlaku*
37	I will receive the same encouragement from the teacher as other students do. *Saya akan mendapat galakan daripada guru sama seperti pelajar-pelajar lain.*	1	2	3	4	5
38	I will get the same opportunity to contribute to class discussions as other students. *Saya akan dapat menyumbang kepada perbincangan kelas sama seperti pelajar-pelajar lain.*	1	2	3	4	5
39	My work will receive as much praise as other students' work. *Kerja saya akan mendapat pujian sama seperti pelajar-pelajar lain.*	1	2	3	4	5
40	I will get the same opportunity to contribute to answer questions as other students. *Saya akan mendapat peluang menjawab soalan-soalan sama seperti pelajar-pelajar lain.*	1	2	3	4	5
41	If you read this item, please circle 5. *Sekiranya anda membaca item ini, sila bulatkan 5.*	1	2	3	4	5

Questionnaire End.
Soal Selidik Tamat.

Thank You!
Terima Kasih!

APPENDIX G: Modified of the Attitude Towards Chemistry Lessons Scales (ATCLS) – *Actual Form*

Curtin University

Science & Mathematics Education Centre (SMEC)

ATTITUDES TOWARD CHEMISTRY LESSONS SCALES
SKALA SIKAP TERHADAP PEMBELAJARAN KIMIA

Actual Form
Borang Sebenar

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: _________________

Form/*Tingkatan*:______________ School/*Sekolah*: ______________________________

Information for Students
Maklumat untuk Pelajar

1. This questionnaire is **bilingual**.
   Soal selidik ini adalah dalam ***dwibahasa.***

2. This questionnaire consists of 12 items to describe your attitudes toward acids-bases chemistry lessons. Decide your level of **agreement** for each of the statements given in terms of the scale provided. Draw a **circle** around the particular number of your choice to indicate your response.
   Soal selidik ini mengandungi 12 item bagi menggambarkan sikap anda terhadap pembelajaran asid-bes kimia. Tentukan tahap ***persetujuan*** *anda bagi setiap pernyataan diberikan berdasarkan skala yang disediakan.* ***Bulatkan*** *pada nombor pilihan anda bagi menentukan respon anda.*

3. Answer **all** questions. **Fifteen minutes** are allocated for this questionnaire.
   Jawab ***semua*** *soalan.* ***Lima belas minit*** *diperuntukkan untuk soal selidik ini.*

4. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
   Sesetengah pernyataan dalam soal selidik ini hampir sama dengan pernyataan yang lain. Jangan risau berkenaan ini. Berikan sahaja pendapat anda bagi semua pernyataan. Tiada jawapan 'betul' atau 'salah'. Hanya pendapat anda yang diperlukan.

Instruction: Decide your level of **agreement** for each of the statements given in terms of the scale below:
Arahan: *Tentukan tahap* ***persetujuan*** *anda bagi setiap pernyataan diberikan berdasarkan skala dibawah:*

1	if you/*sekiranya anda*	Strongly Disagree/*Sangat Tidak Setuju*
2	if you/*sekiranya anda*	Disagree/*Tidak Setuju*
3	if you are/*sekiranya anda*	Not Sure/*Tidak Pasti*
4	if you/*sekiranya anda*	Agree/ *Setuju*
5	if you/*sekiranya anda*	Strongly Agree/*Sangat Setuju*

Draw a **circle** around the particular number of your choice to indicate your response.
Bulatkan *pada nombor pilihan anda bagi menentukan respon anda.*

	Items/***Item***	**Strongly Disagree**/ ***Sangat Tidak Setuju***	**Disagree**/ ***Tidak Setuju***	**Not Sure**/ ***Tidak Pasti***	**Agree**/ ***Setuju***	**Strongly Agree**/ ***Sangat Setuju***
1	I like acids-bases chemistry more than any other chemistry topic. *Saya suka asid-bes kimia melebihi topik-topik kimia yang lain.*	1	2	3	4	5
2	Acids-bases chemistry lessons are interesting. *Pelajaran asid-bes kimia adalah menarik.*	1	2	3	4	5
3	Acids-bases chemistry is useful for solving everyday problems. *Asid-bes kimia berguna untuk menyelesaikan masalah seharian.*	1	2	3	4	5
4	Acids-bases chemistry is one of my favourite topics. *Asid-bes kimia adalah salah satu topik kegemaran saya.*	1	2	3	4	5
5	I am willing to spend more time reading acids-bases chemistry books. *Saya sanggup meluangkan lebih masa membaca buku-buku asid-bes kimia.*	1	2	3	4	5
6	I like to do acids-bases chemistry experiments. *Saya suka melakukan eksperimen-eksperimen asid-bes kimia.*	1	2	3	4	5
7	When I am working in the acids-bases chemistry lab, I feel I am doing something important. *Apabila saya bekerja di dalam makmal asid-bes kimia, saya merasakan sedang melakukan sesuatu yang penting.*	1	2	3	4	5
8	People must understand acids-bases chemistry because it affect their lives. *Manusia perlu memahami asid-bes kimia kerana ia mempengaruhi kehidupan mereka.*	1	2	3	4	5
9	I like trying to solve new problems in acids-bases chemistry. *Saya gemar menyelesaikan masalah-masalah baru dalam pelajaran asid-bes kimia.*	1	2	3	4	5
10	Doing acids-bases chemistry experiments in school is fun. *Menjalankan eksperimen-eksperimen asid-bes kimia di sekolah adalah menyeronokkan.*	1	2	3	4	5

	Items/*Item*	**Strongly Disagree/** ***Sangat Tidak Setuju***	**Disagree/** ***Tidak Setuju***	**Not Sure/** ***Tidak Pasti***	**Agree/** ***Setuju***	**Strongly Agree/** ***Sangat Setuju***
11	Acids-bases chemistry is one of the most important topics for people to study. *Asid-bes kimia adalah salah satu topik yang amat penting bagi manusia untuk dipelajari.*	1	2	3	4	5
12	If I had a chance, I would do a project on acids-bases chemistry. *Sekiranya diberi peluang, saya akan menjalankan projek asid-bes kimia.*	1	2	3	4	5

Questionnaire End.
Soal Selidik Tamat.

Thank You!
Terima Kasih!

APPENDIX H: Modified of the Attitude Towards Chemistry Lessons Scales (ATCLS) – *Preferred Form*

Science & Mathematics Education Centre (SMEC)

ATTITUDES TOWARD CHEMISTRY LESSONS SCALES
SKALA SIKAP TERHADAP PEMBELAJARAN KIMIA

Preferred Form
Borang Harapan

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: ____________________________

Information for Students
Maklumat untuk Pelajar

1. This questionnaire is **bilingual**.
   Soal selidik ini adalah dalam ***dwibahasa.***

2. This questionnaire consists of 12 items to describe your **preferred** attitudes toward acids-bases chemistry lessons. Decide your level of **agreement** for each of the attitudes you **prefer** in terms of the scale provided. Draw a **circle** around the particular number of your choice to indicate your response.
   Soal selidik ini mengandungi 12 item bagi menggambarkan sikap ***harapan*** *anda terhadap pembelajaran asid-bes kimia. Tentukan tahap* ***persetujuan*** *anda bagi setiap sikap yang anda* ***harapkan*** *berlaku berdasarkan skala yang disediakan.* ***Bulatkan*** *pada nombor pilihan anda bagi menentukan respon anda.*

3. Answer **all** questions. **Fifteen minutes** are allocated for this questionnaire.
   Jawab ***semua*** *soalan.* ***Lima belas minit*** *diperuntukkan untuk soal selidik ini.*

4. Some statements in this questionnaire are fairly similar to other statements. Don't worry about this. Simply give your opinion about all statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
   Sesetengah pernyataan dalam soal selidik ini hampir sama dengan pernyataan yang lain. Jangan risau berkenaan ini. Berikan sahaja pendapat anda bagi semua pernyataan. Tiada jawapan 'betul' atau 'salah'. Hanya pendapat anda yang diperlukan.

Instruction: Decide your level of **agreement** for each of the attitudes you prefer in terms of the scale below:
Arahan: *Tentukan tahap* ***persetujuan*** *anda bagi setiap sikap yang anda harapkan berlaku berdasarkan skala dibawah:*

1	if you/*sekiranya anda*	Strongly Disagree/*Sangat Tidak Setuju*
2	if you/*sekiranya anda*	Disagree/*Tidak Setuju*
3	if you are/*sekiranya anda*	Not Sure/*Tidak Pasti*
4	if you/*sekiranya anda*	Agree/*Setuju*
5	if you/*sekiranya anda*	Strongly Agree/*Sangat Setuju*

Draw a **circle** around the particular number of your choice to indicate your response.
Bulatkan *pada nombor pilihan anda bagi menentukan respon anda*.

	Items/**Item**	**Strongly Disagree**/ ***Sangat Tidak Setuju***	**Disagree**/ ***Tidak Setuju***	**Not Sure**/ ***Tidak Pasti***	**Agree**/ ***Setuju***	**Strongly Agree**/ ***Sangat Setuju***
1	I prefer acids-bases chemistry more than any other chemistry topic. *Saya berkecenderung terhadap asid-bes kimia melebihi topik-topik kimia yang lain.*	1	2	3	4	5
2	Acids-bases chemistry lessons will surely be interesting. *Pelajaran asid-bes kimia pasti akan menarik.*	1	2	3	4	5
3	Acids-bases chemistry will be useful for solving everyday problems. *Asid-bes kimia akan berguna untuk menyelesaikan masalah seharian.*	1	2	3	4	5
4	Acids-bases chemistry will be one of my favourite topics. *Asid-bes kimia akan menjadi salah satu topik kegemaran saya.*	1	2	3	4	5
5	I would be inclined to spend more time reading acids-bases chemistry books. *Saya akan cenderung untuk meluangkan lebih masa membaca buku-buku asid-bes kimia.*	1	2	3	4	5
6	I would prefer to do acids-bases chemistry experiments. *Saya berharap akan dapat melakukan eksperimen-eksperimen asid-bes kimia.*	1	2	3	4	5
7	When I am working in the acids-bases chemistry lab, I will feel to be doing something important. *Apabila saya bekerja di dalam makmal asid-bes kimia, saya akan merasakan sedang melakukan sesuatu yang penting.*	1	2	3	4	5
8	People must understand acids-bases chemistry because it will affect their lives. *Manusia perlu memahami asid-bes kimia kerana ia akan mempengaruhi kehidupan mereka.*	1	2	3	4	5
9	I would like solving new problems in acids-bases chemistry. *Saya akan gemar menyelesaikan masalah-masalah baru dalam pelajaran asid-bes kimia.*	1	2	3	4	5

	Items/**Item**	**Strongly Disagree/** ***Sangat Tidak Setuju***	**Disagree/** ***Tidak Setuju***	**Not Sure/** ***Tidak Pasti***	**Agree/** ***Setuju***	**Strongly Agree/** ***Sangat Setuju***
10	Doing acids-bases chemistry experiments in school will be fun. *Menjalankan eksperimen-eksperimen asid-bes kimia di sekolah akan menyeronokkan.*	1	2	3	4	5
11	Acids-bases chemistry will be one of the most important topics for people to study. *Asid-bes kimia akan menjadi salah satu topik yang amat penting bagi manusia untuk dipelajari.*	1	2	3	4	5
12	If I had a chance, I will do a project on acids-bases chemistry. *Sekiranya diberi peluang, saya akan menjalankan projek asid-bes kimia.*	1	2	3	4	5

Questionnaire End.
Soal Selidik Tamat.

Thank You!
Terima Kasih!

APPENDIX I: Acids-Bases Achievement Test (ABCAT) – ***Create Multiple-Choice Items with Free Responses of the Initial Version (English)***

ACIDS AND BASES CHEMISTRY ACHIEVEMENT TEST

Name: ________________________ School: _______________________

Class: ______________ Date: _____________

Instructions to Students:

This paper consists of 8 items that evaluate your understanding of several properties of acids and bases.

Each of the items in this paper consists of two parts.

In the first part of each item, circle one of the responses, A, B, C, D, etc., to indicate what you consider to be the most appropriate answer.

In the second part, suggest your reason for selecting the particular response.

Remember it is important to provide a reason for selecting a particular answer in each item.

Do not forget to record your name and other details on this page.

Note to the teacher:

Please collate your students' answer scripts and mail them to the address below.

Muhd Ibrahim Muhamad Damanhuri
Science and Mathematics Education Centre (SMEC)
Curtin University of Technology
Building 220
GPO Box U1987
Perth, W.A. 6845,
AUSTRALIA.
Email: muhdibrahim83@gmail.com
Mobile: +61450578984 / +60194401808

1. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. Yet, only HCl has acidic properties while CH_4 does not.

   A. True*
   B. False

   The reason for my answer is:

   ____

   ____

   ____

2. What is a property of citrus fruits like oranges and lemons?

   A. Acidic*
   B. Basic
   C. Neutral

   The reason for my answer is:

   ____

   ____

   ____

3. Some brands of ‘effervescent’ Vitamin C tablets contain sodium bicarbonate, tartaric acid and citric acid. When added to water, the tablets…

   A. cause the temperature of the water to rise.
   B. produce vigorous fizzing.*
   C. break up into small pieces and dissolve.
   D. produce a white precipitate.

   The reason for my answer is:

   ____

   ____

   ____

4. Baking soda (sodium bicarbonate) added to dough when baking bread causes the bread to rise.

    A. True*
    B. False

   The reason for my answer is:

   ____

   ____

   ____

5. After a kettle is used to boil water over a long period of time, the inside of the kettle becomes coated with 'scales' (consisting of calcium carbonate). What could you use to remove this coating?

    A. An aqueous solution of baking soda.
    B. Lemon juice diluted with water.*
    C. An aqueous solution of sodium hydroxide.

   The reason for my answer is:

   ____

   ____

   ____

6. If soil has a pH value of less than 7, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?

    A. Common salt
    B. Vinegar
    C. Lime (calcium oxide)*
    D. Caustic soda

   The reason for my answer is:

   ____

   ____

   ____

7. When pieces of chopped red cabbage are boiled with water and the resulting mixture is filtered, a purple solution is obtained. This purple solution can be used to distinguish between...

   A. lemonade and lime juice.
   B. lemonade and tap water.*
   C. rain water and mineral water.

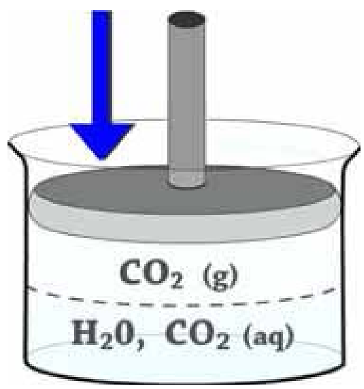
The reason for my answer is:

____

____

____

8.



A certain number of moles of carbon dioxide (CO_2) and 100mL of pure water containing dissolved carbon dioxide are placed in an enclosed container with an attached piston at a temperature of 25°C. When the piston is pushed down, the pH value of solution will.....

   A. increase.
   B. decrease.*
   C. remain unchanged.

The reason for my answer is:

____

____

____

@->--- THANK YOU ---<-@

APPENDIX J: Acids-Bases Achievement Test (ABCAT) – ***Create Multiple-Choice Items with Free Responses of the Initial Version (Malay)***

UJIAN PENCAPAIAN ASID DAN BES KIMIA

Nama: ________________________ Sekolah: _______________________

Kelas: _____________ Tarikh: ____________

Arahan kepada pelajar:

Kertas ini mengandungi 8 item yang menilai pemahaman anda mengenai beberapa sifat-sifat asid dan bes.

