A Study of Science Curriculum Implementation in Secondary School in Thailand

A thesis submitted to the University of Manchester for the degree of Doctor of Philosophy in the Faculty of Humanities

2015

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# TABLE OF CONTENTS

LIST OF TABLES..............................................................................................................7
LIST OF FIGURES.............................................................................................................8
LIST OF ABBREVIATIONS...............................................................................................9
ABSTRACT......................................................................................................................13
DECLARATION................................................................................................................14
COPYRIGHT STATEMENT...............................................................................................15
ACKNOWLEDGEMENT..................................................................................................16
INTRODUCTION TO THE THESIS..................................................................................18
CHAPTER 1: THE CONTEXT FOR THE STUDY: LITERATURES

AND POLICY CONTEXTS.................................................................................................20
1.1 Overview of Thailand Education System.................................................................20
  1.1.1 The First Phase of Education Reform (1868-1910)............................................22
  1.1.2 The Second Phase of Education Reform (1973-1980).....................................23
  1.1.3 The Third Phase of Education Reform (1997-2010)........................................25
  1.1.4 Current Situation of Thai Education ...............................................................27
1.2 International Development in Science Teaching....................................................35
  1.2.1 Developments in England and Wales: Role of Science..................................40
  1.2.2 Science Curriculum in the US: Shock of Sputnik...........................................52
  1.2.3 Developments in Europe: Changing World......................................................62
  1.2.4 Problems of Developing Countries: Example of Malawi..............................65
  1.2.5 Summary and Key Themes..............................................................................71
1.3 Curriculum Theory and Science Education...........................................................74
  1.3.1 Types of Curriculum......................................................................................76
CHAPTER 3: RESEARCH FINDINGS

3.1 Analysis of Science Classroom Observation

3.2 Results from the Analysis of Science Classroom Observation Data
   3.2.1 Combination of SCL and TCL with a Tendency towards SCL
   3.2.2 Combination of SCL and TCL with a Tendency towards TCL
   3.2.3 Teacher-Centred Learning (TCL)

3.3 Analysis of Science Teachers Interviews
   3.3.1 Perspectives on the Reform
      3.3.1.1 Policy Failure
      3.3.1.2 Social/Economic Failure
      3.3.1.3 Teacher/School-Related Factors
      3.3.1.4 Parental Attitudes and Understanding
   3.3.2 Perspectives on Implementation
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.2.1 Issues Related to School Organisation and Management</td>
<td>209</td>
</tr>
<tr>
<td>3.3.2.2 Issues Related to Teachers</td>
<td>215</td>
</tr>
<tr>
<td>3.3.2.3 Issues Related to Students</td>
<td>216</td>
</tr>
<tr>
<td>3.3.2.4 Issues Related to Families</td>
<td>221</td>
</tr>
<tr>
<td>3.3.2.5 Other Factors</td>
<td>222</td>
</tr>
<tr>
<td>3.4 Analysis of Student Focus Group Interviews</td>
<td>223</td>
</tr>
<tr>
<td>3.4.1 Students’ Attitudes on Learning/Studying Science and its Importance or Usefulness</td>
<td>223</td>
</tr>
<tr>
<td>3.4.2 Students’ View on Teaching Science</td>
<td>227</td>
</tr>
<tr>
<td>3.4.3 Students’ View on Learning/Studying Science</td>
<td>233</td>
</tr>
<tr>
<td>3.4.4 Students’ Strategy to Inquire</td>
<td>235</td>
</tr>
<tr>
<td>3.4.5 Students’ View on What Made Science Attractive to Them</td>
<td>236</td>
</tr>
<tr>
<td>3.4.6 Students’ Ways/Strategies to Manage Revision or Carry out Science Homework</td>
<td>238</td>
</tr>
<tr>
<td>3.4.7 Students’ Views on Tests/Exam in Science</td>
<td>240</td>
</tr>
<tr>
<td>3.4.8 Students’ Future Plans</td>
<td>243</td>
</tr>
<tr>
<td><strong>CHAPTER 4: DISCUSSION</strong></td>
<td>246</td>
</tr>
<tr>
<td>4.1 Major Emerging Issues</td>
<td>248</td>
</tr>
<tr>
<td>4.1.1 National, Social and Economic Context</td>
<td>248</td>
</tr>
<tr>
<td>4.1.2 The Reform Context</td>
<td>257</td>
</tr>
<tr>
<td>4.1.3 School Context</td>
<td>271</td>
</tr>
<tr>
<td>4.1.3.1 School Factors</td>
<td>277</td>
</tr>
<tr>
<td>4.1.3.2 Teachers-Related Factors</td>
<td>285</td>
</tr>
<tr>
<td>4.1.3.3 Student Related Factors</td>
<td>296</td>
</tr>
<tr>
<td>4.2 Research Questions</td>
<td>299</td>
</tr>
</tbody>
</table>
4.2.1 What do heads of science departments and science teachers think about the changes?....................................................................................................................300

4.2.2 Has science teaching in these schools changed since the third reform? How has it changed?..................................................................................303

4.2.3 What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?..........305

CHAPTER 5: CONCLUSIONS AND POLICY RECOMMENDATIONS.....309

REFERENCES........................................................................................................326

Appendix 1: Teacher participant information sheet..............................................355
Appendix 2: Teacher consent form........................................................................358
Appendix 3: Student participant information sheet.............................................359
Appendix 4: Student consent form........................................................................362
Appendix 5: Science Lesson Observation Schedule..........................................363
Appendix 6: Interview Schedule for Semi-structured Interview..........................364
Appendix 7: Student Focus Group Interview Schedule......................................366
Appendix 8: Tally of frequency of teaching approach occurred in the science lesson observations.................................................................368
Appendix 9: Information of teacher interviewees..................................................369

Word count: 87,741 words
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Transformation Ratio of Primary Students</td>
<td>30</td>
</tr>
<tr>
<td>Table 2</td>
<td>Transformation Ratio of Lower Secondary Students to Upper Secondary Level</td>
<td>31</td>
</tr>
<tr>
<td>Table 3</td>
<td>Transformation Ratio of Lower Secondary Students to Vocational Education Level</td>
<td>32</td>
</tr>
<tr>
<td>Table 4</td>
<td>Samples of Coding</td>
<td>151</td>
</tr>
<tr>
<td>Table 5</td>
<td>Sample of Main Ideas Generated</td>
<td>152</td>
</tr>
<tr>
<td>Table 6</td>
<td>Sample of Codes Generated</td>
<td>157</td>
</tr>
<tr>
<td>Table 7</td>
<td>Sample of Themes Generated</td>
<td>165</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1  Model of curriculum development.................................83
Figure 2  Flowchart of Research Design........................................121
Figure 3  Procedures of Data Collection........................................141
Figure 4  Procedures of Data Analysis............................................147
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAAS</td>
<td>American Association for the Advancement of Science</td>
</tr>
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<td>ASE</td>
<td>Association for Science Education</td>
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<tr>
<td>AYP</td>
<td>Adequately Yearly Progress</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<td>EBL</td>
<td>Enquiry-based learning</td>
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<td>ESA</td>
<td>Educational Service Areas</td>
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<td>EU</td>
<td>European Union</td>
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<tr>
<td>GCE</td>
<td>General Certificate of Education</td>
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<td>GCSE</td>
<td>General Certificate of Secondary Education</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GERM</td>
<td>Global Education Reform Movement</td>
</tr>
<tr>
<td>GNI</td>
<td>Gross National Income</td>
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<td>HRD</td>
<td>Human Resource Development</td>
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<td>ICT</td>
<td>Information and communications technology</td>
</tr>
<tr>
<td>IMD</td>
<td>International Institute for Management Development</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Pest Management</td>
</tr>
<tr>
<td>IPST</td>
<td>Institute for the Promotion of Teaching Science and Technology</td>
</tr>
<tr>
<td>IQ</td>
<td>Intelligence Quotient</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>JCE</td>
<td>Junior Certificate of Education</td>
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<td>KPI</td>
<td>Key Performance Index</td>
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<td>LEA</td>
<td>Local Education Authority</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>MOE</td>
<td>Ministry of Education</td>
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<td>MOI</td>
<td>Ministry of Interior</td>
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<td>MSCE</td>
<td>Malawian Secondary Certificate of Education</td>
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<td>NCTL</td>
<td>National College and Teaching and Leadership</td>
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<td>NEA</td>
<td>National Education Acts</td>
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<td>NEPAD</td>
<td>New Partnership for African’s Development</td>
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<td>NESDB</td>
<td>National Economic and Social Development Board</td>
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<tr>
<td>NICHD</td>
<td>Institute of Child Health and Human Development</td>
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<td>NIETS</td>
<td>National Institute of Educational Testing Service</td>
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<tr>
<td>NRC</td>
<td>National Research Council</td>
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<td>NSTA</td>
<td>National Science Teachers Association</td>
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<tr>
<td>O-NET</td>
<td>Ordinary National Education Test</td>
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<td>OBEC</td>
<td>Office of the Basic Education Commission</td>
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<td>OCSC</td>
<td>Office of the Civil Service Commission</td>
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<td>OEC</td>
<td>Office of the Education Council</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OFSTED</td>
<td>Office for Standards in Education, Children’s Services and Skills</td>
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<td>OHEC</td>
<td>Office of the Higher Education Commission</td>
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<td>ONEC</td>
<td>Office of the National Education Commission</td>
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<tr>
<td>ONESQA</td>
<td>Office for National Education Standards and Quality Assessment</td>
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<td>OPEC</td>
<td>Office of the Private Education Commission</td>
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<td>OTEPC</td>
<td>Office of the Teacher Civil Service and Educational Personnel Commission</td>
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<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>PBL</td>
<td>Problem-based learning</td>
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<td>PC</td>
<td>Personal Computer</td>
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<td>PCK</td>
<td>Pedagogical Content Knowledge</td>
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<tr>
<td>PGCE</td>
<td>Postgraduate Certificate in Education</td>
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<tr>
<td>PIRLS</td>
<td>Progress in International Reading Literacy Study</td>
</tr>
<tr>
<td>PISA</td>
<td>Programme for International Student Assessment</td>
</tr>
<tr>
<td>PPP</td>
<td>Purchasing Power Parity</td>
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<tr>
<td>QA</td>
<td>Quality Assurance</td>
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<tr>
<td>QTS</td>
<td>Qualified Teacher Status</td>
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<td>SAO</td>
<td>Sub-district Authority Organization</td>
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<td>SCL</td>
<td>Student-Centred Learning</td>
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<td>SEO</td>
<td>Schools of Expanded Opportunity</td>
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<td>SES</td>
<td>Socioeconomic status</td>
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<td>SSCR</td>
<td>Secondary Science Curriculum Review</td>
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<tr>
<td>STEM</td>
<td>Science, Technology, Engineering, and Mathematics</td>
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<tr>
<td>STS</td>
<td>Science-Technology-Society</td>
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<tr>
<td>TALULAR</td>
<td>Teaching and Learning Using Locally Available Resources</td>
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<td>TCL</td>
<td>Teacher-Centred Learning Approach</td>
</tr>
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<td>TDRI</td>
<td>Thailand Development Research Institute</td>
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<tr>
<td>TEF</td>
<td>Thailand Education Fund</td>
</tr>
<tr>
<td>TIMSS</td>
<td>Third International Mathematics and Science Survey</td>
</tr>
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<td>UK</td>
<td>United Kingdom</td>
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<td>UN</td>
<td>United Nations</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
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</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational, Scientific and Cultural Organization</td>
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<td>UREC</td>
<td>University Research Ethic Committee</td>
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<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>USD</td>
<td>United States Dollar</td>
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<tr>
<td>ZFI</td>
<td>Zone of Feasible Innovation</td>
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</tbody>
</table>
ABSTRACT

Educational reform has been perceived as a process whereby the Thai Government expects to increase the national competitiveness and stimulate literacy across the country. Its crucial concept was to implement the student-centred learning approach (SCL). This study presents an analysis of classroom observation focusing on lower secondary (Mattayom 1-3) science classrooms in 14 schools located in a rural area in Thailand and discusses the implementation of the current science curriculum. Additionally, a thematic analysis of interviews with lower secondary school science teachers and focus group interviews of students are presented. Based on the thematic analysis, perceptions of 22 science teachers on the current science curriculum implementation and prospective factors which tend to deteriorate the effectiveness of curriculum implementation are addressed. Like the teachers’ interviews, students’ perceptions regarding science and benefit of studying science are obtained from 30 groups of students, using the thematic analysis and are presented in this study. Based on the observations of 22 science classrooms, teachers’ practices in implementing the current science curriculum in the rural context can be categorised, based on their inclination towards particular learning approaches, into three groups; namely combination of the student-centred learning (SCL) approach and the teacher-centred learning (TCL) approach with a tendency towards SCL, combination of SCL and TCL with a tendency towards TCL ,and the teacher-centred learning (TCL).The teachers’ perceptions could be described into two perspectives; namely on the reform and on implementation, and each perspective can be classified into several themes, and the major issues emerged are discussed. The students’ perceptions can be categorised into eight themes such as attitudes regarding learning/studying science, future plans, etc.. The study is expected to contribute to the understanding of current science teaching and improving its practices for the science teachers in Thailand. Eventually, these experiences could be an example for other transitional countries in the wider context.
DECLARATION

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ACKNOWLEDGEMENTS

The completion of my Ph.D. thesis has been a long journey, and it has been a truly life-changing experience for me. It would not have been possible without the support and guidance that I received from many people.

First and foremost, I would like to express my special appreciation and heartfelt thanks to my first supervisor Professor Mel West, who has been a tremendous mentor for me. I would like to thank him for his encouragement I received throughout my research work, the advice, ideas, moral support and patience in guiding me and for allowing me to grow as an educational researcher. His advice has been invaluable.

I would also like to thank my second supervisor, Dr. Liz Smith for guiding me through all these years. Her understanding, supports, encouragement and attention I received also helped me through my entire journey.

Special thanks go out to Professor Dr. M.R. Jisnuson Svasti. His helps and supports encouraged me to commence my academic life and he is the one who has shown me what the “real teacher” looks like.

My thanks also go out to the supports I received from Associate Professor Dr. Bhinyo Panijpan, Associate Professor Dr. Pintip Ruenwongsa and Associate Professor Dr. Wannapong Triampo. Without them, my journey would be more complicated.

I would also like to thank Assistant Professor Dr. Namkang Sriwattanarothai and Assistant Professor Dr. Watcharee Ketpichainarong. Both of them supported me when I recruited participants and collected data for my Ph.D. thesis.

My friends in Thailand, Edinburgh and Manchester are also credited. Mental supports and encouragements from all of them helped me through all many years of hard work.

Words cannot express how grateful I am to my mother, Mrs. Suwattana Siriwat and father, Senior Colonel Anan Siriwat. Special thanks to them for all of the sacrifices
and unconditional supports that they have made on my behalf. Your loves and encouragements are what sustains me thus far.
INTRODUCTION TO THE THESIS

Thailand is living in the blend of the three centuries. If you are in the south where the majority of businesses are tourist-related and there are tourists, pubs and beaches, you face the 20th century’s problems such as pollutions and environmental degradation. Then it is said to be in the 20th century area. When you move towards the middle of the country, where an industrial revolution is taking place and in Thailand, that is the 21st century phenomena. In the north, people are still living in the 19th century. There are still a lot of natural forests and some world heritage sites which are preserved.

Bangkok is the capital city, surrounded by pollutions and concrete jungles. There is a belt between Bangkok and other parts that is scheduled for developments. This place is where people are moving from the lands into the factories and it is more prosperous. That is where the industrial revolution is taking place, and, of course, that is where parents want their children to get a job after leaving schools. That is where the government wants international companies to build factories. This area is occupied by factories or is reserved for building factories. That is what the 21st century Thailand looks like. The south earns income from tourists, and Thailand tries to boost the economy by industrialising the central of country and surrounding areas while keeping the north preserved as UN’s world heritage sites. The 20th century part of Thailand is the holiday industry with the islands in the south. That is the main industry in the 20th century.

Disparity of development is a common problem in many Asian countries, such as India and Vietnam. In Thailand, it is very difficult to quickly develop the whole country, and one of the problems is transportation. In order to get from the far south to the far north in Thailand, you really need vehicles with four-wheel drive. You can make a trip in a land rover, but you would not set out by using a normal car from Bangkok to the far south. Your options are limited. What you can do is to follow the road and read signs. You cannot step off the road because many places are dirt roads.
From what are described above, it clearly reflects that modernization has taken place in Thailand. However, the progress of modernization is not evenly distributed throughout the country. Few things have been left behind and one of those things is ‘public schooling’.

In Thailand, the quality of public schooling, particularly in rural schools is one of topics that have been widely discussed. The Thai government by Ministry of Education attempts to improve the situation by introducing various strategies. However, it seems that the situation has not manifested a sign of significant improvement. This issue leads to the construction of this research and what will be described in this thesis will provide clues of why Thai education, particularly public schooling in rural areas, did not show a sign of quality improvement.
CHAPTER 1
THE CONTEXT FOR THE STUDY: LITERATURES AND POLICY CONTEXTS

1.1 Overview of Thailand’s Education System and Context

For Thailand, the Gross National Income (GNI) per capita in 2014 was, based on PPP (Purchasing Power Parity), 14,870 USD (World Bank, 2014b). This means the comparable average income per head of Thai citizen was 14,870 USD per year. In addition, Gross Domestic Product (GDP) of Thailand was 404,824 million USD which ranked the 29th among 195 countries (World Bank, 2014a).

Currently, the formal education of Thailand is divided into early education for children aged 3-5, basic education, vocational and technical education, and higher education. The basic education consists of 6 years of primary education (year 1-6 or Pratom 1-6), followed by 3 years of lower secondary education (year 7-9 or Mattayom 1-3) and 3 years of upper secondary education (year 10-12 or Mattayom 4-6). Thai education provides 12 years of the free basic education to all children aged 6 to 17, 9 years of which are compulsory education. Eight core subjects that have been stated in the National Curriculum include: Thai language, mathematics, science, social studies, health and physical education, arts, careers and technology, and foreign languages (Ministry of Education Thailand [MOE], 2008).

Regularly, students who are continuing their study beyond compulsory education will complete further three years of upper secondary level and then choose either applying for a job or pursuing the higher education. Students will take the National Examination or O-NET at the end of Pratom 3, Pratom 6 and Mattayom 3. However, the students are also required to take a final examination at the end of Pratom 6, Mattayom 3 and Mattayom 6 (only for those who pursue general upper secondary education). Students who pass this examination will obtain a Certificate of Primary Education, a Certificate of Lower Secondary Education and a Certificate of Secondary Education, respectively. For those students who obtain the Certificate of
Lower Secondary Education, they can choose to continue to either general upper secondary education or vocational upper secondary education. For the vocational education, there are two most common certificates that may be awarded which are the Certificate in Vocational Education and the Certificate in Dual Vocational Education (N. Clark, 2014).

According to the announcement issued by the Ministry of Education of Thailand, an allowance class size for pre-school education is 30 students per class, for primary education is 30 students per class and for secondary education is 40 students per class (Ramasutra & Rohitsatiern, 2015). In addition, 200 school days are required each year (N. Clark, 2014). The average number of students per teacher in primary school in 2012 was 16 (UNESCO Institute for Statistics, 2016a), and the average number of students per teacher in secondary school in 2011 was 20 (UNESCO Institute for Statistics, 2016b).

Nowadays, there are two systems of teacher training in Thailand. The first system is 5-years programme in Faculty of Education and the second programme is 4+1 programmes consisting of 4 years in Faculty of Science (for prospective science teacher) or other faculties and one year of post-baccalaureate diploma in teacher training. All teacher trainee candidates are required to undertake an entrance examination to enter pre-service teacher education programme regardless public universities or Rajabhat Universities (formerly known as teacher colleges). In order to complete the 5-years programme, the minimum credits required are 30 for general education subjects, 46 credits for teaching profession and pedagogy-related subjects, 76 credits for subjects of specialisation and 6 credits for elective courses with the addition of 1 year student teaching or professional practice. In order to complete the 4+1 programme, the minimum credits required for teaching profession and pedagogy subjects are 33 plus 1 year of student teaching. All of these requirements will be undertaken simultaneously during the 1-year post-baccalaureate diploma (The Teachers Council of Thailand, 2012).

Prior to 2013, graduates who obtain a Bachelor’s degree in Education from universities where the teacher training programme had been approved, according to the 2013 professional standard, by Board of Teacher Education were qualified for
the teaching licence automatically. For those who have started a Bachelor’s degree from 2013 onwards, they are required to undertake the test either in the last year of the Bachelor’s degree or after completing the study to obtain the teaching licence. Those who obtain Bachelor’s degree in other subjects and pursue the 4+1 programme are also required to pass the test to obtain teaching licence and become qualified for teaching (Daily News, 2014a; Thongthew, 2014). To ensure the quality of the teacher training programme, the curriculum structures as well as descriptions of the training course offered are requested to undergo a review and approve by the sub-committee members appointed by the Teacher’s Council of Thailand Board (Durongkaveroj, 2008; Thongthew, 2014).

To look at the education reform, it is necessary to consider the historical context as well as the evolution of the education reform in order to inform readers of key incidences in the development of Thai education.

1.1.1 The First Phase of Education Reform (1868 – 1910)

Thailand has undertaken educational reforms three times since 1868. The first reform was an initiative of King Chulalongkorn (King Rama V). With respect to the first reform, Human Resource Development (HRD) has become a critical consideration which the King Rama V believed contributed to the prosperity of the country (Fry & Bi, 2013). Considering the quality of human resource, education was also perceived to be an element that inevitably played a role due to its importance in creating moral dimensions of people (Fry & Bi, 2013).

This reform has led Siam (the former name of Thailand) to undergo a transformation from a traditional into modernising society and later to became contemporary Thailand (Fry & Bi, 2013). By this reform, modern secular educational system was regarded as a key scenario. This system was believed to be a system that effectively educates Thai people throughout the country. The importance of education was also recognised as the way to prepare individuals with skills particularly in commerce and English. These skills were demanded in order to support a long-standing notion that Siam held a central location in Asia and
Southeast Asia in terms of trade and commerce (Fry & Bi, 2013). Eventually, modern secular education that has been introduced to the Thai Society since late 1800s was accomplished as 29% of the male school-age group was educated by 1911, and the modern education has been served throughout the entire country by 1935 (Fry & Bi, 2013).

Issues of the education disparity in educational resources and the unequal distribution of quality educational services to remote areas have been discussed since the first reform. Furthermore, discussions regarding educational budgets allocation across the country also occurred (Fry & Bi, 2013). The reform of King Rama V has been acknowledged as a root of a highly centralised and standardised education system, which has been embedded in Thai society since then (Fry & Bi, 2013). Consequently, these two characteristics of the educational system were determined as factors contributing to failure to pursue concepts of differential local needs and cultural democracy which were developed by Ramírez and Castañeda in 1974 (Ramírez & Castaneda, 1974). Moreover, these two characteristics of the education system were also mentioned by several Thai scholars as it has contributed to uprising in northeast and the deep south of Thailand (Chalermsripinyorat, 2004; Chattip, 1984; Chalida, 2009 cited in Fry & Bi, 2013). The political unrest and insurgency in the Deep South of Thailand have been persisted overtime.

1.1.2 The Second Phase of Education Reform (1973-1980)

The initiative that led to the second reform was believed to be an effect of political activities during 1958-1973. Since June 1932, Thailand has transferred her form of government from absolute monarchy to constitutional monarchy. It seemed that Thailand’s political system became democracy. However, there have been arguments opposing this claim. In fact, the only one dominant group of people had influence over Thai politics, and those people were the military. They ruled the country in an authoritarian manner (Chaloemtiarana, 2007). Evidences that support this argument might be drawn from the fact that military coups d’état are frequently carried out in order to dethrone civilian leaders (Fry & Bi, 2013).
The political unrest due to a student uprising on the 6th of October 1973 is the starting point that has led to the more genuine democracy. By the 9th of October 1973, which was three days after the arrest of student leader Thirayudh Boonmi along with approximately 2,000 activists, students gathered at Thammasat University for rally in order to protest against the arrest (Fry & Bi, 2013). The reason of the arrest was the distribution of leaflets by the student leaders and activists. Information contained in the leaflets called for promulgation of a permanent constitution. They were accused by the military government led by Thanom Kittikajorn of being engaged in a conspiracy to overthrow the government. Four days later, the number of protesters increased to approximately 80,000, and they occupied Rajdamnnern Avenue. The confrontation between the protesters and Thai police as well as military has increased its degree of violence, as hundreds of protesters and innocent people were killed (Fry & Bi, 2013). As a consequence of the student uprising as well as the political unrest in a period of 1973-1976, there was an arrangement of a meeting between King Bhumibol Adulyadej (King Rama IX) and the three military leaders. Finally, all of the three military leaders agreed to resign from the government. Consequently, the interim government led by Professor Sanya Thammasakdi, the new Prime Minister, became a key element that ruled the country during a transition to the more genuine democracy (Fry & Bi, 2013). In addition, this movement paved the way for the enactment of 1997 constitution (Klein, 1998) that entails the major educational reform which is the third phase of the reform to be described in the next section.

As a consequence of the student uprising, the reform movement emerged. Key elements of the second reform stemmed from a critique in the performance of administration and management of education. Prior to the reform, three ministries were in charge of administering the Thai Education. The Ministry of Interior (MOI) was engaged in the management of primary education both in Bangkok and outside Bangkok. The Ministry of Education (MOE) was engaged in the management of secondary education, and the Department of University Affairs was engaged in the management of higher education. This structure of management was criticised as a cause of administrative inefficiencies and redundancies. Another critique was about the role of the MOI in the management of rural primary education. Finally, through
the leadership of Sippaonnda Ketudat, the MOE was given the authority to manage rural primary education which was previously managed by the MOI. Furthermore, the Office of the National Primary Education Commission was also established. The transfer of scope and framework between the MOI and the MOE contributed to the establishment of ‘Rongrian Kayai Oga’ or Schools of Expanded Opportunity (SEO), which are primary schools that have extended their provision to cover the lower secondary level (Fry & Bi, 2013). This is considered as an initiative that greatly increases an opportunity of students to access to lower secondary education throughout the country. Schools of Expanded Opportunity still exist and have become the major sample of this study, as this type of school is generally located in rural areas and provides compulsory education to the children in those areas.

The student uprising in 1973 has led issues of social justice to become a greater concern in the Thai society. As a consequence, educational research particularly related to inequity and inequality extensively increased. Because the previous government was military dictatorship, the curriculum being implemented at that time was regarded as rigid and restrictive. Therefore, more open and relevant curriculum was demanded (Fry & Bi, 2013).

1.1.3 The Third Phase of Education Reform (1997-2010)

The Asian economic crisis in 1997 triggered a period of major changes in social and economic policies. Thailand has since undergone the political reforms which resulted in the releasing of the new constitution in 1997. Out of these reforms, decentralisation and educational reform were mandated as a strategy to help recover from the crisis (Fry, 2002). During the development phase of the reform plan, educational reform experiences from various countries such as Australia, New Zealand and China were critically examined and the best practices and most relevant to the Thai context were drawn out (Fry & Bi, 2013).

As a consequence of the releasing of the new constitution, the new National Education Acts (NEA) was enacted. This created a shift in philosophical underpinning which required the reconstruction of educational system in terms of its
structure, ways of learning and pedagogy (Fry & Bi, 2013). With this regard, key components of the third education reform initiative can be described as follows:

1) Establishing the ‘Education for All’ scheme to provide 12 years of free education and 9 years of compulsory education.

2) Restructuring the MOE as well as establishing unity of educational administrative bodies.

3) Reforming higher education and providing more public universities with autonomy in budgets and governance.

4) Decentralising education by establishing local Educational Service Areas (ESAs)

5) Considering to integrate local wisdom into the curriculum

6) Introducing the concept of the Student- or Learner-Centred model of pedagogy

7) Emphasising on implementing a holistic approach to reform

8) Promoting national, master and lead teachers as a part of strategy to establish teacher networks

9) Approving the system for issuing teacher licence and transforming the Teachers’ Council into the Teaching Profession Council

10) Establishing the Office for National Education Standards and Quality Assessment (ONESQA) which provides an external evaluation for all schools at all levels every five years.

11) Promoting site-based training that aims to create innovative teacher learning.

12) Introducing the utilisation of IT to enhance student and teacher learning.

13) Emphasising on the life-long learning concept
14) Emphasising on the utilisation of diverse form of learning approaches and learning sources

15) Establishing a special office, which is the Office of Education Reform, to encourage implementation of the reform and prepare essential legislations during the first three years of the reform

(Office of the National Education Commission [ONEC], 2002).

There were several changes when the NEA of 1999 was enacted. In terms of government’s provision, compulsory education was extended from six years to nine years, and government-funded education was made available for all children from year 1 to year 12 (Boonklurb, 2000). Moreover, the decentralisation of education was implemented in accordance with the NEA of 1999 as well (Boonklurb, 2000).

In 2003, there was a merger of the Department of University Affairs, the ONEC and the MOE to become a single Ministry of Education (Sirikul and Yuwadee, 2002 cited in Fry & Bi, 2013). This is regarded as a major restructuring in the administrative system of Thai education that was carried out in response to the NEA of 1999 (amended in 2002) (Fry & Bi, 2013).

1.1.4 Current Situation of Thai Education

Several government organisations conducted studies or surveys to examine effectiveness of Thailand’s education and factors that are related to or influence the quality of Thai education, with various indicators.

The Office of the National Economic and Social Development Board (NESDB) surveyed Thailand’s situation of poverty and disparity in 2012. This survey indicates that the decrease in opportunity to access to educational services is associated with the progression in education level. Evidence of this claim are data obtained from the survey which described the net enrolment ratio of primary education, secondary education and upper secondary education as 87.6%, 67.6% and 55.1%, respectively. In addition, there is significant difference between people who live in urban and rural areas, and among different parts of Thailand. Consequently,
enormous differences in career development of people who live in different regions are instigated (Office of the National Economic and Social Development Board [NESDB], 2012).