Setiap item di dalam kertas ini mengandungi dua bahagian.

Pada bahagian pertama setiap item, bulatkan salah satu respon, A, B, C, D, atau sebagainya bagi jawapan yang anda rasakan paling sesuai.

Dalam bahagian kedua, cadangkan sebab anda memilih jawapan tersebut.

Perlu diingatkan bahawa adalah penting untuk menyediakan sebab pemilihan sesuatu jawapan bagi setiap item.

Jangan lupa untuk merekodkan nama anda dan maklumat lain pada muka surat ini.

Arahan kepada guru:

Sila kumpulkan skrip jawapan pelajar anda dan poskan kepada alamat di bawah.

Muhd Ibrahim Muhamad Damanhuri
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1. Dua bahan biasa ditemui yang berformula HCl dan CH_4 mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl mempunyai sifat-sifat asid tetapi CH_4 tidak.

   A. Betul*
   B. Salah

   Sebab bagi jawapan saya adalah:

   ____

   ____

   ____

2. Apakah sifat buah-buahan sitrus seperti oren dan lemon?

   A. Berasid*
   B. Berbes
   C. Neutral

   Sebab bagi jawapan saya adalah:

   ____

   ____

   ____

3. Sesetengah jenama tablet Vitamin C yang berbuih mengandungi sodium bikarbonat, asid tartarik dan asid sitrik. Apabila dicampur ke dalam air, tablet tersebut...

   A. menyebabkan suhu air meningkat.
   B. mengasilkan bunyi desis yang kuat.*
   C. berpecah menjadi butiran-butiran kecil dan larut.
   D. menghasilkan mendakan putih.

   Sebab bagi jawapan saya adalah:

   ____

   ____

   ____

4. Soda penaik (sodium bikarbonat) yang ditambah kepada doh semasa pembuatan roti akan menyebabkan roti meningkat.

    A. Betul*
    B. Salah

Sebab bagi jawapan saya adalah:

____

____

____

5. Selepas cerek air digunakan untuk suatu tempoh masa yang lama, keadaan di dalam cerek tersebut akan disaluti ‘saduran’ (terdiri daripada kalsium karbonat). Apakah yang akan anda gunakan untuk menyingkirkan saduran tersebut?

    A. Larutan akues soda penaik.
    B. Jus lemon dicairkan dengan air.*
    C. Larutan akues sodium hidroksida.

Sebab bagi jawapan saya adalah:

____

____

____

6. Jika tanah mempunyai nilai pH kurang daripada 7, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

    A. Garam biasa
    B. Cuka
    C. Kapur (kalsium oksida)*
    D. Soda kaustik

Sebab bagi jawapan saya adalah:

____

____

____

7. Apabila cebisan potongan kubis merah dididihkan dengan air dan hasil campurannya ditapis, suatu larutan ungu akan diperolehi. Larutan ungu tersebut boleh digunakan untuk membezakan antara...

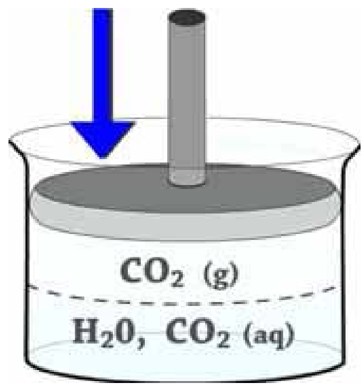
   A. lemonade dan jus limau.
   B. lemonade dan air pili.*
   C. air hujan dan air mineral.

   Sebab bagi jawapan saya adalah:

   ___

   ___

   ___

8. 

   Sebilangan mol tertentu karbon dioksida (CO_2) dan 100mL air tulen yang mengandungi karbon dioksida terlarut dimasukkan ke dalam satu bekas tertutup yang disambung ke sebuah piston pada suhu 25°C. Apabila piston itu ditekan, nilai pH larutan akan…..

   A. meningkat.
   B. berkurangan.*
   C. tidak berubah.

   Sebab bagi jawapan saya adalah:

   ___

   ___

   ___

@->--- TERIMA KASIH ---<-@

APPENDIX K: Acids-Bases Achievement Test (ABCAT) – ***Pilot Test of the Initial Version (English)***

ACIDS AND BASES CHEMISTRY ACHIEVEMENT TEST

Name: ______________________ School: _____________________

Class: _____________ Date: ____________

Instructions to Students:

This paper consists of 11 items that evaluate your understanding of several properties of acids and bases. Each item has two parts: a multiple-choice response followed by a multiple-choice reason. For each item, you are asked to make the most appropriate choice from the multiple-choice response section and circle your answer A, B, C, etc. Then choose one of the reasons from the multiple-choice reason section that best matches your answer to the first part and circle your answer 1, 2, 3, etc. If you do not agree with any of the given reasons, please write your reason in the space provided.

Remember it is important to answer both parts of each item.

Do not forget to record your name and other details on this page.

Note to the teacher:

Please collate your students' answer scripts and mail them to the address below.

Muhd Ibrahim Muhamad Damanhuri
Science and Mathematics Education Centre (SMEC)
Curtin University of Technology
Building 220
GPO Box U1987
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AUSTRALIA.
Email: muhdibrahim83@gmail.com
Mobile: +61450578984 / +60194401808

1. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. Yet, only HCl has acidic properties while CH_4 does not.

   A. True*
   B. False

   The reason for my answer is:

   1. Only HCl dissolves in water to produce H^+ ions.
   2. CH_4 completely ionised to produce more H^+ ions in water than HCl.
   3. Any substance that contains H atom in the molecular formula is acidic.
   4. Only HCl completely ionised to produce H^+ ions in water.*
   5. *Other reason:*

   ____

   ____

2. What is a property of citrus fruits like oranges and lemons?

   A. Acidic*
   B. Basic
   C. Neutral

   The reason for my answer is:

   1. Citrus fruits have pH value less than 7.*
   2. Citrus fruits have harmful and poisonous properties.
   3. Citrus fruits have pH values greater than 7.
   4. *Other reason:*

   ____

   ____

3. Some brands of 'effervescent' Vitamin C tablets contain sodium bicarbonate, tartaric acid and citric acid. When added to water, the tablets…

   A. cause the temperature of the water to rise.
   B. produce vigorous fizzing.*
   C. break up into small pieces and dissolve.
   D. produce a white precipitate.

   The reason for my answer is:
   1. H^+ ions are produced when the acids ionise in water.
   2. The sodium bicarbonate completely reacts with the acids to produce a neutral salt and water.
   3. CO_2 gas is produced when the acids react with the sodium bicarbonate.*

4. The sodium element in sodium bicarbonate is highly reactive in water.
5. *Other reason:*

   ____

   ____

4. Baking soda (sodium bicarbonate) added to dough when baking bread causes the bread to rise.

   A. True*
   B. False

   The reason for my answer is:

   1. OH^- ions are produced when sodium bicarbonate reacts with water in the dough.
   2. H^+ ions are produced when sodium bicarbonate reacts with water in the dough.
   3. The sodium bicarbonate decomposes when heated to produce CO_2 gas.*
   4. *Other reason:*

   ____

   ____

5. After a kettle is used to boil water over a long period of time, the inside of the kettle becomes coated with ‘scales’ (consisting of calcium carbonate). What could you use to remove this coating?

   A. An aqueous solution of baking soda.
   B. Lemon juice diluted with water.*
   C. An aqueous solution of sodium hydroxide.

   The reason for my answer is:

   1. The calcium carbonate coating completely reacts with the acidic solution to produce a neutral salt and water.
   2. The calcium carbonate coating dissolves by reacting with the alkaline solution.
   3. The calcium carbonate coating dissolves by reacting with the acidic solution.*
   4. *Other reason:*

   ____

   ____

6. If soil has a pH value of less than 7, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?

   A. Common salt
   B. Vinegar
   C. Lime (calcium oxide)*
   D. Caustic soda

   The reason for my answer is:

   1. The basic substance neutralises the acidic soils.*
   2. The basic substance reduces the soil acidity to pH value greater than 7.
   3. The acidic substance changes the pH of soil closer to the ideal pH.
   4. *Other reason:*

   ____

   ____

7. When pieces of chopped red cabbage are boiled with water and the resulting mixture is filtered, a purple solution is obtained. This purple solution can be used to distinguish between...

   A. lemonade and lime juice.
   B. lemonade and tap water.*
   C. rain water and mineral water.

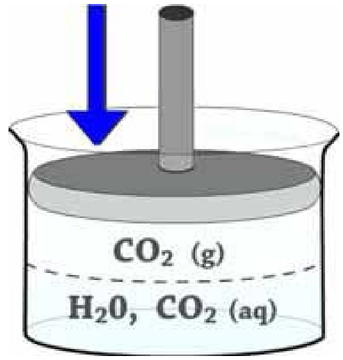
   The reason for my answer is:

   1. The purple cabbage solution can be used to distinguish between the acidic and neutral solutions.
   2. The purple cabbage solution can be used to distinguish between the acidic and alkaline solutions.*
   3. The purple cabbage solution is a phenolphthalein indicator.
   4. *Other reason:*

   ____

   ____

8.



A certain number of moles of carbon dioxide (CO_2) and 100mL of pure water containing dissolved carbon dioxide are placed in an enclosed container with an attached piston at a temperature of 25°C. When the piston is pushed down, the pH value of solution will.....

A. increase.
B. decrease.*
C. remain unchanged.

The reason for my answer is:

1. The CO_2 gas molecules contain acidic properties.
2. The CO_2 gas molecules do not dissolve in water.
3. The water contains a high concentration of H^+ ions.
4. The concentration of CO_2 in water increases producing more acidic solution.*
5. *Other reason:*

____

____

9. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.

A. True
B. False*

The reason for my answer is:

1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
2. Potassium hydroxide and ammonia are only partially ionised in water.
3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
4. Potassium hydroxide and ammonia ionise completely in water.
5. *Other reason:*

____

____

10. Concentrated solutions of acids and alkalis are also strongly acidic and alkaline.

    A. True
    B. False*

    The reason for my answer is:

    1. The solutions contain high concentrations of H^+ or OH^- ions.
    2. The solutions may or may not be highly ionised in aqueous solution.*
    3. Relatively large amounts of the substances are dissolved in water.
    4. *Other reason:*

    ____

    ____

11. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain weakly alkaline chemicals like sodium hydroxide and ammonia, but not acids.

    A. True*
    B. False

    The reason for my answer is:

    1. Alkalis are soapy and so are able to wash away stains.
    2. Acids are more corrosive than alkalis and so are more effective in removing stains.
    3. Alkalis dissolve grease present in dirt more readily than acids.*
    4. Acids are able to neutralise alkali stains present in dirt.
    5. *Other reason:*

    ____

    ____

@->--- THANK YOU ---<-@

APPENDIX L: Acids-Bases Achievement Test (ABCAT) – ***Pilot Test of the Initial Version (Malay)***

UJIAN PENCAPAIAN ASID DAN BES KIMIA

Nama: ______________________ Sekolah: _____________________

Kelas: ____________ Tarikh: ___________

Arahan kepada pelajar:

Kertas ini mengandungi 11 item yang menilai pemahaman anda mengenai beberapa sifat-sifat asid dan bes. Setiap item terdiri daripada dua bahagian: respon pelbagai pilihan diikuti sebab pelbagai pilihan. Bagi setiap item, anda dikehendaki membuat pilihan yang paling sesuai pada bahagian respon pelbagai pilihan dengan membulatkan jawapan anda samada A, B, C, atau sebagainya. Anda kemudiannya dikehendaki memilih salah satu sebab di bahagian sebab pelbagai pilihan yang sepadan dengan jawapan anda di bahagian pertama dan bulatkan jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda tidak bersetuju dengan mana-mana sebab yang diberikan, anda diminta untuk menulis sebab anda di ruang yang disediakan.

Anda diingatkan untuk menjawab kedua-dua bahagian pada setiap item.

Jangan lupa untuk merekodkan nama anda dan maklumat lain pada muka surat ini.

Arahan kepada guru:

Sila kumpulkan skrip jawapan pelajar anda dan poskan kepada alamat di bawah.

Muhd Ibrahim Muhamad Damanhuri
Science and Mathematics Education Centre
Curtin University of Technology
Building 220
GPO Box U1987
Perth, W.A. 6845,
AUSTRALIA.
Email: muhdibrahim83@gmail.com
Mobile: +61450578984 / +60194401808

1. Dua bahan biasa ditemui yang berformula HCl dan CH_4 mengandungi unsur hydrogen. Walaubagaimanapun, hanya HCl mempunyai sifat-sifat asid tetapi CH_4 tidak.

    A. Betul*
    B. Salah

    Sebab bagi jawapan saya adalah:

    1. Hanya HCl larut dalam air untuk menghasilkan ion-ion H^+.
    2. CH_4 mengalami ionisasi lengkap menghasilkan lebih banyak ion-ion H^+ di dalam air berbanding HCl.
    3. Sebarang bahan yang mengandungi atom H di dalam formula molekulnya adalah berasid.
    4. Hanya HCl yang mengalami ionisasi lengkap di dalam air untuk menghasilkan ion-ion H^+.*
    5. *Sebab lain:*

    ____

    ____

2. Apakah sifat buah-buahan sitrus seperti oren dan lemon?

    A. Berasid*
    B. Berbes
    C. Neutral

    Sebab bagi jawapan saya adalah:

    1. Buah-buahan sitrus mempunyai nilai pH kurang daripada 7.*
    2. Buah-buahan sitrus memiliki ciri-ciri berbahaya dan beracun.
    3. Buah-buahan sitrus mempunyai nilai pH lebih daripada 7.
    4. *Sebab lain:*

    ____

    ____

3. Sesetengah jenama tablet Vitamin C yang berbuih mengandungi sodium bikarbonat, asid tartarik dan asid sitrik. Apabila dicampur ke dalam air, tablet tersebut...

    A. menyebabkan suhu air meningkat.
    B. mengasilkan bunyi desis yang kuat.*
    C. berpecah menjadi butiran-butiran kecil dan larut.
    D. menghasilkan mendakan putih.

Sebab bagi jawapan saya adalah:

1. Ion-ion H^+ dihasilkan apabila asid-asid tersebut mengalami ionisasi di dalam air.
2. Sodium bikarbonat bertindakbalas lengkap dengan asid-asid tersebut menghasilkan garam neutral dan air.
3. Gas CO_2 dibebaskan apabila asid-asid tersebut bertindakbalas dengan sodium bikarbonat.*
4. Elemen sodium yang terdapat di dalam sodium bikarbonat adalah sangat reaktif di dalam air.
5. *Sebab lain:*

   ____

   ____

4. Soda penaik (sodium bikarbonat) yang ditambah kepada doh semasa pembuatan roti akan menyebabkan roti meningkat.

   A. Betul*
   B. Salah

   Sebab bagi jawapan saya adalah:

   1. Ion-ion OH^- dibebaskan apabila sodium bikarbonat bertindakbalas dengan air yang terdapat di dalam doh.
   2. Ion-ion H^+ dibebaskan apabila sodium bikarbonat bertindakbalas dengan air yang terdapat dalam doh.
   3. Sodium bikarbonat terurai apabila dipanaskan menghasilkan gas CO_2.*
   4. *Sebab lain:*

      ____

      ____

5. Selepas cerek air digunakan untuk suatu tempoh masa yang lama, keadaan di dalam cerek tersebut akan disaluti 'saduran' (terdiri daripada kalsium karbonat). Apakah yang akan anda gunakan untuk menyingkirkan saduran tersebut?