In terms of the access to secondary education (including vocational education), the net enrolment rate of children whose standard of living is below the poverty line is 36.4% whilst the net enrolment rate of those whose standard of living is above the poverty line is 57.9% (NESDB, 2012). These data suggest that economically disadvantaged people have less opportunity to access to secondary education and have less chance to complete compulsory education. When comparing opportunities to access to secondary education between the children who live in urban and rural areas, the net enrolment rate of the urban areas is 59.5% while of those in the rural areas is 51.6% (NESDB, 2012). These data suggest that children in the urban areas have more opportunity to access to secondary education and have more chance to complete compulsory education.

During the academic years 2011-2012, the net enrolment ratio in primary education is 96%. It implies that Thailand has accomplished the goal of primary education in which the expected ratio of the net enrolment of primary education is 95%. As aforementioned, lower secondary education is also compulsory, so the target enrolment ratio of lower secondary education is 100%. In fact, the net enrolment ratio obtained is unsatisfactory 95%, which is still below the target. However, the obtained ratio is still higher than the global average which is 82% and also higher than 90% which is the average of countries in East Asia-Pacific region (Office of the Education Council [OEC], 2014). For upper secondary education, the net enrolment ratio is 76%. This ratio is slightly higher than the target, which is 75%. When compared with other Asian countries, Thailand has a higher net enrolment ratio of upper secondary education than Malaysia and Indonesia which is at 49% and 71%, respectively, and also higher than the average of countries in Asia-Pacific region which is 70%. However, the obtained ratio is still significantly low when compared with the net enrolment ratio of the Organisation for Economic Co-operation and Development or OECD countries, as most of them obtain 90% or higher (OEC, 2014).
Interestingly, the government policy stating that all children are mandated to receive 9 years of compulsory education might not be fully functional, as a set of data indicate a decrease in transformation ratio of primary students (cf. Table 1). In general, students who complete lower secondary level and expect to carry out further studies can choose either to proceed to upper secondary education or vocational education. It is clear that upper secondary education attracts more students than vocational education, as the transformation ratio of the former increased while the ration of the latter decreased (cf. Tables 2 and 3) (MOE, 2010; MOE, 2011; MOE, 2012; MOE, 2013).
Table 1. Transformation Ratio of Primary Students

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Finishing primary education</th>
<th>Starting secondary education</th>
<th>Finishing primary education</th>
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<th>Finishing primary education</th>
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<tr>
<td>2009-2010</td>
<td>935,140</td>
<td>938,143</td>
<td>855,836</td>
<td>851,808</td>
<td>835,929</td>
<td>828,076</td>
<td>824,211</td>
<td>813,304</td>
</tr>
<tr>
<td>Transformation Ratio</td>
<td>100.29</td>
<td>99.53</td>
<td>99.06</td>
<td>98.68</td>
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Table 2. Transformation Ratio of Lower Secondary Students to Upper Secondary Level

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</thead>
<tbody>
<tr>
<td>Transformation Ratio</td>
<td>56.39</td>
<td>56.73</td>
<td>57.68</td>
<td>59.90</td>
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<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Finishing Lower secondary education</th>
<th>Starting Vocational Education</th>
<th>Finishing Lower secondary education</th>
<th>Starting Vocational Education</th>
<th>Finishing Lower secondary education</th>
<th>Starting Vocational Education</th>
<th>Finishing Lower secondary education</th>
<th>Starting Vocational Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation Ratio</td>
<td>33.64</td>
<td>32.68</td>
<td>31.20</td>
<td>29.56</td>
<td></td>
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Table 3. Transformation Ratio of Lower Secondary Students to Vocational Education Level
From a survey conducted in 2006, obtained data indicates that the percentage of workforce population aged 25 years old with lower secondary diploma was 32.2, lower than the percentage obtained in Indonesia, Malaysia and Philippines. Although the percentage has slowly increased since 2002, the researcher of this survey suggested that it would be a long way to achieve the target, which is set at 65% by 2018 (OEC, 2014). This suggestion might reflect that Thailand needs to do more to narrow the education gap, as one of the reasons underlying an ineffective production of a quality workforce is that the disparity in opportunity to access to educational services still exists.

According to the study by the International Institute for Management Development (IMD) in 2012, Thailand’s world competitiveness in education was ranked at 52 from the total of 59 countries. However, Thailand was in a slightly higher position than Indonesia, Philippines and India, but still far behind Singapore, Taiwan, Hong Kong and South Korea (IMD cited in NESDB, 2012).

In 2012, the results from international assessment bodies such as the Programme for International Student Assessment or PISA indicate that the average scores of literacy, mathematics and science of Thai students has slightly increased from the previous PISA assessment which was conducted in 2009. However, the overall performance of Thai students aged 15 was still below the PISA average. When compared with other countries who undertook the same assessment, the performance of Thai students was ranked at 50 from the total of 65 countries. At this position, Thailand was behind China, Singapore, Hong Kong, Taiwan, South Korea, Macao, Japan and Vietnam. However, Thailand was in a better position than Malaysia and Indonesia. The average score of Thai students particularly in science is 444. With such score, Thailand was ranked at 48, which was better than Malaysia and Indonesia, but worse than Vietnam (OEC, 2014).

The comparisons with other Asian countries suggest Thailand’s education are mediocre among the others. However, there are problems and issues that require solutions, particularly the issue of educational disparity.
In summary, Thailand has undergone three major phases of education reform and each phase has a different starting point. Within the first phase of the reform that emphasised the development of quality of human resource, the modern secular system was introduced. In addition, the importance of knowing Commerce and English was recognised. The first phase of the reform was considered as highly centralised and standardised education and it is believed that the first phase led to political problems which would become the major turning point of Thai Education in ten years later.

The second phase was led by the effect of political activities. Although the form of government has transferred from the absolute monarchy to the constitutional monarchy, the military was the only political hegemony. The starting point of the second phase of the reform was students’ movements through political activities that led to the arrest of the student leader by the military government. The student uprising occurred and was followed by the political unrest, then the confrontation between the protestors and Thai police happened and led to the tragedy when innocent people were killed. In order to restrain the situation, the meeting between King Bhumibol Adulyadej (King Rama IX) and the three military leaders was held afterwards and then the interim government was established. As a result, the performance of administration and management of education were criticised. This led to the restructuring of government officials in the Ministry of Education and key upshot was the establishment of Schools of Expanded Opportunity (SEO).

The third phase of the reform was triggered by the Asian Economic Crisis in 1997. This led to the enactment of the National Education Act and resulted in restructuring of education system in term of its structure and way of learning and pedagogy. Several concepts were acknowledged and implemented by the Act. The decentralisation of education by establishing Educational Service Areas (ESAs), the provision of free education for 12 years and compulsory education for 9 years to all children, the introduction of SCL concept and the establishment of the Office for National Education Standards and Quality Assessment (ONESQA) were examples of components of the third education reform initiative.
Survey data obtained in 2012 describe an opportunity to access the secondary education of economic disadvantage people in Thailand was less than that of economic advantage people. Therefore, economic disadvantage people have less chance to complete the compulsory education. The same set of the survey data also suggested children in urban areas have more opportunity to access the secondary education than that of children in rural areas. This implies children in urban areas have more chance to complete the compulsory education.

During 2011-2012, the net enrolment ratio of the primary education achieved the expectation while that of the secondary education was below the target. However, the net enrolment ratio of the secondary education obtained was higher than the global average and also higher than the East Asia-Pacific region average. Although all children are mandated to receive 9 years of the compulsory education but the transformation ratio of primary students decreased. For post compulsory education, the vocational education has less attraction to the lower secondary students than that of the upper secondary education.

Results from the international assessment such as PISA in year 2012 shows scores in literacy, mathematics and science of Thai students aged 15, although slightly increased from 2009, were still below the PISA average.

1.2 International Developments in Science Teaching

To examine concepts relating to science teaching and curriculum, I explore recent trends and issues influencing science teaching in developed countries such as the United States, England and Wales or other European Countries. With respect to this, I analyse key concepts of science education and underlying motives to implement changes as well as expected goals as a useful context for a comparison to that of Thailand.

Regarding the development of the science curriculum, the focus is on the most intense period of the reform in England and Wales and the US that took place during the 1950s-1990s. As will be described below, I observe that Thailand is currently in a similar reform process that these developed countries went through in that period. Therefore, the references which will be cited henceforth tend to be rather
contemporary with the documents reported about the science reform in the England and Wales and the US. For England and Wales, I will describe what went on in more than 10 years leading up to the national curriculum. For the US, I will illustrate the challenge and concerns that were raised since 1950s and led the US to make great efforts in becoming the first-rank in science and technology.

In the following sections I look at the development of school science curricula in three countries. These are selected not because I propose to conduct a comparative study nor they are similar to Thailand, but because the developments in these countries were useful to the development of my thinking. On one hand, considering the contexts of these countries, e.g. those of the US and the England and Wales, help me identify the kinds of ideas that have informed science curriculum development over recent years. On the other hand, the Republic of Malawi, demonstrate that economic development, while being an advantage, is not a pre-requisite for creative thinking and practical action. Before I consider developments in these countries, I will first briefly describe the contexts of the UK, the US and the Republic of Malawi, respectively.

In 2014, the World Bank reported that, based on PPP, the GNI per capita of the UK was 39,500 USD. This means the comparable average income per head of the UK’s citizen was 39,500 USD per year (World Bank, 2014b). Moreover, the GDP of the UK was 2,988,893 million USD which ranked the fourth among 195 countries (World Bank, 2014a).

Nowadays, the education system of the UK consists of five stages including Early Years, Primary Education, Secondary Education, Further Education and Higher Education. Compulsory Education is provided for all children aged 5 to 16. Further Education and Higher Education are not compulsory while the Higher Education will be undertaken further from General Certificate of Education (GCE) A level and their equivalent. Most of the Higher Education are taking place in universities and other Higher Education Institutes and colleges (UK Government Digital Service, 2012).
In 2015, the average class size of primary education (key stage 1) in England that is taught by one teacher was 27.4. This was not exceeding the infant class size limit which is 30 for one-teacher class according to the School Admission Regulation 2012 (Department for Education, 2015). During one school year, local-authority-maintained schools are recommended to open, at least, for 190 days or 380 sessions (House of Commons Library, 2016).

To become a teacher in England, candidates must obtain Qualified Teacher Status (QTS) through successful completion of the initial teacher training. In addition, there are basic General Certificate of Secondary Education (GCSE) requirements for teacher trainee applicants as follows: 1) obtain a GCSE grade C (at least) in Maths and English for teach in secondary level and 2) obtain a GCSE grade C (at least) in Maths, English and Science for teach in primary level. In order to be eligible to teach science, the teacher trainee applicants are required to obtain A*, A or B A-level (or equivalent) of two relevant subjects. Currently, there are two types of teacher training including School-led training and University-led training. School-led training is a one-year course that prepares graduates who want to get an opportunity to learn from hands-on training in a school. Most courses have a postgraduate qualification as a part of it which requires the graduates to undertake it as Master’s-level credits. The university-led training offers both graduate and postgraduate trainings. Normally, the postgraduate training is a one-year course for full-time and two-year courses for part-time. For the postgraduate science teaching trainees, the undergraduate degree obtained must be relevant to science subjects the trainees aim to be specialised, such as Biology, Chemistry or Physics. For the undergraduate training, it normally takes 3-4 years with a combination of learning practical skills in real classrooms. For those undergraduate trainees who aim to be a science teacher, the trainees are required to pursue Bachelor Degree in Science with QTS (Department for Education, 2016; National Careers Service, 2016; Tech First, 2016; Universities and Colleges Admissions Service, 2016).

Let us now shift our focus to the US. The World Bank (2014) reported that the GNI per capita at PPP was 55,900 USD. This means the average amount of money that one citizen earns was 55,900 USD a year (World Bank, 2014b).
addition, the GDP of the US was at 17,419,000 Million USD, ranking the first. These data suggest the US is the world’s largest economy among 195 countries (World Bank, 2014a). The formal education of the US consists of 4 levels including Preschool, Elementary/Primary School, Middle School, and High School. In general, the mandatory formal education is provided for children aged 5/6 to 16 (kindergarten – grade 12). However, the required ages of children vary slightly state by state because an authority over public or state-funded school belongs to an individual state departments of education (The US-UK Fullbright Commission, 2016).

The average size of classroom of primary education which is taught by one teacher was 21.13 (The Organisation for Economic Co-operation and Development [OECD], 2014). Compulsory instruction time in primary education was 5,802 hours within 6 years and in secondary education was 3,033 hours within 3 or 4 years (The Organisation for Economic Co-operation and Development [OECD], 2015).

Teacher training courses in the US are provided by colleges or universities through a Bachelor’s degree. For science teacher training, the trainees can choose to be specialised either in science or in a single branch of the sciences. The trainees can also choose either a major in education or a minor in education and a major in a science field. The teacher training programme can also be pursued along with the Bachelor’s degree programme or subsequently completed the programme after obtaining the Bachelor’s degree. During the training programme, the trainees are required to undertake an internship or supervised work programme at a local school and such programme must be accredited by an organization, for example, the National Council for Accreditation of Science Teachers. Before leaving for a teaching profession, the trainees are required to pass a licensing examination and obtain teacher certification, and must accomplish requirements of State’s Board of Education (Study.com, 2016).

Finally, let us again shift our focus to the case of the Republic of Malawi. In 2014, World Bank has reported the GNI per capita, based on PPP, of the Republic of Malawi was $790 (World Bank, 2014b). Thus, the average income that one citizen earns in a year was 790 USD. In addition, GDP of the Republic of Malawi was at 4,258 million USD which ranked the 161st among 195 countries (World Bank,
The education system comprises of Pre-school Education, Primary Education, Secondary Education, and University. However, only the primary education are supported by the government and is provided for free to all students in the Republic of Malawi. In general, the primary education offers education for children aged 6 to 13 and this refers to standard 1 to 8. Before leaving a primary school, students must obtain a primary school leaving certificate by taking the standard 8 final examination. Students who pass this exam can progress to the secondary education. Although the secondary education in Malawi is provided by the government but it is not for free. The secondary education in Malawi normally takes 4 years which refers to form 1 to form 4. Before leaving from form 2, students are required to pass the Junior Certificate of Education (JCE) in order to progress to form 3. In order to graduate from secondary school, students are required to pass the Malawi Secondary Certificate of Education (MSCE) in form 4. Most of students who graduate from form 4 and obtain the MSCE are usually taking a job as the MSCE is considered as adequate credentials for applying jobs in the Republic of Malawi (RIPPLE Africa, 2016).

A report from UNESCO described, in the Republic of Malawi, there were more than 80 students in one classroom (United Nations Educational Scientific and Cultural Organization [UNESCO], 2015). In addition, teacher shortage is a serious problem because, in primary school, there was an increasing of student/teacher ration from 63:1 to 76:1 during 1999-2011 (United Nations Educational Scientific and Cultural Organization [UNESCO], 2013).

For the teacher production in the Republic of Malawi, the Ministry of Education takes a leading role. Most teachers in the Republic of Malawi usually start their career as a primary school teacher in a demonstration school which located nearby the teacher training sites (Stateuniversity.com, 2016). Training for secondary school teacher is provided by the School of Education. There are 3 types of professional qualifications including Diplomas of Education, Bachelor’s of Education, and the University certificate of Education. Prospective teachers can enter the training as either degree or diploma candidate and pursue the course of study for general degree in Education afterwards. For the Diploma and Bachelor’s degree,
subjects that the individual candidates wish to take as specialisation such as science are provided by the university (Stateuniversity.com, 2016).

1.2.1 Developments in England and Wales: Role of Science

As this study has been partially conducted in England and Wales and I — the researcher of this study — am based mainly in England and Wales, reflections of the development of thinking practice in science education in England and Wales seems an obvious starting point.

In the 1960s, science education in England and Wales was provided to the majority of students in form of general or vocational nature through the tripartite system including grammar, technical and secondary modern schools. Conversely, students in a grammar school minority carried out the GCE courses which was more academic and could be a starting point for studying science as well as could be foundation for further studies at A-level. With respect to both cases, the number of girls attending biology classes was higher than boys while the number of boys attending physical sciences was higher than girls (Millar & Osborne, 1998). Throughout this period, the Nuffield Foundation became a key actor who undertook major curriculum innovation. The Nuffield Foundation supported funding for curriculum reform in all three main sciences, and at both O-level and A-level. Considerations of roles and use of experimental work were superior and had an impact upon the science teaching practice and still persists over time (Millar & Osborne, 1998).

The needs of the majority of students became more important due to a growing concern of the comprehensivisation of the school structure in the mid 1960s. As a result, an appropriate science education for the less academic students was provided through the development of several science courses including Nuffield Secondary Science in the late 1960s and Science at Work in the 1970s (Millar & Osborne, 1998). During the 1980s, other science courses were developed with an effort directed toward the ‘process of science’, for instance, Warwick Process Science and Science in Process. This was a result of an argument that viewed
knowledge base as less in value and importance due to the fact that it was always changing (Millar & Osborne, 1998).

During the 1980s, the concept of ‘broad and balanced’ science education was brought into action and articulated by Her Majesty’s Inspectorate in their policy statement for Science 5–16. With respect to this, students aged 14-16 should undertake science education which occupied 20% of the curriculum time. This was believed to be a key mechanism to remove gender-related effects in subject choices and ensure broad and general curriculum that suited students for all levels. As a result of this, the GCSE was introduced as a single examination system. The GCSE consists of three main sciences which were designed to be suitable for all students and contributed to a double award GCSE (Millar & Osborne, 1998).

Science for primary school students was also a point of interest. Attempts to improve primary science education such as Science 5–13 in the 1970s created attention toward the potential of science education for primary-school-aged students. Although this was a good initiative, the quality of provision was argued because many schools could not offer an education that surpassed the limitation of nature studies (Millar & Osborne, 1998). In 1978, Her Majesty’s Inspectorate conducted a survey on Science in Primary Schools, and the outcomes of this survey indicated that science teaching in primary schools was undertaken with disappointing progress. This dissatisfaction led to the introduction of an emergent consensus which was set out in the 1985 Policy Statement for Science 5–16. The consensus stated science as an important subject that should be included in primary education for every student. In addition, topics of physical and biological sciences should be incorporated and teaching practice should rely on practical investigation and enquiry (Millar & Osborne, 1998).

Between 1981 and 1986, the Secondary Science Curriculum Review (SSCR) was published by a cooperation of Heinemann and the Association for Science Education (ASE). The review activities were operated with auspices of the School Curriculum Development Committee and support from the ASE. Moreover, the SSCR was also supported by the Department of Education and Science, local
education authorities and the School Council (The School Curriculum Development Committee, 1987). It aimed to support schools to provide a broad-based science curriculum to all young people and was an outcome of a working of teacher network, which consisted of groups of teachers across the country, and a central team (The School Curriculum Development Committee, 1987).

The central team of SSCR launched a discussion paper in 1984. This paper indicates a minimum entitlement in terms of school’s provision which should be offered through school’s programme of science and related studies and expected outcomes that students should gain from such provision throughout a period of compulsory schooling (Bentley et al., 1984).

To make learning effective, the SSCR suggested that the learning should be seen as relevant by students. This means students should be able to link the learning with their personal experiences and aspirations. With this regard, recommendations suggested in the SSCR emphasise school as a place that should offer proper environment where young people can develop their aspirations and accumulate personal experiences. Young people should be encouraged to make decisions regarding their own learning needs. In addition, strategies related to development of self-reliance and self-directing of young people have also been required in order to provide direct experiences to those young people in the responsibility (Bentley et al., 1984).

In order to provide such proper environment, several provisions are required, including 1) the learning environment that is open for students’ expressions in aspirations as well as individual needs. When students fulfil their achievement, praise from teachers and peers can be given and students can accept it without being embarrassed; 2) effective time allocation that provides sufficient time for ideas sharing and talking of students and teachers; 3) training of students’ interpersonal skills; 4) a plan to facilitate individuals’ learning experiences which emphasises students’ prior knowledge and experiences; 5) a system that allows the negotiation of activities in addition to the minimum entitlement; and 6) valuing student’s point of
view relating progress through courses with an equal extent as those of teachers and parents (Bentley et al., 1984).

The SSCR also suggested that schools, as learning environment providers, should develop two further areas relating to the learners’ skills and activities. The two further areas are 1) the development of the learners’ skills to confidentially use scientific capabilities to negotiate, make decisions and discuss ideas with peers or others and 2) rendering the learners’ skills to make links between ideas and processes developed in science, and the resolution of technological problems. Below is a list of skills and processes that are required, in combination with the two further areas described above, as a composition of the minimum entitlement (Bentley et al., 1984).

Skills required include listening, talking, writing, drawing, reading, numeracy, estimating, small group skills, nonverbal communication, observing, searching, measuring, manipulating, graphicy and recording (Bentley et al., 1984).

Processes required include 1) communication which covers thinking, questioning, seeking help, negotiating and discussing; 2) information processing which consists of selecting, defining and using relationships, defining and controlling interacting variables, designing and drawing conclusions; and 3) problem solving and decision making regarding experimentations. These comprise of predicting, entailing and inferring, developing hypotheses, interpreting, modelling, evaluating, assessing, classifying and managing time (Bentley et al., 1984, p.6-7).

The following attitudes are encouraged in the minimum entitlement because those are believed to be crucial elements for students to enhance self-directed science study capabilities. To adopt such attitudes, students’ ability to handle changes from personally held ideas relating science to conventional scientific concepts, although difficult, is needed because those attitudes influence knowledge system held. Therefore, encouragement of those attitudes is necessary to facilitate the changes. Those attitudes include open-mindedness, self-criticism, independence of thought, responsibility, perseverance, co-operation, scepticism, desire to be well-informed,
confidence, respect, willingness to be involved, sensitivity, enthusiasm, tolerance, persuasiveness, questioning and trust (Bentley et al., 1984).

Rather than seeing it as a list of topics to be covered, the content described above is suggested to be treated as a framework whose aim is to approach the basic substance of science courses (Bentley et al., 1984). In addition, the central team acknowledges that the essential element is a construction of learning experiences that has to be fitted with the students’ developmental needs. Thus, they suggest schools to treat the substance of science courses in three experiential phases including:

1) Introductory phase

Knowledge, skills and attitudes are considered as starting points for students since they get to know a scientific idea for the first time. Once this personal knowledge are encouraged to make it observable and clearly expressed, it can be a foundation for activities planning which can create a strong base of experiential learning. Consequently, students’ ability to explore further ideas apart from their existent ideas is promoted. Attempt to formalise ideas being explored and make them theoretical should be allowed in a lesser extent than effort to grant freedom to students to explore and investigate alternative ideas according to their own concepts (Bentley et al., 1984).

2) Enhancement experiences

This phase focuses on organising learning environments suitable for students to practice their skills and develop latent scientific ideas. This can be conducted by introducing a diverse array of alternative experiences and encouraged exploration. Using contexts that have implication to students, students are encouraged to play roles in the development of their own understanding, skills and attitudes by implementing a combination of ideas listed above rather than carrying out those lists sequentially. The combination of listed ideas can be in a form of topics, themes or modules depending on negotiation with individuals or small groups. In this phase, the central team emphasised the development of students’ capability and confidence which engage concepts of how scientific ideas are used, cultural significance and personal interpretation (Bentley et al., 1984).
3) Application and exploratory experiences

This phase was considered by the central team as a mechanism provided by teachers and peers to enable students to utilise knowledge, skills and processes gained from the other two phases previously described to build up further ideas about areas of science, through confidence they have developed and accumulated involving their understanding of scientific ideas (Bentley et al., 1984).

Changes in how students learn and views of people in the society toward science are key factors that render the development in science education in a form of the SSCR. Previously, people perceived science as a body of knowledge that comprises of objectives and facts. Later, such perception has been changed, as science has now been viewed as a practical activity which has an impact over the values of the society where it is practiced (The School Curriculum Development Committee, 1987). Concurrently, there has been growing understanding that students have brought their own ideas about how the world works to their science classrooms and such ideas are likely to oppose conventional ideas. In order to respond with the changes in the perception of science, several requirements are needed:

1) Encourage a development of a teaching style that lets students use their imagination especially in a topic that students are interested in or curious about. Make links between content of science and student’s experiences and background by using a variety of means or language that inspires students to search for their own ideas about science (The School Curriculum Development Committee, 1987).

2) Affirm trust and respect between students and teachers as the central importance in science education. This is expected to create a learning environment in which students and teachers are working together and sharing the excitement emerged during a period when a scientific idea is uncovered in the laboratory (The School Curriculum Development Committee, 1987).

3) Build a sense of responsibility of students to themselves, others and their community. Students are expected to make decisions that benefit their own quality of life and the society (The School Curriculum Development Committee, 1987).
4) Assist students to elucidate their ideas regarding the scientific and technological issues, particularly the issues that affect individuals and community (The School Curriculum Development Committee, 1987).

The role of teachers has been recognised, as science teachers from more than 80 local education authorities worked with the SSCR. Benefits they gained from their participation were opportunities to identify their particular interests and concerns relating to their teaching. Due to the fact that the review activities were undertaken in small groups, it was easy to follow the interests and, as a result, new teaching materials and approaches were often produced (The School Curriculum Development Committee, 1987).

Working with the SSCR has also benefited the science teachers as they had opportunities to work with experts or professionals from other schools. By working with the SSCR, their skills and practices were developed and, as a result, the benefits they gained also advantaged their students (The School Curriculum Development Committee, 1987).

Other agencies interested in science education were put in contact with individual working groups and the central team. This was an opportunity to expand their network. Outcomes of the SSCR activities have led to a growing concern of the need to constantly review the science curriculum and its explanation which translates into practice (The School Curriculum Development Committee, 1987).

Another major incidence in education of England and Wales is the introduction of the National Curriculum. The National Curriculum of England was established under the 1988 Education Reform Act and it has been implemented in all maintained schools across the country through the 1990’s. It aims are 1) to prescribe school subjects, 2) to establish an entitlement for all students regardless of their differences in abilities, social background, culture, ethnic, race and gender, 3) to establish standards for learning and attainment which can be communicated and observable for students, parents, teachers, governors and the public, and establish standards for the performance of all students in all subjects included in the National Curriculum, 4) to promote continuity and coherence through an emphasis on a
coherent national framework that promotes curriculum continuity. This includes the facilitation of students’ transition between schools and between phases of education, and 5) to promote public understanding as well as raise confidence in the works of schools and trustworthiness of learning outcomes from compulsory education. This includes provision of common ideas for discussion of education issues among students, parents, teachers, governors and employers (Moon, 1991; The Children Schools and Families Committee, 2009). According to the National Curriculum, all students are required to study ten subjects throughout their compulsory years, all of which are divided into two categories including ‘core subjects’ and ‘foundation subjects’. The core subjects consist of English, mathematics and science. The foundation subjects include art and design, science and technology, geography and history, ICT, music and physical education (The Children Schools and Families Committee, 2009).

Moon (1991) elaborated that the government’s interests in the establishment of the National Curriculum were originated from several motives. The government, at the time, saw that the National Curriculum will provide a framework that could eliminate differences between schools, rule out inequality of education, improve the quality of schooling and raise standards, improve school-parent communication by using a common language to explain or describe students’ progress, minimise breaks in continuity of students’ education due to changes of schools of students and changes of posts of teachers, improve record-keeping and monitoring of progress when there is a transfer of students to the upper level of education, and recognise individual attainment by changing the form of assessment from standard based on relative information to absolute standard. This means the new form of assessment will determine if students have demonstrated individual knowledge and competency in the different parts of the curriculum (Moon, 1991).

Significance of the National Curriculum in raising standards has become a government’s interest because of the issues of declining in standards of attainment and variation of standards (Moon, 1991), and failure to recognise the changing needs of industry and society (The Children Schools and Families Committee, 2009). Interestingly, two of the prime ministers have selected the former issue, which
became public acceptance, for political advantage. In 1976, James Callaghan expressed his concern during his speech at Ruskin College, Oxford, about complaints given by the industrial sector regarding the incompetence of new recruits. Eleven years later, Margaret Thatcher, in her speech to the conservative party, said

To compete successfully in tomorrow’s world--against Japan, Germany and the United States--we need well-educated, well- trained, creative young people. If education is backward today, national performance will be backward tomorrow (Margaret Thatcher, 1987 cited in Moon, 1991).

Thatcher’s speech has also reminded the public of the link between schooling and economic success (The Children Schools and Families Committee, 2009).

As described above, the National Curriculum was introduced, and science has been included in the curriculum for children aged 5-16 as a core subject. Consequently, all changes which have been happening in the late 1980s have become discontinued. In addition, 80% of all students undertake double science GCSE at the age of 16, and the double science GCSE is included in a programme that covers all of the major sciences (Millar & Osborne, 1998).

In 1998, Millar and Osborne claimed that science is a superior element of the primary education, and literacy and numeracy are essential skills required in the primary science curriculum (Millar & Osborne, 1998). The notion that learning science involves more than knowing facts and concepts about the natural world has been widely accepted. Opportunities for personal enquiry have also become an importance element that should occupy curriculum time in a significance extent (Millar & Osborne, 1998). Outcomes from Ofsted inspections indicated that these changes have succeeded, as Ofsted satisfied with over 80% of lessons they inspected. Results from international survey such as the Third International Mathematics and Science Survey (TIMSS) also revealed that, when compared with other countries, there was an improvement in performance in science of English students, at all ages (Millar & Osborne, 1998).
A major development of science curriculum in England and Wales is the establishment of a course called ‘Twenty First Century Science’ which aims to develop scientific literacy of people in the country (Nuffield Foundation, 2015). According to Millar (2006), this course has been designed to emphasise ‘science for citizenship’ concept which is based on the notion that a broad education about science will benefit all students (Millar, 2006). This course consists of two major key elements including the content of science and a set of ‘idea-about-science’ (Osborne, 2007). Subsequently, students are allowed to take additional academic science, a course in applied science or, no more science (Osborne, 2007).