   A. Larutan akues soda penaik.
   B. Jus lemon dicairkan dengan air.*
   C. Larutan akues sodium hidroksida.

   Sebab bagi jawapan saya adalah:

   1. Saduran kalsium karbonat bertindakbalas lengkap dengan larutan berasid tersebut untuk menghasilkan garam neutral dan air.
   2. Saduran kalsium karbonat larut apabila bertindakbalas dengan larutan beralkali tersebut.

3. Saduran kalsium karbonat larut apabila bertindakbalas dengan larutan berasid tersebut.*
4. *Sebab lain:*

____

____

6. Jika tanah mempunyai nilai pH kurang daripada 7, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

    A. Garam biasa
    B. Cuka
    C. Kapur (kalsium oksida)*
    D. Soda kaustik

    Sebab bagi jawapan saya adalah:

    1. Bahan berbes tersebut dapat meneutralkan keasidan tanah.*
    2. Bahan berbes tersebut mengurangkan keasidan tanah sehingga nilai pH melebihi 7.
    3. Bahan berasid tersebut menukarkan pH tanah mendekati nilai pH yang ideal.
    4. *Sebab lain:*

    ____

    ____

7. Apabila cebisan potongan kubis merah dididihkan dengan air dan hasil campurannya ditapis, suatu larutan ungu akan diperolehi. Larutan ungu tersebut boleh digunakan untuk membezakan antara...

    A. lemonade dan jus limau.
    B. lemonade dan air pili.*
    C. air hujan dan air mineral.

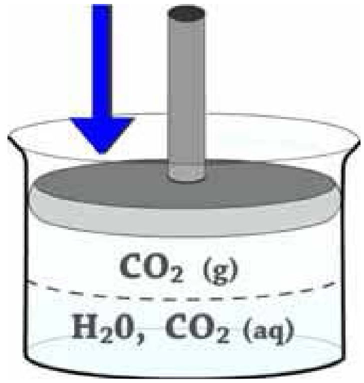
    Sebab bagi jawapan saya adalah:

    1. Larutan ungu kobis boleh digunakan untuk membezakan antara larutan berasid dan larutan neutral.
    2. Larutan ungu kobis boleh digunakan untuk membezakan antara larutan berasid dan larutan beralkali.*
    3. Larutan ungu kobis ialah penunjuk *phenolphtalein*.
    4. *Sebab lain:*

    ____

    ____

8.



Sebilangan mol tertentu karbon dioksida (CO_2) dan 100mL air tulen yang mengandungi karbon dioksida terlarut dimasukkan ke dalam satu bekas tertutup yang disambung ke sebuah piston pada suhu 25°C. Apabila piston itu ditekan, nilai pH larutan akan…..

A. meningkat.
B. berkurangan.*
C. tidak berubah.

Sebab bagi jawapan saya adalah:

1. Molekul-molekul gas CO_2 ini memiliki sifat-sifat berasid.
2. Molekul-molekul gas CO_2 ini tidak larut dalam air.
3. Air tersebut mengandungi kepekatan ion-ion H^+ yang tinggi.
4. Kepekatan CO_2 dalam air meningkat menghasilkan lebih banyak larutan berasid.*
5. *Sebab lain:*

____

____

9. Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

A. Betul
B. Salah*

Sebab bagi jawapan saya adalah:

1. Akues kalium hikdroksida mengalami ionisasi lengkap di dalam air, manakala akues amonia hanya mengalami ionisasi separa.*
2. Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.
3. Akues amonia, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.
4. Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

5. *Sebab lain:*

____

____

10. Larutan asid dan alkali pekat adalah juga asid dan alkali kuat.

    A. Betul
    B. Salah*

    Sebab bagi jawapan saya adalah:

    1. Larutan-larutan tersebut mengandungi kepekatan ion-ion H^+ atau OH^- yang tinggi.
    2. Larutan-larutan tersebut mungkin atau mungkin tidak mengalami ionisasi lengkap di dalam larutan akues.*
    3. Secara relatifnya, sebahagian besar bahan-bahan tersebut larut di dalam air.
    4. *Sebab lain:*

    ____

    ____

11. Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali lemah seperti sodium hidroksida dan amonia, tetapi bukan asid.

    A. Betul*
    B. Salah

    Sebab bagi jawapan saya adalah:

    1. Sifat alkali seperti sabun membolehkan kotoran dibersihkan.
    2. Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.
    3. Alkali dapat melarutkan gris pada kotoran lebih mudah berbanding asid.*
    4. Asid dapat meneutralkan kotoran yang bersifat alkali.
    5. *Sebab lain:*

    ____

    ____

@->--- TERIMA KASIH ---<-@

APPENDIX M: Acids-Bases Achievement Test (ABCAT) – ***Create Multiple-Choice Items with Free Responses of the Amended Version (Bilingual)***

Curtin University

Science & Mathematics Education Centre (SMEC)

ACIDS-BASES CHEMISTRY ACHIEVEMENT TEST
UJIAN PENCAPAIAN ASID-BES KIMIA

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: _____________________________

Section A
Seksyen A

Instruction: Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
Arahan: *Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan* ***bulatkan*** *jawapan anda dalam kertas ujian ini.*

1. An acid displays its properties when it…..
   Suatu asid menunjukkan sifat-sifatnya apabila ia…..

   A. ionises in water to produce H^+ ions.*
   mengion dalam air menghasilkan ion-ion H^+.

   B. ionises in propane to produce H^+ ions.
   mengion dalam propana menghasilkan ion-ion H^+.

   C. ionises in water to produce OH^- ions.
   mengion dalam air menghasilkan ion-ion OH^-.

   D. ionises in propane to produce OH^- ions.
   mengion dalam propana menghasilkan ion-ion OH^-.

2. Which of the following statements is correct about the pH of a solution?
   Yang mana antara pernyataan berikut benar mengenai skala pH?

   A. A solution that has pH value less than 7 is an alkaline solution.
   Larutan yang mempunyai nilai pH kurang daripada 7 adalah larutan beralkali.

   B. A solution that has pH value more than 7 is an acidic solution.
   Larutan yang mempunyai nilai pH lebih daripada 7 adalah larutan berasid.

   C. A solution that has pH value equal to 7 is a neutral solution.*
   Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan neutral.

   D. A solution that has pH value equal to 7 is an alkaline solution.
   Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan beralkali.

3. Which of the following equations correctly describes the relationship between concentration (g dm^{-3}) and molarity (mol dm^{-3})?
Yang mana antara persamaan berikut adalah betul menggambarkan hubungan di antara kepekatan (g dm^{-3}) dan kemolaran (mol dm^{-3})?

A. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Concentration (g dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$ *
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Kepekatan (g dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

B. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Concentration (g dm}^{-3})}$
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kepekatan (g dm}^{-3})}$

C. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molarity (mol dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Kemolaran (mol dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

D. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Molarity (mol dm}^{-3})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kemolaran (mol dm}^{-3})}$

4. Which of the following solutions has the lowest pH value?
Yang mana antara larutan berikut mempunyai nilai pH paling rendah?

A. 20 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
20 cm^3 asid sulfurik 2.0 mol dm^{-3}.

B. 20 cm^3 of 3.0 mol dm^{-3} sulphuric acid.*
20 cm^3 asid sulfurik 3.0 mol dm^{-3}.

C. 50 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
50 cm^3 asid sulfurik 2.0 mol dm^{-3}.

D. 100 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
100 cm^3 asid sulfurik 2.0 mol dm^{-3}.

5. Distilled water is added to 50 cm^3 of 2 mol dm^{-3} potassium hydroxide solution to produce 250 cm^3 of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution produced?
Air suling ditambahkan kepada 50 cm^3 larutan kalium hidroksida 2 mol dm^{-3} untuk menghasilkan 250 cm^3 larutan kalium hidroksida. Apakah kepekatan larutan kalium hidroksida yang dihasilkan?

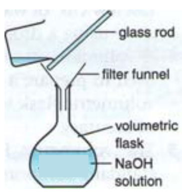
A. 0.3 mol dm^{-3}.

B. 0.4 mol dm^{-3}.*

C. 0.5 mol dm^{-3}.

D. 0.6 mol dm^{-3}.

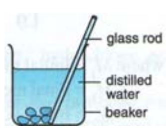
6. The diagrams below, **not** necessarily in the correct order, show five steps involved in the preparation of a standard solution of sodium hydroxide, NaOH.
*Gambarajah di bawah **tidak** semestinya disusun dalam turutan yang betul menunjukkan lima langkah yang terlibat dalam penyediaan suatu larutan piawai sodium hidroksida, NaOH.*

I. 

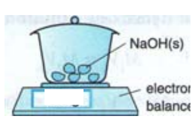
The aqueous NaOH solution is transferred to a volumetric flask.
Larutan NaOH akues dipindahkan ke dalam kelalang isipadu.

II. 

Distilled water is added up to the graduation mark.
Air suling ditambahkan sehingga ke penanda aras.

III. 

NaOH solid is dissolved using distilled water.
Pepejal NaOH dilarutkan menggunakan air suling.

IV. 

NaOH solid is weighed.
Pepejal NaOH ditimbang.

V. 
The NaOH solution is shaken.
Larutan NaOH digoncang.

Which of the following is the correct order of steps in the preparation of a standard solution of sodium hydroxide, NaOH?
Yang mana antara berikut adalah turutan langkah yang betul dalam penyediaan larutan piawai sodium hidroksida, NaOH?

A. I, III, IV, II, V.

B. III, V, I, II, IV.

C. IV, III, I, II, V.*

D. II, I, III, V, IV.

7. Which of the following is **not** a step in the procedure to prepare a solution with a specified concentration using the dilution method?
*Yang manakah antara berikut **bukan** merupakan langkah penyediaan larutan dengan kepekatan tertentu menggunakan kaedah pencairan?*

A. Distilled water is added to the volumetric flask until the graduation mark.
Air suling ditambahkan ke dalam kelalang isipadu sehingga ke penanda aras.

B. A few drops of universal indicator solution are added into the volumetric flask.*
Beberapa titis larutan penunjuk semesta ditambahkan ke dalam kelalang isipadu.

C. The volume of stock solution required is calculated.
Isipadu larutan stok yang diperlukan dikira.

D. The required volume of stock solution is transferred into the volumetric flask using a pipette.
Isipadu larutan stok yang diperlukan dipindahkan ke dalam kelalang isipadu menggunakan pipet.

8. Which of the following apparatus might **not** be needed for a titration experiment?
*Yang manakah antara radas berikut mungkin **tidak** diperlukan dalam eksperimen pentitratan?*

A. Pipette.
Pipet.

B. White tile.
Jubin putih.

C. Retort stand.
Kaki retot.

D. Test tube.*
Tabung uji.

9. Which of the following equations most accurately describes the neutralisation reaction between the acid, HA, and magnesium hydroxide?
Yang mana antara persamaan berikut paling tepat menggambarkan tindakbalas peneutralan di antara asid, HA, dan magnesium hidroksida?

A. $Mg(OH)_2 + HA \rightarrow MgA_2 + H_2O$

B. $Mg(OH)_2 + 2HA \rightarrow MgA_2 + 2H_2O$*

C. $MgA_2 + H_2O \rightarrow Mg(OH)_2 + HA$

D. $MgA_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HA$

10. A group of chemistry students carried out an experiment in the school laboratory to determine the concentration of a hydrochloric acid solution by titration. In order to do that, they added a few drops of phenolphthalein indicator solution into 25 cm^3 of 1.5 mol dm^{-3} sodium hydroxide solution. The alkali solution was then titrated with the acid solution. The average volume of the hydrochloric acid solution used for this experiment was found to be 28.15 cm^3. What is the concentration of the hydrochloric acid solution used in this experiment?
Sekumpulan pelajar kimia telah menjalankan suatu eksperimen di makmal sekolah untuk menentukan kepekatan suatu larutan asid hidroklorik melalui pentitratan. Untuk itu, mereka telah menambahkan beberapa titis larutan penunjuk phenolphthalein ke dalam 25 cm^3 larutan sodium hidroksida 1.5 mol dm^{-3}. Larutan alkali itu kemudiannya telah dititratkan dengan larutan asid tersebut. Isipadu purata bagi larutan asid hidroklorik yang digunakan dalam ekperimen ini didapati sebanyak 28.15 cm^3. Apakah kepekatan larutan asid hidroklorik yang digunakan dalam eksperimen ini?

A. 2.35 mol dm^{-3}.

B. 2.30 mol dm^{-3}.

C. 1.82 mol dm^{-3}.

D. 1.33 mol dm^{-3}.*

11. When a standard solution of specific concentration is diluted, the concentration of the solution will _____, while the number of moles of solute present will be _____.
Apabila suatu larutan piawai berkepekatan tertentu dicairkan, kepekatan larutan tersebut akan _____, manakala bilangan mol bahan terlarut yang hadir akan _____.

A. increase; decrease
bertambah; berkurang

B. increase; constant
bertambah; tetap sama

C. decrease; constant*
berkurang; tetap sama

D. decrease; decrease
berkurang; berkurang

12. Aqueous potassium hydroxide reacts with _____ to produce a salt and water.
Kalium hidroksida akues boleh mengalami tindakbalas dengan _____ untuk menghasilkan garam dan air.

A. Glacial acetic acid.
Asid asetik glasial.

B. Aqueous sodium chloride.
Sodium klorida akues.

C. Dilute nitric acid.*
Asid nitrik cair.

D. Aqueous magnesium hydroxide.
Magnesium hikdrosida akues.

Section B
Seksyen B

This **test** consists of 11 items. Each item in this section has two parts. In the first part of each item, **circle** one of the responses, A, B, C, D, etc., to indicate what you consider to be the most appropriate answer. In the second part, **suggest** your reason for selecting the particular response in the space provided.
Ujian *ini mengandungi 11 item. Setiap item di dalam seksyen ini mengandungi dua bahagian. Pada bahagian pertama setiap item,* ***bulatkan*** *salah satu jawapan, A, B, C, D, atau sebagainya bagi pertimbangan jawapan anda yang paling sesuai. Dalam bahagian kedua,* ***cadangkan*** *sebab memilih jawapan tersebut di ruang yang disediakan.*

1. Chemical X shows the following properties:
Bahan kimia X menunjukkan ciri-ciri berikut:

- ✓ Tastes bitter and feels soapy.
Berasa pahit dan licin.

- ✓ Turns red litmus paper blue.
Menukarkan kertas litmus merah kepada biru.

- ✓ Reacts with an acid to produce a salt and water.
Bertindakbalas dengan asid untuk menghasilkan garam dan air.

- ✓ Produces ammonia gas when heated with an ammonium salt.
Menghasilkan gas ammonia apabila dipanaskan dengan garam ammonium.

- ✓ Reacts with an aqueous salt solution to produce a metal hydroxide.
Bertindakbalas dengan larutan garam akues untuk menghasilkan logam hidroksida.

Which of the following is most probably chemical X?
Yang mana antara berikut paling berkemungkinan bahan kimia X?