An evaluation study suggested that this course was found to be more satisfactory to teachers, as they enjoyed teaching this course. In addition, students found it relevant and interesting which resulted in an increase of students’ intention to sustain the study of science past the age of 16 (Osborne, 2007). However, it could not be concluded that the introduction of the course has led to a substantial change in the students’ uptake of science, as there is no significant difference and a research indicated that a factor which had a significant impact over student engagement with science is teaching quality (Osborne, Simon, & Collins, 2003; Osborne, 2007).

Scientific literacy has been defined in different ways, and the distinction between those meanings and science education has not been clarified (Osborne, 2007). Meanings of scientific literacy and science education as well as relationship between those terms were also analysed and proposed by Norris and Phillips (2003). They saw scientific literacy as a required ability to analyse and interpret texts which, according to Norris and Phillips (2003), is called ‘literacy’. In addition, they saw an outcome of empirical data collection in texts. Therefore, an ability to read texts is a must for an understanding of science (Norris & Phillips, 2003). Interpretation and argumentation also have fundamental roles in science education (Norris, Phillips, & Osborne, 2008).

In order to enable people in a society to interpret and evaluate science-related publications as well as writing about science, Osborne (2007) sees that in science education the society requires knowledge and an understanding of scientific content, a scientific approach to conduct an enquiry, and the idea that science is ‘the social
practice of the community’ (Osborne, 2007). Necessity of such understanding was also extended by the media due to the fact that political and moral dilemmas emerging within a society during the twenty-first century are in close relationship with science (Financial Times Editorial, 1999 cited in Osborne, 2007; Independent Editorial, 1999 cited in Osborne, 2007).

New emerging issues related to scientific advancement such as stem cell research or related to human survival such as global warming are calling for people’s attitude that acknowledges an engagement in public debates in these issues. As Osborne (2000) suggested, critical engagement is required in order to avoid emerging risks from public scepticism of scientific expertise which is a cause of locating unjustifiable confinement on research and technological development of the future. This unfavourable situation is believed to be a factor that leads to a public demand of simple and guileless application of the precautionary pillar to scientific research. This limits advancement in science that may solve problems emerging in the contemporary society (Osborne, 2007). In England and Wales, STEM (Science, Technology, Engineering, and Mathematics) was mentioned in 2011 in the report ‘The Plan for Growth’ (Department for Business Innovation & Skills, 2011). Within this report, the importance of science and mathematics and role of STEM are highlighted. STEM has been regarded as a major force that drives growth and economic recovery as well as the creation of innovation (The Parliament Office of Science and Technology, 2013).

Research and development (R&D) is one of the most important factors that affect the innovation process. Investment in R&D is found to have a direct link with the improvement of productivity (Roberts, 2002). Although the proportion of GDP spent on R&D in the UK has fallen, the UK’s R&D performance has recently exhibited an improvement, with increased investment from the public sector being accompanied by improvement in investment in private sector R&D (Roberts, 2002). This led to an increased demand for scientists and engineers to work in R&D. At the same time, demand for graduates with degrees in highly numerate science and engineering has increased due to vacancies in other areas, such as the financial services sector (Roberts, 2002). Although there were a relatively high number of
overall science and engineering students in the UK, the numbers of students choosing to study mathematics, physics, chemistry and engineering-related branches has significantly decreased (Roberts, 2002). Recently, there has been an increasing emphasis on multidisciplinary and interdisciplinary research, for example in the biological sciences. The fields of engineering and the physical sciences also affect this research (Roberts, 2002).

Another issue regarding science and engineering skills that requires attention is the emergence of a disconnect between the demands of businesses for employees highly skilled in science and engineering and the supply of science and engineering graduates. As a result, a skills shortage problem has become apparent (Roberts, 2002). In regard to the issues described, development of STEM skills and knowledge in young people is likely to be major interest and concern.

Although scientific R&D does not account for all innovation, the demand for human intelligence to discover or develop new products or services means that the success of R&D and innovation relies on the availability and capabilities of scientists and engineers (Roberts, 2002). Hence, it is necessary that the provision of skilful science and engineering graduates keep pace with investment in R&D and innovation, and with the demand of these graduates from other sectors (Roberts, 2002).

The need for young people to acquire STEM skills and knowledge also still continues. STEM skills and knowledge are believed to benefit those young people because they will help them take advantage of the increasing numbers of jobs and careers available (Collinson, 2014). According to the CBI/Pearson Education and Skills Survey (2014), 39% of employers reveal that they encounter difficulties recruiting STEM-skilled personnel, with a shortage of STEM-qualified technicians (CBI, 2014 cited in Collinson, 2014).

Furthermore, the significance of STEM education has been linked with scientific literacy, as STEM education is believed to be a way to prepare people with scientific literacy and numerical understanding. These two desirable abilities of people are considered important elements for citizens in order to debate and make decisions (The Parliament Office of Science and Technology, 2013). Therefore, not
only will a person who wishes to become a scientist or an engineer benefit from the development of STEM skills, but so will all the citizens of the society (Collinson, 2014). Modern society is largely driven by technology and this leads to an emergence of various technological issues that are relevant to everyday life and all citizens are required to make a personal judgment about. Thus, an appropriate understanding of scientific and mathematical approaches is vital if citizens are to make informed decisions regarding those issues (Collinson, 2014). Moreover, the quality of science teachers and qualified students are significant for STEM economy (The National STEM Centre, 2015).

When considering the history of science teaching development described earlier, views of England and Wales on the importance of science education are heavily embedded in societal aspect of science and its impact on society, livelihood and well-being of the citizens in the country. Considerations regarding what is good science and what people should learn are likely outcomes of this motive.

1.2.2 Science Curriculum in the US: Shock of Sputnik

The US has possessed a leading position in science and technology endeavour. Therefore, key concepts or principles that influence science education of the US would be worth careful examination.

After the Soviet Union launched the Sputnik satellite in 1957, science education in the US has become more important. On the basis of national security concerns, science education during the post-war period focused on the role of science educators who should cultivate citizens’ understanding in science as well as good attitudes on working with scientists (DeBoer, 2000). Evidence that represents the emergent of ‘civic responsibility’ theme after World War II can be seen in the Yearbook Committee:

In our society many demands peculiar to a democracy are placed on all citizens... One is the responsibility to help decide how scientific knowledge will be used (National Society for the Study of Education [NSSE], 1960, p. 113 cited in DeBoer, 2000).
However, there was a suggestion that science education should also emphasise the general and liberal aspects of education as well. Such suggestions:

Not because there are satellites following their elliptical orbits about the earth nor because other nations have given emphasis to training in technology and science, and not because of any alteration of our scale of values, should it suddenly be declared that science must occupy the commanding position at all levels in our educational system. . . [W]e live in an environment molded by the applications of science, and we believe some of the processes used in arriving at conclusions in science have a relevance to our thinking and, indeed, to our behavior in other phases of life. Hence, education in science should be a part of the intellectual heritage of all (NSSE, 1960, p. 24 cited in DeBoer, 2000).

Interestingly, many science educators saw goals of science education from a different angle. They viewed science teaching was vital for developing the quality of life of citizens, as it should help individuals tailor themselves to be able to live in the modern society (DeBoer, 2000). However, national security concerns and the development of technology have changed the world. These have led to the implementation of a new approach of science education. With respect to this, ‘scientific literacy’ has come to light, as it is considered the goals of science teaching for general education purpose (DeBoer, 2000; Waterman, 1960). The Rockefeller Brothers Fund issued a report in 1958. The report focused on challenges that emphasised how education system could be utilised more effectively to help people develop skills and knowledge to deal with rapid changes in scientific and technological aspects of society, for instance, nuclear energy, space explorations, cell biology, brain physiology and the increase in complexity of social organisations (Rockefeller Brothers Fund Inc., 1958, p.28). To respond with this, personnel with high levels of skills were in demand. However, issues relating to inadequate supply of technically trained personnel were also critically concerned (DeBoer, 2000).
In order to deal with these challenges, attempts ‘to turn to organised intellectual effort as never before in history’ which focused on highly educated members of society was asserted (Rockefeller Brothers Fund Inc., 1958, p.10). However, an emphasis that a highly educated member of society needed to understand the scientific endeavour was also addressed as an importance issue, apart from the demand of adequate number of mathematicians, engineers and scientists (Rockefeller Brothers Fund Inc., 1958, p.11). In response to this emphasis, ‘scientific literacy’ was regarded as a solution to accommodate citizens in the society to broadly understand science and be able to deal with rapid changes and development of scientific enterprise, regardless of whether he or she was to become a scientist (DeBoer, 2000; Fitzpatrick, 1960 cited in Hodson, 2008).

In 1958, Paul DeHart Hurd expressed the same concern as the Rockefeller report. Hurd also raised another concern which was a conflict between the goals of liberal science education and the goal of producing technically trained workforce (Hurd, 1958). In Hurd’s view, the need for students to continuously develop appreciation in science was also important. Learning experiences valuable for continuously developing an appreciation of science should also be taken into account. With respect to this, appreciation of science should be developed as a process for uncovering and exemplifying essential nature of scientific endeavour (Hurd, 1958). In the same year, scientific literacy was also recognised by Richard McCurdy, President of the Shell Chemical Corporation. He referred to the ideas given by Frederick Seitz, chairman of the American Institute of Physics, which defined scientific literacy for general students that they should place primary emphasis on a continuing course in general science at the secondary school level, which gives familiarity with the history and accomplishments of science and its relation to the matters of everyday life. This should be descriptive and inspirational, placing emphasis upon the cultural roots and the goals of science and the countless ways in which it affects our understanding of the world about us (Seitz, 1958, p.15).
Definition of scientific literacy given by a number of scientists and science educators mostly addressed content knowledge in a broad range of scientific fields. The new rigorous science courses were designed by scientists, and talented students were targets of academy, as efforts were implemented to attract those students to study science. In contrast, linkage between science and experiences obtained in everyday lives as well as applications of science were considered in a lesser extent (DeBoer, 2000). However, goals of science education were shifted in 1970’s. By this period, account of society was included. Applications of science and the relationship between science and society were addressed. Definition of scientific literacy was, at that time, described in relation to applications of science in everyday experiences (DeBoer, 2000).

The concept of science education shifted again in early 1980’s. The Science-Technolo-Society or STS concept was addressed by the National Science Teachers Association (NSTA). They considered that the goal of science education was ‘to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use this knowledge in their everyday decision-making’ (National Science Teachers Association [NSTA], 1982 cited in DeBoer, 2000). STS curriculum aimed to provide knowledge to students about relationship as well as mutual interests between science and technology and society. In addition, STS curriculum also aimed to develop students’ ability to make decisions on social issues which are related to science (DeBoer, 2000; Heath, 1992). However, a disadvantage of STS concept was mentioned by several educators. They saw that social issues would not help citizens obtain real understanding of the basic integrity of science (Kromhout & Good, 1983). A study of science-based social problems would not provide students with stable background to assess new coming issues (DeBoer, 2000). Other critiques regarding STS was that goals of STS would not be achieved because science- and technology-related issues in the real world context are more complex and require an understanding of relevant political and economic aspects as well as knowledge of science which is far beyond a level that school students could be expected to obtain (DeBoer, 2000).
During the debate of whether science content or science-related social issues were primary discipline of science education in the US, another issue came into existence. This issue was a decline of academic standards of the US education, as there was evidence to show that young American people have poor academic performance, especially in maths and science, and this affected the position of the US in world economic ranking (The National Commission on Excellence in Education, 1983). In late the 1980’s, the clear national goals established according to a support from National Governors Association and President Bush were seen as a way to create international competitiveness of the US (U.S. Department of Education, 1991).

By the 1990’s, science education reform became a major consideration of the nation (Hamilton, Stecher, & Yuan, 2008). The reform has increasingly emphasised academic standards and has aimed to make a rigorous academy and accountability through comprehensive content knowledge (Hamilton et al., 2008). It can be implied that this reform is a standard-based reform (DeBoer, 2000).

In 1989, the American Association for the Advancement of Science or AAAS published ‘Project 2061’s Science for All Americans’ in response to the standard-based reform (Roseman, 1997). Within the report, goals of science education were clarified and this benefited educators in that they could implement scientific literacy and make it achievable by all students (Bybee, 2005; DeBoer, 2000). The emphasis to reform was that the US saw that they, when compared with other countries, had not prepared young people for the world that science and technology have a significant function (American Association for the Advancement of Science [AAAS], 1995). Suggested learning outcomes by the Project 2061 include

- being familiar with the natural world and respecting its unity;
- being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another;
- understanding some of the key concepts and principles of science;
- having a capacity for scientific ways of thinking;
- knowing that science, mathematics, and technology are human enterprises;
- and knowing what that implies about their strengths
and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes (AAAS, 1989).

In 1996, the National Science Education Standards was introduced in response to the reform. The standards was the government’s approach which involved an establishing of national goals and generating standards which were proposed to meet those goals. The content standards were justified based on five main assumptions including:

1) Everyone needs to use scientific information to make choices that arise every day.

2) Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology.

3) Everyone deserves to share in the excitement and personal fulfilment that can come from understanding and learning about the natural world.

4) More and more jobs demand advanced skills, requiring that people be able to learn, reason, think creatively, make decisions, and solve problems. An understanding of science and the process of science contributes in an essential way to these skills.

5) To keep pace in global markets, the United States needs to have an equally capable citizenry.

(National Research Council [NRC], 1996, p.1-2)

Within the National Science Education Standards, the term ‘scientific literacy’ was included and expressed as

Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict
natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately (NRC, 1996, p.22).

Goals of US science teaching and its implications have been summarised and explained by DeBoer (2000) as follows:

1. Teaching science and learning about science is seen as a part of cultural experiences that are expected to impart from generation to generation. It has been acknowledged, since the middle of the 19th century, in the curriculum that well-informed, cultured and literate individuals are expected to recognise how the natural world works, what is the scientific way of thinking and what are impacts of science on society.

2. Science is also contributing to an increase of quality and enhancing opportunities in employment and further studies for students. Within the society where science and technology play enormous roles, knowledge and skills are required to cultivate in students during science classes. This will benefit students as these two elements are useful in terms of its application in the world of work and raising quality of manpower which will promote long term employment prospects. In addition, students with skills and knowledge will gain more benefit in terms of employment, as they are sensitive to potential careers that are science-related.

3. Implication of teaching and learning science also covers its usefulness for everyday living. Selected science concepts and principles, for example, friction and light and heat, should be taught in a way that enables students to recognise and understand application of science in their everyday lives.
This is acknowledged as a goal of science teaching since the early part of the 20th century.

4. Preparing citizens in the society to deal with scientific-related issues and participate in the democratic society is also recognised as a goal of science education in US. The issues that people are encountering in everyday lives, for instance, global warming, genetically modified foods and nuclear power, require awareness as well as understanding from citizens. Decisions relating to these issues which have been made also demand an understanding from citizens in society. Furthermore, investigation skills regarding these issues are also required of the citizens in order to allow them to influence or criticise policies which affect their lives directly as well as their communities.

5. Science should be taught as a way to look at the natural world. With this perspective, students are expected to learn how to use this way of thinking as a means to generate knowledge. Students are also expected to be able to determine whether others use the methods of science correctly. Furthermore, nature and characteristics of evidence, objectivity and bias, validity of data, scepticism, tentativeness and assumptions of regularity and unity in the natural world are demanding students to recognise and be aware. However, students also have to acknowledge that this way of thinking is not an absolute thought. Other ways of thinking such as emotional and spiritual aspects are also functional. Students need to identify a border line that distinguishes these aspects from nature of scientific thought. Therefore, students should be able to recognise the real meaning and characteristics of science.

6. Students are expected to develop an ability to follow discussions as well as publications regarding science-related issues which show up through the media. In addition, an ability to participate in conversations about science and those issues that emerge in their everyday lives will also be cultivated in students through science education. Scientific discoveries and its following discussions should be comprehended by students.
7. Because science is directly linked with the natural world, science education has been recognised as a way to help people appreciate the natural world. Students will be introduced to a lesson or a study that enables them to establish good understanding and perceptiveness on living organisms, natural resources and environment as well as accumulate direct experiences in natural phenomena.

8. Citizens that have appreciated as well as felt enthusiasm on science will be prepared to exploit advantages from scientific expertise. This is considered as a way to advance the field of science. This intention is developed based on the assumption that science is, if considering all related factors, a beneficent force and that the method of science and awareness of science will promote students’ appreciation of science.

9. Interdependence and relationship of science and technology have also been taken into account. Therefore, science education in the US has included various aspects of technology in the science curriculum because technological designs require knowledge in scientific principles as well as scientific enquiry methods. Furthermore, skills in planning, conducting experiments and evaluating technological inventions are also demanded. The role of the study of technology has been mentioned, as it has attracted and motivated students to study science because it can be directly observed and interacted with students in their everyday lives.

The concept of STEM has become important in the US, as it was addressed in a speech given by the President Barack Obama in 2010. In his speech, the significance of the four elements of STEM was pointed out as ‘Leadership tomorrow depends on how we educate our students today especially in science, technology, engineering and maths’ (US Department of Education, 2015). In addition, there are worries about a relatively small number of Americans who pursue expertise in these four vital elements, and an inadequate supply of skilled teachers in those four areas have been considered as a cause that make the US lose their leading position in a global economy (US Department of Education, 2015). Therefore, President Obama
has prioritised to increase the number of teachers and students who are skilful in science, technology, engineering and mathematics. With regard to this ambitious initiative, President Obama has set out the goal for STEM education as ‘within a decade, Americans must move from the middle to the top of the pack in science and maths’ (US Department of Education, 2015). To serve this goal, several investments whose objective is to improve teaching and learning in STEM were included in the fiscal year 2015 budget (US Department of Education, 2015).

While England and Wales currently consider science education as significant for developing scientific knowledge of citizens which will affect quality of living, another mighty country such as the US has emphasised the purposes of science education in a different way.

In England and Wales, science education is regarded as a significant factor for improving the quality of life; consequently, they seek to empower their citizens with scientific knowledge. As a result, the introduction of science education reform in England and Wales started out, as motivated by a realisation that science should be essential not only for those people who are going to be scientist but also for everyone in the society. However, other countries, such as the US, base their rationale for science education reform upon different motives which are an enhancement of the national competitiveness and a concerning of national security and defence.

When considering the history of science teaching development described earlier, the US has declared their position as leader of the world. The launching of the Sputnik by the Soviet Union has initially led to a period of self-doubt of competency and capacity in science and technology of the country because the development of Aeronautic and Space technology could symbolise the technological advancement as well as the competitiveness of the country. Consecutively, a period of self-examination has become emanate in order to identify the position of the US in the global ranking. All of these are initiated from the fright of the US over an issue regarding how the Soviet Union could develop their science and technology faster than the US. At the time, the US recognised the Soviet Union as a main competitor. Therefore, the US has put enormous efforts to catch up and stay ahead of the Soviet
Union through an investment in the development of space technology which demands scientifically-skilled workforce. This also conveys national concerns about security and defence i.e. weaponry development. As a result, these factors have pressured the US to reform their education, especially science education with an initiative to find a way to make the US reach and stay on top and ensure that they have the best weapons and powerful economy.

1.2.3 Developments in Europe: Changing World

For European countries, gender equity and the involvement of social context with science and technology have become discussion issues. Less interest of girls in school science has been noticed in a study of Brotman & Moore, 2008. Explanation regarding this issue was given in a report of Eurydice in 2011. The difference in interest in science between boys and girls is the answer. Boys are usually interested in technological elements that are contained in the traditional science curricula. Conversely, a number of studies revealed that girls are generally not showing much interest in science (Baram-Tsabari & Yarden, 2008; Häussler & Hoffmann, 2002; Murphy & Whitelegg, 2006). Therefore, the difference in interest in science between the two genders has become an important issue that policy makers and other related stakeholders cannot overlook if they wish to raise students’ motivation in learning science (Eurydice, 2011). This issue has also raised concern in international organisations such as United Nations Educational, Scientific and Cultural Organization or UNESCO (UNESCO, 2010). According to international studies such as PISA, countries where there is less difference between genders in the interest in science are the higher-attaining countries (UNESCO, 2010).

One way that educators think that will help improve students’ motivation and interest in science, in both genders, is to develop scientific ideas originated from social and real-life situations and contexts as well as applications of science in everyday lives (Bennett, Lubben & Hogarth, 2006). This strategy has been named ‘science-technology-society (STS) approach’ or ‘context-based science teaching’ (Eurydice, 2011).
Within the STS approach, the social and cultural context of science must be taken into account. To do this, tacit values of scientific knowledge and practices would have to be examined. In addition, consideration of social condition as well as consequence of scientific knowledge and its following modification, investigation of structure and process of scientific activity are also required (Eurydice, 2011).

According to several studies, science contents that attract female students are usually those relating to humans, including human body as well as health and wellbeing. On the other hand, science contents that attract male students involve technological and social aspects (UNESCO, 2010). However, common interests shared among boys and girls have also been noticed. Thus, context-based science teaching or STS approach whose focuses are at humans and social context around science would be of mutual interest between both sexes (Häussler & Hoffmann, 2002).

Eurydice (2011) proposed that European countries emphasise and address the following contextual issues in primary science and secondary science education:

1. The environment and sustainability. Almost all European countries have incorporated the environmental aspects in science teaching both in primary and secondary science, and focus on ‘the environmental implications of scientific activity’.

2. Science and everyday technology. Connection of science and technology in everyday lives has been addressed in primary science teaching while technological application of scientific phenomena has been focused on in primary science.

3. Using examples relating to the human body and its functions for contextualising scientific phenomena have been recommended for primary science in 27 European counties and for lower secondary science in 29 European countries. Examples of this approach are how electricity current plays a role in muscles and body system or effects of pharmaceutical products on the human skin.
4. Considerations of ethical issues that would emerge from science and technological advancements have been considered in a few European countries.

5. Because the development of scientific knowledge may be perceived as a social practice which is needed to consider the political, historical and cultural realisms, embedding science into its social and cultural context is crucial and unavoidable.

6. The history of science has been emphasised in primary science of less than half of the European countries. Human ideas about the natural world that has been studied since the prehistoric time are also suggested in lower secondary science of many European countries.

7. Philosophy of science is a common aspect of science teaching that has been suggested for primary science in one third of the European countries and for lower secondary science in a half of the European countries.

It seems that European countries agreed with some agenda proposed by the US and England and Wales. Generally, European countries do not have specific agenda which are different from the US and England and Wales. Mostly, they have considered common citizenship and understanding of impact of science on the environment surrounding their citizens. Another concern is internationalism, and this has subsequently led to growing interests on environmental and sustainability.

Generally, the limit in educational resources and facilities is a constraint that hinders teaching and learning in a classroom. Consequences of the constraint would be more explicit when conducting science teaching. Many African countries have encountered the constraint due to their poor economic condition and the way they deal with the constraint would be useful for an educator in a country that has faced the same limitations.

Learning from science teaching practices of those African countries and the approaches they used would provide clue for, not only Thailand, but also other developing countries or disadvantaged countries who need to undertake science teaching even though they are in mediocre condition and in a need to raise the quality of science teaching.
1.2.4 Problems of Developing Countries: Example of Malawi

According to the rationale described above, it is also interesting to look at educational practices in other parts of the world, particularly African countries, many of which are listed as least developed country (United Nations, 2014) and one of which is the Republic of Malawi. In the Republic of Malawi, Teaching and Learning Using Locally Available Resources or TALULAR is regarded as an approach to promote quality teaching and learning in the classroom (Malawi Institute of Education, 2004). According to a report from Malawi Institute of Education (2004), the diverse ranges of such available resources can be

1) Human resources which are experts from different fields such as village heads who can discuss and provide information relating to cultural practices or medical personnel who can transfer knowledge and discuss issues relating to health problems.

2) Animal resources such as wildlife, pets or farm animals and its products such as milk and cheese.

3) Plants such as trees, vegetables, grass or exotic trees, etc.

4) Material resources such as soils, water, stones, cloths, etc.

5) Non-material resources such as time, language, culture, etc.

As for teaching aids, objects from real life as opposed to theoretical constructs can be used as well. Additionally, models, presentation, pictures or drawings are also regarded as resources (Malawi Institute of Education, 2004).

Aims of using TALULAR in teaching and learning include 1) to provide hand-on and direct experiences within the realities of social and physical context; 2) to assure quality of retention of knowledge; 3) to encourage relevant and significant communication; 4) to promote students’ motivation to learn; 5) to promote students’ active participation; 6) to help students to comprehend complicated topics; 7) to help students understand the main points and able to integrate what they have learnt together with knowledge, skills and attitudes; 8) to help students expand their interests to other areas of learning; 9) to help teachers lighten their workload as their verbal expression will be reduced; and 10) to encourage students to use their creative thinking and ideas (Malawi Institute of Education, 2004). Additionally, TALULAR
is an environmental friendly approach, and using TALULAR can promote sustainability as well (Malawi Institute of Education, 2004).

In addition, Malawi Institute of Education (2004) has identified advantages of using TALULAR which include:

1) It helps teachers stimulate creativity of students through processes of making and using TALULAR
2) It helps teachers identify students’ interests and motivate them to learn as students have already experienced locally available resources, and teachers can use the TALULAR to assist students to discover new ideas.
3) It helps teachers organise a diverse array of activities to promote effective teaching and learning.
4) It promotes interests, accountability and participation of community as community members contribute objects or resources which will be used in school.
5) It is inexpensive or costs nothing, as the materials are locally available and environmental friendly.

Teaching science requires resources such as environments, materials and equipment and trained science teachers who have knowledge in safety and ability to regulate experimental works that, sometimes, have to deal with hazardous substances. Therefore, it is interesting that the least-developed country encountering problems in poverty, human resources and economic vulnerability, the Republic of Malawi has implemented an approach where students and teachers utilise things surrounding them to facilitate their effective science teaching and learning. Reflecting on this teaching practice in the Republic of Malawi, teaching science using locally available resources might be an appropriate teaching practice that should be considered by Thai educators or policy makers, as schools in rural areas in Thailand might consider using this approach in pursue science teaching.

Developed countries mentioned above are considered wealthy countries. It would not be very difficult for them to focus on science and technology because investment in scientific endeavour such as equipment and/or facilities is attainable for them. With respect to this, the gap between developed and undeveloped countries
is obviously recognised. However, it does not mean that undeveloped or developing countries could not undertake science teaching and science education. The TALUALR approach, which is implemented in the Republic of Malawi, can be an example that clearly demonstrates what disadvantaged countries can do. Although they do not have adequate facilities and resources but they think they can teach science. In a developing country like Thailand, problems in shortage of resources still persist over time and Thailand has not demonstrated concrete agenda as the Republic of Malawi did.

If we look at the pattern of development in concepts of science education in the US, England and Wales and European countries, it is clear that the contents and systems vary from country to country. Nevertheless, although these things are different among countries, several common concepts or themes of science education were implemented in many of these countries. Key concepts or themes that were universally employed include the consideration of relationship between social context and science and technology, ‘Science For All Americans’, for example, emphasises on 1) building scientific literacy of the citizens of the country, 2) applications and knowledge of science in daily life, 3) processes of science and experimental/practical work, 4) influences as well as relationship of science and environment, 5) relationship of science and natural phenomena, and 6) importance and significance of science, technology, engineering and mathematics on a country’s competitiveness and position in the global market. These concepts or themes identified above are likely to be discovered in many countries and in many science education schemes, and they contribute to what might be called essential science knowledge in the 21st century.

Literacy is perceived as a necessary factor that contributes to success in the development of a country. Apart from the literacy, numeracy has also come into the light. Then, both literacy and numeracy have become prominence in schools and towards the end of this century, people started to recognise scientific literacy. The demand of understanding from the public toward the significance of scientific literary is stemmed from the fact that the world is changing. Science and technology become essential factors that affect every aspect of people’s lives, then it is
necessary for every citizen to understand the nature of science and technology as well as processes of science in order to learn and habituate these processes (Nelson, 1999).

An economic capability of the nation to compete with other nations is a factor that influences the national economy in which successful competing in the global market contributes to the national wealth. In this regard, a vigorous research and development programme is considered to be a strong foundation that facilitates the enhancement of international competitiveness (Laugksch, 2000). Such a R&D programme can help a country secure a leading position in the worldwide race through the production of new high-technology products and it can help developing countries create a niche market and seek benefits from it. When such an R&D programme is supported, scientists, engineers and technically trained personnel will be constantly supplied (Laugksch, 2000). Regarding this, scientific literacy comes under the spotlight because only countries whose citizens acquire an appropriate level of scientific literacy will have the ability to maintain this supply. Moreover, scientific literacy helps promote the ability of citizens to participate intelligently in the economic sector (Walber, 1983 cited in Laugksch, 2000). Therefore, scientific literacy is a form of human capital that affects the economy of countries.

Significant of scientific literacy in the modern society is also described by Turiman and his colleagues (2012). They stated in their work that skills considered as essential skills for the 21st century consist of digital age literacy, inventive thinking, effective communication and high productivity. One of the abilities required in digital age literacy is scientific literacy. This can be implied that decision-making, participating in democratic society which has many issues related civil and cultural and sustaining the economy require knowledge and understanding of scientific concepts and processes (Turiman, Omar, Daud, & Osman, 2012).

Greater support for science in a society implies that the society has higher levels of scientific literacy among its populace (Laugksch, 2000). This occurs as a result of a higher number of new recruits would be attracted to science (Laugksch, 2000) and, according to Shortland (1988, p. 307 cited in Laugksch, 2000), ‘it is often suggested that public support for science depends upon at least a minimal level of
general knowledge about what scientists do’. If citizens did not value scientists’ goals and objectives, what those scientists were attempting to do, or recognise the processes necessary to achieve them, then financial support from public funds would not be supplied (Laugksch, 2000). Science itself also gains benefits from the promotion of greater scientific literacy in the society. Increasing public understanding of the objectives, processes, and capabilities of science leads to a reduction in unrealistic and impractical expectations of science by the public (Laugksch, 2000). If the public acquires unrealistic expectations, a loss of confidence in science and withdrawal of support for science may occur. Therefore, enhancing the level of scientific literacy could help counteract these threats (Laugksch, 2000).

The media is considered to be the main means of distributing information and ideas about science to the public. When dealing with the media, scientists should not attempt to censor what will be published or disseminated, but rather help the public gain better understanding of the contents released. Regarding this point, significance of promoting scientific literacy among populace is spotlighted (Jenkin, 2002).

In addition, scientific literacy also affects the process of making policy. According to the report by the Royal Society of London *The Public Understanding of Science*, a scientifically literate public significantly helps to improve the quality of public decision-making (Royal Society, 1985, p. 9 cited in Laugksch, 2000). The explanation of this claim is that the decisions a citizen makes based on an appropriate understanding of the issues are likely to be more beneficial than decisions made without such understanding. This notion was also supported by the scholar Prewitt (1983), who stated that citizens who comprehend science will be better able to support the democratic process in societies. With their scientific and technical base, those scientifically literate citizens will be significantly involved in and engaged with public processes, policy-making and social change (Prewitt, 1983 cited in Laugksch, 2000).

Scientific literacy also benefits individuals directly. When a citizen acquires more knowledge, they will gain the ability to better negotiate their way through the society in which they are living (Laugksch, 2000). Personal decisions regarding general issues in everyday life, such as diet and vaccination would also be improved.
by their scientific understanding (Laugksch, 2000). In addition, greater scientific understanding also helps prevent the dissemination of pseudo-scientific information that could lead to the emergence of misleading ideas such as inappropriate diets (Royal Society, 1985, p. 10 cited in Laugksch, 2000). When a populace becomes scientifically literate, citizens gain more competence and confidence in dealing with the science- and technology-related issues that emerge in their everyday lives (Laugksch, 2000).

According to Showalter (1974 cited in Laugksch, 2000), a scientifically literate person is:

1) A person who understands the nature of scientific knowledge,
2) A person who accurately applies scientific concepts, principles and theories in order to interact with his/her surrounding environment,
3) A person who uses scientific processes when solving problems, making decisions, and advancing his/her understanding of the surrounding environment,
4) A person who interacts with the aspects and issues of his/her surrounding environment on the basis of the values that underlie science,
5) A person who understands and recognises the benefits of joining science and technology, their interrelationship, and the impact of these on other aspects of society.
6) A person who develops more satisfying and exciting views of the surrounding environment as a consequence of undertaking science education and aims to make this education to be one of life-long learning,
7) A person who possesses manipulative skills related to science and technology.

Millar and Hunt (2002) also pointed out that simply understanding scientific explanations is not sufficient for citizens to be able to make use of scientific knowledge appropriately. The citizens are also required to comprehend some Ideas-about-Science that include: 1) Ideas about data, how and where these data are produced, as well as ideas about relationships between evidence and explanation, 2) Ideas about the influence of society on scientific work, 3) Ideas about causality
between a factor and a given outcome, 4) Ideas about risk measurement and assessment in different circumstances, and 5) Ideas about the relationship between science and society, the impact of technology on society, public decisions about science and technology, as well as any ethical issues that may arise (Millar & Hunt, 2002).

Another aspect of scientific literacy that enhances the well-being of an individual is the increasing opportunities for employment. Recent economic trends are regarded as ‘knowledge-based’ so the quality of human resources has become a major economic asset of science and technology driven societies (Brooks, 1991 cited in Laugksch, 2000). As a result, scientifically literate citizens may have more opportunities to find employment and to take advantage of the benefits of technical developments in their workplace (Thomas & Durant, 1987 cited in Laugksch, 2000).

According to the definitions of scientific literacy as previously described, a scientifically literate citizen requires not only the possession of scientific knowledge but also an understanding of scientific processes. An understanding of scientific processes is derived from the practice of scientists, i.e. how they think, how they analyse data obtained and how they solve problems. Therefore, scientifically literate children are expected to not only know some science, but also know how to carry out science. Therefore, at the least they should be able to carry out such recognise and use evidence, find solutions or solve problems, test hypotheses, and make deductions based on observations and experiences.

1.2.5 Summary and Key Themes

The theme of science teaching in the US is ‘strategic importance of science and technology’. It could be elaborated that the US science teaching was firstly considered for serving national defence and security purposes. This has led to the ambition in which the US wants to be on top of the world. Subsequently, implications of science and its practical applications have played an important role to serve this ambitious goal as science and technology are fundamental for manufacturing. In addition, other than the US government, science and technology are recognised by US corporations as cornerstone for development of industry, able to strengthen national economy and subsequently encourage the intention to
dominate the world market. An example of the industry to which science particularly physics has contributed enormously is semiconductors industry. It can be asserted that the development of such industry benefits the US economy because semiconductors industry is regarded as Hi-Technology (HT) manufacturing and that HT manufacturing possessed 27% of global sharing in 2012, followed by China that possessed 24% of global sharing (National Science Board, 2014). That is why the US has science at the forefront.

Unlike the US, themes of science teaching in England and Wales refer to contents and methods. Concepts of Science for All Students (including girls) have revealed societal position of science in England and Wales. With respect to this, the emphasis on what kind of scientific knowledge that all children should understand and why people should understand these scientific knowledge are central to science education of England and Wales. In addition, implications of science that would be expected to affect citizens such as stem cell research are also taken into account.

The concept of science for all in England and Wales and that of the US differ in the trigger point to implement. In England and Wales, science for all means science for all citizens, regardless of their gender or academic level. That is to say, everyone can learn science. On the other hand, science for all Americans is initiated from an aim of the US to become a global leader in science and technology.

Although within the US and England and Wales different driving forces and motives for introducing science reform can be identified, in fact, their intentions regarding science teaching are very similar. As described above, they are both interested in ‘science for all’ which is a concept that focuses on the idea that science and technology are relevant to all children at all ages. They are both keen on the idea that the country has to prepare citizens to live in society that is increasingly depending on science and technology. The significance of this idea is that if the citizens do not understand the place of science and technology, they will struggle because they may not be able to participate fully in society generally, and in particular may find it harder to get employment.
Science in everyday life is a concept that is addressed frequently in the US and the EU. However, there is a slight difference in a way that science in everyday life concept in the US is linked with scientific literacy. The definition of scientific literacy in the US during the 1970s was explained with an association of applications of science in everyday life, while, in the EU, it is tied with the concept of STS or Science-Technology-Society approach, in which science in everyday life is a setting of the STS. The concept of science in everyday life reminds us of the rationale of teaching science. Science should not be instructed based on an assumption that science is a theoretical subject. Rather, science is seen as a practical subject that requires practical experiences, and the learning process of learners has to be taken into account.

In both the US and the EU, an account of societal context and culture and their relationship with science and technology have been recognised. However, implications of STS in the EU differ from that of the US in that the EU sees STS as a tool to promote students’ interest and motivation in science and subsequently to eliminate issues about gender-specific subjects. This assumption is alive on the basis of a belief that students (both boys and girls) develop scientific ideas that have arisen from real-life situations. This is expected to attract students to science, as they can acquire scientific ideas from their own experiences, regardless of their gender.

Although these concepts or issues are differently interpreted and explained, some concepts or issues have been similarly recognised and translated among different countries, and the main similarity is around issues of STEM education, the role of experimental work and the emphasis on the process of science.

The concept of STEM education in the US and England and Wales is similar in that it was introduced to serve economic purposes. Moreover, STEM education in both countries has focused on the development and the increasing number of skilful teachers and students in science, technology, engineering and mathematic subjects.

The role of experimental work in science teaching is considered as an important element in science education of both the US and England and Wales. That
is to say, experimental work or conducting an experiment is required for science teaching in both countries.

Both the US and England and Wales have recognised the importance of process of science and have required students to understand this complex process. In both countries, the emphasis has been heavily placed on how to work scientifically, rather than focusing on contents of scientific knowledge.

The lesson learnt from the TALULAR approach in the Republic of Malawi has reflected an idea that science teaching can be conducted even in a disadvantaged place that has encountered poverty and shortage of facilities and resources. As long as teachers have strong determination to provide quality teaching to students, deficiency seems not to be a major obstacle. Therefore, the production of teachers with perseverance should be emphasised, as this kind of teacher can be the main driving force in improving the quality of science education.

Details of environment and sustainability issues in each region are different. Global warming and climate change are likely to be major global concerns whilst farming and crop production would be more serious issues in the African region (New Partnership for African's Development [NEPAD], 2013). However, at last, people are starting to realise and understand that science is vital for their lives; science is vital for the conservation of sustainability of this planet.

All of these concepts have been discussed and implemented for nearly 40 years. When looking at Thailand recently, it seems that Thailand pursued these concepts behind time as what has been done in Thailand is reflected below.

1.3 Curriculum Theory and Science Education

Whether or not it is made explicit, when subject content is organised into a curriculum there are usually some assumptions underpinning the way it is sequenced and the intended teaching methods. Just what these assumptions are may be particularly relevant in the case of science, as it may be that some approaches focus too much on the content of learning, and not enough on the process. It will therefore
be helpful to look briefly at some of the ways curriculum has been conceptualised before looking in detail at the science curriculum in Thailand.

Curriculum has been classified in many ways including prescriptive, descriptive and both. Ellis (2004, p.4) argues that ‘prescriptive curriculum definitions provide us with what ought to happen, and they more often than not to take the form of a plan an intended programme, or some kind of expert opinion about what needs to take place in the course of study’. Prescriptive curricula are also analogised with medical prescriptions. The teacher is compared to a patient, who will decide whether they will follow the prescribed curriculum. Doctors provide prescriptions, but it is the patients’ right to decide whether they will follow the prescriptions provided (Glatthorn, Boschee, Whitehead, & Boschee, 2012). This underlines that the official or prescribed curriculum is one thing, but that often what teachers do in the classroom is another.

Another definition of curriculum was proposed by Akker and colleagues (2009), as ‘a plan for learning’, claiming that thinking of the curriculum as a ‘plan’ offers a useful basis for an interpretation and communication of curriculum issues. In contrast with the prescriptive approach, the descriptive approach conceives curriculum ‘not merely in terms of how things ought to be, but how things are in real classrooms’ (Ellis, 2004, p.5). Glatthorn and colleagues (2012) refers to the descriptive curriculum as the ‘experiences’ of learners. According to this, the experienced curriculum extends beyond the definition of content or knowledge to be covered and involves classroom activities and events.

Indeed, there is a variety of the definitions provided for prescriptive and descriptive curricula, depending on scope and emphasis. However, Glatthorn et al. (2012) criticised that there are two criteria required for a useful definition of curriculum. These include clarity regarding the general understanding of the language that is supposed to be used by educators, and the belief among these educators using the curriculum that in so doing they can achieve quality education. At the same time, the same team of researchers concluded that the curriculum is a broad concept, that goes beyond lists of content and embraces ‘the plans made for guiding learning in the schools, usually represented in retrievable documents of
several levels of generality, and the actualisation of those plans in the classroom, as experienced by the learners and as recorded by an observer, those experiences take place in a learning environment that also influences what is learned’ (Glatthorn et al., 2012, p.4).

1.3.1 Types of Curriculum

Curriculum is classified by Glatthorn et al. (2012) into six types as follows.

1) The recommended curriculum
2) The written curriculum
3) The supported Curriculum
4) The taught curriculum
5) The tested curriculum
6) The learned curriculum

Among these types, the written, the supported, the taught and the tested curriculum are considered as the intentional curriculum. The intentional curriculum is a set of learning goals that the school system adopts as conscious intentions. In contrast, the ‘hidden’ curriculum is a form of learning that is unintentionally produced by the school system (Glatthorn et al., 2012).

The idea that curriculum might cover more than what intended by curriculum developers is not new. Indeed in the late 1970’s, Goodlad and associates (1979) suggested five different perspectives from which a curriculum can be viewed:

1) The ideological curriculum

The ideological curriculum is believed, by scholars and teachers, to be the ideal curriculum and it contains ideas that aim to reflect funded knowledge.

2) The formal curriculum
The formal curriculum is also called ‘sanctioned curriculum’ and, according to Goodlad & Associates (1979), it represents society’s interests due to that fact that the formal curriculum is officially approved by state and local school boards.

3) The perceived curriculum

The perceived curriculum is mental image of the curriculum that teachers, parents and others have in their mind.

4) The operational curriculum

The operational curriculum is a form of curriculum that represents what are observed or actually happened in the classroom.

5) The experiential curriculum

The experiential curriculum is a form of curriculum that represents learners’ experiences.

Based on the work of Goodlad & Associates (1979), forms of curriculum were re-classified by Akker and colleagues (2009), into three levels and were split up into six forms. The three levels include:

1) Intended — this was split up into ideal and formal (written) curriculum.

2) Implemented — this was split up into perceived and operational curriculum.

3) Attained — this was split up into experiential and learned curriculum.

When we consider these various perspectives regarding forms of curriculum, we conclude that Thai science curriculum is a formal, ideal or written curriculum. The evidence for this claim is that, in general, the Thai science curriculum describes what is to be learned in science and identifies the expected outcomes in term of learning standards and learner’s qualities (The Institute for the Promotion of Teaching Science and Technology, 2008).
1.3.2 The Components of the Curriculum

1.3.2.1 Curricular Policies

According to Glatthorn and colleagues (2012), curricular policies refer to ‘the set of rules, criteria, and guidelines intended to control curriculum development and implementation’ (p.18). By referring to the work of Kirst (as cited in Glatthorn, 1987), Glatthorn and colleagues (2012) described there are macro policies and micro policies. Regarding this, Kirst gave an example of macro policies as ‘a broad policy on courses required in schools’, and micro policy as ‘a set of recommendations for a specific curriculum unit in a given subject’ (as cited in Glatthorn et al., 2012, p.18). In addition, significance of policy making is also reflected in ‘the authoritative allocation of competitive values’ (as cited in Glatthorn, 1987, p.15). The impacts of school policies and practices upon students are also spelled out by Glatthorn and colleagues (2012). Regarding this, it was suggested that the prioritisation of ‘learning for all’ signals to school principals or administrators that they should emphasise the significance of measured outputs for all, as a key strategy for human resource development (Mizell, 2010 cited in Glatthorn et al., 2012).

1.3.2.2 Curricular Goals

Glatthorn and colleagues (2012) defines a curricular goal as the widespread and long-term outcomes that are expected to be achieved. According to this definition, three critical points emerge; 1) goals are more general than objectives, 2) goals require a considerable period of time to be achieved, and therefore 3) goals are long-term outcomes that the school system hopes to achieve through the entire educational process

1.3.2.3 Field and Programme of Study

A field of study is a set of learning experiences that are organised and have defined boundaries, and are typically offered through multiple years of learning.

A programme of study is total set of learning experiences that the school offers to a particular group of learners. A programme of study also can cover several years. Programmes of study often delineate which subjects are core subjects and
which are elective subjects as well as describing time allocation and credits (Glatthorn et al., 2012).

1.3.2.4 Course of Study

A course of study is a set of organised learning experiences and it can be regarded as a subset of both a programme of study and a field of study. A course of study offers learning experiences to the students who receive academic credits through a semester or a specified period of time e.g. a year. Usually, a title and a grade level are indicated in the course of study (Glatthorn et al., 2012).

1.3.2.5 Unit of Study

A unit of study is an organised set of learning experiences that relates to a course of study. Generally, units of study cover a few weeks and are arranged on particular concepts. Rose (2010) criticised that guideline for units of study are often based on ‘standards’ that cannot be easily followed by teachers (Rose, 2010). Consequently, some teachers cannot make a link between the standards and units as they plan (Glatthorn et al., 2012).

Robert Marzano and colleagues (2001) (as cited in Glatthorn et al., 2012) suggested the best way to develop unit of study is to view ‘the process as a series of phases’. He described the planning phase of unit development is supposed to include;

1) Strategies for setting goals of learning should be developed at the beginning of a unit.

2) Strategies for monitoring progress, introducing new knowledge, practicising, reviewing and applying knowledge should be constructed and carried out during a unit.

3) Strategies for helping students examine their achievements should be undertaken at the end of a unit.

Marzano also proposed the best-practice approach which is including 1) introduction of components and sup-components of the unit process to students and
following by 2) construction of tasks to emphasise those components or sup-components.

1.3.2.6 Lessons

A lesson is a set of learning experiences that are created for pursuing specific and limited objectives. Actually, lessons are subsets of units but they are sometimes neglected by teachers during a period of planning of instruction, according to Glatthron and colleagues (2012).

To encourage effective curriculum planning, Marzano and his colleagues (2001) (as cited in Glatthorn et al., 2012, p.21) described lesson activities that have a strong influence on student achievement as follows:

1) Identifying similarity and differences
2) Summarising and note taking
3) Reinforcing effort and providing recognitions
4) Homework and practice
5) Non-linguistic representations
6) Cooperative learning
7) Setting objectives and providing feedback
8) Generating and testing hypotheses
9) Questions, cues, and advance organisers

By reflecting on factors described above, Glatthron and colleagues (2012) draw out an important point, which is the need to ‘emphasise meta-cognitive control’ when planning a curriculum. In their point of view, Meta-cognitive ability is vital and helps learners to understand ‘what it means to be educated’. They also mentioned that it is possible that teachers recognise the importance of meta-cognition but they may be put off by its complexity.
### 1.3.3 Hidden Curriculum

Of course, the received curriculum extends beyond what is taught in classrooms. According to Glatthron and colleagues (2012), the hidden curriculum can be defined as ‘those aspects of schooling, other than the intentional curriculum, that seem to produce changes in student values perceptions and behaviours (p.25)’. By reflecting this definition, it could be seen that students learn not only from the intentional curriculum, but also from other sources. In addition, Glatthorn and his colleagues also suggested that the hidden curriculum can be classified and/or categorised into two aspects. Those two aspects include:

1) The constant of the hidden curriculum

As recognised by many researchers that cultural factors might be seen as constants, Glatthron and colleagues (2012) also acknowledged this. The ideology of the larger society is the constant of the hidden curriculum and schools in the US can be used as an example for portraying this aspect: those schools reflect the ideology of democratic capitalism in the US.

2) The variable of the hidden curriculum

Glatthron and colleagues (2012) classified factors subject to variation in the hidden curriculum into three categories as follows:

2.1 Organisational variables

This term refers to judgements about teacher assignment and how student will be grouped for instruction. Other organisational variables that impact include class size, the quality of libraries, student morals, special help, assessment strategies and even community or other factors outside the school

2.2 Social System Variables

School culture is emphasised as significant factor that is often became overloaded when there is an attempt to improve school. As Glatthron and colleagues (2012) refer the work of McREL (Mid-continent Research for Education and Learning), school culture is ‘a shared vision, a sense of purpose, cohesiveness,
overall well-being of staff members, predictable routines, and a sense of control’ (Waters, 2009 cited in Glatthorn et al., 2012, p.28). The significance of school culture is also mentioned by Linda Darling-Hammond (2010). She states that ‘creating schools that enable all children to learn requires the development of systems that enable all educators and schools to learn’ (Darling-hammond, 2010, p.8). In response to Darling-Hammond’s point of view, districts’ social system and integration of students by socioeconomic status are taken into account by several school leaders (Glatthorn et al., 2012).

Opportunities for students to participate in decision-making activities are influenced by administrators and teachers through effective leadership. These factors are considered as building block of desirable and vigorous organisational culture (Waters, 2009 cited in Glatthorn et al., 2012).

The involvement of parents and community can also impact schools and their operations, for example, parents’ support of technology. When the parent recognises how technology impacts their children, they will become a supporter of educational technology (Glatthorn et al., 2012). For the community, their impacts on curriculum development can be in a form of financial supports. When members of community satisfied with schools’ activities and pedagogy, financial supports will be provided. Those include more staff, improved facilities, materials etc. (Glatthorn et al., 2012).

2.3 Cultural Variables

In schools that have students with diverse culture and linguistic backgrounds, teaching requires both specialised teaching practices and integration of English language learning and leadership. These are important requirements particularly for students from historically marginalised group (Lundquist & Hill, 2009).

Cooperative working of administrators and teachers is also vital and influences these factors of the hidden curriculum.
1.3.4 Curriculum Development

The process of improvement and innovation in education are central to development of the curriculum (Akker et al., 2009). A variety of models for curriculum development have been proposed. One of those models is suggested by Akker and colleagues (2009), which contains five core activities as shown below.

![Figure 1. Model of curriculum development](image)

All of these core activities are interacting simultaneously. An analysis of the existing setting and conceptualisation of the proposed innovation are usually a starting phase. Within this phase, there are several important activities that can be classified as: problem analysis, context analysis, needs analysis and knowledge-base analysis (Akker et al., 2009). With regard to these activities, designated guidelines are constructed and the requirement for the design undergoes several steps including developing, testing and refining.

From the model shown above, continuous evaluation is at the centre. Therefore, it plays an important role in curriculum development process (Akker et al., 2009).

The ways in which these five core activities are carried out are contingent upon the curriculum development approach, which can be 1) instrumental approach,
2) communicative approach, 3) artistic approach and 4) pragmatic approach (Akker et al., 2009).

1) Instrumental Approach

For this approach, a systematic design process is the key factor. This approach requires thorough analysis, which produces clear and measurable objectives and leads to the designing of the development process. One such strategy for systematic curriculum development was proposed by Ralph Tyler in 1949. He provided a framework called the ‘Tyler Rationale’ which consists of a number of questions, including:

Objectives: Which objectives should education aim for?

Learning experience: Which learning experiences are most suitable in order to obtain these objectives?

Organisation: How could these learning experiences be organised effectively?

Evaluation: How can we determine whether the objectives have been achieved?

(Tyler, 1949 cited in Akker et al., 2009, p.16)

This framework became popular due to its simplicity. It is believed that systematic answers to these four questions will increase the validity and internal consistency of a curricular design. However, several disadvantages of this approach were identified. Generally, this approach is restricted because the attainment of predetermined objectives is emphasised. Therefore, it would be difficult to make an adjustment when user’s needs are changed. Another identified disadvantage is that this approach considers factual and empirical data, but education is usually relevant to social-political aspects, as well as personal views and opinions (Akker et al., 2009).
2) Communicative Approach

This approach relies on the building of relationships among stakeholders and involvement of curriculum developers and other parties. The starting point of this approach is subjective perceptions and points of views of curriculum designers, target groups and stakeholders. To design the process, consensus is required from interested parties who have their own visions. Thus, central to this design process is deliberation and negotiation (Akker et al., 2009).

An example of the communicative approach is proposed by Decker Walker, 1971; 1990 (as cited in Akker et al., 2009, p.17). As seen by Walker, the desired features of curricular products are created from the complex practice of negotiation. Walker’s model consists of three phases that include:

The platform of ideas: During the first phase, designers and other parties involved present their views and opinions about the problem while striving for consensus.

Deliberation: Designers and other parties involved generate possible solutions for the problem identified and discuss the most desirable solution.

Design: During this phase, the results of the deliberation phase are transformed into a draft of the final product.

An advantage of this model is broad support as involved parties have an opportunity to contribute. However, this model is time-consuming and may not achieve internal consistency (Akker et al., 2009).

3) Artistic Approach

In this approach, the personal views and expertise of the curriculum designer are prominent. There is no requirement of fix procedure or criteria, rather emphasis anticipation and visions of the designer as well as contexts and characteristics of the target group. A well-known advocate of this approach is Elliot Eisner (1979). In his view, the teacher plays important role in which the teacher will face the real situation
and they will anticipate as well as make decisions about the curriculum by using their own experiences and visions (Eisner, 1979). By reflecting on the curriculum, Eisner suggested seven aspects that should be paid attention: objectives, content, learning situations, organisation of learning experiences, organisation of content, presentation forms, and evaluation forms (Eisner, 1979). Advantages of this approach are at the emphasis on carrying out the curriculum in practice and the opportunity to attune the curriculum to fit with students’ needs. However, the narrow scope of the products, which is a result from the emphasis on specific contexts, can be regarded as a disadvantage of this approach (Akker et al., 2009).

4) Pragmatic Approach

Central to this approach is the emphasis on the ‘practical usability’ and close interplay between local practices and users is required. For this approach, formative assessment is fundamental. Firstly, a draft of a possible final product or prototype is developed from evidences obtained from experts and literatures. The prototype then undergoes a cycle of design, evaluation and revision according to the wishes and possibilities of the users. However, difficulty may arise from the variation between user wishes or complexity of experts’ insights and literatures. Regarding this, Akker and colleagues (2009) suggested that the determinant should be the designer’s vision.

In order to identify the most appropriate approach described above, it is essential to determine the level of curriculum development. The communication or instrumental approach is often implemented at the macro level. At the micro level, or in the classroom, the most suitable one is the artistic approach (Akker et al., 2009). When taking the scope of the curriculum product into account, the artistic or pragmatic approach seems to be the suitable approach for the context-specific products. For the generic products, the instrumental or communicative approach is recommended (Akker et al., 2009). In addition to the level of curriculum development and the scope of curriculum product, the composition of the design team is also crucial. For a large team of designer, it is obvious that greater extent of time is required for discussion. Therefore, the communicative approach seems to be the most suitable one for a large team of designer. On the other hand, an artistic
approach is suitable for a small team, or only the designer who implements alone. Therefore, individual creativity is allowed (Akker et al., 2009).

1.3.5 Curriculum Development at Macro Level

Curriculum development at the macro level refers to the development of generic curriculum framework (Akker et al., 2009). Such frameworks may be introduced in a form of core objectives and examination programme that offers guidance for generate national education objectives and contents. Generally, there is a great diversity of demands, visions and expectations on education at national level due to the fact that each of stakeholders has their own demands and interests. Requirements addressed in the curriculum are from interests of various stakeholders, for example, parents, religious groups, industry or social organisation. This became an important challenge in the development of framework at the macro level (Akker et al., 2009).

At the national level, it is essential for governments to ensure the quality of education by making choices. Regarding this, international development agenda and framework are founded to be factors that influence the process of decision making. A process of clearly defining of the core of the curriculum are required and should be followed by the process of legitimisation and validation of the choices by experts and stakeholders, and by using different strategies. The relevance and desirability of the objectives and contents are regarded as the first argument that should be taken into account for justifying the curricular choices. According to this argument, a discussion which places an emphasis on the practicality of implementation should be led by schools and teachers (Akker et al., 2009). In addition, several important aspects should be considered, including:

- The pupils’ competence
- The teacher’s competence
- Social support for innovations
- Learning time
- Educational Arrangement

In addition, there are issues that should be taken into account when developing curriculum policies, such as:

1) Should emphasis be put on a communal and uniform educational programme or should there be room for flexibility, diversity, and choices for schools and pupils?

2) Is there central direction or a degree of local autonomy and responsibility?

3) Is supervision based on a firm control system and around centrally defined results or on a decentralized accountability that displays confidence in the competence of schools and teachers?

(Akker et al., 2009, p.22).

For countries that highly centralise education systems, detailed regulations for objectives and content, school time, teaching standards and tests, and selection of education materials are often specified in the curriculum. This leaves little room for schools and teachers to participate and supply input. Nevertheless, there are also European Countries that have a less centralised education system. Their objectives and contents of curriculum are placed in a general plan and provide more opportunity to schools to develop what seems most relevant locally (Akker et al., 2009).

Of course, different forms of curriculum exhibit different strengths and weaknesses. For a short term period, the prescriptive curriculum defines the desired results and such curricula, when compared with a more decentralised model, often contribute to improved learning outcomes. However, it would not be easy to sustain these effects in a long run. A more flexible curriculum seems more motivating because it requires direct involvement of schools and teachers. Therefore, education improvement is more sustained through a period of time. However, a disadvantage of more flexible curriculum would be risks that emerge from lack of clear focus on objectives and contents. These will prevent systematic working of schools and
teachers and could result in different in poor levels of improvement (Akker et al., 2009).

Recently, EU countries such as the Netherlands also encounter problems relating to the quality of pupils’ mastery of basic skills in language and arithmetic. Therefore, the development of referenced levels for literacy and numeracy in this country now focuses on the process of curriculum development at the macro level. The existence of the problems is supported by empirical evidences including the decline in results from international comparison and the performance of student teachers when taking tests at the start of the teacher training course. According to this, several reasons that contributed to these difficulties were identified and all of them were relating to lack of basic skills in literacy and numeracy. Those reasons included inadequate pedagogical approaches and learning resources, lack of school time, lack of maintenance during the learning career, teachers’ lack of knowledge and skills and insufficient alignments among school types (Akker et al., 2009, p.25).

In response to these problems, the government set up an expert group for the teaching of literacy and numeracy and specified the desired learning results through a central framework. Its objective is to improve cooperative working and alignment between primary education and the entry level of higher education. The expert group is a group of researchers, teachers and experts from various disciplines including subject matter experts and education experts. Formulated recommendations and advices were also presented to members of the parliament. Following this, methods for validation and legitimising, the practicality and content were carefully considered. However, the critical step was the obtaining of the voices from the field. This step was undertaken under the support from the school councils for primary and secondary education. By this step, teachers’ opinions on desirability, practical methods for implementation and the feasibility of the advice were tested. The Development of policy proposals was the next step, and central to this step was the broadening of support from the public (Akker et al., 2009).
1.3.6 Curriculum Development at the Micro Level

At the micro level, produced curricular products consist of lesson materials and resources. Generally, these are available commercially, and the use of them by schools and teachers is non-compulsory. Schools and the teachers can cherry-pick materials used from the diverse range of available resources. Nowadays, printed and digital versions of teaching materials are published by many publishers, allowing an easy access to teaching materials in a convenient and effective fashion. However, this phenomenon can restrict curricular innovations when there is an excessive reliance on materials produced by teachers (Akker et al., 2009), though in the Netherlands this phenomenon has produced positive outcomes when there is an increasing involvement of schools in curricular innovation. According to this, schools acquire the authority to develop local curricula (Akker et al., 2009), based on their own materials and ideas.

According to by Akker and colleagues (2009), curriculum innovation involves changes in teachers’ thinking and performing, and also includes a learning process among these teachers. Fullan (2007b) described there are three situations where such change is necessary. Those situations are 1) when new teaching materials are employed, 2) when there is a requirement for the adaptation and demonstration of different pedagogical or organisational behaviours, particularly when this requires substantial ‘unlearning’ of existing roles, and 3) when there are alterations of perceptions and attitudes regarding the profession, the pupils’ role and the teachers’ role. However, van Driel (2008) (as cited in Akker et al., 2009) argued that the teachers’ pedagogical content knowledge and skills demand constant change, and this was elaborated by Akker and colleagues (2009) that continuing ‘Reorientation on and reinforcement of pedagogical content knowledge are considered the keys to successful curriculum improvement’ (Akker et al., 2009, p.34).