A. Dry ammonia gas.
Gas ammonia kering.

B. Sodium hydroxide dissolved in propane.
Sodium hidroksida larut dalam propana.

C. Glacial acetic acid.
Asid asetik glasial.

D. Aqueous calcium hydroxide.*
Kalsium hidroksida akues.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

2. The table shows the pH value of four aqueous solutions, P, Q, R, and S.
Jadual di bawah menunjukkan nilai pH bagi empat larutan, P, Q, R, dan S.

Solution/*Larutan*	P	Q	R	S
pH value/*Nilai pH*	13	7	3	9

Which of the following solutions will react with calcium carbonate to produce carbon dioxide gas?
Yang manakah antara larutan tersebut akan bertindakbalas dengan kalsium karbonat untuk menghasilkan gas karbon dioksida?

A. P

B. Q

C. R*

D. S

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

3. When methyl orange indicator in a titration experiment turns yellow, this indicates the reaction between acid solution and alkali solution has reached its end point.
Apabila penunjuk metil oren dalam suatu eksperimen pentitratan bertukar ke warna kuning, ini menunjukkan tindakbalas antara larutan asid dan larutan alkali telah mencapai takat akhir.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

4. What is the main apparatus that is used in the preparation of a standard solution?
Apakah radas utama yang digunakan dalam penyediaan suatu larutan piawai?

   A. Volumetric flask*
   Kelalang isipadu.

   B. Beaker
   Bikar.

   C. Measuring cylinder
   Silinder penyukat.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

5. Both sulphuric acid and ethanoic acid are strong acids.
Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

   A. True.
   Betul.

   B. False.*
   Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

6. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. However, only HCl has acidic properties while CH_4 does **not**.
Dua bahan yang biasa ditemui mempunyai formula HCl dan CH_4 yang mana kedua-duanya mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl menunjukkan sifat-sifat asid tetapi CH_4 ***tidak****.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

7. What is a property of citrus fruits like oranges and lemons?
Apakah sifat buah-buahan sitrus seperti oren dan lemon?

A. Acidic.*
Berasid.

B. Basic.
Berbes.

C. Neutral.
Neutral.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

8. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain alkaline chemicals like sodium hydroxide and ammonia, but **not** acids.
Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali seperti sodium hidroksida dan amonia, tetapi ***bukan*** *asid.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Alkalis are soapy and so are able to wash away stains.
Sifat alkali yang licin membolehkan kotoran dibersihkan.

2. Acids are more corrosive than alkalis and so are more effective in removing stains.
Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.

3. Alkalis dissolve grease and oils present in dirt more readily than acids.*
Alkali dapat melarutkan gris dan minyak yang hadir dalam kotoran lebih mudah berbanding asid.

4. Acids are able to neutralise alkalis present in dirt.
Asid dapat meneutralkan alkali yang hadir dalam kotoran.

5. Other reason:
Sebab lain:

____

____

9. If soil is too acidic, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?
Jika tanah terlalu berasid, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

A. Common salt.
Garam biasa.

B. Vinegar.
Cuka.

C. Lime (calcium oxide).*
Kapur (kalsium oksida).

D. Caustic soda.
Soda kaustik.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

10. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.
Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
Kalium hikdroksida akues mengalami ionisasi lengkap di dalam air, manakala ammonia akues hanya mengalami ionisasi separa.

2. Potassium hydroxide and ammonia are only partially ionised in water.
Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.

3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
Amonia akues, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.

4. Potassium hydroxide and ammonia ionise completely in water.
Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

5. Other reason:
Sebab lain:

____

____

11. Concentrated solutions of acids and alkalis are also strongly acidic and alkaline.
Larutan asid dan alkali pekat adalah juga asid dan alkali kuat.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The solutions contain high concentrations of H^+ or OH^- ions.
Larutan-larutan tersebut mengandungi kepekatan ion-ion H^+ atau OH^- yang tinggi.

2. The solutions may or may not be highly ionised in aqueous solution.*
Larutan-larutan tersebut mungkin atau mungkin tidak mengalami ionisasi lengkap di dalam larutan akues.

3. Relatively large amounts of the substances are dissolved in water.
Secara relatifnya, sebahagian besar bahan-bahan tersebut larut di dalam air.

4. Other reason:
Sebab lain:

____

____

Test End.
Ujian Tamat.

Thank You!
Terima Kasih!

APPENDIX N: Acids-Bases Achievement Test (ABCAT) – *Developing Second Tiers Distracters of the Amended Version (Bilingual)*

Name/*Nama*:__________________________________ Gender/*Jantina*:____________

Form/*Tingkatan*:___________ School/*Sekolah*:_______________ Email/*Emel*:_______

This **test** consists of 11 items. Each item in this section has two parts. In the first part of each item, **circle** one of the responses, A, B, C, D, etc., to indicate what you consider to be the most appropriate answer. In the second part, **suggest** your reason for selecting the particular response in the space provided.
***Ujian** ini mengandungi 11 item. Setiap item di dalam seksyen ini mengandungi dua bahagian. Pada bahagian pertama setiap item, **bulatkan** salah satu jawapan, A, B, C, D, atau sebagainya bagi pertimbangan jawapan anda yang paling sesuai. Dalam bahagian kedua, **cadangkan** sebab memilih jawapan tersebut di ruang yang disediakan.*

1. Chemical X shows the following properties:
Bahan kimia X menunjukkan ciri-ciri berikut:

- ✓ Tastes bitter and feels soapy.
Berasa pahit dan licin.

- ✓ Turns red litmus paper blue.
Menukarkan kertas litmus merah kepada biru.

- ✓ Reacts with an acid to produce a salt and water.
Bertindakbalas dengan asid untuk menghasilkan garam dan air.

- ✓ Produces ammonia gas when heated with an ammonium salt.
Menghasilkan gas ammonia apabila dipanaskan dengan garam ammonium.

- ✓ Reacts with an aqueous salt solution to produce a metal hydroxide.
Bertindakbalas dengan larutan garam akues untuk menghasilkan logam hidroksida.

Which of the following is most probably chemical X?
Yang mana antara berikut paling berkemungkinan bahan kimia X?

A. Dry ammonia gas.
Gas ammonia kering.

B. Sodium hydroxide dissolved in propane.
Sodium hidroksida larut dalam propana.

C. Glacial acetic acid.
Asid asetik glasial.

D. Aqueous calcium hydroxide.*
Kalsium hidroksida akues.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

2. The table shows the pH value of four aqueous solutions, P, Q, R, and S.
Jadual di bawah menunjukkan nilai pH bagi empat larutan, P, Q, R, dan S.

Solution/*Larutan*	P	Q	R	S
pH value/*Nilai pH*	13	7	3	9

Which of the following solutions will react with calcium carbonate to produce carbon dioxide gas?
Yang manakah antara larutan tersebut akan bertindakbalas dengan kalsium karbonat untuk menghasilkan gas karbon dioksida?

A. P

B. Q

C. R*

D. S

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

3. When methyl orange indicator in a titration experiment turns yellow, this indicates the reaction between acid solution and alkali solution has reached its end point.
Apabila penunjuk metil oren dalam suatu eksperimen pentitratan bertukar ke warna kuning, ini menunjukkan tindakbalas antara larutan asid dan larutan alkali telah mencapai takat akhir.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

4. What is the main apparatus that is used in the preparation of a standard solution?
Apakah radas utama yang digunakan dalam penyediaan suatu larutan piawai?

   A. Volumetric flask*
   Kelalang isipadu.

   B. Beaker
   Bikar.

   C. Measuring cylinder
   Silinder penyukat.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

5. Both sulphuric acid and ethanoic acid are strong acids.
Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

   A. True.
   Betul.

   B. False.*
   Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

6. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. However, only HCl has acidic properties while CH_4 does **not**.
Dua bahan yang biasa ditemui mempunyai formula HCl dan CH_4 yang mana kedua-duanya mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl menunjukkan sifat-sifat asid tetapi CH_4 ***tidak****.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

7. What is a property of citrus fruits like oranges and lemons?
Apakah sifat buah-buahan sitrus seperti oren dan lemon?

A. Acidic.*
Berasid.

B. Basic.
Berbes.

C. Neutral.
Neutral.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

8. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain alkaline chemicals like sodium hydroxide and ammonia, but **not** acids.
*Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali seperti sodium hidroksida dan amonia, tetapi **bukan** asid.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Alkalis are soapy and so are able to wash away stains.
Sifat alkali yang licin membolehkan kotoran dibersihkan.

2. Acids are more corrosive than alkalis and so are more effective in removing stains.
Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.

3. Alkalis dissolve grease and oils present in dirt more readily than acids.*
Alkali dapat melarutkan gris dan minyak yang hadir dalam kotoran lebih mudah berbanding asid.

4. Acids are able to neutralise alkalis present in dirt.
Asid dapat meneutralkan alkali yang hadir dalam kotoran.

5. Other reason:
Sebab lain:

____

____

9. If soil is too acidic, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?
Jika tanah terlalu berasid, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

A. Common salt.
Garam biasa.

B. Vinegar.
Cuka.

C. Lime (calcium oxide).*
Kapur (kalsium oksida).

D. Caustic soda.
Soda kaustik.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

____

____

____

10. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.
Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
Kalium hikdroksida akues mengalami ionisasi lengkap di dalam air, manakala ammonia akues hanya mengalami ionisasi separa.

2. Potassium hydroxide and ammonia are only partially ionised in water.
Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.

3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
Amonia akues, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.

4. Potassium hydroxide and ammonia ionise completely in water.
Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

5. Other reason:
Sebab lain:

____

____

11. Concentrated solutions of acids and alkalis are also strongly acidic and alkaline.
Larutan asid dan alkali pekat adalah juga asid dan alkali kuat.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The solutions contain high concentrations of H^+ or OH^- ions.
Larutan-larutan tersebut mengandungi kepekatan ion-ion H^+ atau OH^- yang tinggi.

2. The solutions may or may not be highly ionised in aqueous solution.*
Larutan-larutan tersebut mungkin atau mungkin tidak mengalami ionisasi lengkap di dalam larutan akues.

3. Relatively large amounts of the substances are dissolved in water.
Secara relatifnya, sebahagian besar bahan-bahan tersebut larut di dalam air.

4. Other reason:
Sebab lain:

____

____

Items End.
Item Tamat.

Thank You!
Terima Kasih!

APPENDIX O: Acids-Bases Achievement Test (ABCAT) – *Pilot Test of the Amended Version (Bilingual)*

Science & Mathematics Education Centre (SMEC)

ACIDS-BASES CHEMISTRY ACHIEVEMENT TEST
UJIAN PENCAPAIAN ASID-BES KIMIA

Pilot-Test
Ujian Rintis

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

*Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara **sukarela**. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda. **Identiti** anda akan **dirahsiakan** dan **dilindungi** sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: _____________________________

Information for Students
Maklumat untuk Pelajar

1. This test is **bilingual**.
   *Ujian ini adalah dalam **dwibahasa**.*

2. The test is composed of two sections, Section A and Section B.
   Ujian ini terdiri daripada dua seksyen, Seksyen A dan Seksyen B.

   (a) **Section A** consists of 12 items. Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
   ***Seksyen A** mengandungi 12 item. Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan **bulatkan** jawapan anda dalam kertas ujian ini.*

   (b) **Section B** consists of 11 items. Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.
   ***Seksyen B** mengandungi 10 item. Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandugan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan **bulatkan** jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan **bulatkan** jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda **tidak** bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

3. Answer **all** questions. **Forty-five minutes** are allocated for this test.
   *Jawab **semua** soalan. **Empat puluh lima minit** diperuntukkan untuk ujian ini.*

Section A
Seksyen A

Instruction: Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
Arahan: *Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan* ***bulatkan*** *jawapan anda dalam kertas ujian ini.*

1. An acid displays its properties when it…..
Suatu asid menunjukkan sifat-sifatnya apabila ia…..

    A. ionises in water to produce H^+ ions.*
    mengion dalam air menghasilkan ion-ion H^+.

    B. ionises in propane to produce H^+ ions.
    mengion dalam propana menghasilkan ion-ion H^+.

    C. ionises in water to produce OH^- ions.
    mengion dalam air menghasilkan ion-ion OH^-.

    D. ionises in propane to produce OH^- ions.
    mengion dalam propana menghasilkan ion-ion OH^-.

2. Which of the following statements is correct about the pH of a solution?
Yang mana antara pernyataan berikut benar mengenai skala pH?

    A. A solution that has pH value less than 7 is an alkaline solution.
    Larutan yang mempunyai nilai pH kurang daripada 7 adalah larutan beralkali.

    B. A solution that has pH value more than 7 is an acidic solution.
    Larutan yang mempunyai nilai pH lebih daripada 7 adalah larutan berasid.

    C. A solution that has pH value equal to 7 is a neutral solution.*
    Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan neutral.

    D. A solution that has pH value equal to 7 is an alkaline solution.
    Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan beralkali.

3. Which of the following equations correctly describes the relationship between concentration (g dm^{-3}) and molarity (mol dm^{-3})?
Yang mana antara persamaan berikut adalah betul menggambarkan hubungan di antara kepekatan (g dm^{-3}) dan kemolaran (mol dm^{-3})?

A. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Concentration (g dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$ *
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Kepekatan (g dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

B. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Concentration (g dm}^{-3})}$
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kepekatan (g dm}^{-3})}$

C. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molarity (mol dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Kemolaran (mol dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

D. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Molarity (mol dm}^{-3})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kemolaran (mol dm}^{-3})}$

4. Which of the following solutions has the lowest pH value?
Yang mana antara larutan berikut mempunyai nilai pH paling rendah?

A. 20 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
20 cm^3 asid sulfurik 2.0 mol dm^{-3}.

B. 20 cm^3 of 3.0 mol dm^{-3} sulphuric acid.*
20 cm^3 asid sulfurik 3.0 mol dm^{-3}.

C. 50 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
50 cm^3 asid sulfurik 2.0 mol dm^{-3}.

D. 100 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
100 cm^3 asid sulfurik 2.0 mol dm^{-3}.

5. Distilled water is added to 50 cm^3 of 2 mol dm^{-3} potassium hydroxide solution to produce 250 cm^3 of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution produced?
Air suling ditambahkan kepada 50 cm^3 larutan kalium hidroksida 2 mol dm^{-3} untuk menghasilkan 250 cm^3 larutan kalium hidroksida. Apakah kepekatan larutan kalium hidroksida yang dihasilkan?

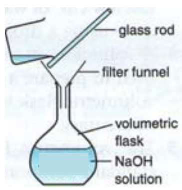
A. 0.3 mol dm^{-3}.

B. 0.4 mol dm^{-3}.*

C. 0.5 mol dm^{-3}.

D. 0.6 mol dm^{-3}.

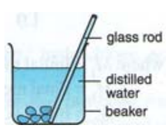
6. The diagrams below, **not** necessarily in the correct order, show five steps involved in the preparation of a standard solution of sodium hydroxide, NaOH.
*Gambarajah di bawah **tidak** semestinya disusun dalam turutan yang betul menunjukkan lima langkah yang terlibat dalam penyediaan suatu larutan piawai sodium hidroksida, NaOH.*

I. 

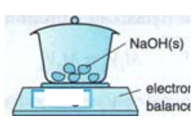
The aqueous NaOH solution is transferred to a volumetric flask.
Larutan NaOH akues dipindahkan ke dalam kelalang isipadu.