Learning resources in the form of exemplary lesson materials are perceived as an ideal means for making generic innovation seem feasible to busy teachers. This is an effective strategy to put innovation into teaching practice (Akker et al., 2009). Exemplary lesson materials have been seen as a resource offering both inspiration for and practical assistance in changing practices (Akker et al., 2009).
He argues that this is because such materials

1) acknowledge expected phenomena that often arise during lessons,

2) offer guidelines for practical use,

3) provide ‘pegs’ for discussion, reflection, feedback and exchange of ideas and experiences,

4) help reduce the early problems experienced during innovation and simultaneously promote local adaptation and ownership,

5) promote dialogue and reflections among involved stakeholders regarding expected outcomes and teaching practices, and

6) stimulate the refinement or re-design of teachers own materials (Akker et al., 2009).

Furthermore, teaching materials that demonstrate relevance, consistency, practicality and effectiveness will benefit the further scaling-up of change processes, and also lead to the professional developments of teachers as well as construction of knowledge concerning the design of such materials (Akker et al., 2009).

1.3.7 Curriculum Development at School level

In the Netherland’s example aforementioned, schools have some autonomy to develop curriculum for their own schools. As indicated in the national curriculum framework, aims and contents which are in accordance with the school’s needs can be addressed by schools themselves. Various questions and dilemma have been given rise as a result of challenges to develop a relevant and cohesive curriculum, and schools have to deal with this matter. Those questions and dilemmas relate to how appropriately curricular choices correspond with the central vision on learning, the need to retain coherence while offering choice and how stakeholders are involved in the decision making process (Akker et al., 2009).

But the role of teacher is central here; quite simply curriculum development without teacher development is unlikely to happen. Teachers’ perceptions and
attitudes significantly affect the implementation of change and these perceptions themselves often change over time during the change process (Akker et al., 2009). According to the Concerns-Based Adoption Model (CBAM) proposed by Loucks-Horsley (1996), teachers’ concerns during an experiencing of a change process can be categorised into three main phases as follows.

1) Self orientation: This is relating to teachers’ concerns about the effects of changes on their own performance and practices.

2) Task orientation: This is relating to teachers’ concerns about the teaching methods or tasks which will be carried out in a classroom.

3) Impact orientation: This is relating to teachers’ concerns about impact of the change, its outcomes and effectiveness.

Akker and colleagues (2009) suggested schools stick with timelines that are consistent with the development of teachers’ skills and accommodate their needs and concerns. However, often teachers have been given little opportunity to develop themselves during periods of major curriculum reform.

The willingness to change of teachers is also a factor that influences curriculum innovation in schools. It involves the perceptions and views teachers have towards the intended changes. Akker and colleagues (2009) lists a number of ‘classic’ stages in teachers’ attitudes toward change, each of them requiring a different approach if change is to be achieved;

1) Problem denial: This issue is common when there has been little preparation to change teacher’s educational practices.

2) Tentative recognition: Teachers recognise the problem but they are not prepared to change because they perceive the problem is caused by something or someone else.

3) Preparation: Teachers agree that the change is needed and they are prepared to carry out the change. More information for teachers is also required.
4) Implementation: The implementation of change is carried out by teachers. However, it requires enormous efforts from teachers because it is easy to fail and recede to the previous practices.

5) Maintenance: Teachers are completely familiar with the change and implement it intuitively.

(Akker et al., 2009).

How such matters are managed at school level depends very much on School culture. Teacher collaboration is crucial when implementing change, but school cultures do not always encourage this. The distribution of leadership and curriculum control within the school also reflects school culture. In a culture that values teachers and encourages them to experiment, change will be less difficult to accomplish. In a culture where teachers are closely monitored and student outcomes are regularly measured, change is rather a hassle. We need to ask: what is the prevailing culture into which curriculum reform is placed, and how involved or responsible do teachers feel for the success of the change? In more centrally controlled systems, teachers feel little personal responsibility for the success of curriculum reforms, and that will always lead to implementation problems (Ainscow & West, 2006).

Cohesive curriculum innovation also demands active and well planned communications. All parties involved should communicate each other in a topic of activity and their reflection upon implications, and should also indicate to what extent the formulated series of actions conform with the framework of innovation (Akker et al., 2009).

So, we can see that there is a considerable body of knowledge about the nature of curriculum and curriculum planning, about what curriculum development means and what it involves, about what factors are likely to ensure that it succeeds or fails. This knowledge base will be important when considering whether the current science curriculum reform in Thailand has been developed sensibly, implemented appropriately, and may help to explain any successes or problems discovered during the fieldwork in schools.
1.4 Science Teaching in Thailand

1.4.1 Science Education

Science education has been defined as building understanding of students of knowledge and ideas of science, developing students’ critical reasoning, and developing students’ understanding of scientific process, epistemology, values as well as implications of scientific knowledge, and cultivating collaborative working skills to students and providing opportunities to students in accumulating experiences (Osborne, 2007). An aim of science education is also to activate students’ curiosity on phenomena in the world (Millar & Osborne, 1998).

The importance of science and technology has become apparent in the Thai society since the Eighth National Social and Economic Development Plan was introduced in 1997 (Boonklurb, 2000). The development of human resources in science and technology has been considered as a part of a strategy to situate Thailand among the nations of the world and to prepare people of Thailand to succeed in the twenty-first century (Boonklurb, 2000).

In addition, the National Education Act which was passed in 1999 also stated the importance of science and technology. Apart from the intention to develop cooperative, physical and intellectual capabilities of the Thai citizens, Thai education has also emphasised knowledge, values and learning process as well as integrating those three concerns together and cultivating them in students at each grade level (Boonklurb, 2000). This has been applied with the learning of science and technology in a way that concepts of science and technology will be taught, and students are expected to apply and utilise those concepts within everyday lives or community-related contexts such as environmental management and natural resource conservation (Boonklurb, 2000). This corresponds with the concepts which have been proposed in SSCR of England and Wales in that students should perceive learning as relevant.

As in England and Wales, science is compulsory and freely available to all citizens in every educational level including primary school level, lower secondary
and upper secondary school level (Yuenyong & Narjaikaew, 2009). At the lower secondary level, students have to study general science as a core-compulsory course, and students are also able to study one more general science course as an optional subject. Students will be divided into science and non-science streams at upper secondary level. Students who enter the science stream are those who aim to pursue higher education in science or science-related areas, such as medicine or engineering. Students who decide to enter the non-science stream mostly aim to pursue higher education in arts or others areas that are not related to science (Boonklurb, 2000). Science education in Thailand before the third education reform mainly emphasised the memorisation in teaching processes. Theoretical work and practical work were not brought together in the same class. Abstract lesson contents, such as formulae and equations were often too difficult for students to understand and calculate. Moreover, lesson contents were fragmented with little relationship between topics within the same lesson sequence (Klainin, n.d.).

After science education in Thailand underwent the reform in 1997, a government institute was established that plays a key role in teaching science, mathematics and computer education, the Institute for the Promotion of Teaching Science and Technology (IPST). The responsibilities of IPST are to conduct and promote research and development in science, mathematics and technology education. IPST also offers in-service training on teaching/learning in science, mathematics and technology education. Moreover, IPST is a major government body that establishes and evaluates standards of teaching/learning in science, mathematics and technology education and produces, revises and updates the national science, mathematics and technology curricula (Boonklurb, 2000). Not only science education in England and Wales that places an emphasis on scientific literacy, Thai science education also emphasises on scientific literacy, as IPST indicates that the goal of science education in Thailand after the reform is to increase scientific literacy. This will enable students to understand scientific knowledge and be able to recognise the relationship between science, technology, society and the environment. Furthermore, people with scientific literacy will be able to develop critical thinking skills, investigating, communicating and making decisions related to science and
technologies (the Institute for the Promotion of Teaching Science and Technology [IPST], 2002 cited in Yuenyong & Narjaikaew, 2009). Constructivism has become an important perspective that influences science teaching in Thailand, as we can see IPST has emphasises on enquiry-based teaching/learning processes and project-based skills, which involve analysis, evaluation and synthesis. This is consistent with a notion proposed in the 1999 National Education Act that learning through practical work could enable students to think critically, develop good reading habits and motivate students to seek knowledge (Boonklurb, 2000). In addition, IPST considers the importance of using information technology (IT) for science teaching and learning, as they hope to develop IT skills among science teachers in order to enable them to use IT as a tool for teaching in science classes. Furthermore, IPST has encouraged students to use IT themselves to seek information from data sources (Boonklurb, 2000).

Objectives of the previous national science curricula have been generated by IPST. The curricula expect students to understand the nature of science as well as theories, concepts and principles of basic science (Boonklurb, 2000). Additionally, process of learning science and research in science and technology as well as good attitude on science will be promoted to students. Finally, following the curricula, students are expected to recognise impact and understand relationship of science, technology, humanity and environment as well as acquiring ability to demonstrate application of science and technology in everyday lives (Boonklurb, 2000).

Under the responsibility of IPST, the enquiry approach has been employed in teaching and learning science and has incorporated mathematics and computer teachers (Boonklurb, 2000). Nevertheless, several constraints, for instance, shortage of qualified teachers and science equipment and inappropriate class sizes, have impeded the implementation of this approach. In addition, the university entrance examination system has been found to be another constraint that hinders teaching and learning of science (Boonklurb, 2000). This is because students have emphasised on passing the examination and being granted the entry to university, rather than the real objective of teaching and learning science which emphasises on content and learning process (Boonklurb, 2000).
According to the latest Thai science curriculum which has been implemented since 2008, science has been considered mechanism which helps people develop necessary skills that facilitate living and working in knowledge-based societies (IPST, 2008). These skills include reasoning, analysing, thinking creatively, enquiring, criticising, problem solving and making decision on the basis of valid data and trustworthy evidence (IPST, 2008). As described in the curriculum, sufficient knowledge of science and its application are also mandatory for all people in order to prepare them to respond with a global culture. Furthermore, goals of scientific literacy which were indicated in the curriculum are to enable people in societies to comprehend and deal with technological products and reasonably utilise scientific knowledge with responsibility (IPST, 2008).

Contents of the curriculum are categorised into eight main areas which consist of 1) Living Things and Living Processes, 2) Life and the Environment, 3) Matters and Properties of Matters, 4) Forces and Motion, 5) Energy, 6) Processes that Shape the Earth, 7) Astronomy and Space and 8) Nature of Science and Technology (The Institute for the Promotion of Teaching Science and Technology, 2008). Out of these contents, students are expected to be able to make a connection between scientific knowledge and scientific processes, and develop skills to explore and construct ideas and knowledge through multiple experiences in problem solving as well as investigative processes, participate in all stages of learning and accumulate experiences in hand-on activities that are suitable to them (IPST, 2008).

Same as science education in other countries described earlier, recent Thai science education has also emphasised implementing the same concepts or themes. Concepts of science for all students, scientific literacy, relationship of science and technology and society, relevance of science in everyday life and importance of scientific process in developing quality citizens have been mentioned almost everywhere. In Thailand, science teaching practice emphasising using locally available resources was also mentioned. The using of local wisdom partially related to the TALULAR approach was mentioned in the previous core curriculum. However, the meaning of using locally available resources in Malawi and Thailand is slightly different. In Malawi’s context, ‘using of locally available resources’
includes both human resources and material resources while in Thailand’s context this term heavily refers to human resources and tacit knowledge that can be transferred between human to human.

Although Thailand has addressed those key concepts or themes in the curriculum and emphasised to develop effective education, there must be something wrong with the implementation or practice as several issues still persisted over time.

1.4.2 Key Issues Emerging

More Than ten years after the third reform has been introduced, the Thai education still encounters several issues including:

1.4.2.1 Planning/ Implementation of Reforms

After Thailand underwent the third educational reform in 1997, decentralisation of educational administration and management has also been undertaken, apart from the introduction of the student-centred learning (SCL) concept and the establishments of government services organisation. Administrative and management structures were transformed and were operating thus far. After undertaking decentralisation for more than 10 years, problems relating to decentralisation were identified and reported (Cheangkul, 2007).

In the light of decentralisation, one major notion that has been applied was the transformation of management structure from Provincial and District Educational Office into Educational Service Areas (ESAs). The management pattern of the former was a separation between primary educational section and secondary education section. As a result, the total number of ESAs across the country is 175 and each of the ESA offices is responsible for management of both primary and secondary education in its area (Cheangkul, 2007).

Important issues relating to current management structure can be identified as follows:

1) Unbalanced number of personnel among ESAs offices in each province.

   Mostly, ESAs offices located in urban areas are popular among
personnel, and the number of personnel in the urban offices are usually over the limit. This has caused other educational province area offices to lack personnel, resulting in ineffective function and poor performance of the offices.

2) Lack of opportunity in obtaining skill development of ESAs personnel which results in the loss of morale.

3) ESA offices in some areas, particularly in remote areas, have held an excessive number of schools under their supervisions. This situation may create problems because the geographical characteristic has delayed coordination process as well as communicative ability between the offices and schools under their supervision.

4) There is no clear regulation which indicates responsibility of schools and ESA offices. In addition, central government agencies hold power and have not exactly implemented decentralisation scheme.

5) ESA offices that are not located in urban areas usually encounter problems in terms of shortage of equipment, building, durable articles and personnel. As a result, those rural ESA offices are unable to operate effectively and cannot provide sufficient services to schools under their supervision. This problem is even more severe in a province that supervises three or more ESAs.

6) There is a lack of heterogeneity of organisational culture in each ESA. This could be a consequence of previous embedded organisational culture that existed before the decentralisation. Additionally, personnel who previously worked in organisations that were decentralised, including Department of General Education and Office of the National Primary Education Commission, are still attached to working habits accumulated while working with previous administrators.

7) Committees of ESAs have no power and role in decision making. In other words, the committees of ESAs and school committees have not clearly understood their roles. They have perceived their role to be a counselling one. Decisions have been solely made by school administrators.
8) Legislations of laws regarding an operation of post-decentralisation educational organisations were delayed. Regulations were not clearly asserted. These difficulties impeded an ability of ESAs to operate effectively.

9) Schools have no genuine authorities over their own management of budgets and human resources. Rather, their authorities are limited only for management of academic and general administrative matters. In addition, personnel recruitment, performance assessment as well as consideration of reward and punishment are determined by ESAs. Internal displacement and shifting of personnel in ESAs were decided by central government agency which is the Office of the Basic Education Commission (OBEC). This creates difficulties to schools, as they do not have authority to choose personnel suitable to their school-context requirement (Cheangkul, 2007).

1.4.2.2 Curriculum and Assessment

The Office of the Education Council (OEC) has monitored and assessed outcomes of basic education learning reform. With respect to this, OEC has summarised and published a report online which allows researchers to further study in order to extend an understanding toward the learning reform in Thailand.

According to the report, teachers have not confidently designed lesson plans and implemented the curriculum due to the fact that the curriculum was newly introduced and those teachers have never implemented it before. Another problem stemmed from unplanned teacher training programme because instructors of the training programme have a diverse array of expertise and personal stances. The instructors then provided training according to their preferences and resulted in the teachers being confused and frustrated with overloaded information and unable to implement the curriculum effectively (Cheangkul, 2007).

At the basic education level, issues related to shortage of teachers still exist. In some schools, the number of teachers is not enough to provide teaching for every
education level, and teachers do not teach according to their specialisation. With respect to this, the three deficit specialisations are mathematics, science and English. At higher education as well as vocational education level, issues related to students’ gaining hand-on experiences in a company or factory are acknowledged (Cheangkul, 2007).

Since the introduction of the learning reform, there has been an alteration of assessment method. According to the new assessment method, teachers were expected to assess student performance using several criteria including behaviour and collaboration skill along with exam scores. However, current teachers seem unable to implement the new version of assessment method effectively. In addition, IT skill of primary school students has not been fully developed when compared with students in secondary and higher education levels (Cheangkul, 2007).

Issues encompassing professional development of teachers were also mentioned. Funding to promote teachers through conducting classroom research has been limited. Reforms of curriculum and strategies to generate and improve teaching skill in terms of content knowledge and psychology of teaching have been neglected. Regulations and codes of conduct have not been ameliorated to support the improvement of pedagogy and professional advancement of teachers. There have been frequent trainings for teachers. However, some of those teachers were struggling to apply what they learned in the actual classroom. This might be due to a limit in content knowledge and misconception of learning reforms of the teachers. Furthermore, there has been an imbalance between the number of current teachers in the education system and the number of recent retirees from the system. The situation was even worse because a numbers of newly appointed teachers did not fulfil vacant positions, and this resulted in a shortage of teachers (Cheangkul, 2007).

In the past 10 years, the external education quality assessment was twice undertaken by the Office for National Education Standards and Quality Assessment (ONESQA). Therefore, the current assessment which has been carried out since 2011 is the third time, and major concern of this assessment is the teaching outcomes of each school. Currently, ONESQA has reduced assessment standards and indicators from 14 standard criteria and 60 indicators to 12 standard criteria and 27
indicators. The indicators are divided into 3 categories which are indicators of general obligation, indicators of identity and additional indicators. Indicators of general obligation are developed with an objective of determining the ability of a school to conduct general obligations required by ONESQA. Indicators of identity are set by each school itself to determine to what extent characteristics of students are in line with the visions and goals of the school. Additional indicators are also set by the school in order to evaluate the school’s performance in social responsibility and societal problems solving (Thailand Development Research Institute [TDRI], 2013).

However, producing reports of these indicators seems to be a burden for schools. Not only details of outcomes, but the schools have also included supplementary documents with the reports. With respect to this, teachers have to allocate working period to produce the reports, resulting in less time to develop student achievement. At the same time, there is time limitation of assessors to evaluate and produce evaluation reports. Thus, an accuracy as well as relevancy of the evaluation reports may be difficult to assess (TDRI, 2013).

External assessment criteria set by ONESQA put emphasis on a determination of student achievement only to some extent. Evidence regarding this claim can be seen from the fact that there is only one indicator which deals with student achievement during the recent external assessment. This indicator measured student achievement by looking at the number of students who obtained good scores in the standard national test. Although ONESQA has weighed this indicator as 20% of overall indicators, which is in a greater extent than others indicators, there was a criticism that 20% weight was still low when compared with the significance of this indicator, especially in the current situation in which few schools can accomplish this indicator (TDRI, 2013).

A group of researchers criticised the reason behind the intention of ONESQA to fix the assessment criteria to be less challenging to accomplish; disadvantaged schools would not be able to achieve the ultimate challenge criteria, and ONESQA has to make the assessment criteria practical for all schools across the country.
Adversely, the committee of ONESQA explained that those criteria could be amended to be more challenging if it was demanded from various stakeholders. However, the criteria set by ONESQA have not considered scrutinising the schools’ context. For example, small schools in remote areas should be assessed using special criteria that differ from criteria used to assess large schools (TDRI, 2013).

The same group of researchers reminded that schools should not solely rely on the external assessment of ONESQA because the assessment criteria used reflected student achievement only to some extent. Schools that put an over-emphasis on the external assessment tend to adjust their conditions and environment to be in line with the assessment criteria. However, this effort has not promoted student achievement in those schools (TDRI, 2013).

In the meantime, assessment reports and recommendations have been produced by ONESQA and sent to schools within 20 days of the last assessment date. By and large, ONESQA has not pointed out the process or procedure to be implemented in order to enhance the quality of schools. Moreover, ONESQA has not undertaken further additional analysis of the assessment outcomes, apart from the recommendations proposed by the inspector teams. As a result of this circumstance, qualities of the assessment reports and recommendations produced depended on the experiences and expertise of inspectors (TDRI, 2013).

Actually, further analysis of the assessment outcomes was omitted because of limited budgets. In each fiscal year, ONESQA obtains a budget for conducting the assessment in 7,000 schools across the country. However, in the past, there was no plan to conduct assessment of schools located in the same areas in the same fiscal year. Therefore, the regional comparison and further analysis by ONESQA could not be done effectively. To overcome this problem, ONESQA has revised their plan to conduct the assessment in schools located in the same areas in order to enable further analysis of the assessment outcomes (TDRI, 2013).

Issues related to the implication of the assessment outcomes have been criticised. Although the assessment reports were published, those reports were
written only to show average evaluation scores and certified results obtained by schools. Further analysis such as compilation, categorisation and interpretation of the evaluation scores has not been revealed. This limits the public’s interest as well as exploitation of the assessment reports and, as a consequence, confines public involvement (TDRI, 2013).

Currently, schools under the affiliation of OBEC have not been given authority to set up their own organisation and administrative management scheme. In contrast, those schools have to follow policies or schemes assigned by OBEC. For example, those schools cannot recruit their own teachers and personnel or cannot design their own budget plans. This type of management has restricted schools to exploit outcomes from both external and internal assessments (TDRI, 2013).

With reference to the third education reform in Thailand under 1.3, one concept that has been integrated into the taught curriculum, according to the NEA, is ‘local wisdom’. With regard to this integration, several researchers studied the implementation of this one specific reform and found the integrated curriculum unsuccessful. The local wisdom concept was not genuinely integrated, but rather superficially integrated. Those researchers characterised factors limiting successful implementation as follows: limited budget and time, improper training and low level of motivation (Barron-Gutty & Chupradit, 2009, p. 35 cited in Hallinger & Lee, 2011).

1.4.2.3 Supply and Quality of Teachers

Recent information published by Office of the Basic Education Commission (OBEC) in 2013 (as cited in TDRI, 2013) states that the total numbers of teachers affiliated with OBEC is 412,018 and the total numbers of students is 7,397,961. Thus far, the ratio of teacher/primary school students is at 1:16, and for teacher/secondary school students is at 1:21, which closely meets teacher/student ratio from OECD countries such as Korea which has 1:21 in primary and 1:17 in secondary education (OBEC, 2013 cited in TDRI, 2013).
The deficiency or shortage of teachers has also been mentioned. In 2010, OBEC encountered problem of which there were 66,094 positions of teacher vacancies. The positions required include mathematics teachers, English teachers, science teachers and Thai teachers. With respect to this, the vacant positions are calculated as 14%, 13%, 12.5% and 12% of the total vacant positions, respectively (Komchadleuk, 2011 cited in TDRI, 2013).

Consequently, deficiencies of teacher have affected management of education in terms of the number of teachers not being consistent with total workload generated in a school. Thus, tasks of those existing teachers are not only teaching but also administrative tasks. This has affected the quality of teaching because individual teacher has handled both teaching and administrative tasks, and difficulties have emerged due to insufficient time for lesson preparation (TDRI, 2013). This problem has existed for nearly 10 years, as in 2004 a study indicated that 24% of existing mathematics teachers did not specialise in mathematics. The same study also revealed that 13% of existing science teachers did not graduate with a science degree (Atagi, 2011).

In terms of teacher trainees, the criticism is toward the quality of graduated teacher trainees. Faculties of Education in many Thai universities do not attract students with outstanding performance. In addition, the issue regarding the superfluous number of enrolled teacher students is also mentioned (TDRI, 2013). In 2011, there were approximately 900,000 teachers who recently obtained their teaching license, but less than 33% of them did not belong to any education organisation (TDRI, 2013). The imbalance of teacher production has also been recognised by related stakeholders, as the Office of the Higher Education Commission (OHEC) anticipated that Thailand will have more than 240,000 new teacher graduates in 2017 while only 200,000 teachers will retire in the same year (Thaipost, 2013 cited in TDRI, 2013).

A team of researchers from TDRI criticised that the debate on issues regarding teachers in Thailand are heavily related to the issue of recruitment (TDRI, 2013). With respect to this, several policies that aim to attract students with
outstanding performance to become teachers have been implemented through various initiatives, for example, raising the standard base for monthly salary. Conversely, policies related to continuous improvement of teacher quality have been acknowledged in a lesser extent than the former policy (TDRI, 2013). Implementation of the policy that puts an emphasis on increasing teacher income without sufficient consideration of performance may lead to the teachers neglecting to do research relating to the improvement of student quality and performance (TDRI, 2013).

1.5 Regional Developments and Pressures

The Asia Economic Crisis in 1997 has compelled each of the Asian countries to adjust their strategies to promote the development of the country in every aspect in order to restore and enhance their competitiveness. In addition, the emergence of international concept such as globalisation has also affirmed the importance of the adjustment. Thailand, like other Asian countries, has to confront the economic difficulties. Then, Thailand needed to withstand the difficulties. The effects of the crisis over social and economic condition in Thailand along with the response to the crisis from other Asian countries have pressured Thailand to enhance the country’s competitiveness in order to secure a place in Asian economy. Therefore, it is also necessary to have a look at what has been happening in the education system in countries in the same region as Thailand, the Asia region. This is because social and economic conditions of these countries are always linked to and influence their education systems, and it has inevitably affected Thailand in all aspects including education, society and economy.

In the past decade, the growing impact of globalisation has influenced economic, social and political developments of countries around the world including countries in the East Asia region (Mok & Welch, 2003). With respect to this, enhancing competitiveness in the global economy becomes key element that governments of those countries see as way to secure their place in the global marketplace (Mok, 2003). For that reason, the governments began to scrutinise their education system and have devised different reform measures to improve the quality of education (Mok, 2006).
Within the East Asian countries, common challenges are identified as follows:

- The emergent of the knowledge economy and the changing university;
- Human progress that is increasing at a continuous rate;
- The consideration of using Information Technology as a significant tool for education delivery;
- ‘Massification of higher education’ and the requirement of quality control;
- Financial crisis over the East Asian countries and the post-crisis adjustments;
- Social and political changes, and the demand for higher education changes.

(Towsend and Cheng, 2000 cited in Mok, 2006)

The Asian Financial Crisis in 1997 is an incident that influenced education policies of countries in the East Asia region. This was considered by Asian education scholars as a major contextual variable that is required for analysing changes in education policy and transformation in education governance. Additionally, the economic downturn in the post-crisis period has been acknowledged as benchmark for the examination of its impacts over changes in economic, social and political structures. Consequently, such changes become crucial elements that have framed the way in which education policy is elaborated. This also influenced decisions that those East Asian governments made regarding the adoption of strategies to deal with challenges of globalisation (Holliday & Wilding, 2003; Tom, 2003 cited in Mok, 2006). International organisations such as OECD, UNESCO and World Bank have played roles in education systems of different countries around the world. Their recommendations, research outcomes related to cross-national comparisons and their funding competency are believed to be driving forces that pressure education ministries of different countries to change their mindsets and also influence the process of curriculum development. Several studies have also revealed common concepts which appeared in education reform proposals of different countries. These concepts are competitiveness, global competence, diversity and choices (Gopinathan,
2007; Mok & Welch, 2003). There is a growing concern of the importance of ‘choice’ for students and parents, school governance and management due to the introduction of marketisation concepts to school system. This is reflected in the following remark:

In the past, most educational reform movements focused on curriculum and teaching methods. Today’s reform, however, centres more on issue of governance.... Education cannot be improved unless actors are brought into the decision arena, changing the way which educational policy decisions are made, shifting power toward parents, and exposing overly bureaucratic school systems to some form of market discipline (Schneider, Teske, & Marschall, 2000, p.21).

Market-driven ideas and practices have become more intense as there was the introduction of the ranking of schools or league table. In addition, there was a demand for strengthening the parent-school relationship through particular mechanism. With respect to this mechanism, places for parents and community in governance processes in school have been established (Bridges & McLaughlin, 1994; Good & Barden, 2000; Leung, 2003). Educational Developments in the Asia-Pacific region were significantly shaped by several notions, for instance, diversity of schools, parental choices, and school autonomy and school accountability. As a result of this occurrence, ideas and practices related to marketisation, privatisation and decentralisation are being adopted in order to transform management practices of educational institutions to be more responsive to the social and economic changes. Several studies have also confirmed this claim, as it described concerns over widened access, funding, accountability and quality. In addition, managerial efficiency is also a global trend related to education (Mok & Tan, 2004; Tsang, 2002 cited in Mok, 2006).

Education developments in Hong Kong, Taiwan, Singapore, South Korea, Mainland China, Japan, the Philippines, Cambodia, New Zealand and Australia were also studied and compared. Results of these studies indicate that trends of marketisation and corporatisation have become major concerns for these countries. Accordingly, strong considerations regarding roles of education in improving the
competitiveness and in securing their places in regional and world markets have become apparent. As a consequence of this, ideas of ‘life-long learning’ and ‘quality education’ have been acknowledged as a way to prepare their citizens to be responsive to knowledge-based economy (Weng, 2000 cited in Mok, 2006; Tse, 2002).

In terms of school education and school governance, changes have occurred in the light of the same policy climate described above. Schools are demanded to carry out diversification process in order to respond to the socioeconomic changes and the needs of the knowledge-based economy (Mok, 2006). To do this, schools are required to change their school governance models and process of curriculum design. For example, school-based management practice has been adopted by Hong Kong governments a decade ago. The adoption led to the increasing flexibility and school autonomy. This allowed schools to make their system more compatible and responsive with the changes. Additionally, ideas of making school system more diversified were introduced and implemented through a direct subsidy scheme. This idea has also been implemented in Singapore, where independent and autonomous schools are permitted to obtain more flexibility and autonomy in curriculum design and (Mok, 2006).

Diversification and decentralisation of school system have also been implemented in Taiwan and South Korea. These strategies were introduced due to governments’ intentions to cultivate creativeness and innovativeness in students and also make them more responsive to changes from inside and outside their societies. Schools and universities in Mainland China have also been diversified. This was clearly reflected in an increasing number of non-state sectors and actors in financing and providing education services. Higher education in Japan has also undergone corporatisation. Market ideas and strategies are seen by the Japanese government as instruments to reform higher education system. Same as other East Asian countries, the reason to implement the reform is to make higher education in Japan more flexible and responsive to the global climate (Mok, 2006).
Different comparative studies regarding education developments of countries in the Asia Pacific region have been done and have drawn out common patterns and trends of the education development as follows:

- Re-establishing national aims and visions for education;
- Expanding and restructuring education systems;
- Establishing quality assurance practices and education standards;
- Promoting excellence in education through balanced use of education quality concept and encouragement of competitiveness, and also considering to employ market forces;
- Implementing privatisation and diversification of education;
- Implementing decentralisation and school-based management practices;
- Emphasising to use development planning and strategic management concepts;
- Introducing concept of parental and community involvement in school education;
- Employing IT to support learning and teaching;
- Devising new methods of learning and teaching as well as new curricula;
- Changing examination and evaluation practices;
- Examining means to enhance teacher quality; and
- Requiring continuous professional developments for teachers and leaderships.

(Cheng and Townsend, 2000 cited in Mok, 2006).

Another criticism regarding the international reform movement was given by a Finnish educator, Pasi Sahlberg, who is currently a visiting professor of practice at Harvard University’s Graduate School of Education. In his work, the notion of
Global Education Reform Movement or GERM has become evident. GERM has been referred to as an educational reform doctrine that has been adopted by many countries throughout the world such as the US, the UK and Australia (Sahlberg, 2012). GERM is believed to have been promoted through interventions in national education reforms and policy formulation which were formulated by the interests of international development agencies and private enterprises (Sahlberg, 2012).

Sahlberg (2012) identified five globally common characteristics of education policies and reform principles that have been implemented since 1980s including:

1). Standardisation of education. Standard-based education policies have been put into action since the 1990s. This notion regards clear and sufficiently high performance standards for schools, teachers and students as important elements, and this has been widely accepted by policy makers and education reformers because it contributes to the improvements of expected outcomes. Subsequently, the strategy to assess these high performance standards has become a crucial factor. Thus, enforcement of external testing and evaluation systems emerged to serve this aspect.

In the UK, standardised education can be recognised in the form of standardised curriculum. During 1980s-1990s, standardised education system was emphasised by the Governments of England and Wales and its aims were to raising standards and enhancing the ability of workforce. Regarding this, a standardised national curriculum was introduced, for students aged between 7 and 16, with an intention to solve problems related to poor literacy and numeracy and also to impoverish standards. The national curriculum ensured all students aged 7-16 to study a prescribed set of learning until reaching requisite quality and level (Machin & Vignoles, 2006; Shuayb & Donnell, 2008).

Standardisation of education also encompasses the standardised testing. According to the No Child Left Behind (NCLB) Act that was constituted by the US Government in 2001, it is mandatory that every student in grade 3-8 of public schools, regardless of socioeconomic backgrounds, physical conditions and home languages, pass the standardised tests in reading and mathematics every year (Rubin & Kazanjian, 2011). This government initiative was considered to be a tool for prove
and ensure that actual learning has happened in the students. Consequently, Adequate Yearly Progress (AYP) became a significant determinant of the continuation of schools. The AYP results will be used as indicator that reflect teacher and school performance and also will be used as a criteria for determining whether schools will be taken over by State (restructuring), shut down or let continue their education activities (Rubin & Kazanjian, 2011). In addition, AYP results affected profession’s continuation of teachers because teachers will lose their jobs if their schools undergo the restructuring (Rubin & Kazanjian, 2011).

As described above, the standardised education has contributed to the change of the US and the UK education system. However, there were arguments regarding significance of the implementation of standardised testing. Danish Murtaza (2015) argued that the standardised tests force teachers to teach for the tests rather than teach to serve student’s needs because their jobs depend on the test’s results. Moreover, the standardised tests force students to make themselves compatible with a particular means in order to evaluate their performance (Murtaza, 2015). This is in contrast with the fact that ‘every child is different, every child is unique’ In the academic setting, ways of students’ learning and performing are also unique. Therefore, the standardised tests causes a trouble to students who have bad test results even though they might have an excellent performance in a normal classroom (Murtaza, 2015).

Other arguments state that the standardised education, as the current education movement, emphasises ‘if-then rewards’ approach which limits student’s autonomy, mastery and determination (Pink, 2011 cited in Sheninger, 2012). This will be the case because these three characteristics are vital for realising and maintaining intrinsic motivation. With such approach, extrinsic motivation is supplied to students through the proceeding to the next level or graduate if their scores meet the requirement of the standardised tests. However, those forms of extrinsic motivation will not be sustained (Pink, 2011 cited in Sheninger, 2012). When implementing the standardised tests, there is no motivation created because students cannot find meaning, values and relevancy in the tests. The standardised tests motivate teachers, but through reasons related to job security and finance.
Furthermore, the standardised of education confines the curriculum and also creates environment where creativity, critical thinking and enquiry are restricted or do not exist (Pink, 2011 cited in Sheninger, 2012).

However, benefits and advantages of the standardised tests were investigated. Without the standardised tests, reliance on individual teacher in grading and testing would be enhanced. Therefore, grades and test scores given by the teacher are not likely to be generalised when compared with the scores obtained from the standardised test (Phelps, 2008). Furthermore, there is an advocate; Prof Stephen G. Sireci described benefits of the standardised tests. He believes

Standardised simple means that the test content is equivalent across administrations and that the conditions under which the test is administered are the same for all test takers...standardised tests are used to provide objective information. For example, employment tests are used to avoid unethical writing practices (e.g., nepotism, ethnic, discrimination etc.). If an assessment system uses tests that are not standardised, the system is likely to be unfair to many candidates (Sireci, 2005, p.113)

2). Focusing on core subjects. According to Sahlberg’s interpretation, core subjects include literacy and numeracy, which also covers science. Basic student knowledge and skills in reading, writing and mathematics were considered superior targets and indicators of education reforms and, as a consequent, were heightened. Furthermore, international student assessment surveys, such as PISA, TIMSS and Progress in International Reading Literacy Study (PIRLS), were acknowledged as criteria of good education performance. Therefore, elements that these international surveys have prescribed to assess including reading, mathematical and scientific literacy have become determinative factors that manifest success or failure of students, teachers and schools and also an entire system of education. On the other hand, social studies, arts, music and physical education have become diminished in many school curricula.
3). Searching for the safest ways to reach learning goals. Sahlberg claimed that this characteristic reduces degrees of freedom in experimentation in a classroom, and alternative pedagogical approaches also decreased. He also suggested that research on education systems that have pursued policies regarding achievement of predetermined standards and prioritised core subjects indicated the same. The research pointed out that teaching and learning had become narrower and the focus of teachers had shifted to ‘guaranteed content’, as they saw it as the best way to prepare students for tests. As a result of these changes, experimentation was minimised and alternative pedagogical approaches are in limited use.

4). Using of corporate management models as a main driver of improvement. Sahlberg indicated that these educational policies and ideas were adopted from the business world and were implemented to serve political and economic purposes rather than considering developing human capital to achieve goals in terms of morality. With respect to the exchange of these innovations between outside and inside the educational systems, according to Sahlberg’s view, this situation had reduced the chance of successful educational change by two factors. First, the role of national policy development was restricted as well as enhancement of education system’s capabilities to sustain renewal. Second, teachers’ and schools’ attempts to learn from each other as well as from previous experiences were disabled.

5). Adopting test-based accountability policies. Sahlberg noticed that there was a strong binding between school performance especially raising student achievement and processes of accrediting, promoting, inspecting, rewarding and punishing schools and teachers. With this regard, determinants of schools’ and teachers’ success or failure were standardised tests and external teacher evaluations. In addition, Sahlberg stated that these determinants had confined considerations regarding schooling to only some aspects, for instance, student achievement in mathematical and reading literacy, results of exit examination and designated teacher classroom behaviour.

When scrutinising trends or mutual interests regarding science education among Asian countries, almost all of those mutual interests that have been
implemented in these Asian countries are likely to be established and employed to serve economic-related purposes. Those ideas include globalisation, marketisation, decentralisation, introduction and utilisation of IT for education purposes. Additionally, school-based management and community involvement, although these two ideas are not likely to serve economic-related purposes, were considered as strategies to help improve science education in the countries.

1.6 Research Questions

The development of science teaching from several countries described earlier reveal underlying themes that have been introduced, to some extent, to Thailand. Hence, it clearly shows that Thailand has considered the same issues, though a bit late, as other countries have. Thailand has learnt what has happened and how we can do better. After implementing the third reform for more than 10 years, several issues still persist over time. In addition, the results of international assessment bodies such as PISA revealed that the performance of Thai students in mathematics and science are still below the average. Furthermore, the performance of Thai students in domestic assessment is also unsatisfactory as the mean score in science in the Ordinary National Education Test (O-NET) is lower than 50%.

Schools in rural areas of Thailand are a target of development in education. This claim can be seen in the government’s strategy to support small rural schools, as it is believed to be a key mechanism to increase the quality of education across the country. In addition, a distant learning project which emphasises using e-learning to lessen the gap between urban and rural schools has also been introduced (MOE, 2008). However, data from an OECD report indicated that there were more reports of shortage or inadequacy of educational resources from principals of schools located in rural area of Thailand reported than those from principals of schools located in town (The Organisation for Economic Co-operation and Development [OECD], 2013).

The earlier discussion of the reform shows that Thailand has not succeeded in reforming the education system. In addition, when one considers the current situation of science education in Thailand which has undergone the major reform for more
than ten years along with the emerging key issues and conditions of schools in rural area described by the international organization, it is reasonable to determine if this reform initiative significantly helps improve science teaching in rural areas of Thailand. Regarding this, we should investigate how the new science curriculum is being implemented in rural secondary schools in Thailand and the perceptions of department heads and science teachers regarding the changes that have emerged from the implementation of the major reform, as well as what they think would be possible factors limiting the effectiveness of science teaching. These elements described subsequently lead to the planning of this study, and research questions of this study include

1) Has science teaching changed since the third reform? How has it changed?
2) What do heads of science departments and science teachers think about the changes?
3) What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?
4) What might be done to improve the implementation and enhance student learning experiences in science?

In this chapter, the background and current situation of Thai education are described, and this provides insight into the education reforms that have occurred in Thailand since 1868. Key themes of science education of England and Wales, US and European countries are also examined and discussed.

Science educations in Thailand as well as key issues that have emerged after the third reform implemented are drawn out. In addition, developments of science education of some Asian countries are presented. In the last section of this chapter, underlying justifications which lead to planning of this study and formulation the research questions are described.

In the next chapter, research strategy and methods will be described together with the process of data collection and data analysis, trustworthiness and ethical considerations.
CHAPTER 2
PLANNING THE ENQUIRY: RESEARCH STRATEGY
AND METHODS

Research Methodology

This chapter will discuss the methodology used for gathering and analysing data. The application of qualitative enquiry that corresponds to the research questions of this study as well as the research design will be addressed. The aims of each research question will be elaborated. Details of the participants and selection criteria as well as the testing of the data collection tools will also be explained. The data collection procedures and data analysis will be described in detail. The form of the write-up report is revealed. Finally, research integrity and ethical considerations are demonstrated.

2.1 Development of Research Questions

In 1997, Thailand underwent a period of major change in social and economic policies as a consequence of the Asian economic crisis. As a result, the new constitution came into effect; decentralisation and educational reform were also mandated to help recover from the crisis (Fry, 2002). In this regard, educational reform was expected by the Thai government to help increase the nation’s competitiveness and raise scientific literacy among the people in the country. Its key concept was to implement the student-centred learning approach that evolved from the constructivist learning theory (Pillay, 2002). According to the principle of this approach, active engagement of learners is required for developing knowledge in real contexts or situations, and the learners must be able to link their learning experiences with the world outside the classroom (Pillay, 2002). Apart from the principle described, further details and a definition of the student-centred learning approach will be provided in the next chapter.

Research from several studies has demonstrated that hands-on activities, which stem from constructivist learning theory, enable students to learn from direct experience, help increase students’ critical thinking, and enhance conceptual understanding (Chanchaichaovivat, 2008; Keeratichamroen, 2010). However, thus
far, the overall student performance in reading, mathematics, and science did not clearly exhibit significant improvement. This was reflected in results from an international assessment conducted by PISA in 2012 indicating that, among the 65 countries that participated in the assessment, although they slightly increased from 2009, the performance scores of 15-year-old Thai students in all three categories were still significantly below average (IPST, 2013). Moreover, Thai students reflected on their experiences in the classroom and indicated that teachers failed to facilitate learning and control the classroom environment; they reported that friends at the back of the classroom even fell asleep and the teacher just ignored them (UNESCO, 2011).

In fact, studies conducted by Hallinger (2010) and Hallinger and Lee (2011) aimed to gain an understanding of the Thai education reform and the obstacles that hinder successful education reform. However, the key participants in these studies were elites who played roles in the top management level of Thai education and school principals. Therefore, the meanings of incidents that occurred during the reform were interpreted based on the personal experiences and perceptions of those elites, which presumably differed from those of the implementers, such as teachers (Hallinger & Lee, 2011; Hallinger, 2010).

In light of the situation described above, this study aims to examine how the new science curriculum is being implemented and to investigate factors influencing its effectiveness by exploring the perceptions and experiences of heads of science departments and science teachers with respect to the implementation of the student-centred learning approach, and by observing how science teachers implement the student-centred learning approach in lower secondary school classrooms, focusing on schools in rural areas of Thailand.

Considering the inquiries described above, research questions can be specified as follows:

1) Has science teaching changed since the third reform? How has it changed?

This research question aims to investigate teachers’ practice in science classrooms. In this regard, data to be obtained will describe how teachers teach
science, what pedagogy these teachers mainly used in science classrooms before and after the implementation of the student-centred learning approach, and to what extent they implement the student-centred learning approach. To obtain the expected data, classroom observations in the participating schools were carried out, as observation is a useful tool for capturing real incidents that occur in certain circumstances (Morley, 2007). In addition, a few government agencies’ documents, lesson plans, and/or school science curricula that offer information relating to the implementation of the student-centred learning approach before and after the third reform were searched and scrutinised.

2) What do heads of science departments and science teachers think about the changes?

In most small schools, heads of science departments not only manage teaching but also teach lessons. Therefore, many heads of science departments and science teachers can explain their views from a teacher’s point of view. This research question intends to reveal the perceptions and attitudes of science teachers regarding the changes emerging from the implementation of the reform. Their opinion on how much Thai education has improved since the major reform in 1997, and factors affecting the reform will be reviewed. In accordance with the aim of the research question, the interview method will be implemented to gain insight into teachers’ perceptions and their opinions about the reform. Interviewing was chosen as a tool for gathering data because, according to Merriam (1998), it can be used to examine personal perceptions regarding a particular issue and their interpretations.

3) What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?

Teachers’ replies to this research question will reflect their experiences regarding difficulties they encountered during the implementation of the student-centred learning approach in science classrooms. Factors they perceived as obstacles that prevent the effective implementation of the student-centred learning approach will be illustrated. Again, teachers’ perceptions will be elicited to illustrate what they perceive as the difficulties, and the interview method was chosen as means to obtain the perceptions.
4) What might be done to improve the implementation and enhance student learning experiences in science?

Outcomes from previous research questions will be synthesised and generalised. This is expected to provide policy suggestions to educators and policymakers in terms of context-specific actions and general practices.

2.2 Research Design

This section will explore the methodology that will be used in this study. In this regard, the rationale in using qualitative enquiry as well as observation and interviews will be described. In addition, the summarised details of the research design in relation to the research questions are illustrated in a flowchart below (cf. Figure 2).

2.2.1 Qualitative Enquiry

This study uses multiple qualitative methods to find out how effectively the new science curriculum is being implemented in rural secondary schools in Thailand. Regarding this, data were collected and analysed concerning the perceptions of department heads and science teachers regarding the implementation of new science curriculum, which is based on the student-centred learning approach, and what they think are possible factors limiting the effectiveness of science teaching after Thailand has undergone educational reform for more than 10 years. Moreover, the strategies that these science teachers use to implement the student-centred learning approach are described, along with suggestions for improvement.

Qualitative research is a tool for gaining understanding of people’s perceptions and how they see and interpret the world. Consequently, qualitative research does not focus on testing existing theories but, rather, seeks to develop theories, hypotheses, and concepts from empirical data. Qualitative research usually requires the researcher to go to the site where s/he can collect data in the natural setting and observe behaviour directly (Merriam, 1998).
Figure 2. Flowchart of Research Design

<table>
<thead>
<tr>
<th>RQ1: Has science teaching changed? How has it changed?</th>
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<tbody>
<tr>
<td><strong>Framework of question</strong></td>
</tr>
<tr>
<td>- science curriculum both before and after the implementation</td>
</tr>
<tr>
<td><strong>Resource</strong></td>
</tr>
<tr>
<td>- Government agencies’ document</td>
</tr>
<tr>
<td>- School science curricula and lesson plans</td>
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<tr>
<td>- Classroom observations</td>
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<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td>- Recent and previous classroom practice</td>
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<tr>
<td>- The change in classroom practice</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RQ2: What do heads of science departments and science teachers think about the changes?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Framework of questions</strong></td>
</tr>
<tr>
<td>- The effectiveness of the implementation of new science curriculum</td>
</tr>
<tr>
<td><strong>Resource</strong></td>
</tr>
<tr>
<td>- Interviews with science teachers</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td>- Perceptions</td>
</tr>
<tr>
<td>- Experiences</td>
</tr>
<tr>
<td>- Activities/practices obstacles</td>
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</tbody>
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<table>
<thead>
<tr>
<th>RQ3: What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Framework of questions</strong></td>
</tr>
<tr>
<td>- The effectiveness of the implementation of new science curriculum</td>
</tr>
<tr>
<td><strong>Resource</strong></td>
</tr>
<tr>
<td>- Student focus group interviews</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td>- Perceptions of students on learning science</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplements: What students think about learning science?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Framework</strong></td>
</tr>
<tr>
<td>- What students acquired in the science classrooms</td>
</tr>
<tr>
<td><strong>Resources</strong></td>
</tr>
<tr>
<td>- Student focus group interviews</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
</tr>
<tr>
<td>- Perceptions of students on learning science</td>
</tr>
</tbody>
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| RQ4: What might be done to improve the implementation and enhance student learning experiences in science? |
|----------------------------------------------------------------------------------------------------------------|---|
| **Framework of question**                                                                                   |
| - outcomes                                                                                                      |
| - suggestions                                                                                                  |
| **Resource**                                                                                                   |
| - Findings from analyses of teachers and students interviews, and classroom observations                         |
| **Analysis**                                                                                                   |
| - ‘what might improve science education’                                                                       |

These characteristics of qualitative research correspond with the definition of ‘naturalistic inquiry’ that was explained by Lincoln & Guba (1985):
Naturalistic inquiry is always carried out, logically enough, in a natural setting, since context is so heavily implicated in meaning. Such a contextual inquiry demands a human instrument. The human instrument builds upon his or her tacit knowledge, and uses method that are appropriate to humanly implemented inquiry: interviews, observations, document analysis, unobtrusive clues, and the like (Lincoln & Guba, 1985, p. 185-187).

An example of qualitative research related to the implementation of the student-centred learning approach can be seen in the study conducted by Brush and Saye (2000). Their study examined problems that history teachers encountered when implementing the student-centred learning approach with high school students in the US, using semi-structured interviews and classroom observation. Prior to the implementation of the student-centred learning approach, the learning approach was teacher-centred. After the teachers implemented the student-centred learning approach, the researchers found that there were problems relating to teachers’ understanding of their role as facilitators, their ability to manage classrooms, the ability to provide feedback to students, and the use of cooperative learning activities to serve the objectives of the student-centred learning approach. These problems resulted from inadequate preparation and limited knowledge about the role of teachers as facilitators in the classroom. In this regard, the researchers suggested that teachers require support structures, such as feedback or discussion with experts (Brush & Saye, 2000).

The implementation of an enquiry-based teaching approach in primary classrooms in Hong Kong was studied by Yeung (2009) using qualitative enquiry. The feasibility of implementing the enquiry approach was examined and outcomes of the implementation were illustrated. Yeung undertook lesson observations to investigate teachers’ practice in implementing the enquiry-based teaching approach in the classroom. Furthermore, Yeung conducted interviews to explore the teachers’ perceptions on the enquiry-based teaching approach (Yeung, 2009). As a result of this qualitative enquiry, Yeung indicated that teachers’ perceptions of the enquiry-
based teaching approach were positive, but it was not implemented as a usual practice. Rather, teachers implemented it only at a trivial level. In addition, the implementation of the enquiry-based teaching approach was not affected by the socio-economic background of schools and traditional teaching practice (Yeung, 2009). Cultural issues and contextual factors were addressed as constraints that hindered reforms in curriculum and pedagogy. Teachers’ priority in implementing the enquiry-based teaching approach was still given to academic achievement. This resulted in delayed implementation. Yeung concluded that curriculum improvement in Hong Kong was obstructed by a cultural barrier. People’s perception regarding successful learning was still dominated by academic achievement. Traditional top-down policy-making processes that caused the de-skilling of teachers were mentioned as another constraint that impeded the process of implementing the enquiry-based teaching approach. Inadequate support from the government in terms of staffing and training from experts were also regarded as constraints that detained the implementation of the enquiry-based teaching approach (Yeung, 2009). Another study that probed US teachers’ perception of learner-centred pedagogy and learning theories is that of Yilmaz (2008), who employed qualitative enquiry in the form of semi-structured interviews to investigate teachers’ views on behaviourist, cognitive, and constructivist learning theories as well as difficulties related to the implementation of learner-centred instruction. In addition, Yilmaz’s justification in choosing semi-structured interviews as an enquiry method was explained. To avoid an influence of interview questions on teachers’ perspectives, questions to be asked in the interviews were constructed in a broad way (Yilmaz, 2008). A positive attitude of the teachers toward learner-centred instruction was reported in the study. The teachers believed that the learner-centred instruction was a strategy that possibly increased students’ attention toward the instruction, making the instruction more enjoyable, challenging, and relevant to students’ learning (Yilmaz, 2008).

The literature described above along with the definition of naturalistic enquiry given by scholars demonstrates that different aspects of the implementation of the student-centred learning approach have been studied by researchers using qualitative methods, namely observation and interview, and these studies revealed that teachers
were important actors. Therefore, it is sensible that the main data collection and analysis methods for teacher participants under study are qualitative methods that aim to discover the views of heads of science departments and science teachers regarding educational reform, examine the practices of teachers in the classroom, and evaluate how much science policy and curriculum implementation in school reflects the reform.

Because of the current situation in Thai education, which led to the construction of the research questions described above, it is necessary to gain access to targeted schools and approach key participants directly to acquire the direct experiences of the key participants and to allow me to observe actual situations and any constraints that they. In addition, this study can partially be an ethnography study because I, as the researcher, have participated in situations similar to those observed to some extent and have reflected on what I saw as well as my interpretations of those situations.

Considering the research rationale, it is necessary for me to be present in the fieldwork and interact with key participants. Hence, it was decided that the method that best suits this investigation was qualitative or naturalistic enquiry.

2.3 Methodology

2.3.1 Observation Method

Observation offers directness in that a researcher watches people and listens to what they say rather than asking them. Furthermore, data obtained from direct observation provide information about experiences in depth (Lincoln & Guba, 1985). At the same time, observation data can be used in conjunction with other techniques. In this sense, observation data can be utilised to validate or support data obtained from other techniques (Robson, 2002). However, issues related to the presence of the observer affecting the situation observed have been considered. Solutions regarding this can include attempting to make those being observed neglect to notice that they are being observed or making them familiar with the presence of the observer so that they will carry on as if no observer were present (Gittelsohn, Shanker, West, Ram, & Gnywali, 1997). In general, observation is time-consuming. More structured
observation, which requires some type of observation schedule, can lessen observation time. However, time for developing such a schedule is still required (Robson, 2002).

Observational methods can be categorised, according to the degree of the structure, into two major approaches: informal observation and formal observation. Informal observation approaches are ‘less structured’ (Robson, 2002), and the observer is free to consider what information should be collected and by what means. Information obtained from these approaches is ‘relatively complex and unstructured’ (Robson, 2002). In addition, an observer who conducts research by these approaches is required to perform difficult tasks, including synthesising, abstracting, and organising data obtained. The other type is formal observation approaches, whose structure and direction with respect to the targets of observation are pre-specified. Therefore, the observer focuses only on what is already decided to be relevant and ignores other things that are considered irrelevant to the purpose of the study (Robson, 2002). It is easier to obtain reliability and validity with a formal approach. However, complexity and completeness may not be achieved by these approaches (Robson, 2002). With this in mind, formal observation is conducted in this study, as the targets of the observations have been pre-specified. In addition, an observation schedule, which has been designed and piloted, is used to gather data.

2.3.2 Interview Method

Webb and Webb (1932) described an interview as a conversation that requires the interviewers to ‘bear in mind that it is desirable to make the interview pleasing to the person interviewed. It should seem to him or her an agreeable form of social intercourse’ (p. 139).

The authors also mentioned the superiority of conversations over formal question-and-answer sessions in which the outcomes of conversations are rich and detailed data can be utilised along with other materials (Webb & Webb, 1932). Another major advantage of interviews was described by Lincoln and Guba (1985). They stated that interviews provide an opportunity to an observer to move back and forth during an interview session to reconstruct meaning from past statements given
by participants, make sense of present statements, and identify possible statements that may be expressed by participants (Lincoln & Guba, 1985).

Semi-structured interviews and unstructured interviews are different in their degree of formality. Robson (2002) explained that a semi-structured interview requires a list of proposed questions that the interviewer can modify according to their appropriateness, determined by the interviewer’s perception. In addition, particular questions that happen to be inappropriate for a particular interviewee can be omitted. At the same time, questions that seem to be more appropriate can be added (Robson, 2002). An unstructured interview could be more informal than a semi-structured interview in that the interviewer merely proposes areas of interest and concern but lets the conversation grow freely (Robson, 2002).

Semi-structured and unstructured interviews are usually employed in a flexible qualitative design. King (1994) referred to semi-structured and unstructured interviews as qualitative research interviews and described several circumstances that could make use of the qualitative research interviews. One of these is a circumstance where a researcher aims to obtain individual perceptions of the participants on a particular phenomenon (King, 1994). Therefore, a semi-structured interview could be employed in this study as a tool to acquire the sense that science teachers convey regarding the reform.

Face-to-face interviews offer opportunities to investigate individual motives that cannot be noticed explicitly. Such a benefit cannot be offered by postal and other self-administered questionnaires. However, this method requires skill and experience on the part of the interviewer, and issues related to the lack of standardisation and biases may arise. Obviously, interviews require several preparation steps, and all these steps must be carefully undertaken. Interview timetable arrangement and acquiring permission to gain access are time-consuming. In some cases, rescheduling appointments is needed if an interviewee fails to be present, and this consumes more time (Robson, 2002).

A focus group is a particular type of interview conducted in a group setting that focuses on a specific topic. It is usually carried out in a way such as open-ended
group discussion, and the researcher usually acts as a moderator. Generally, a focus group interview is used in combination with other methods, such as observation and individual interviews (Cash, Anansuchatkul, & Busaya-wong, 1999). Some methodological issues of focus groups were raised by Sim in 1998. The personal skills and characteristics of the moderator as well as how data are recorded influence the quality of data gathered from a focus group. An individual perception or phenomenon cannot be obtained by this method. Rather, collective ones are likely to be found. The researcher cannot expect to acquire a consensus in attitudes because the opinions of the group members may diverge. Participants’ perspectives can reveal only their range and nature, but the degree of intensity is less accessible by the focus group interview method. Data from focus groups can be generalised based on a theoretical stance, not an empirical and statistical stance (Sim, 1998).

2.4 Testing Data Collection Tools

An observation tool used in this study was piloted in science classrooms in Manchester areas. Topics used for the semi-structure interviews with teacher participants were raised from data obtained from classroom observations as well as various sources of literatures including publications, book chapters, news and the national curriculum.

2.4.1 Development of an Observation Schedule

This section is largely taken from a pilot study that I previously carried out to examine the observation schedule (Siriwat, 2012). Details are described henceforth:

An observation instrument was piloted, and it was firstly developed for conducting this research by using the criteria for the inspection of maintained schools set out in the Ofsted guidance as models. I recognised that those criteria were designed for an evaluation of schools then I had adapted those criteria to make them suitable with my research purposes. According to the inspection criteria, Ofsted emphasises teaching that promotes students’ achievement which includes effective teachers’ planning and implementing activities, appropriate marking and assessment as well as effective feedback (The Office for Standards in Education, Children’s Services and Skills [Ofsted], 2011; (Ofsted), 2012).
From Ofsted’s inspection reports about teaching, main factors were extracted and grouped into 4 themes, as follows:

1) Effective planning. This refers to the extent to which an appropriate lesson structure enables students to expand their knowledge, skills and understanding.

2) Assessing, monitoring and giving feedback. This refers to the provision of detailed and accurate feedback from teachers as well as the process of monitoring and assessing students’ learning.

3) Professional knowledge and understanding. This refers to the teachers’ capacity to motivate students to learn and their mastery of subject knowledge.

4) Teaching and learning strategies. These refer to teaching that enables students to develop critical thinking, discover their own knowledge, and actively engage in activities that promote learning.

(Siriwat, 2012, p.1)

The following step was to add some activities related to the quality of science teaching, as indicated in the Ofsted evaluation reports. I as the researcher drew up a schedule using tick boxes to be able to quickly record the activities in the classroom under the themes described above. After finishing the first draft of the observation schedule, I discussed it with my co-supervisor. She is a Postgraduate Certificate in Education (PGCE) tutor and as such has substantial expertise in lesson observation. The classrooms that I went to observe were science classrooms and the teachers are teacher trainees from the School of Education, the University of Manchester. After this discussion I made a revision to the schedule as follows:

1. I added some characteristics related to the student-centred classroom, such as ‘ideas and experiences of students are drawn upon’ and ‘promote autonomy, interaction and choices’, under the teaching and learning strategies theme (Bansberg, 2003; McCombs & Miller, 2007).
2. Free spaces were also provided in each theme for recording quotes or critical incidents illustrating the student-centred teaching method.

(Siriwat, 2012, p.1)

Having made these changes, I hoped that this version of the observation schedule would enable me to capture authentic classroom practice.