II. 

Distilled water is added up to the graduation mark.
Air suling ditambahkan sehingga ke penanda aras.

III. 

NaOH solid is dissolved using distilled water.
Pepejal NaOH dilarutkan menggunakan air suling.

IV. 

NaOH solid is weighed.
Pepejal NaOH ditimbang.

V. 
The NaOH solution is shaken.
Larutan NaOH digoncang.

Which of the following is the correct order of steps in the preparation of a standard solution of sodium hydroxide, NaOH?
Yang mana antara berikut adalah turutan langkah yang betul dalam penyediaan larutan piawai sodium hidroksida, NaOH?

A. I, III, IV, II, V.

B. III, V, I, II, IV.

C. IV, III, I, II, V.*

D. II, I, III, V, IV.

7. Which of the following is **not** a step in the procedure to prepare a solution with a specified concentration using the dilution method?
*Yang manakah antara berikut **bukan** merupakan langkah penyediaan larutan dengan kepekatan tertentu menggunakan kaedah pencairan?*

A. Distilled water is added to the volumetric flask until the graduation mark.
Air suling ditambahkan ke dalam kelalang isipadu sehingga ke penanda aras.

B. A few drops of universal indicator solution are added into the volumetric flask.*
Beberapa titis larutan penunjuk semesta ditambahkan ke dalam kelalang isipadu.

C. The volume of stock solution required is calculated.
Isipadu larutan stok yang diperlukan dikira.

D. The required volume of stock solution is transferred into the volumetric flask using a pipette.
Isipadu larutan stok yang diperlukan dipindahkan ke dalam kelalang isipadu menggunakan pipet.

8. Which of the following apparatus might **not** be needed for a titration experiment?
*Yang manakah antara radas berikut mungkin **tidak** diperlukan dalam eksperimen pentitratan?*

A. Pipette.
Pipet.

B. White tile.
Jubin putih.

C. Retort stand.
Kaki retot.

D. Test tube.*
Tabung uji.

9. Which of the following equations most accurately describes the neutralisation reaction between the acid, HA, and magnesium hydroxide?
Yang mana antara persamaan berikut paling tepat menggambarkan tindakbalas peneutralan di antara asid, HA, dan magnesium hidroksida?

A. $Mg(OH)_2 + HA \rightarrow MgA_2 + H_2O$

B. $Mg(OH)_2 + 2HA \rightarrow MgA_2 + 2H_2O$*

C. $MgA_2 + H_2O \rightarrow Mg(OH)_2 + HA$

D. $MgA_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HA$

10. A group of chemistry students carried out an experiment in the school laboratory to determine the concentration of a hydrochloric acid solution by titration. In order to do that, they added a few drops of phenolphthalein indicator solution into 25 cm^3 of 1.5 mol dm^{-3} sodium hydroxide solution. The alkali solution was then titrated with the acid solution. The average volume of the hydrochloric acid solution used for this experiment was found to be 28.15 cm^3. What is the concentration of the hydrochloric acid solution used in this experiment?
Sekumpulan pelajar kimia telah menjalankan suatu eksperimen di makmal sekolah untuk menentukan kepekatan suatu larutan asid hidroklorik melalui pentitratan. Untuk itu, mereka telah menambahkan beberapa titis larutan penunjuk phenolphthalein ke dalam 25 cm^3 larutan sodium hidroksida 1.5 mol dm^{-3}. Larutan alkali itu kemudiannya telah dititratkan dengan larutan asid tersebut. Isipadu purata bagi larutan asid hidroklorik yang digunakan dalam ekperimen ini didapati sebanyak 28.15 cm^3. Apakah kepekatan larutan asid hidroklorik yang digunakan dalam eksperimen ini?

A. 2.35 mol dm^{-3}.

B. 2.30 mol dm^{-3}.

C. 1.82 mol dm^{-3}.

D. 1.33 mol dm^{-3}.*

11. When a standard solution of specific concentration is diluted, the concentration of the solution will _____, while the number of moles of solute present will be _____.
Apabila suatu larutan piawai berkepekatan tertentu dicairkan, kepekatan larutan tersebut akan _____, manakala bilangan mol bahan terlarut yang hadir akan _____.

A. increase; decrease
bertambah; berkurang

B. increase; constant
bertambah; tetap sama

C. decrease; constant*
berkurang; tetap sama

D. decrease; decrease
berkurang; berkurang

12. Aqueous potassium hydroxide reacts with _____ to produce a salt and water.
Kalium hidroksida akues boleh mengalami tindakbalas dengan _____ untuk menghasilkan garam dan air.

A. Glacial acetic acid.
Asid asetik glasial.

B. Aqueous sodium chloride.
Sodium klorida akues.

C. Dilute nitric acid.*
Asid nitrik cair.

D. Aqueous magnesium hydroxide.
Magnesium hikdrosida akues.

Section B
Seksyen B

Instruction: Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.
Arahan: *Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandugan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan* ***bulatkan*** *jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan* ***bulatkan*** *jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda* ***tidak*** *bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

1. Chemical X shows the following properties:
Bahan kimia X menunjukkan ciri-ciri berikut:

✓ Tastes bitter and feels soapy.
Berasa pahit dan licin.

✓ Turns red litmus paper blue.
Menukarkan kertas litmus merah kepada biru.

✓ Reacts with an acid to produce a salt and water.
Bertindakbalas dengan asid untuk menghasilkan garam dan air.

✓ Produces ammonia gas when heated with an ammonium salt.
Menghasilkan gas ammonia apabila dipanaskan dengan garam ammonium.

✓ Reacts with an aqueous salt solution to produce a metal hydroxide.
Bertindakbalas dengan larutan garam akues untuk menghasilkan logam hidroksida.

Which of the following is most probably chemical X?
Yang mana antara berikut paling berkemungkinan bahan kimia X?

A. Dry ammonia gas.
Gas ammonia kering.

B. Sodium hydroxide dissolved in propane.
Sodium hidroksida larut dalam propana.

C. Glacial acetic acid.
Asid asetik glasial.

D. Aqueous calcium hydroxide.*
Kalsium hidroksida akues.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Chemical X could ionise in water to produce H^+ ions.
Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion H^+.

2. Chemical X could ionise in water to produce OH^- ions.*
Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion OH^-.

3. Chemical X could ionise to produce OH^- ions in the absence of water.
Bahan kimia X boleh mengion untuk menghasilkan ion-ion OH^- tanpa kehadiran air.

4. Chemical X is soluble in water.
Bahan kimia X larut di dalam air.

5. Other reason:
Sebab lain:

____

____

2. The table shows the pH value of four aqueous solutions, P, Q, R, and S.
Jadual di bawah menunjukkan nilai pH bagi empat larutan, P, Q, R, dan S.

Solution/*Larutan*	P	Q	R	S
pH value/*Nilai pH*	13	7	3	9

Which of the following solutions will react with calcium carbonate to produce carbon dioxide gas?
Yang manakah antara larutan tersebut akan bertindakbalas dengan kalsium karbonat untuk menghasilkan gas karbon dioksida?

A. P

B. Q

C. R*

D. S

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The solution contains a higher concentration of OH^- ions than H^+ ions.
   Larutan tersebut mengandungi kepekatan ion-ion OH^- yang lebih tinggi berbanding ion-ion H^+.

2. The solution contains a higher concentration of H^+ ions than OH^- ions.*
   Larutan tersebut mengandungi kepekatan ion-ion H^+ yang lebih tinggi berbanding ion-ion OH^-.

3. The solution contains equal concentrations of H^+ and OH^- ions.
   Larutan tersebut mengandungi kepekatan ion-ion H^+ dan ion-ion OH^- yang sama.

4. Other reason:
   Sebab lain:

   ____

   ____

3. When methyl orange indicator in a titration experiment turns yellow, this indicates the reaction between acid solution and alkali solution has reached its end point.
   Apabila penunjuk metil oren dalam suatu eksperimen pentitratan bertukar ke warna kuning, ini menunjukkan tindakbalas antara larutan asid dan larutan alkali telah mencapai takat akhir.

   A. True.
   Betul.

   B. False.*
   Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Methyl orange turns yellow because neutralisation has occurred.
   Metil oren bertukar ke warna kuning kerana peneutralan telah berlaku.

2. Methyl orange turns yellow because water and a salt are present in the solution.
   Metil oren bertukar ke warna kuning kerana terdapat kehadiran air dan garam dalam larutan tersebut.

3. Methyl orange turns yellow because there is an excess of alkali in the solution.*
   Metil oren bertukar ke warna kuning kerana terdapat lebihan alkali dalam larutan tersebut.

4. Methyl orange turns yellow because there is an excess of acid in the solution.
Metil oren bertukar ke warna kuning kerana terdapat lebihan asid dalam larutan tersebut.

5. Other reason:
Sebab lain:

____

____

4. What is the main apparatus that is used in the preparation of a standard solution?
Apakah radas utama yang digunakan dalam penyediaan suatu larutan piawai?

A. Volumetric flask*
Kelalang isipadu.

B. Beaker
Bikar.

C. Measuring cylinder
Silinder penyukat.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. It is easier to dissolve the solute by shaking.
Ia memudahkan bahan terlarut melarut dengan menggoncang.

2. It prevents the solution from splashing out.
Ia dapat mengelakkan larutan tersebut daripada terpercik keluar.

3. It can measure a fixed volume of solution more accurately.*
Ia dapat menyukat isipadu tetap larutan dengan lebih tepat.

4. Other reason:
Sebab lain:

____

____

5. Both sulphuric acid and ethanoic acid are strong acids.
Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Sulfuric acid ionises completely in water to produce H^+ ions, while ethanoic acid ionises partially in water to produce H^+ ions.*
Asid sulfurik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid etanoik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

2. Ethanoic acid ionises completely in water to produce H^+ ions, while sulfuric acid ionises partially in water to produce H^+.
Asid etanoik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid sulfurik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

3. Both acids ionise completely in water to produce H^+ ions.
Kedua-dua asid tersebut mengion lengkap di dalam air untuk menghasilkan ion-ion H^+.

4. Both acids ionise partially in water to produce H^+ ions.
Kedua-dua asid tersebut mengion separa di dalam air untuk menghasilkan ion-ion H^+.

5. Other reason:
Sebab lain:

____

____

6. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. However, only HCl has acidic properties while CH_4 does **not**.
Dua bahan yang biasa ditemui mempunyai formula HCl dan CH_4 yang mana kedua-duanya mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl menunjukkan sifat-sifat asid tetapi CH_4 ***tidak****.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. CH_4 completely ionises to produce more H^+ ions in water than HCl.
   CH_4 mengalami ionisasi lengkap menghasilkan lebih banyak ion-ion H^+ di dalam air berbanding HCl.

2. Any substance that contains H atom in the molecular formula is acidic.
   Sebarang bahan yang mengandungi atom H di dalam formula molekulnya adalah berasid.

3. Only HCl ionises to produce H^+ ions in water.*
   Hanya HCl yang mengalami ionisasi di dalam air untuk menghasilkan ion-ion H^+.

4. Other reason:
   Sebab lain:

   ____

   ____

7. What is a property of citrus fruits like oranges and lemons?
   Apakah sifat buah-buahan sitrus seperti oren dan lemon?

   A. Acidic.*
   Berasid.

   B. Basic.
   Berbes.

   C. Neutral.
   Neutral.

   The reason for my answer is:
   Sebab bagi jawapan saya adalah:

   1. Citrus fruits have pH value less than 7.*
      Buah-buahan sitrus mempunyai nilai pH kurang daripada 7.

   2. Citrus fruits have pH values greater than 7.
      Buah-buahan sitrus mempunyai nilai pH lebih daripada 7.

   3. Citrus fruits have pH values equal to 7.
      Buah-buahan sitrus mempunyai nilai pH bersamaan 7.

4. Other reason:
   Sebab lain:

   ____

   ____

8. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain alkaline chemicals like sodium hydroxide and ammonia, but **not** acids.
   Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali seperti sodium hidroksida dan amonia, tetapi ***bukan*** *asid.*

   A. True.*
      Betul.

   B. False.
      Salah.

   The reason for my answer is:
   Sebab bagi jawapan saya adalah:

   1. Alkalis are soapy and so are able to wash away stains.
      Sifat alkali yang licin membolehkan kotoran dibersihkan.

   2. Acids are more corrosive than alkalis and so are more effective in removing stains.
      Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.

   3. Alkalis dissolve grease and oils present in dirt more readily than acids.*
      Alkali dapat melarutkan gris dan minyak yang hadir dalam kotoran lebih mudah berbanding asid.

   4. Acids are able to neutralise alkalis present in dirt.
      Asid dapat meneutralkan alkali yang hadir dalam kotoran.

   5. Other reason:
      Sebab lain:

      ____

      ____

9. If soil is too acidic, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?
Jika tanah terlalu berasid, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

A. Common salt.
Garam biasa.

B. Vinegar.
Cuka.

C. Lime (calcium oxide).*
Kapur (kalsium oksida).

D. Caustic soda.
Soda kaustik.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The basic substance neutralises the acidic soils.*
Bahan berbes tersebut dapat meneutralkan keasidan tanah.

2. The basic substance changes the soil acidity to a pH value greater than 7.
Bahan berbes tersebut mengurangkan keasidan tanah sehingga nilai pH melebihi 7.

3. The acidic substance changes the pH of soil closer to the ideal pH.
Bahan berasid tersebut menukarkan pH tanah mendekati nilai pH yang ideal.

4. Other reason:
Sebab lain:

____

____

10. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.
Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
   Kalium hikdroksida akues mengalami ionisasi lengkap di dalam air, manakala ammonia akues hanya mengalami ionisasi separa.

2. Potassium hydroxide and ammonia are only partially ionised in water.
   Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.

3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
   Amonia akues, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.

4. Potassium hydroxide and ammonia ionise completely in water.
   Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

5. Other reason:
   Sebab lain:

   ____

   ____

11. Concentrated solutions of acids and alkalis are also strongly acidic and alkaline.
    Larutan asid dan alkali pekat adalah juga asid dan alkali kuat.

    A. True.
       Betul.

    B. False.*
       Salah.

    The reason for my answer is:
    Sebab bagi jawapan saya adalah:

    1. The solutions contain high concentrations of H^+ or OH^- ions.
       Larutan-larutan tersebut mengandungi kepekatan ion-ion H^+ atau OH^- yang tinggi.

    2. The solutions may or may not be highly ionised in aqueous solution.*
       Larutan-larutan tersebut mungkin atau mungkin tidak mengalami ionisasi lengkap di dalam larutan akues.

    3. Relatively large amounts of the substances are dissolved in water.
       Secara relatifnya, sebahagian besar bahan-bahan tersebut larut di dalam air.

4. Other reason:
Sebab lain:

____

____

Test End.
Ujian Tamat.

Thank You!
Terima Kasih!

APPENDIX P: Acids-Bases Achievement Test (ABCAT) – *Pre-Test of the Amended Version* (*Bilingual)*

Science & Mathematics Education Centre (SMEC)

ACIDS-BASES CHEMISTRY ACHIEVEMENT TEST
UJIAN PENCAPAIAN ASID-BES KIMIA

Pre-Test
Ujian Pra

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:____________________________ Gender/*Jantina*: ________________

Form/*Tingkatan*:_____________ School/*Sekolah*: _____________________________

Information for Students

Maklumat untuk Pelajar

1. This test is **bilingual**.
   *Ujian ini adalah dalam **dwibahasa**.*

2. The test is composed of two sections, Section A and Section B.
   Ujian ini terdiri daripada dua seksyen, Seksyen A dan Seksyen B.