The pilot observations were performed in several science lessons in Manchester area. All of the lessons were in secondary classrooms but different in levels: some were sixth-form classrooms, some were A-Level classrooms and some were normal classrooms. All of the teacher trainees were informed about the objective of my visit, which was only for testing the observation instrument, and were assured that the data obtained would not affect their assessment scores. I arrived at the classrooms early and had an opportunity to choose where to sit and observe the class. I normally sat at the back of the classroom from where I would be able to clearly see the interactions between teacher and students and between students and peers. I was also allowed to talk with students and ask them questions or even join their working groups. When there was any activity relating to the characteristics of the classroom practice I was looking for through my observation schedule, the tick box in front of that characteristic was checked and a summary was collected and described (if applicable) in the space provided (Siriwat, 2012).

The first class observed was a biology revision class for A-level students at School A. Students were divided into 4 groups; each group was taught by 2 teacher trainees from the School of Education, the University of Manchester. Only 3 groups of students were observed due to the time limit.

Students in the first group were taught the topic of cell division. The teacher trainees explained the objective of this class in detail before they started any activity. All students were encouraged to participate during the lesson, as the teacher trainees provided pens and white boards individually and asked them to answer questions and present to friends. The teacher trainees also monitored students’ learning by asking follow-up questions related to students’ answers. The second group of students observed were also A-level students. The teacher trainees used a mind map to pull
together overall ideas students had about food and water transportation systems in plants. The teacher trainees also made use of other activities such as quizzes to examine students’ prior knowledge and understanding of lessons. They also promoted interactions among students and between students and teachers by allowing students to discuss results with friends in the same group. The third group of students were first asked to answer questions about the characteristics of living organisms and the key differences between humans and plants. These questions led to a step-by-step overview on general characteristics of living organisms, and the teacher trainees used these questions to generate discussion and stimulate students to think critically. The teacher trainees also provided students opportunities to discuss with peers and for group work (Siriwat, 2012).

After these trial observations, I again consulted my co-supervisor. Further revisions were made to the schedule:

1. I moved ‘Good pace of teaching’ from the teaching and learning strategies theme to the effective planning theme.

2. In addition, after these classroom observations, I identified an omission on the schedule. ‘Make connections to the real world context’ was then added into the teaching and learning theme.

   (Siriwat, 2012, p.2)

This revised schedule was then used in the next classroom observation.

At the second school, School B, again students were at A-level and the class was for a revision lesson in chemistry. The teacher was a teacher trainee from the School of Education, the University of Manchester. She started the class by giving an overview of the lesson objectives to the students. Then, she asked students to do group work in form of a quiz and gave students a chemistry model which was to be used as a tool to find answers for the quiz. During the lesson, the teacher circulated around the class to discuss with students in every group. When every student finished their group work, the teacher asked the students to present and discuss their answers with other groups. Again, the teacher tried to encourage the students to
discuss by asking further questions related to the results the students obtained. The teacher also challenged the students to think critically and discuss their own knowledge. The teacher wrote chemistry equations on the white board and left some blank spaces, and asked the students to help her complete the equations. After observing this lesson, I made further revisions to the observation schedule:

1. I put ‘various/multiple assessment’ into the assessing, monitoring and giving feedback theme

2. I put ‘stimulate students to construct meaning through appropriate questions’ into the teaching and learning theme.

(Siriwat, 2012, p.3)

This revised schedule was used in the next classroom observation. Moreover, my co-supervisor informed me that the next lesson would feature the enquiry-based approach to learning.

The third occasion that I went to observe was, again, School A. The students were in years 7-9. This time, I had opportunities to observe 2 classes. These classes were taught by 2-3 teacher trainees from the School of Education, the University of Manchester, using an enquiry-based teaching approach. The first lesson was about the floating and sinking of an object. The teacher trainees asked students to discuss the floating and sinking. In this regard, most questions that the teacher trainees used to stimulate students’ discussion began with ‘why?’ and ‘what do you think?’. During the discussion, the teacher trainees appeared to take into account students’ prior knowledge and wrote 5 phrases on the white board. These phrases were constructed from answers given by the students and these phrases would be further investigated to confirm whether they were true or not by carrying out an experiment. The teacher trainees used experiments as a tool to help the students find answers to the questions posed by the discussion at the beginning of this class. The teacher trainees also required the students to explain their answers and present them to other students in the class (Siriwat, 2012).
The second class focused on plant seeding, influenced by environment factors such as water and wind. The teacher trainees started the lesson by informing the students of the objectives of the lesson, provided a fact sheet and asked students an open-ended question, which was indicated in the fact sheet. The teacher trainees encouraged the students to discuss the main characteristics of seeds such as easily enabling them to spread in the air, traveling in the water, etc. After the practical works finished, a discussion took place. The teachers asked the students to get together in pairs and asked them to do a revision quiz. The teacher trainees also challenged and encouraged the students to discover their own knowledge by setting a competition. They encouraged the students to design a ‘seed copter’ using materials provided. The winner would be the group that could construct a seed copter that could spend the longest time floating and travelling in the air. After the competition, the teacher trainees asked the students to discuss the advantages and disadvantages of their seed copters, and also asked the students what they would change if they did this experiment again (Siriwat, 2012).

Before the next lesson in which I observed experienced teachers. I further revised the schedule thus:

1. I split ‘engage students actively in activities/problem solving/critical thinking/construct meaning’ up into ‘promote active students’ engagement’ and ‘promote problem solving/critical thinking/construct meaning’.

2. I took ‘supportive’ and ‘stimulate students to construct meaning through appropriate questions’ out. This was because I found that the former one could be considered as ‘guide all students in assessing their own learning/discover own knowledge’ and the latter one could be considered as ‘promote problem solving/critical thinking/construct meaning’.

This revised schedule was then used in the next classroom observation in which I had an opportunity to observe science classrooms taught by experienced teachers, but this time I was not allowed to join in students’ activities or ask them any questions. I went to School C and observed three science lessons. All of these experienced teachers were informed about the purpose of the visit--that it was only
for testing the observation instrument—and that the data obtained was not affecting any of their profession assessment scores (Siriwat, 2012).

The first lesson was for year 9 students. The lesson was about diet and health, and was an extension lesson from the previous weeks’ topic. Therefore, the teacher showed the students five questions relating to the previous lesson and asked them to complete these questions within 5 minutes. Furthermore, the teacher gave the students worksheets and asked them to work in pairs. After the students had finished their task, the teacher concluded all corresponding answers on the white board, showing the students how to calculate Body Mass Index (BMI) and then discussed how to achieve an appropriate BMI. At the end of the lesson, the teacher showed the students a BBC news story relating to the problem of obesity in children and discussed it with her students. She also assigned every student to write an article for the school website to educate parents how to help their children avoid obesity and stay healthy (Siriwat, 2012).

The second lesson was on the ecological food web. Again, this lesson was a revision that would help the students prepare themselves for the exam, and the teacher gave the students a worksheet and asked them to complete it in pairs. During this task, the teacher discussed with every pair of students and helped them in case they needed some more clarification. Another worksheet was provided, and, again, the teacher asked the students to complete it in pairs but they could not finish it on time, so the teacher asked them to complete it at home. The last 10 minutes of this lesson was a memory test, with the teacher showing several presentation slides and asking the students to remember keywords which appeared on the slide and then help her to write those keywords on the white board (Siriwat, 2012).

The third lesson was on the periodic table, gas and pH. There were one main teacher responsible for conducting the lesson and two assistant teachers. The objective of this class was communicated to the students and the main teacher gave out a worksheet to the students and asked them to work in pairs. The teachers tried to promote the students’ critical thinking by guiding them using colour pencils to compare with pH colour and also linked this to elements in the periodic table. The
teachers also made use of computer games to stimulate students’ engagement (Siriwat, 2012).

After these three lessons, I also had an opportunity to discuss briefly with each teacher during the lunch break. All of the teachers said that the important factor that would enable teachers to control the classroom, implement teaching planning and achieve a quality of teaching was that the teacher had to know every student in the class. This also included knowing the level of individual learning ability. Moreover, the teachers had to devise a strategy to continuously assess students’ learning, for example through questioning, and this would also help the teachers to adapt the lessons in order to make them compatible with the students’ learning ability and raise students’ achievement (Siriwat, 2012).

From the responses to the questions on their practice, they all tried to create the environment that favoured the students’ learning in the classroom. All of them admitted that those classrooms were not absolutely student-centred classrooms, due to that fact that there was a limitation of some students’ learning ability. Although main activities such as problem-solving and critical-thinking, which are characteristics of student-centred classrooms, were implemented, sometimes the teachers had to use a more didactic approach, rather than let the students think for themselves. Moreover, there are some students with behavioural problems in the classroom. Therefore, these students were not able to fully engage in the collaborative working with friends due to their aggressive behaviour. These were reasons why those teachers were not able to completely implement the student-centred learning approach. I had anticipated that because of these lessons observed were revision lessons, which mostly aimed at preparing students for the examination, I would not see any activity that encouraged students to give a presentation. Some of the teachers said that they actually used this kind of activity, but normally for a lesson involved with computer or information technology (Siriwat, 2012).

I repeated observations in different schools and with different teachers. This could be considered as a way to ensure the validity of this observation instrument devised. Moreover, I was able to develop this observation instrument in lessons given by several experienced teachers in the natural setting. This is also considered
as a strategy to enhance validity and reliability of this instrument. The discussion with those experienced teachers during the lunch break, although quite brief due to the limit of time, could help examine the data gained from using the instrument, to see whether they accurately reflected teachers’ views of their own practice. Moreover, the discussion also benefited the study in that data in greater detail were gained (Siriwat, 2012).

However, further pilot classroom observation would also be conducted in each participating school in Thailand, to ensure the relevance of the schedule, and to check that it corresponds with the context before the data collection began. With the actual study in mind, I further revised the schedule as thus:

1. I made ‘motivate student’ to be more understandable by revising it into ‘motivate student to participate’ and then moved this item from the professional knowledge and understanding theme to the teaching and learning theme.

2. I took ‘adapt lesson to respond with students’ learning’ out. This is because I found that this characteristic was not usually seen while classroom observation took place, but rather uncovered through discussion or interview with teachers.

(Siriwat, 2012, p.8)

This revised schedule (See Appendix 5: Science Lesson Observation Schedule 5) would be used in the classroom observation in Thailand.

The final version of the lesson observation schedule was obtained after five revisions. The first revision was made according to a suggestion from the thesis co-supervisor. Other three revisions were made according to experiences I gained during the pilot observations. The final version of observation schedule consists of 4 main themes which are effective planning, professional knowledge and understanding, assessing, monitoring and giving feedback, and teaching and learning. The observation schedule changed its layout from vertical orientation to
horizontal orientation. This adaptation was for convenience of me as I was able to record every incidence observed in one page (Siriwat, 2012).

2.4.2 Development of Interview Schedule

Information obtained from the classroom observations together with information from published government policy documents relating to the quality of science teaching were extracted and grouped into four main interview topics: the background of the interviewees, their opinions about the reform, their practices and difficulties they encountered in their classrooms, and their motivation to implement such practices. The pilot interview was also performed with a science teacher from a non-participant school. Data obtained from the pilot interview were transcribed to see whether other topics needed to be discussed with interviewees. The results from the pilot interview revealed that there were other topics, apart from the four main topics, that should also be discussed, such as how the interviewees define effective implementation of the student-centred learning approach. In addition, other topics could be raised during the interviews if they were related to ongoing conversations and could help clarify the interviewees’ ideas.

The topics of student focus group discussions were developed based on the conversations with teacher participants during semi-structured interviews, together with information from other sources, such as lesson plans, the national curriculum, and publications. With regard to the semi-structured interviews, information elicited from the teacher participants were used to identify the teachers’ major concerns. Topics of the focus group discussion include what made them enjoy studying science, which topic of science lessons they liked most, how studying science benefits them, and what types of activities they perform in a science classroom. As with the teacher interviews, other topics of discussion could be added if they could be linked with ongoing conversations and could help me gain more insight into the students’ ideas.

Data obtained from the semi-structured interviews and student focus group interviews were gathered using the interview schedule as a guideline. Because a semi-structured interview allows a flexible arrangement of the list of topics and sequence of questions, the interview schedule can be less complicated than that of a
structured interview (Robson, 2002). According to the general concept of semi-structured interviews, it is possible to include following points in the interview schedule:

- Introductory comments.

- Topic headings and key questions. In this study, the first heading can be a topic related to the interviewees’ background. This was expected to provide information to the researcher, such as the interviewees’ specialisation.

- For the student focus group interviews, related prompts were also prepared.

- Closing comments.

(Adapted from Robson, 2002)

Apart from the list of questions prepared, other questions can be added during the interviews if there are responses from the interviewees that need to be further clarified. Questions listed in the interview schedule were ticked off when they were posed to the interviewees. Though the interviews were audio-recorded, a substantial amount of note taking space was also needed just case there was a problem with an audio-recording device, such as a loss of battery power.

2.5 Samplings

This study was undertaken in Samutsongkram Province, the smallest province in Thailand. It covers 416.7 km², and its southern part is adjacent to the Gulf of Thailand (Samutsongkhram Province, 2014). A report on the gross provincial product (at current market prices) in 2011 indicated the share of non-agriculture business at 83.60% and the share of agriculture business at 16.40%. The most effective non-agriculture business was industrial, which provided a market share of 22.60%. The most active agriculture business, which possessed 11.90% of the total market value, was livestock (Ministry of Finance (Thailand), 2011). According to a provincial report in 2013, three societal problems raised concerns, as these problems
tended to be more severe. These were problems related to the increased number of children exhibiting inappropriate behaviours, problems related to an increase in the number of divorced families, and problems related to the higher number of elderly people and disabilities (Samutsongkhram Provincial Social Development and Human Security Office, 2013). Although Samutsongkram Province is 1.30 hours from Bangkok, its poverty incidence is at 13.1%, whilst the poverty incidence of other provinces around Bangkok, including Nonthaburi, Pratumthani, Samutsakorn, and Samutprakarn is at 1.4%, 2.6%, 9.5%, and 3.1%, respectively (National Statistical Office (Thailand), 2010).

Apart from information related to the size and social and economic background of the province, data from Samutsongkhram Primary Educational Service Area Office and the Secondary Education Service Area 10 indicate that Samutsongkram has fifteen Schools of Expanded Opportunity (SEO) and nine non-SEO secondary schools; therefore, it is feasible with a timeline (approx. five to six months) to carry out the data collection process in the province (Samutsongkhram Primary Educational Service Area Office, 2013; The Secondary Education Service Area Office 10, 2013).

The selected participants in this study are 22 secondary science teachers and 30 groups of lower secondary students from 14 schools (in total) located in Samutsongkram Province. Eleven of these schools are schools that were established as primary schools but have extended their teaching to cover the lower secondary school level. This types of school is called a ‘School of Expanded Opportunity’. The establishment of Schools of Expanded Opportunity was the government’s initiative to extend the length of mandatory education from six years to nine years. At first, the initiative was implemented in selected schools from 38 provinces that were defined as disadvantaged areas. This was the government’s emphasis to narrow the education gap between children in urban and rural areas. Later, the government expanded the initiative to cover primary schools that had an adequate number of personnel and teaching spaces throughout the country, except Bangkok (Office of The Basic Education Commission, n.d.). Three of the participating schools are secondary, mainstream, and government-funded. Students range in age from 13-17 years
(Mattayom 1 to Mattayom 6). Students who finish Mattayom 6 will obtain a certificate, and they may leave to find a job or go on to higher education.

The ‘Schools of Expanded Opportunity’ or SEO are a type of school that I intended to study in terms of their teaching practices and their management of the student-centred learning approach. Most SEO schools are located in disadvantaged areas, and most of the students in these schools are from lower social and economic backgrounds. Therefore, data that obtained from those schools were expected to reflect the implementation of the student-centred learning approach in situations that differed from other types of mainstream schools.

Some of the science teachers from the subject schools had participated in a project that was undertaken by the Institute of Innovative Learning in Thailand, where I have a work connection. Therefore, I took this opportunity to gain access to the SEO schools through the connection with my colleagues in Thailand.

2.6 Data Collection

According to Patton (2015), triangulation in qualitative enquiry is a technique that helps enhance credibility of a study which ‘involves gathering and analysing multiple perspectives, using diverse sources of data, and during analysis, using alternative framework’ (Patton, 2015, p.652). In addition, Golafshani (2003) also describes that ‘triangulation may include multiple methods of data collection and analysis’ (p.604). In order to ensure the credibility of this study, I planned to perform a crude triangulation by using multiple methods of data collection. Therefore, when I was in the field, the data collection phase of this study was conducted by three methods including documentary research, classroom observation, and interviews. The data collection procedure is summarised in Figure 3. The first data collection process was based on documentary research. As explained by Merriam (1998), documents are free and stable, and the researcher was able to scrutinise them. However, an assessment of authenticity and accuracy was needed because documents are not always consistent with actual circumstances and practices (Merriam, 1998). In addition, their purpose is not for conducting research, so they must be viewed with caution (Riley, 1963).
Documents were researched and analysed to find evidence relating to the introduction of the new curriculum and the concept of the student-centred learning approach proposed by Thai government agencies. I scrutinised policy documents and used them to carry out an analysis of the national and individual schools’ science curricula. At first, the science curricula and lesson plans, from both before and after the implementation of the student-centred learning approach, were expected to be analysed to examine the scope of recent classroom practices and the changes in teaching practice in science education. Thus, both the national perspective and the school perspective were considered. However, it was problematic to obtain individual schools’ science curricula, particularly before the implementation of the student-centred learning approach, because the participant schools did not retain the previous versions of the science curricula, which were outdated and no longer in use. Instead, it was easier to obtain previous versions of textbooks or teachers’ handbooks from individual teacher participants. Therefore, data regarding curriculum content and classroom practices could be accessed through these sources provided by the individual teacher participants. Recent school science curricula were given to me by one of the teacher participants and, surprisingly, lesson plans could be obtained very easily because they had been commercialised, converted into the form of PDF files and stored on a DVD, and sold along with a textbook. Thus, the lesson plans could be printed out by teachers.

As mentioned above, observation is a useful tool for capturing real incidents that occur in certain circumstances (Morley, 2007). Having considered the application of the observation method along with its benefits and disadvantages, I employed classroom observation as a method to illustrate science classroom practices. I conducted pilot observations of science classrooms in several secondary schools in the Manchester area. The access to perform pilot lesson observations in the UK was arranged through my supervisors. Regarding this, I gained experience conducting classroom observations and had opportunities to test and revise the observation schedules. In Thailand, before the data collection process took place, I planned to pilot the latest version of observation schedule again in a non-participating school to ensure the reliability of the observation schedule. Unfortunately, I could not perform the pilot observation as planned because the non-
participating schools could not allocate classrooms for the pilot observation as a result of unforeseen circumstances.

Figure 3. Procedures of Data Collection

According to the research plan that was proposed prior to the fieldwork, the current research was designed to be a case study. Each participating school represented one case to be studied, and data from each case study will be produced through the observations and the interview programme. Regarding this, the latest
version of the observation schedule was expected to be used in the observation programme, which consisted of 10 to 12 science classrooms observations per week, and the programme was to be performed for two weeks in each participating school. Therefore, around 20 to 24 lesson observations would be carried out in each participating school. The interview programme in each participating school would also be set out. Each programme included interview sessions with the head of the science department and three to four science teachers. Thus, four to five interview sessions would be carried out in each participating school. However, there were unanticipated circumstances in which, when I turned up at the fieldwork for the survey, I found that there were only one or two science teachers (including the head teacher) in each prospective participating school. Thus, the total number of classroom observations in each participating school would not reach 20 within two weeks as expected. Furthermore, the number of interview sessions in each participating schools would be equal to or less than two, which was much fewer than I had planned. This circumstance inevitably affected this study because the obtained number of classrooms and interviewees would not have produced a desirable amount of qualitative data. Therefore, it was necessary to recruit more secondary science teachers and participating schools. Fortunately, the science teachers from SEO schools who had already agreed to participate helped provide names and contact numbers of some science teachers in other SEO schools in Samutsongkram Province. I was then able to recruit more teacher interviewees and to observe science classrooms that were taught by these new interviewees. Additionally, I searched for names and contact numbers of SEO schools located in Samutsonkram Province that had never been contacted before in the government database and made direct contact with the principals of those schools. At this stage, I obtained 16 secondary science teacher interviewees from all participating SEOs and observed 21 science classrooms of 11 teachers from nine SEOs.

Unexpectedly, one of interviewees from an SEO school offered me an opportunity to talk with her teacher, who was also a secondary science teacher from a non-SEO secondary school. This was an opportunity to gather data from a different source. I took this opportunity and contacted the teacher to ask for permission.
Fortunately, she was willing to talk with me. Thus, I arranged an interview session and was able to gain one more interviewee. However, I did not have an opportunity to observe her classrooms. After obtaining one interviewee from a non-SEO secondary school, I thought it would be more practical to gather more interviewees from other non-SEO secondary schools. Thus, I started to recruit more secondary science teachers through existing connections with my colleagues in Thailand and obtain more science teachers. Although more teacher interviewees were obtained, I had an opportunity to observe only one more science classroom at nearly the end of the semester. I could not observe all the secondary science classrooms (years 7 to 9) in every participating school for several reasons that will be stated below. Nevertheless, I was able to observe 22 science classrooms (in total) of 11 teachers from nine SEOs and one teacher from one non-SEO.

During the collection of the observation data, classroom plans as well as seating arrangements were written in the space provided in the observation schedule. The total number of students was also recorded. Activities, teachers’ actions, and students’ responses were noted, and if there was unclear or ambiguous information, it was discussed with teachers at the end of the lessons. Interactions between teachers and students, such as eye contact, were minimised or omitted in the notes to limit observer effects. I chose to sit at the back of the classroom, where I could clearly observe interactions, gestures, and events happening in the classroom.

Simple quantitative data drawn from the observation instrument, such as the frequency of teaching approaches that the science teachers used in the classroom, together with the qualitative data obtained from the observations and documentary research, were used to design questions to be asked in the semi-structured interviews. As explained by Merriem (1998), the interview is a tool to examine personal perceptions regarding a particular issue and their interpretations (Merriam, 1998). Considering this explanation along with the definition and benefits of interviews, the interview method was chosen as a tool to capture the perceptions and experiences of heads of science departments and science teachers from schools in a rural area in Thailand.
Heads of science departments from participating schools and science teachers from each school who had varying experience in science teaching were interviewed (in their own language) to obtain their perceptions regarding the reform and ideas drawn from their experiences and practices regarding the implementation of the new science curriculum, which is largely based on the student-centred learning approach. In addition, factors hindering the implementation of the new science curriculum were identified. The interview sessions were carried out in each participating school, and each interview session took 45 to 60 minutes and was audio-recorded and transcribed. As a result of obtaining more participating schools, the teacher interviews were performed with 22 science teachers in total. During the interviews, I carefully raised ongoing questions that were not leading questions and observed the interviewees’ body language, verbal tones, and facial expressions and noted this information on a piece of paper. In addition, a list of research questions was brought, along with a list of interview questions. This was for my convenience to capture the content of interview conversations corresponding to the research questions. Some interview sessions were interrupted because the interviewees were asked to help with schoolwork by other school personnel or their students came to ask about activities that the interviewees had assigned to those students.

Student focus group interviews were performed with 30 groups of students. The definition of a focus group was explained by Lederman (1990) as ‘a technique involving the use of in-depth group interviews in which participants are selected because they are a purposive, although not necessarily representative, sampling of a specific population, this group being “focused” on a given topic’ (p. 117). An advantage of a focus group is that it is a way to encourage people who tend to be unresponsive or feel that they have nothing to say (Kitzinger, 1995). In addition, people who are unwilling to be interviewed on their own can be more encouraged to speak by this method (Kitzinger, 1995).

I used this method to learn about ideas and perceptions of student participants rather than using other types of interview methods because student participants would be more encouraged to participate using this method. In this study, each group consisted of four to five students, and an interview timetable was arranged by the
teacher participants. Students were asked to discuss (in their own language) topics that I raised. This was a strategy to obtain students’ ideas and perceptions regarding studying science and the extent to which they recognised the benefits of studying science. In addition, this was a tool to indirectly assess whether students were able to comprehend the science lessons. The student participants were from Mattayom 1 (year 7) -Mattayom 3 (year 9) from 10 SEOs. I could not perform focus group interviews with students in all the participating schools, and the limitations will be described below. Each focus group interview session took 30 to 45 minutes and was audio-recorded and transcribed in the interviewees’ native language (Thai). During the student interviews, I used the same strategy when performing interviews with the teacher interviewees, in which I avoided asking leading questions and observed their body language, their verbal tone, and their facial expressions and noted this information on a piece of paper.

The data gathered included 22 lesson observations in the classrooms of 12 teachers along with interviews with 22 science teachers and with 30 focus groups in total. As described earlier, the data gathering approach was no longer a case study but an interview-based approach. The data collection process was carried out in Thailand over a period of six to seven months, and it took place in the second semester of the school year of 2012. The literature review was ongoing and revised as issues related to this study emerged during the process of this study. Documentary research and some initial analysis were initially performed in the UK. The first two months of the data collection process in Thailand was spent piloting and becoming familiar with schools and participants.

During the data collection process, there were many unforeseen circumstances that affected the processes. I was unable to carry out the observation according to a plan; there was an urgent request from a community that asked students to join an event; teachers were assigned to attend a meeting outside the schools; both teachers and students spent excessive time preparing for an assessment by funding sponsors; and there was a national exam tutorial week and thus no lessons, which also affected my ability to conduct student interviews. In addition, some classrooms were under construction and refurbishment during the observation.
Some teachers saw it as an inappropriate time to observe their teaching and allowed only interviews with them. When encountering these situations, I solved the problems case by case, using personal judgement based on the need to take every opportunity to obtain data.

2.7 Data Analysis

The data analysis was conducted with two sets of data, as summarised in Figure 4. After the data collection procedures, quantitative and qualitative data gathered from the observations were analysed to illustrate science classroom practices after the implementation of the new science curriculum. Simple quantitative data were reported in the form of basic statistical data, such as the frequency of activities. Qualitative data from the observations were analysed by examining both similarities to and differences from the qualitative data obtained from references such as research publications relating to the student-centred learning approach and its applications. In addition, the effectiveness of practical works implemented in the observed science lessons was also analysed using the framework proposed by Abrahams & Millar (2008).
Figure 4. Procedures of Data Analysis

I. Data from Classroom Observations

Simple Quantitative Data Analysis

Qualitative Data Analysis

Analysis of Effectiveness of Practical works (Abrahams & Millar, 2008)

II. Data from Interviews

Theme Analysis

Listen to interview tapes 2 times, then excerpt and index

Transcribe

Generate codes, coding

Collate / codify

Identify potential themes, sort codes generated into identified potential themes

Review

Review themes, identify sub-themes

Repeat
Transcripts from the semi-structured teacher interviews in their native language were analysed using thematic analysis to obtain the key ideas reflecting the perceptions of the interviewees regarding the new science curriculum and their practices, and then they were translated and reported in English. Transcripts in Thai obtained from the student focus group interviews were analysed using the theme analysis method as well to obtain students’ attitudes regarding topics around learning science. The next step was to translate the discussions into English.

Thematic analysis has been defined as ‘a method for identifying, analysing and reporting pattern (theme) within data. It minimally organises and describes your data set in (rich) detail’ (Braun & Clarke, 2006, p. 79). Furthermore, thematic analysis is considered a realistic method that can report experiences as well as the reality of participants (Braun & Clarke, 2006). Details of theoretical knowledge of approaches, such as discourse analysis or grounded theory, are not demanded by a theme analysis. Therefore, a theme analysis can be employed by new qualitative researchers because it provides more accessible forms of analysis (Braun & Clarke, 2006).

The data obtained from each participant were analysed based on the context of each participating school and generalised to obtain general ideas that reflected the effectiveness of the implementation of the new science curriculum. The data analysis process performed in this study was adapted from guidelines provided by Braun and Clarke (2006) and proceeded as follows:

1. I started the data analysis process by listening to each of the interview audio-recorded files before transcribing the tape to familiarise myself with the audio data obtained. I listened to each of the interview files again and took short notes while listening to identify the main ideas from what the teachers expressed that corresponded to the research questions. At the same time, conversations that represented those main ideas were also excerpted and indexed. I excerpted and indexed the interviews because the data collection method was a semi-structured interview and the topics discussed could be expanded to allow the interviews to be smooth. Thus, the data obtained were redundant and needed to be carefully selected. This step was carried out using the software Express Scribe software,
which is available for free. This software can play an audio file at various speeds. Using the software, I was able to listen to the audio recordings at slow speed and to pause or play back the audio files to specific points of recording time. I listened to portions of conversations, which were excerpted and indexed for the second time, and then proceeded to step 2.

2. Once I finished listening to the interview audio files, the transcribing process started. I transcribed the excerpts obtained from step 1 using exactly the same words as the participants stated, and verbal tones were also noted. In addition, non-verbal expressions of the participants, such as headshakes, that I recorded during the interviews were also added to the transcription.

3. I performed step 1 and 2 with all of interview data obtained.

4. I looked through the transcriptions and refined the main ideas generated in step 1. I paid attention to all excerpted data equally and started to generate codes. A code in qualitative research has been defined as ‘a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data’ (Saldana, 2013, p. 3). Excerpted data and their corresponding codes were labelled using numbers as well as highlighter pens. Samples of coding are shown below in Table 4.

5. The following process was used to collate the labelled data within each code into computer files. Each computer file contains a code with its corresponding labelled data. Before proceeding to the next step, I reviewed the collated data to check for errors in coding or mistakes in labelling and collating data. This process is called ‘codifying’ according to an explanation given by Grbich (2007): ‘when codes are applied or reapplied to qualitative data, you are codifying – the process that permits data to be segregated, grouped, regrouped and relink in order to consolidate meaning and explanation’ (p. 21). Considering the explanation given above, ‘codifying’ is a process used to arrange, organise, and categorise similar coded data when they share the same characteristics (Saldana, 2013).
6. After obtaining the different codes, I identified potential themes that overarched the codes generated. As a result, some codes could be placed within more than one theme. Therefore, the following steps were used to sort the codes into identified potential themes and then collate relevant codes within the identified themes. In this regard, I identified relationships between codes and between themes using a mind-map. Other codes that did not fit or were not related to the potential themes were separated.