   (a) **Section A** consists of 12 items. Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
   ***Seksyen A** mengandungi 12 item. Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan **bulatkan** jawapan anda dalam kertas ujian ini.*

   (b) **Section B** consists of 10 items. Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.
   ***Seksyen B** mengandungi 10 item. Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandugan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan **bulatkan** jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan **bulatkan** jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda **tidak** bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

3. Answer **all** questions. **Forty-five minutes** are allocated for this test.
   *Jawab **semua** soalan. **Empat puluh lima minit** diperuntukkan untuk ujian ini.*

Section A

Seksyen A

Instruction: Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.

Arahan: *Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan **bulatkan** jawapan anda dalam kertas ujian ini.*

1. Aqueous potassium hydroxide reacts with _____ to produce a salt and water.
Kalium hidroksida akues boleh mengalami tindakbalas dengan _____ untuk menghasilkan garam dan air.

   A. Glacial acetic acid.
   Asid asetik glasial.

   B. Aqueous sodium chloride.
   Sodium klorida akues.

   C. Dilute nitric acid.*
   Asid nitrik cair.

   D. Aqueous magnesium hydroxide.
   Magnesium hikdrosida akues.

[1 mark/Understanding/LO5/Post:A12]

2. A group of chemistry students carried out an experiment in the school laboratory to determine the concentration of a hydrochloric acid solution by titration. In order to do that, they added a few drops of phenolphthalein indicator solution into 25 cm^3 of 1.5 mol dm^{-3} sodium hydroxide solution. The alkali solution was then titrated with the acid solution. The average volume of the hydrochloric acid solution used for this experiment was found to be 28.15 cm^3. What is the concentration of the hydrochloric acid solution used in this experiment?
Sekumpulan pelajar kimia telah menjalankan suatu eksperimen di makmal sekolah untuk menentukan kepekatan suatu larutan asid hidroklorik melalui pentitratan. Untuk itu, mereka telah menambahkan beberapa titis larutan penunjuk phenolphthalein ke dalam 25 cm^3 larutan sodium hidroksida 1.5 mol dm^{-3}. Larutan alkali itu kemudiannya telah dititratkan dengan larutan asid tersebut. Isipadu purata bagi larutan asid hidroklorik yang digunakan dalam ekperimen ini didapati sebanyak 28.15 cm^3. Apakah kepekatan larutan asid hidroklorik yang digunakan dalam eksperimen ini?

   A. 2.35 mol dm^{-3}.

   B. 2.30 mol dm^{-3}.

   C. 1.82 mol dm^{-3}.

   D. 1.33 mol dm^{-3}.*

[1 marks/Analysing/LO26/Post:A10]

3. Which of the following apparatus might **not** be needed for a titration experiment?
Yang manakah antara radas berikut mungkin ***tidak*** *diperlukan dalam eksperimen pentitratan?*

A. Pipette.
Pipet.

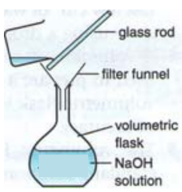
B. White tile.
Jubin putih.

C. Retort stand.
Kaki retot.

D. Test tube.*
Tabung uji.

[1 mark/Remembering/LO24/Post:A8]

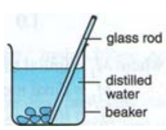
4. The diagrams below, **not** necessarily in the correct order, show five steps involved in the preparation of a standard solution of sodium hydroxide, NaOH.
Gambarajah di bawah ***tidak*** *semestinya disusun dalam turutan yang betul menunjukkan lima langkah yang terlibat dalam penyediaan suatu larutan piawai sodium hidroksida, NaOH.*

I. 

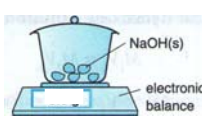
The aqueous NaOH solution is transferred to a volumetric flask.
Larutan NaOH akues dipindahkan ke dalam kelalang isipadu.

II. 

Distilled water is added up to the graduation mark.
Air suling ditambahkan sehingga ke penanda aras.

III. 

NaOH solid is dissolved using distilled water.
Pepejal NaOH dilarutkan menggunakan air suling.

IV. 

NaOH solid is weighed.
Pepejal NaOH ditimbang.

V. 
The NaOH solution is shaken.
Larutan NaOH digoncang.

Which of the following is the correct order of steps in the preparation of a standard solution of sodium hydroxide, NaOH?
Yang mana antara berikut adalah turutan langkah yang betul dalam penyediaan larutan piawai sodium hidroksida, NaOH?

A. I, III, IV, II, V.

B. III, V, I, II, IV.

C. IV, III, I, II, V.*

D. II, I, III, V, IV.

[1 mark/Applying/LO17/Post:A6]

5. Which of the following solutions has the lowest pH value?
Yang mana antara larutan berikut mempunyai nilai pH paling rendah?

A. 20 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
20 cm^3 asid sulfurik 2.0 mol dm^{-3}.

B. 20 cm^3 of 3.0 mol dm^{-3} sulphuric acid.*
20 cm^3 asid sulfurik 3.0 mol dm^{-3}.

C. 50 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
50 cm^3 asid sulfurik 2.0 mol dm^{-3}.

D. 100 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
100 cm^3 asid sulfurik 2.0 mol dm^{-3}.

[1 mark/Analysing/LO19/Post:A4]

6. Which of the following statements is correct about the pH of a solution?
Yang mana antara pernyataan berikut benar mengenai skala pH?

A. A solution that has pH value less than 7 is an alkaline solution.
Larutan yang mempunyai nilai pH kurang daripada 7 adalah larutan beralkali.

B. A solution that has pH value more than 7 is an acidic solution.
Larutan yang mempunyai nilai pH lebih daripada 7 adalah larutan berasid.

C. A solution that has pH value equal to 7 is a neutral solution.*
Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan neutral.

D. A solution that has pH value equal to 7 is an alkaline solution.
Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan beralkali.

[1 mark/Remembering/LO7/Post:A2]

7. Which of the following equations correctly describes the relationship between concentration (g dm^{-3}) and molarity (mol dm^{-3})?
Yang mana antara persamaan berikut adalah betul menggambarkan hubungan di antara kepekatan (g dm^{-3}) dan kemolaran (mol dm^{-3})?

A. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Concentration (g dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$ *
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Kepekatan (g dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

B. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Concentration (g dm}^{-3})}$
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kepekatan (g dm}^{-3})}$

C. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molarity (mol dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Kemolaran (mol dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

D. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Molarity (mol dm}^{-3})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kemolaran (mol dm}^{-3})}$

[1 mark/Remembering/LO15/Post:A3]

8. Distilled water is added to 50 cm^3 of 2 mol dm^{-3} potassium hydroxide solution to produce 250 cm^3 of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution produced?
Air suling ditambahkan kepada 50 cm^3 larutan kalium hidroksida 2 mol dm^{-3} untuk menghasilkan 250 cm^3 larutan kalium hidroksida. Apakah kepekatan larutan kalium hidroksida yang dihasilkan?

A. 0.3 mol dm^{-3}.

B. 0.4 mol dm^{-3}.*

C. 0.5 mol dm^{-3}.

D. 0.6 mol dm^{-3}.

[1 mark/Analysing/LO20/Post:A5]

9. Which of the following is **not** a step in the procedure to prepare a solution with a specified concentration using the dilution method?
*Yang manakah antara berikut **bukan** merupakan langkah penyediaan larutan dengan kepekatan tertentu menggunakan kaedah pencairan?*

A. Distilled water is added to the volumetric flask until the graduation mark.
Air suling ditambahkan ke dalam kelalang isipadu sehingga ke penanda aras.

B. A few drops of universal indicator solution are added into the volumetric flask.*
Beberapa titis larutan penunjuk semesta ditambahkan ke dalam kelalang isipadu.

C. The volume of stock solution required is calculated.
Isipadu larutan stok yang diperlukan dikira.

D. The required volume of stock solution is transferred into the volumetric flask using a pipette.
Isipadu larutan stok yang diperlukan dipindahkan ke dalam kelalang isipadu menggunakan pipet.

[1 mark/Understanding/LO18/Post:A7]

10. Which of the following equations most accurately describes the neutralisation reaction between the acid, HA, and magnesium hydroxide?
Yang mana antara persamaan berikut paling tepat menggambarkan tindakbalas peneutralan di antara asid, HA, dan magnesium hidroksida?

A. $Mg(OH)_2 + HA \rightarrow MgA_2 + H_2O$

B. $Mg(OH)_2 + 2HA \rightarrow MgA_2 + 2H_2O$*

C. $MgA_2 + H_2O \rightarrow Mg(OH)_2 + HA$

D. $MgA_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HA$

[1 mark/Understanding/LO23/Post:A9]

11. When a standard solution of specific concentration is diluted, the concentration of the solution will _____, while the number of moles of solute present will be _____.
Apabila suatu larutan piawai berkepekatan tertentu dicairkan, kepekatan larutan tersebut akan _____, manakala bilangan mol bahan terlarut yang hadir akan _____.

A. increase; decrease
bertambah; berkurang

B. increase; constant
bertambah; tetap sama

C. decrease; constant*
berkurang; tetap sama

D. decrease; decrease
berkurang; berkurang

[1 mark/Understanding/LO16/Post:A11]

12. An acid displays its properties when it…..
Suatu asid menunjukkan sifat-sifatnya apabila ia…..

A. ionises in water to produce H^+ ions.*
mengion dalam air menghasilkan ion-ion H^+.

B. ionises in propane to produce H^+ ions.
mengion dalam propana menghasilkan ion-ion H^+.

C. ionises in water to produce OH^- ions.
mengion dalam air menghasilkan ion-ion OH^-.

D. ionises in propane to produce OH^- ions.
mengion dalam propana menghasilkan ion-ion OH^-.

[1 mark/Remembering/LO3/Post:A1]

Section B
Seksyen B

Instruction: Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.

Arahan: *Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandungan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan* ***bulatkan*** *jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan* ***bulatkan*** *jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda* ***tidak*** *bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

1. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.
   Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

   A. True.
   Betul.

   B. False.*
   Salah.

   The reason for my answer is:
   Sebab bagi jawapan saya adalah:

   1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
   Kalium hikdroksida akues mengalami ionisasi lengkap di dalam air, manakala ammonia akues hanya mengalami ionisasi separa.

   2. Potassium hydroxide and ammonia are only partially ionised in water.
   Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.

   3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
   Amonia akues, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.

   4. Potassium hydroxide and ammonia ionise completely in water.
   Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

   5. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Analysing/ LO11/Post:B10]

2. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain alkaline chemicals like sodium hydroxide and ammonia, but **not** acids.
Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali seperti sodium hidroksida dan amonia, tetapi ***bukan*** *asid.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Alkalis are soapy and so are able to wash away stains.
Sifat alkali yang licin membolehkan kotoran dibersihkan.

2. Acids are more corrosive than alkalis and so are more effective in removing stains.
Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.

3. Alkalis dissolve grease and oils present in dirt more readily than acids.*
Alkali dapat melarutkan gris dan minyak yang hadir dalam kotoran lebih mudah berbanding asid.

4. Acids are able to neutralise alkalis present in dirt.
Asid dapat meneutralkan alkali yang hadir dalam kotoran.

5. Other reason:
Sebab lain:

____

____

[1 mark/Applying/LO2/Post:B8]

3. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. However, only HCl has acidic properties while CH_4 does **not**.
Dua bahan yang biasa ditemui mempunyai formula HCl dan CH_4 yang mana kedua-duanya mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl menunjukkan sifat-sifat asid tetapi CH_4 ***tidak****.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. CH_4 completely ionises to produce more H^+ ions in water than HCl.
CH_4 mengalami ionisasi lengkap menghasilkan lebih banyak ion-ion H^+ di dalam air berbanding HCl.

2. Any substance that contains H atom in the molecular formula is acidic.
Sebarang bahan yang mengandungi atom H di dalam formula molekulnya adalah berasid.

3. Only HCl ionises to produce H^+ ions in water.*
Hanya HCl yang mengalami ionisasi di dalam air untuk menghasilkan ion-ion H^+.

4. Other reason:
Sebab lain:

____

____

[1 mark/Understanding/LO1/Post:B6]

4. What is the main apparatus that is used in the preparation of a standard solution?
Apakah radas utama yang digunakan dalam penyediaan suatu larutan piawai?

A. Volumetric flask*
Kelalang isipadu.

B. Beaker
Bikar.

C. Measuring cylinder
Silinder penyukat.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. It is easier to dissolve the solute by shaking.
   Ia memudahkan bahan terlarut melarut dengan menggoncang.

2. It prevents the solution from splashing out.
   Ia dapat mengelakkan larutan tersebut daripada terpercik keluar.

3. It can measure a fixed volume of solution more accurately.*
   Ia dapat menyukat isipadu tetap larutan dengan lebih tepat.

4. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Applying/ LO17/Post:B4]

5. The table shows the pH value of four aqueous solutions, P, Q, R, and S.
   Jadual di bawah menunjukkan nilai pH bagi empat larutan, P, Q, R, dan S.

Solution/*Larutan*	P	Q	R	S
pH value/*Nilai pH*	13	7	3	9

Which of the following solutions will react with calcium carbonate to produce carbon dioxide gas?
Yang manakah antara larutan tersebut akan bertindakbalas dengan kalsium karbonat untuk menghasilkan gas karbon dioksida?

A. P

B. Q

C. R*

D. S

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The solution contains a higher concentration of OH^- ions than H^+ ions.
   Larutan tersebut mengandungi kepekatan ion-ion OH^- yang lebih tinggi berbanding ion-ion H^+.

2. The solution contains a higher concentration of H^+ ions than OH^- ions.*
Larutan tersebut mengandungi kepekatan ion-ion H^+ yang lebih tinggi berbanding ion-ion OH^-.

3. The solution contains equal concentrations of H^+ and OH^- ions.
Larutan tersebut mengandungi kepekatan ion-ion H^+ dan ion-ion OH^- yang sama.

4. Other reason:
Sebab lain:

____

____

[1 mark/Understanding/LO5/Post:B2]

6. When methyl orange indicator in a titration experiment turns yellow, this indicates the reaction between acid solution and alkali solution has reached its end point.
Apabila penunjuk metil oren dalam suatu eksperimen pentitratan bertukar ke warna kuning, ini menunjukkan tindakbalas antara larutan asid dan larutan alkali telah mencapai takat akhir.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Methyl orange turns yellow because neutralisation has occurred.
Metil oren bertukar ke warna kuning kerana peneutralan telah berlaku.

2. Methyl orange turns yellow because water and a salt are present in the solution.
Metil oren bertukar ke warna kuning kerana terdapat kehadiran air dan garam dalam larutan tersebut.

3. Methyl orange turns yellow because there is an excess of alkali in the solution.*
Metil oren bertukar ke warna kuning kerana terdapat lebihan alkali dalam larutan tersebut.

4. Methyl orange turns yellow because there is an excess of acid in the solution.
Metil oren bertukar ke warna kuning kerana terdapat lebihan asid dalam larutan tersebut.

5. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Understanding/LO25/Post:B3]

7. Both sulphuric acid and ethanoic acid are strong acids.
   Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

   A. True.
      Betul.

   B. False.*
      Salah.

   The reason for my answer is:
   Sebab bagi jawapan saya adalah:

   1. Sulfuric acid ionises completely in water to produce H^+ ions, while ethanoic acid ionises partially in water to produce H^+ ions.*
      Asid sulfurik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid etanoik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

   2. Ethanoic acid ionises completely in water to produce H^+ ions, while sulfuric acid ionises partially in water to produce H^+.
      Asid etanoik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid sulfurik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

   3. Both acids ionise completely in water to produce H^+ ions.
      Kedua-dua asid tersebut mengion lengkap di dalam air untuk menghasilkan ion-ion H^+.

   4. Both acids ionise partially in water to produce H^+ ions.
      Kedua-dua asid tersebut mengion separa di dalam air untuk menghasilkan ion-ion H^+.

   5. Other reason:
      Sebab lain:

      ____

      ____

[1 mark/Analysing/ LO10/Post:B5]

8. What is a property of citrus fruits like oranges and lemons?
Apakah sifat buah-buahan sitrus seperti oren dan lemon?

A. Acidic.*
Berasid.

B. Basic.
Berbes.

C. Neutral.
Neutral.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Citrus fruits have pH value less than 7.*
Buah-buahan sitrus mempunyai nilai pH kurang daripada 7.

2. Citrus fruits have pH values greater than 7.
Buah-buahan sitrus mempunyai nilai pH lebih daripada 7.

3. Citrus fruits have pH values equal to 7.
Buah-buahan sitrus mempunyai nilai pH bersamaan 7.

4. Other reason:
Sebab lain:

____

____

[1 mark/Understanding/LO7/Post:B7]

9. If soil is too acidic, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?
Jika tanah terlalu berasid, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

A. Common salt.
Garam biasa.

B. Vinegar.
Cuka.

C. Lime (calcium oxide).*
Kapur (kalsium oksida).

D. Caustic soda.
Soda kaustik.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The basic substance neutralises the acidic soils.*
   Bahan berbes tersebut dapat meneutralkan keasidan tanah.

2. The basic substance changes the soil acidity to a pH value greater than 7.
   Bahan berbes tersebut mengurangkan keasidan tanah sehingga nilai pH melebihi 7.

3. The acidic substance changes the pH of soil closer to the ideal pH.
   Bahan berasid tersebut menukarkan pH tanah mendekati nilai pH yang ideal.

4. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Applying/LO22/Post:B9]

10. Chemical X shows the following properties:
    Bahan kimia X menunjukkan ciri-ciri berikut:

- ✓ Tastes bitter and feels soapy.
  Berasa pahit dan licin.
- ✓ Turns red litmus paper blue.
  Menukarkan kertas litmus merah kepada biru.
- ✓ Reacts with an acid to produce a salt and water.
  Bertindakbalas dengan asid untuk menghasilkan garam dan air.
- ✓ Produces ammonia gas when heated with an ammonium salt.
  Menghasilkan gas ammonia apabila dipanaskan dengan garam ammonium.
- ✓ Reacts with an aqueous salt solution to produce a metal hydroxide.
  Bertindakbalas dengan larutan garam akues untuk menghasilkan logam hidroksida.

Which of the following is most probably chemical X?
Yang mana antara berikut paling berkemungkinan bahan kimia X?

A. Dry ammonia gas.
   Gas ammonia kering.

B. Sodium hydroxide dissolved in propane.
   Sodium hidroksida larut dalam propana.

C. Glacial acetic acid.
   Asid asetik glasial.

D. Aqueous calcium hydroxide.*
Kalsium hidroksida akues.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Chemical X could ionise in water to produce H^+ ions.
Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion H^+.

2. Chemical X could ionise in water to produce OH^- ions.*
Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion OH^-.

3. Chemical X could ionise to produce OH^- ions in the absence of water.
Bahan kimia X boleh mengion untuk menghasilkan ion-ion OH^- tanpa kehadiran air.

4. Chemical X is soluble in water.
Bahan kimia X larut di dalam air.

5. Other reason:
Sebab lain:

____

____

[1 mark/Understanding/LO4/Post:B1]

Test End.
Ujian Tamat.

Thank You!
Terima Kasih!

APPENDIX Q: Acids-Bases Achievement Test (ABCAT) – *Post-Test of the Amended Version (Bilingual)*

Science & Mathematics Education Centre (SMEC)

ACIDS-BASES CHEMISTRY ACHIEVEMENT TEST
UJIAN PENCAPAIAN ASID-BES KIMIA

Post-Test
Ujian Pos

Chemistry
Kimia

Acids & Bases Lessons
Pembelajaran Asid & Bes

My name is Muhd Ibrahim Muhamad Damanhuri and currently am completing research for my Ph.D. at Curtin University in Perth, Western Australia. I am investigating the effectiveness of the acids-bases topic in the Chemistry curriculum prepared by Curriculum Development Division (CDD), Malaysian Ministry of Education. Your views about lessons on acids-bases chemistry are important. This information can be used to assist Malaysian chemistry teachers in making chemistry lessons of the Form 4 Chemistry curriculum more interesting and better understood. Your involvement in this research is entirely **voluntary**. You should be aware that you have the right to discontinue your participation at any time without affecting your personal or social life in any way. Your **identity** will be kept **confidential** and **anonymous** throughout this study.

Nama saya ialah Muhd Ibrahim Muhamad Damanhuri dan kini sedang melengkapkapkan kajian bagi Ph.D. saya di Curtin University, Perth, Western Australia. Saya sedang menyiasat keberkesanan tajuk asid-bes daripada kurikulum kimia yang disediakan oleh Bahagian Pembangunan Kurikulum (BPK), Kementerian Pelajaran Malaysia. Pandangan anda dalam pembelajaran tajuk asid-bes ini adalah sangat penting. Maklumat tersebut boleh digunakan untuk membantu guru-guru kimia di Malaysia untuk menjadikan pembelajaran kimia bagi kurikulum kimia Tingkatan 4 lebih menarik dan lebih mudah difahami. Penyertaan anda dalam kajian ini adalah secara ***sukarela****. Perlu diingatkan di sini bahawa anda mempunyai hak untuk berhenti menyertai kajian ini pada bila-bila masa tanpa mengugat kehidupan peribadi atau sosial anda.* ***Identiti*** *anda akan* ***dirahsiakan*** *dan* ***dilindungi*** *sepanjang kajian ini.*

Your participation in this research is highly appreciated. Thank you!
Penyertaan anda dalam kajian ini amatlah dihargai. Terima kasih!

(Note: Your personal information will be kept personal.)
(Nota: Maklumat peribadi anda akan dirahsiakan)

Name/*Nama*:_____________________________ Gender/*Jantina*: _________________

Form/*Tingkatan*:______________ School/*Sekolah*: ______________________________

Information for Students
Maklumat untuk Pelajar

4. This test is **bilingual**.
   *Ujian ini adalah dalam **dwibahasa**.*

5. The test is composed of two sections, Section A and Section B.
   Ujian ini terdiri daripada dua seksyen, Seksyen A dan Seksyen B.

   (c) **Section A** consists of 12 items. Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
   ***Seksyen A** mengandungi 12 item. Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan **bulatkan** jawapan anda dalam kertas ujian ini.*

   (d) **Section B** consists of 10 items. Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.
   ***Seksyen B** mengandungi 10 item. Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandugan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan **bulatkan** jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan **bulatkan** jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda **tidak** bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

6. Answer **all** questions. **Forty-five minutes** are allocated for this test.
   *Jawab **semua** soalan. **Empat puluh lima minit** diperuntukkan untuk ujian ini.*

Section A
Seksyen A

Instruction: Each item in this section consists of four alternative responses A, B, C and D. For each item, choose one answer only and **circle** your answer in this test booklet.
Arahan: *Setiap item di dalam seksyen ini mengandungi empat pilihan jawapan, iaitu A, B, C dan D. Bagi setiap soalan, pilih satu jawapan sahaja dan* ***bulatkan*** *jawapan anda dalam kertas ujian ini.*

1. An acid displays its properties when it…..
Suatu asid menunjukkan sifat-sifatnya apabila ia…..

    A. ionises in water to produce H^+ ions.*
    mengion dalam air menghasilkan ion-ion H^+.

    B. ionises in propane to produce H^+ ions.
    mengion dalam propana menghasilkan ion-ion H^+.

    C. ionises in water to produce OH^- ions.
    mengion dalam air menghasilkan ion-ion OH^-.

    D. ionises in propane to produce OH^- ions.
    mengion dalam propana menghasilkan ion-ion OH^-.

[1 mark/Remembering/LO3/Pre:A12]

2. Which of the following statements is correct about the pH of a solution?
Yang mana antara pernyataan berikut benar mengenai skala pH?

    A. A solution that has pH value less than 7 is an alkaline solution.
    Larutan yang mempunyai nilai pH kurang daripada 7 adalah larutan beralkali.

    B. A solution that has pH value more than 7 is an acidic solution.
    Larutan yang mempunyai nilai pH lebih daripada 7 adalah larutan berasid.

    C. A solution that has pH value equal to 7 is a neutral solution.*
    Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan neutral.

    D. A solution that has pH value equal to 7 is an alkaline solution.
    Larutan yang mempunyai nilai pH bersamaan 7 adalah larutan beralkali.

[1 mark/Remembering/LO7/Pre:A6]

3. Which of the following equations correctly describes the relationship between concentration (g dm^{-3}) and molarity (mol dm^{-3})?
Yang mana antara persamaan berikut adalah betul menggambarkan hubungan di antara kepekatan (g dm^{-3}) dan kemolaran (mol dm^{-3})?

A. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Concentration (g dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$ *
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Kepekatan (g dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

B. $\text{Molarity (mol dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Concentration (g dm}^{-3})}$
$\text{Kemolaran (mol dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kepekatan (g dm}^{-3})}$

C. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molarity (mol dm}^{-3})}{\text{Molar mass (g mol}^{-1})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Kemolaran (mol dm}^{-3})}{\text{Jisim molar (g mol}^{-1})}$

D. $\text{Concentration (g dm}^{-3}) = \dfrac{\text{Molar mass (g mol}^{-1})}{\text{Molarity (mol dm}^{-3})}$
$\text{Kepekatan (g dm}^{-3}) = \dfrac{\text{Jisim molar (g mol}^{-1})}{\text{Kemolaran (mol dm}^{-3})}$

[1 mark/Remembering/LO15/Pre:A7]

4. Which of the following solutions has the lowest pH value?
Yang mana antara larutan berikut mempunyai nilai pH paling rendah?

A. 20 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
20 cm^3 asid sulfurik 2.0 mol dm^{-3}.

B. 20 cm^3 of 3.0 mol dm^{-3} sulphuric acid.*
20 cm^3 asid sulfurik 3.0 mol dm^{-3}.

C. 50 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
50 cm^3 asid sulfurik 2.0 mol dm^{-3}.

D. 100 cm^3 of 2.0 mol dm^{-3} sulphuric acid.
100 cm^3 asid sulfurik 2.0 mol dm^{-3}.

[1 mark/Analysing/LO19/Pre:A5]

5. Distilled water is added to 50 cm^3 of 2 mol dm^{-3} potassium hydroxide solution to produce 250 cm^3 of potassium hydroxide solution. What is the concentration of the potassium hydroxide solution produced?
Air suling ditambahkan kepada 50 cm^3 larutan kalium hidroksida 2 mol dm^{-3} untuk menghasilkan 250 cm^3 larutan kalium hidroksida. Apakah kepekatan larutan kalium hidroksida yang dihasilkan?

A. 0.3 mol dm^{-3}.

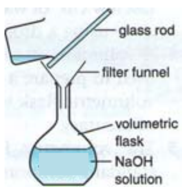
B. 0.4 mol dm^{-3}.*

C. 0.5 mol dm^{-3}.

D. 0.6 mol dm^{-3}.

[1 mark/Analysing/LO20/Pre:A8]

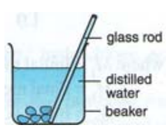
6. The diagrams below, **not** necessarily in the correct order, show five steps involved in the preparation of a standard solution of sodium hydroxide, NaOH.
*Gambarajah di bawah **tidak** semestinya disusun dalam turutan yang betul menunjukkan lima langkah yang terlibat dalam penyediaan suatu larutan piawai sodium hidroksida, NaOH.*

I. 

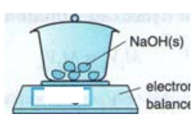
The aqueous NaOH solution is transferred to a volumetric flask.
Larutan NaOH akues dipindahkan ke dalam kelalang isipadu.

II. 

Distilled water is added up to the graduation mark.
Air suling ditambahkan sehingga ke penanda aras.

III. 

NaOH solid is dissolved using distilled water.
Pepejal NaOH dilarutkan menggunakan air suling.

IV. 

NaOH solid is weighed.
Pepejal NaOH ditimbang.

V. 
The NaOH solution is shaken.
Larutan NaOH digoncang.

Which of the following is the correct order of steps in the preparation of a standard solution of sodium hydroxide, NaOH?
Yang mana antara berikut adalah turutan langkah yang betul dalam penyediaan larutan piawai sodium hidroksida, NaOH?

A. I, III, IV, II, V.

B. III, V, I, II, IV.

C. IV, III, I, II, V.*

D. II, I, III, V, IV.

[1 mark/Applying/LO17/Pre:A4]

7. Which of the following is **not** a step in the procedure to prepare a solution with a specified concentration using the dilution method?
*Yang manakah antara berikut **bukan** merupakan langkah penyediaan larutan dengan kepekatan tertentu menggunakan kaedah pencairan?*

A. Distilled water is added to the volumetric flask until the graduation mark.
Air suling ditambahkan ke dalam kelalang isipadu sehingga ke penanda aras.

B. A few drops of universal indicator solution are added into the volumetric flask.*
Beberapa titis larutan penunjuk semesta ditambahkan ke dalam kelalang isipadu.

C. The volume of stock solution required is calculated.
Isipadu larutan stok yang diperlukan dikira.

D. The required volume of stock solution is transferred into the volumetric flask using a pipette.
Isipadu larutan stok yang diperlukan dipindahkan ke dalam kelalang isipadu menggunakan pipet.

[1 mark/Understanding/LO18/Pre:A9]

8. Which of the following apparatus might **not** be needed for a titration experiment?
*Yang manakah antara radas berikut mungkin **tidak** diperlukan dalam eksperimen pentitratan?*

A. Pipette.
Pipet.

B. White tile.
Jubin putih.

C. Retort stand.
Kaki retot.

D. Test tube.*
Tabung uji.

[1 mark/Remembering/LO24/Pre:A3]

9. Which of the following equations most accurately describes the neutralisation reaction between the acid, HA, and magnesium hydroxide?
Yang mana antara persamaan berikut paling tepat menggambarkan tindakbalas peneutralan di antara asid, HA, dan magnesium hidroksida?

A. $Mg(OH)_2 + HA \rightarrow MgA_2 + H_2O$

B. $Mg(OH)_2 + 2HA \rightarrow MgA_2 + 2H_2O$*

C. $MgA_2 + H_2O \rightarrow Mg(OH)_2 + HA$

D. $MgA_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HA$

[1 mark/Understanding/LO23/Pre:A10]

10. A group of chemistry students carried out an experiment in the school laboratory to determine the concentration of a hydrochloric acid solution by titration. In order to do that, they added a few drops of phenolphthalein indicator solution into 25 cm^3 of 1.5 mol dm^{-3} sodium hydroxide solution. The alkali solution was then titrated with the acid solution. The average volume of the hydrochloric acid solution used for this experiment was found to be 28.15 cm^3. What is the concentration of the hydrochloric acid solution used in this experiment?
Sekumpulan pelajar kimia telah menjalankan suatu eksperimen di makmal sekolah untuk menentukan kepekatan suatu larutan asid hidroklorik melalui pentitratan. Untuk itu, mereka telah menambahkan beberapa titis larutan penunjuk phenolphthalein ke dalam 25 cm^3 larutan sodium hidroksida 1.5 mol dm^{-3}. Larutan alkali itu kemudiannya telah dititratkan dengan larutan asid tersebut. Isipadu purata bagi larutan asid hidroklorik yang digunakan dalam ekperimen ini didapati sebanyak 28.15 cm^3. Apakah kepekatan larutan asid hidroklorik yang digunakan dalam eksperimen ini?

A. 2.35 mol dm^{-3}.

B. 2.30 mol dm^{-3}.

C. 1.82 mol dm^{-3}.

D. 1.33 mol dm^{-3}.*

[1 marks/Analysing/LO26/Pre:A2]

11. When a standard solution of specific concentration is diluted, the concentration of the solution will _____, while the number of moles of solute present will be _____.
Apabila suatu larutan piawai berkepekatan tertentu dicairkan, kepekatan larutan tersebut akan _____, manakala bilangan mol bahan terlarut yang hadir akan _____.

A. increase; decrease
bertambah; berkurang

B. increase; constant
bertambah; tetap sama

C. decrease; constant*
berkurang; tetap sama

D. decrease; decrease
berkurang; berkurang

[1 mark/Understanding/LO16/Pre:A11]

12. Aqueous potassium hydroxide reacts with _____ to produce a salt and water.
Kalium hidroksida akues boleh mengalami tindakbalas dengan _____ untuk menghasilkan garam dan air.

A. Glacial acetic acid.
Asid asetik glasial.

B. Aqueous sodium chloride.
Sodium klorida akues.

C. Dilute nitric acid.*
Asid nitrik cair.

D. Aqueous magnesium hydroxide.
Magnesium hikdrosida akues.

[1 mark/Understanding/LO5/Pre:A1]

Section B
Seksyen B

Instruction: Each item of this section has two parts, a multiple-choice content response followed by a multiple-choice reason response. For each item, choose your most appropriate response from the first part and **circle** your answer A, B, C, etc. Then choose one of the reasons from the second part that best matches your answer to the first part and **circle** your answer 1, 2, 3, etc. If you do **not** agree with any of the given reasons, please write your reason in the space provided.
Arahan: *Setiap item daripada seksyen ini terdiri daripada dua bahagian, kandugan respon aneka pilihan diikuti sebab aneka pilihan. Bagi setiap item, buat pilihan yang sesuai daripada bahagian pertama dan* ***bulatkan*** *jawapan anda samada A, B, C, atau sebagainya. Kemudian pilih salah satu sebab di bahagian kedua yang sepadan dengan jawapan anda di bahagian pertama dan* ***bulatkan*** *jawapan anda samada 1, 2, 3, atau sebagainya. Sekiranya anda* ***tidak*** *bersetuju dengan mana-mana sebab yang diberikan, sila tulis sebab anda di ruang yang disediakan.*

1. Chemical X shows the following properties:
   Bahan kimia X menunjukkan ciri-ciri berikut:

   ✓ Tastes bitter and feels soapy.
   Berasa pahit dan licin.

   ✓ Turns red litmus paper blue.
   Menukarkan kertas litmus merah kepada biru.

   ✓ Reacts with an acid to produce a salt and water.
   Bertindakbalas dengan asid untuk menghasilkan garam dan air.

   ✓ Produces ammonia gas when heated with an ammonium salt.
   Menghasilkan gas ammonia apabila dipanaskan dengan garam ammonium.

   ✓ Reacts with an aqueous salt solution to produce a metal hydroxide.
   Bertindakbalas dengan larutan garam akues untuk menghasilkan logam hidroksida.

   Which of the following is most probably chemical X?
   Yang mana antara berikut paling berkemungkinan bahan kimia X?

   A. Dry ammonia gas.
   Gas ammonia kering.

   B. Sodium hydroxide dissolved in propane.
   Sodium hidroksida larut dalam propana.

   C. Glacial acetic acid.
   Asid asetik glasial.

   D. Aqueous calcium hydroxide.*
   Kalsium hidroksida akues.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Chemical X could ionise in water to produce H^+ ions.
   Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion H^+.

2. Chemical X could ionise in water to produce OH^- ions.*
   Bahan kimia X boleh mengion di dalam air untuk menghasilkan ion-ion OH^-.

3. Chemical X could ionise to produce OH^- ions in the absence of water.
   Bahan kimia X boleh mengion untuk menghasilkan ion-ion OH^- tanpa kehadiran air.

4. Chemical X is soluble in water.
   Bahan kimia X larut di dalam air.

5. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Understanding/LO4/Pre:B10]

2. The table shows the pH value of four aqueous solutions, P, Q, R, and S.
   Jadual di bawah menunjukkan nilai pH bagi empat larutan, P, Q, R, dan S.

Solution/*Larutan*	P	Q	R	S
pH value/*Nilai pH*	13	7	3	9

Which of the following solutions will react with calcium carbonate to produce carbon dioxide gas?
Yang manakah antara larutan tersebut akan bertindakbalas dengan kalsium karbonat untuk menghasilkan gas karbon dioksida?

A. P

B. Q

C. R*

D. S

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The solution contains a higher concentration of OH^- ions than H^+ ions.
   Larutan tersebut mengandungi kepekatan ion-ion OH^- yang lebih tinggi berbanding ion-ion H^+.

2. The solution contains a higher concentration of H^+ ions than OH^- ions.*
   Larutan tersebut mengandungi kepekatan ion-ion H^+ yang lebih tinggi berbanding ion-ion OH^-.

3. The solution contains equal concentrations of H^+ and OH^- ions.
   Larutan tersebut mengandungi kepekatan ion-ion H^+ dan ion-ion OH^- yang sama.

4. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Understanding/LO5/Pre:B5]

3. When methyl orange indicator in a titration experiment turns yellow, this indicates the reaction between acid solution and alkali solution has reached its end point.
   Apabila penunjuk metil oren dalam suatu eksperimen pentitratan bertukar ke warna kuning, ini menunjukkan tindakbalas antara larutan asid dan larutan alkali telah mencapai takat akhir.

   A. True.
   Betul.

   B. False.*
   Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Methyl orange turns yellow because neutralisation has occurred.
   Metil oren bertukar ke warna kuning kerana peneutralan telah berlaku.

2. Methyl orange turns yellow because water and a salt are present in the solution.
   Metil oren bertukar ke warna kuning kerana terdapat kehadiran air dan garam dalam larutan tersebut.

3. Methyl orange turns yellow because there is an excess of alkali in the solution.*
   Metil oren bertukar ke warna kuning kerana terdapat lebihan alkali dalam larutan tersebut.

4. Methyl orange turns yellow because there is an excess of acid in the solution.
Metil oren bertukar ke warna kuning kerana terdapat lebihan asid dalam larutan tersebut.

5. Other reason:
Sebab lain:

____

____

[1 mark/Understanding/LO25/Pre:B6]

4. What is the main apparatus that is used in the preparation of a standard solution?
Apakah radas utama yang digunakan dalam penyediaan suatu larutan piawai?

A. Volumetric flask*
Kelalang isipadu.

B. Beaker
Bikar.

C. Measuring cylinder
Silinder penyukat.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. It is easier to dissolve the solute by shaking.
Ia memudahkan bahan terlarut melarut dengan menggoncang.

2. It prevents the solution from splashing out.
Ia dapat mengelakkan larutan tersebut daripada terpercik keluar.

3. It can measure a fixed volume of solution more accurately.*
Ia dapat menyukat isipadu tetap larutan dengan lebih tepat.

4. Other reason:
Sebab lain:

____

____

[1 mark/Applying/ LO17/Pre:B4]

5. Both sulphuric acid and ethanoic acid are strong acids.
Kedua-dua asid sulfurik dan asid etanoik adalah asid kuat.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Sulfuric acid ionises completely in water to produce H^+ ions, while ethanoic acid ionises partially in water to produce H^+ ions.*
Asid sulfurik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid etanoik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

2. Ethanoic acid ionises completely in water to produce H^+ ions, while sulfuric acid ionises partially in water to produce H^+.
Asid etanoik mengion lengkap di dalam air untuk menghasilkan ion-ion H^+, manakala asid sulfurik mengion separa di dalam air untuk menghasilkan ion-ion H^+.

3. Both acids ionise completely in water to produce H^+ ions.
Kedua-dua asid tersebut mengion lengkap di dalam air untuk menghasilkan ion-ion H^+.

4. Both acids ionise partially in water to produce H^+ ions.
Kedua-dua asid tersebut mengion separa di dalam air untuk menghasilkan ion-ion H^+.

5. Other reason:
Sebab lain:

____

____

[1 mark/Analysing/ LO10/Pre:B7]

6. Two common substances that have the formulas HCl and CH_4 both contain the element hydrogen. However, only HCl has acidic properties while CH_4 does **not**.
Dua bahan yang biasa ditemui mempunyai formula HCl dan CH_4 yang mana kedua-duanya mengandungi unsur hidrogen. Walaubagaimanapun, hanya HCl menunjukkan sifat-sifat asid tetapi CH_4 ***tidak****.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. CH_4 completely ionises to produce more H^+ ions in water than HCl.
   CH_4 mengalami ionisasi lengkap menghasilkan lebih banyak ion-ion H^+ di dalam air berbanding HCl.

2. Any substance that contains H atom in the molecular formula is acidic.
   Sebarang bahan yang mengandungi atom H di dalam formula molekulnya adalah berasid.

3. Only HCl ionises to produce H^+ ions in water.*
   Hanya HCl yang mengalami ionisasi di dalam air untuk menghasilkan ion-ion H^+.

4. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Understanding/LO1/Pre:B3]

7. What is a property of citrus fruits like oranges and lemons?
   Apakah sifat buah-buahan sitrus seperti oren dan lemon?

   A. Acidic.*
      Berasid.

   B. Basic.
      Berbes.

   C. Neutral.
      Neutral.

   The reason for my answer is:
   Sebab bagi jawapan saya adalah:

   1. Citrus fruits have pH value less than 7.*
      Buah-buahan sitrus mempunyai nilai pH kurang daripada 7.

   2. Citrus fruits have pH values greater than 7.
      Buah-buahan sitrus mempunyai nilai pH lebih daripada 7.

   3. Citrus fruits have pH values equal to 7.
      Buah-buahan sitrus mempunyai nilai pH bersamaan 7.

4. Other reason:
Sebab lain:

___

___

[1 mark/Understanding/LO7/Pre:B8]

8. Soaps and detergents as well as household cleaners for floors, ovens and glass windows contain alkaline chemicals like sodium hydroxide and ammonia, but **not** acids.
*Sabun, deterjen, dan juga bahan-bahan pembersih rumah untuk lantai, oven, dan cermin tingkap mengandungi bahan kimia alkali seperti sodium hidroksida dan amonia, tetapi **bukan** asid.*

A. True.*
Betul.

B. False.
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Alkalis are soapy and so are able to wash away stains.
Sifat alkali yang licin membolehkan kotoran dibersihkan.

2. Acids are more corrosive than alkalis and so are more effective in removing stains.
Asid adalah lebih korosif berbanding alkali yang mana lebih efektif menanggalkan kotoran.

3. Alkalis dissolve grease and oils present in dirt more readily than acids.*
Alkali dapat melarutkan gris dan minyak yang hadir dalam kotoran lebih mudah berbanding asid.

4. Acids are able to neutralise alkalis present in dirt.
Asid dapat meneutralkan alkali yang hadir dalam kotoran.

5. Other reason:
Sebab lain:

___

___

[1 mark/Applying/LO2/Pre:B2]

9. If soil is too acidic, it is not likely to support the healthy growth of grass. What chemical would you add to the soil to promote the growth of grass?
Jika tanah terlalu berasid, ia dikatakan tidak menyokong pertumbuhan rumput yang sihat. Apakah bahan kimia yang boleh anda tambahkan kepada tanah tersebut untuk menggalakkan pertumbuhan rumput?

A. Common salt.
Garam biasa.

B. Vinegar.
Cuka.

C. Lime (calcium oxide).*
Kapur (kalsium oksida).

D. Caustic soda.
Soda kaustik.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. The basic substance neutralises the acidic soils.*
Bahan berbes tersebut dapat meneutralkan keasidan tanah.

2. The basic substance changes the soil acidity to a pH value greater than 7.
Bahan berbes tersebut mengurangkan keasidan tanah sehingga nilai pH melebihi 7.

3. The acidic substance changes the pH of soil closer to the ideal pH.
Bahan berasid tersebut menukarkan pH tanah mendekati nilai pH yang ideal.

4. Other reason:
Sebab lain:

____

____

[1 mark/Applying/LO22/Pre:B9]

10. Aqueous solutions of potassium hydroxide as well as ammonia are both weak alkalis.
Kedua-dua larutan akues kalium hidroksida dan juga amonia adalah alkali lemah.

A. True.
Betul.

B. False.*
Salah.

The reason for my answer is:
Sebab bagi jawapan saya adalah:

1. Aqueous potassium hydroxide is completely ionised in water, while aqueous ammonia is only partially ionised.*
   Kalium hikdroksida akues mengalami ionisasi lengkap di dalam air, manakala ammonia akues hanya mengalami ionisasi separa.

2. Potassium hydroxide and ammonia are only partially ionised in water.
   Kalium hidroksida dan amonia hanya mengalami ionisasi separa di dalam air.

3. Aqueous ammonia, NH_3, is not an alkali because it does not contain OH^- ions in its formula.
   Amonia akues, NH_3, adalah bukan alkali kerana ia tidak mengandungi ion-ion OH^- di dalam formulanya.

4. Potassium hydroxide and ammonia ionise completely in water.
   Kalium hidroksida dan amonia mengalami ionisasi lengkap di dalam air.

5. Other reason:
   Sebab lain:

   ____

   ____

[1 mark/Analysing/ LO11/Pre:B1]

Test End.
Ujian Tamat.

Thank You!
Terima Kasih!

APPENDIX R: Result of the Factor Analysis of the Student Edition of the QEC

Pattern Matrix[a]

	Component			
	1	2	3	4
AL_B19	.775			
MC_B20	.687			
LA_B12	.623			
TT_B9	.539			
LA_B10	.515			
AI_B21	.513		-.405	
LA_B15	.508			.332
MC_B18	.491		-.381	
CI_B6		.765		
CI_B4		.654		
CI_B5		.627		
CI_B7		.613		
CI_B2		.587		-.312
CI_B3		.575		
TT_B8		.531		
TT_B1		.486		
AI_B26			-.748	
AI_B23			-.695	
MC_B22			-.673	
AL_B25			-.657	
AI_B24			-.622	
TT_B13				.623
TT_B11				.610
AL_B16			-.366	.492
LA_B14	.437			.447
AL_B17				.301

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 16 iterations.