7. After obtaining potential themes as well as their corresponding codes and coded sets of data, I reviewed the themes. In this regard, sub-themes or issues were identified. Within this step, I re-read all the collated data and considered the coherence as well as the consistency of the collated data, as well as the accuracy of each assigned theme’s name in which it represented the meaning of the data set.

8. I repeated steps 6 and 7 to refine the themes and the sub-themes as well as to reorganise collated data. Within this step, new themes and sub-themes emerged when an overlap between themes existed. By the end of this step, I was able to identify the scope of each theme that corresponded with the research questions.
<table>
<thead>
<tr>
<th>Texts</th>
<th>Codes</th>
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<tbody>
<tr>
<td><strong>Sample 1:</strong> Interviewer: Do you think the science curriculum was changed or modified too often? TR: Yes, I think so and it was ¹messy and ¹not coherent. Interviewer: Why do you think Thai education still lags behind others countries? TR: I think ²politics has caused the ³instability of the cabinet. This leads to the ⁴lack of connectedness in their policies. In addition, I think, we have too many scholars and each group told a ⁵different story, and proposed ⁵different schemes, and the cabinet or education minister wanted to ⁶take all those schemes to be implemented! I think we can’t have the best of all those schemes. ⁷Why don’t choose only one to be implemented rigorously. It is possibly not the best practice but, at least, we did it earnestly. It might take us 6-7 years to see results but it should be better than to keep changing. If it’s not successful, we could learn from the failure. I don’t know if this is right but this is what I think.’</td>
<td>1 MESS 2 POLITICS 3 UNSTEADY 4 UNCONNECTED 5 INCOHERENCE 6 REDUNDANT 7 SUGGESTION</td>
</tr>
<tr>
<td><strong>Sample 2:</strong> Interviewer: What do you think about Thai Education? Has it improved? JK: I don’t think so. If it’s good, at least, ⁸it should be better than this. Interviewer: Why you think that? JK: It’s because of ⁹government policies. Interviewer: I see.</td>
<td>8 DISSATISFACTION 9 GOV POLICIES</td>
</tr>
</tbody>
</table>
JK: "Government policies have changed according to politics and it keeps changing."

Interviewer: Ummm

JK: "Changing and changing. If the minister’s position was changed, there must be something changed as well."

Interviewer: Then, the issue is about inconsistency.

JK: Yes. It will be a different story; I think politics has influenced over education a lot, that’s too much."

An example of the thematic analysis of the teacher interviews is shown below. This will demonstrate the process of generating main ideas, coding, generating sub-themes and generating themes/issues.

To analyse the interview data, I listened to each of interview recordings at least twice. While listening to the interview audio files, I took notes, indexed, excerpted, and identified main ideas that corresponded to the research questions. Once I finished listening to the interview audio files, I then transcribed the most important excerpts. Texts from conversations that linked to common factors or ideas were then drawn together around these factors, as illustrated below. This allows me to produce initial summaries of the contents of interviews that I could code to identify key themes.

Table 5. Sample of the main ideas generated

<table>
<thead>
<tr>
<th>Texts</th>
<th>Main Ideas</th>
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<tbody>
<tr>
<td>‘WT: I can teach anyway but the thing I hate most is (point at a pile of documents on her table in front of a classroom). I have to come here (school) on weekends to do these things instead of writing a lesson plan!’</td>
<td>The teacher is required to do a non-teaching job.</td>
</tr>
<tr>
<td>‘BY: I also have to teach Chemistry for the upper secondary level, apart from teaching science for the lower</td>
<td>There is excessive workload for the teacher.</td>
</tr>
</tbody>
</table>
secondary level. I, then, have to plan lessons for this semester and also for the next semester, which will be used in all those levels. This causes me troubles, as I can’t finish preparing lessons beforehand because I have to prepare 3 different lessons which will be taught in one day.’

‘RR: I’m actually a science teacher but I have to teach Buddhist Studies as well because we don’t have enough teachers. I then have to spend even more time preparing Buddhism lessons. Sometimes I had information overload and it made me very exhausted.’

‘RR: The first factor is activities which are not related to teaching. Nowadays, those activities affect teaching because lesson periods are allotted specifically to carry out those activities. It causes less teaching time than normal.’

‘RR: Students can’t concentrate on science lessons taught after sports lessons. They look exhausted and lose their attention. In some cases, students have to learn Mathematics followed by Science. I can notice that the students don’t want to study anymore. There is too much information for them.’

‘OC: It’s about money, in some cases. We didn’t get all of what we requested, and several pieces of existing equipment need to be repaired as well. Actually, we have ten microscopes but half of them are not working right now. Some of the basic chemicals ran out and we still haven’t got any replacement.’

| The teacher is required to teach outside her specialisation. This causes excessive workload. |
| Irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching. |
| Poor timetable management causes students to lose attention in classroom as they feel exhausted from the previous lesson. |
| Shortage of teaching-aid tools causes difficulty in conducting practical work |
‘KS: When I was in the previous school (she had been teaching here for 1 month), there was a problem over there about a shortage of teachers and administration personnel because many teachers applied for an early retirement scheme. There were no replacement positions for teachers who left schools early, I, as the youngest teacher, had to do many tasks which are not related to teaching. I was barely teaching at that time.’

‘KS: The second issue is a lack of IT instruments. It is a problem because I can’t find IT stuff or spare parts from local shop. It’s not the same as the lack of materials that I use for conducting practical work because I can find those materials from the local shops.’

‘PY: I’m really wanted to do it (a lesson plan) but I don’t have time. It’s actually very good to do it according to what we learnt from the teacher training school. You have to understand the curriculum, you have to plan a lesson, and you have to prepare materials for activities in the classroom. However, I’ve got too many classes that I have to teach, then there is no time left for sitting down and doing a lesson plan, but at least, I still have some spare time to read a textbook before I go to bed because I’m single. Let’s imagine others who have children and husband or wife. I’m sure that they have to spend time with families or teach their children some homework.’

‘PAM: We need more IT equipment to assist science teaching. I think students need to practice an enquiry skill using this stuff. Even we have a computer and a projector

The lack of planned substitution for retirement causes the shortage of teaching staff

Shortage of teaching-aid tools causes difficulty in conducting practical work

Excessive workload of the teachers causes difficulty in preparing a lesson plan (not enough time)

Shortage of teaching-aid tools causes difficulty in conducting practical work.
in our school, those apparatuses are not placed here, I mean, not in classroom. Instead, they are in the reading room. It shouldn’t be like that. Other important things are equipment and chemical supplies as well as particular budgets that are allocated only to support teaching science at the secondary level.’

‘WS: I still can’t find any materials from local shop to be used as a replacement for scientific instrument. This can cause a difficulty in which students didn’t have direct experience in conducting practical work. Moreover, it took several months to obtain some scientific apparatus, such as pre-fixed cell slides, after you have purchased them.’

‘NL: It’s about priority. I mean there are other things such as administrative related tasks or landscape improvement jobs that need money for support as well, and the school principal seems to see that those things are quite important.’

‘WD: There are chemicals which were kept on a shelf and have already expired. Some are not useable as their labels have disappeared. So I have to throw all those chemicals away and order replacements. However, it took me 2 years to get a bottle of alcohol.

**Researcher:** Huhh? What’s happened?

**WD:** That alcohol has to be bought together with the purchasing orders of general supplies from elementary and kindergarten departments. It’s about minimum order and the school’s management of budgets.’

| Shortage of teaching-aid tools causes difficulty in conducting practical work. |
| Less emphasis on teaching of school principal |
| Poor administrative management in purchasing causes difficulty in conducting practical work |
‘**BP:** There are too many activities which were not related to teaching. We wanted to teach according to our plan but we don’t have enough time to achieve it. Students’ IQ is another issue but time also matters. Sometimes, we have to do a lot of things within a limit of time in order to let those activities run smoothly. We then compel students to have an extra tutorial class within school in order to prepare them for an exam.’

‘**TM:** I emphasise on lecturing; otherwise, I wouldn’t be able to finish lessons as I have planned. There are a lot of activities which are not related to teaching. If you compare the time you and the students spend on lessons and those activities, I’m very sure that you will see the teachers and the students spend more time attending those activities than studying and teaching.’

‘**UN:** There is a problem when we have to participate in several events hosted by the local authority; for example, provincial athletics game. My school joined this event by sending students as athletes to participate in this game and they also had to do a parade. This caused a reduction in lesson periods and it was difficult to ask the students to join extra tutorial class during weekdays because they had 8-9 lessons per day which was very tough for them.’

‘**UN:** I don’t want students to change classroom every time each lesson ends. Students are likely to spend too much time walking to another classroom and enter the classroom quite late.’

| Too many irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching. | Too many irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching. |
| Irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching. | Poor timetable management allows students to accumulate undisciplined behaviours |
‘TN: It’s about time. Classroom timetables were fixed but, as you see, there are a lot of events and those events are conducted in inside or outside school. This causes less time for students to carry out practical works. Recently, officers from the Ministry of Health asked teachers to perform teeth inspection at school. Teachers have to join the training for teeth inspection at a local health station, and other than the ministry of health, there are others government bodies who are asking teachers to join their campaign.’

‘PM: There are a lot of extracurricular activities. Every local authority in this area aim to get supporting expenses. They then create various activities such as drug prevention training in order to get more supporting money from central government and expect to gain more popularity among the local people (many of administrators of Sub-district Administration Organization are election campaigners of political parties). Many times, the number of participants is smaller less than what the host has expected, so students are asked to join an event. This creates difficulties because I had planned lessons and assigned tasks but they can’t be accomplished because the lessons are interrupted.’

After refined the main ideas, I started to generate codes.

Table 6. Sample of the codes generated

<table>
<thead>
<tr>
<th>Texts</th>
<th>Main Ideas</th>
<th>Codes</th>
</tr>
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<tbody>
<tr>
<td>‘WT: I can teach anyway but the thing I hate most is (point at a pile of documents on her Teacher requires doing non-teaching jobs.</td>
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table in front of a classroom). I have to come here (school) on weekends to do "these things instead of writing a lesson plan!"

‘BY: I also have to teach Chemistry for the upper secondary level, apart from teaching science for the lower secondary level. I, then, have to plan lessons for this semester and also for the next semester, which will be used in all those levels. This causes me trouble as I can’t finish preparing lessons beforehand because I have to prepare 3 different lessons which will be taught in one day.’

‘RR: I’m actually a science teacher but I have to teach Buddhist Studies as well because we don’t have enough teachers. I then have to spend even more time preparing Buddhism lessons. Sometimes I had information overload and it made me very exhausted.’

‘RR: The first factor is activities which are not related to teaching. Nowadays, those activities affect teaching because lesson periods are allotted specifically to carry out those activities. It causes less teaching time than normal’

‘RR: Students can’t concentrate on a

<table>
<thead>
<tr>
<th>Issue</th>
<th>Category</th>
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<tbody>
<tr>
<td>Excessive workload of the teachers due to shortage of science teachers</td>
<td>1 Shortage of teachers</td>
</tr>
<tr>
<td>Teacher requires teaching outside her specialisation. This causes Excessive workload of the teachers.</td>
<td>3 Teach outside specialised</td>
</tr>
<tr>
<td>Irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching.</td>
<td>8 Excessive extra-curricular activities</td>
</tr>
<tr>
<td>Poor timetable</td>
<td>9</td>
</tr>
</tbody>
</table>
**Science lesson that is taught after sports lesson.** They look so tired and lose their attention. In some cases, students have to learn Mathematics followed by Science. I can notice that students don’t want to study anymore. There is too much information for them.’

‘**OC:** It’s about money, in some cases. We didn’t get all of what we requested, and several pieces of existing equipment need to be repaired as well. Actually, we have ten of microscopes but half of them are not working right now. ‘Some of the basic chemicals ran out and we still haven’t got any replacement.’

‘**KS:** When I was in the previous school (she had been teaching here for 1 month). There was a problem over there about a shortage of teachers and administration personnel because many teachers applied for an early retirement scheme. There was no replacement position for teachers who left schools early. I as the youngest teacher, had to do many tasks which were not related to teaching. I was barely teaching at that time.’

‘**KS:** The second issue is a lack of IT instruments. It is a problem because I can’t management causes students lose attention in classroom as they feel tired from the previous lesson. Shortage of teaching-aid tools causes difficulty in conducting practical work. No substitution and this causes lacking of teachers (shortage ) Shortage of teaching-aid tools and/or chemical supplies 5 Lack of maintenance programme 4 Shortage of teaching-aid tools and/or chemical supplies 5 Lack of maintenance programme 1 Shortage of teachers 4 Shortage of teaching-aid tools and/or chemical supplies 5 Lack of maintenance programme 1 Shortage of teachers
find IT stuff or spare parts from the local shops. It’s not the same as the lack of materials that I use for conducting practical work because I can find those materials from the local shops.’

‘PY: I’m really wanted to do it (a lesson plan) but I don’t have time. It’s actually very good to do to according to what we learnt from the teacher training school. You have to understand the curriculum, you have to plan a lesson, and you have to prepare materials for activities in the classroom. However, 'I’ve got too many classes that I have to teach, then there is no time left for sitting down and doing a lesson plan, but at least, I still have some spare time to read a textbook before I go to bed because I’m single. Let’s imagine others who have children and husband or wife. I’m sure that they have to spend time with families or teach their children some homework.’

‘PAM: We need a higher amount of IT equipment to assist science teaching. I think students need to practice an enquiry skill using this stuff, even we have a computer and a projector in our school, those apparatus are not placed here, I mean not in classroom. Instead, they are in reading room. It shouldn’t be like that. Other

<table>
<thead>
<tr>
<th>Difficulty in conducting practical work</th>
<th>Excessive workload of the teachers causes difficulty in preparing a lesson plan (not enough time)</th>
<th>Teaching-aid tools and/or chemical supplies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shortage of teachers</td>
<td>4 Shortage of teaching-aid tools causes difficulty in conducting practical work.</td>
<td>1 Shortage of teachers</td>
</tr>
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</table>
important things are equipment and chemicals supply as well as particular budget that are allocated only to support teaching science at the secondary level.’

‘WS: I still can’t find any materials from local shops to be used as a replacement for scientific instrument. This can cause a difficulty in which students didn’t have direct experience in conducting practical work. Moreover, it took several months to obtain some scientific apparatus, such as pre-fixed cell slides, after you have purchased them’

‘NL: It’s about priority. I mean there are other things such as administrative related tasks or landscape improvement jobs that need money for support as well, and the school principal seems to see that those things are quite important’

‘WD: There are chemicals which were kept on a shelf and have already expired. Some are not useable as their labels have disappeared. So I have to throw all those chemicals away and order replacements. However, it took me 2 years to get a bottle of alcohol.

Researcher: Huhh? What’s happened?

WD: That alcohol has to be bought together with the purchasing orders of general supplies from elementary and
kindergarten departments. It’s about minimum order and the school’s management of budgets’

‘BP: there are too many activities which were not related to teaching. We wanted to teach according to our plan but we don’t have enough time to achieve it. Students’ IQ is another issue but time also matters. Sometimes, we have to do a lot of things within a limit of time in order to let those activities run smoothly. We then compel students to have an extra tutorial class within school in order to prepare them for an exam.’

‘Researcher: Are you currently implementing SCL in your classroom?

TM: To be honest, not every time. I emphasise on lecturing; otherwise, I wouldn’t be able to finish lessons as I have planned.

There are a lot of activities which are not related to teaching. If you compare the time you and the students spend on lessons and those activities, I’m very sure that you will see the teachers and the students spend more time attending those activities than studying and teaching.’

‘UN: There is a problem when we have to participate in several events hosted by the local authority, for example provincial athletics game. My school has joined this...

Too many irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching.

Irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting...
event by sending students as athletes to participate in this game and also has to do a parade. This caused a reduction in lesson periods and it was difficult to ask the students to join extra tutorial class during weekdays because they had 8-9 lessons per day which was very tight for them.’

‘UN: I don’t want students to change classroom every time each lesson ended. Students are likely to spend too much time walking to another classroom and enter the classroom quite late.’

‘TN: It’s about time. Classroom timetables were fixed but, as you see, there are a lot of events and those events are conducted in inside or outside school. This causes less time for students to carry out practical works. Recently, officers from the ministry of health asked teachers to perform teeth inspection at school. Teachers have to join training in teeth inspection at local health station, and other than the ministry of health, there are others government bodies who are asking teachers to join their campaign.’

‘PM: There are a lot of extracurricular activities. Every local authority in this areas aim to get supporting expenses. They then create various activities such as drug prevention training in order to get more science teaching. Poor timetable management allows students to accumulate undisciplined behaviour. Too many irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching. Too many irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching.’

9 Inappropriate timetable arrangement

8 Excessive extracurricular activities
supporting money from central government and also expect to gain more popularity among the local people (many of administrators of Sub-district Administration Organization are election campaigners of political parties). Many times, the number of participants is smaller less than what the host has expected, so students are asked to join an event. This creates difficulties because I had planned lessons and assigned tasks but they can’t be accomplished because the lessons are interrupted.’

I labelled excerpted data and their corresponding codes and collated them. Subsequently, I reviewed those collated data for several times in order to examine if there was an error in coding, labelling and collating data. Once process of reviewing has finished, I started to identify potential themes that overarched the codes generated, and then sorted the codes generated into identified potential themes. After I reviewed the themes for several times, I subsequently identified sub-themes and then re-read all of the collated data to consider the coherence and consistency of the collated data as well as the accuracy of each assigned themes to make sure it represented the meaning of the data set. Coded, collated and sorted data as well as themes and sub-themes generated are shown below.
Table 7. Sample of the themes generated

<table>
<thead>
<tr>
<th>Codes</th>
<th>Texts</th>
<th>Main Ideas</th>
<th>Themes</th>
<th>Sub-Themes</th>
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</thead>
<tbody>
<tr>
<td>1 Shortage of teachers</td>
<td>‘BY: I also have to teach Chemistry for the upper secondary level, apart from teaching science for the lower secondary level. I, then, have to plan a lesson for this semester and also for the next semester, which will be used in all those levels. This causes me trouble, as I can’t finish preparing lessons beforehand because I have to prepare 3 different lessons which will be taught in one day.’</td>
<td>Excessive workload of the teachers due to shortage of science teachers</td>
<td>School organization and management</td>
<td>Shortage in human resources</td>
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<tr>
<td>‘KS: When I was in the previous school (she had been teaching here for 1 month). There was a problem over there about shortage of teachers and administration personnel because many teachers applied for an early retirement scheme. ‘There was no replacement position for teachers who left schools early, I as the</td>
<td>No substitution and this causes lacking of teachers (shortage)</td>
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youngest teacher, had to do many tasks which were not related to teaching. I was barely teaching at that time.’

‘**PY:** I’m really wanted to do it (a lesson plan) but I don’t have time. It’s actually very good to do it according to what we learnt from the teacher training school. You have to understand the curriculum, you have to plan a lesson, and you have to prepare materials for activities in the classroom. However, *I’ve got too many classes that I have to teach*, then there is no time left for sitting down and doing a lesson plan, but at least, I still have some spare time to read a textbook before I go to bed because I’m single. Let’s imagine others who have children and husband or wife. I’m sure that they have to spend time with families or teach their children some homework.’

<p>| Excessive workload of the teachers causing difficulty in preparing a lesson plan (not enough time) |  |  |</p>
<table>
<thead>
<tr>
<th>2 Non-teaching job</th>
<th>‘<strong>WT:</strong> I can teach anyway but the thing I hate most is (point at a pile of documents on her table in front of a classroom). I have to come here (school) on weekends to do <em>these things</em> instead of writing a lesson plan!’</th>
<th>Teacher requires doing non-teaching jobs.</th>
<th>Shortage in human resources</th>
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<tr>
<td>3 Teach outside specialised</td>
<td>‘<strong>RR:</strong> I’m actually a science teacher but I have to <em>teach Buddhism as well</em> because we don’t have enough teachers. I then have to spend even more time preparing Buddhism lessons. Sometimes I had information overload and it made me very exhausted.’</td>
<td>Teacher requires teaching outside her specialisation. This causes excessive workload of the teachers.</td>
<td>Shortage in human resources</td>
</tr>
<tr>
<td>4 Shortage of teaching-aid tools and/or chemical supplies</td>
<td>‘<strong>KS:</strong> The second issue is a lack of IT instruments. It is a problem because <em>I can’t find IT stuff or spare parts from the local shops.</em> It’s not the same as the lack of materials that I use for conducting practical</td>
<td>Shortage of teaching-aid tools causes difficulty in conducting practical work</td>
<td>Inadequate teaching-aid tools</td>
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</table>
work because I can find those materials from the local shops."

‘PAM: We need a higher amount of IT equipment to assist science teaching. I think students need to practice an enquiry skill using this stuff. Even we have a computer and a projector in our school, those apparatus are not placed here, I mean not in classroom. Instead, they are in reading room. It shouldn’t be like that. Other important things are equipment and chemicals supply as well as particular budget that are allocated only to support teaching science at the secondary level.’

‘WS: I still can’t find any materials from local shops to be used as a replacement for scientific instrument. This can cause a Shortage of teaching-aid tools causes difficulty in conducting practical work

Shortage of teaching-aid tools causes difficulty because
<table>
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<tr>
<th>Difficulty in which students didn’t have a direct experience in conducting practical work. Moreover, it took several months to obtain some scientific apparatus, such as pre-fixed cell slides, after you have purchased them. ’</th>
<th>‘OC: It’s about money, in some cases. We didn’t get all of what we requested, and several pieces of existing equipment need to be repaired as well. Actually, we have ten of microscopes but half of them are not working right now. Some of the basic chemicals ran out and we still haven’t got any replacement.’</th>
<th>Shortage of teaching-aid tools causes difficulty in conducting practical work.</th>
<th>Inadequate teaching-aid tools</th>
</tr>
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<tbody>
<tr>
<td><strong>5 Lack of maintenance programme</strong></td>
<td>‘OC: It’s about money, in some cases. We didn’t get all of what we requested, and several pieces of existing equipment need to be repaired as well. Actually, we have 10 of</td>
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microscopes but *half of them are not working right now.* Some of basic chemicals were run out and still haven’t got any replacement.’

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<tr>
<th>6 Inappropriate budget prioritisation</th>
<th>‘NL: It’s about priority. I mean there are other things such as administrative related tasks or landscape improvement jobs that need money for support as well, and <em>the school principal seems to see those things are quite important.</em>’</th>
<th>Less emphasise on teaching of school principal</th>
<th>Inappropriate prioritisation of budget allocation/disbursing money</th>
</tr>
</thead>
</table>
| 7 Problem in disbursing money | ‘WD: There are chemicals which were kept on a shelf and have already expired. Some were not useable as their labels have disappeared. So I have to throw all those chemicals away and ordered replacements. However, *it took me 2 years to get a bottle of alcohol.*

*Researcher:* Huhh? What’s happened? | Poor administrative management in purchasing causes difficulty in conducting practical work | Inappropriate prioritisation of budget allocation/disbursing money |
<p>| | | |</p>
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<tr>
<td>WD: ‘That alcohol has to be bought together with the purchasing orders of general supplies from elementary and kindergarten departments. It’s about minimum order and the school’s management of budgets’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Excessive extra-curricular activities</td>
<td>‘RR: The first factor is  <em>activities which are not related to teaching</em>. Nowadays, those activities affect teaching because lesson periods are allotted specifically to carry out those activities. It causes less teaching time than normal’</td>
<td>Irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching.</td>
</tr>
<tr>
<td></td>
<td>‘BP: there are  <em>too many activities which were not related to teaching</em>. We wanted to teach according to our plan but we don’t have enough time to achieve it. Students’ IQ is another issue but time also matters. Sometimes, we have to do a lot of things within</td>
<td>Too much irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excessive assignment of extra-curricular activities</td>
</tr>
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171
a limit of time in order to let those activities run smoothly. We then compel students to have an extra tutorial class within school in order to prepare them for an exam.’

‘TM: I emphasise on lecturing; otherwise, I wouldn’t be able to finish lessons as I have planned. ⁸There are a lot of activities which are not related to teaching. If you compare the time you and the students spend on lessons and those activities, I’m very sure that you will see teachers and the students spend more time attending those activities than studying and teaching.’

‘UN: There is a problem when we have to participate in several events hosted by the local authority, for example provincial athletics game. ⁸My school has joined this event by teaching.

Too much irrelevant activities lead to reduced teaching time, and this causes difficulty in conducting science teaching.

Irrelevant activities lead to lessen teaching time, and this causes difficulty in conducting
sending students as athletes to participate in this game and also has to do a parade. This caused a reduction in lesson periods and it was difficult to ask the students to join extra tutorial class during weekdays because they had 8-9 lessons per day which was very tight for them.’

‘TN: It’s about time. Classroom timetables were fixed but, as you see, there are a lot of events and those events are conducted in inside or outside school. This causes less time for students to carry out practical works. Recently, officers from the ministry of health asked teachers to perform teeth inspection at school. Teachers have to join training in teeth inspection at a local health station, and other than the ministry of health, there are others government bodies who are asking teachers to science teaching.

Too much irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching.
join their campaign.’

‘PM: ‘There are a lot of extracurricular activities. Every local authorities in this areas aim to get supporting expenses. They then create various activities such as drug prevention training in order to get more supporting money from central government and also expect to gain more popularity among the local people (many of administrators of Sub-district Administration Organization are election campaigners of political party). Many times, the number of participants is smaller less than what the host has expected, so students are asked to join an event. This creates difficulties because I had planned lessons and assigned tasks but they can’t be accomplished because the lessons are interrupted.’

Too much irrelevant activities lead to reduced teaching time and this causes difficulty in conducting science teaching.
| Inappropriate timetable arrangement | 'RR: Students can’t concentrate on a science lesson that is taught after sports lesson. They look so tired and lose their attention. In some cases, students have to learn Mathematics followed by Science. I can notice that students don’t want to study anymore. There is too much information for them.' | 'UN: I don’t want students to change classroom every time each lesson ended. Students are likely to spend too much time walking to another classroom and enter the classroom quite late.' | Poor timetable management causes students lose attention in classroom as they feel tired from the previous lesson. | Poor timetable management allows students to accumulate undisciplined behaviour | Inappropriate classroom timetable arrangement |
2.8 Writing Up

After the analysis process, I wrote up the findings of the analysis. Within the findings chapter, an appropriate amount of extracted data that logically and concisely capture the prevalence of the themes is demonstrated. Therefore, these extracted data are easily recognised as illustrative of the theme or issue. In addition, the findings are reported in the form of analytic narrative that contains my reflections.

2.9 Trustworthiness

As outlined in the data collection section, the data were triangulated using multiple methods to ensure the trustworthiness of this study. Data obtained from the literature review and documentary research were used to develop the questions to be asked in the interviews and to revise the observation schedule. Results from the classroom observation and transcripts produced from the interviews were used to assess the validity of the data produced by the analysis of published sources. Therefore, the trustworthiness of this study was uplifted by the use of the triangulation technique. Piloting the observation schedule was also a strategy to enhance the reliability of this study. The semi-structured interviews were carefully managed, and questions were carefully generated to avoid leading questions. I used multiple participants from multiple participating schools to conduct this study. This is considered a factor that could help to ensure validity and dependability. Participants were asked to provide feedback, and transcripts of interviews were given to individual participants to check their accuracy. Repeated observation sessions in the same classrooms with the same teachers were performed, although not with all of the observed classrooms, as it is considered a strategy to obtain more reliable data. Furthermore, observing from the best position in the classroom eliminated possible factors that could otherwise hamper the observation.

As mentioned earlier, I also ensured the reliability and validity of the data obtained by undertaking a member checking strategy. Excerpts of conversations during teacher interviews were copied and sent to the corresponding teacher interviewees to allow the teacher interviewees to check whether I had precisely copied their words. Although I made the data available to the teacher interviewees to audit them, only two teachers replied and provided some feedback. The data
gathering process was carried out in Thai. Therefore, issues related to translation had to be regarded. To minimise bias caused by mistranslation, I managed to get someone familiar with both Thai and English to look over my translations.

2.10 Ethical Consideration

The participants of this study are teachers and students. Teacher participants in this study are able to self-consent. Therefore, direct consent was given by teacher participants. Student participants were not able to self-consent. Thus, consent was given by the teachers. The information sheet describing the aims of this study, data protection processes, the maintenance of confidentiality of the data produced, and the right of participants to withdraw from this study without any obligation were delivered to the individual participants prior to this study. Pseudonyms were used during the interviews and in the findings chapter. Agreement from participants that data collected may be passed to other researchers was also obtained. The report, including the interview transcripts, was sent to individual participants to ensure the accuracy of the transcription.

It is mandatory, according to the policy of the University of Manchester, for a researcher to obtain ethical approval before conducting any study/research involving human subjects to ensure the rights, well-being, safety, and dignity of participants and the researcher. Therefore, ethical issues that would apply in this study were addressed and the declaration of these issues was undertaken. First, a research risk assessment was performed to assess risk that may arise for participants and me when conducting this study. In addition, the outcome of the risk assessment helped to assess the degree of ethical review required. In this study, the participants are teachers and students, and the data gathering process was conducted in schools in Thailand, which is a country outside the European Union that is not listed on the Foreign and Commonwealth Office’s warning lists. Moreover, this study is a primary research that requires me to contact both teachers and students, who are underage, directly. The research questions of this study require enquiry about the professional practices of the participant teachers, and considering all the criteria described, this study was classified as ‘medium-risk’ research.
After the risk assessment, an ethical approval application describing the aims and objectives of this study, the methodology, details of the participants and recruitment processes, potential risks and precautions taken to minimise those risks, the process of obtaining consent, data protection and confidentiality strategies, and expected arrangements for reporting this study were submitted to the University Research Ethics Committee (UREC). Because this study was conducted overseas, key areas of potential risk and means to control those risks must be identified and submitted to the university. In addition, a criminal record clearance was also obtained because this study required me to work with children. Details of the procedures to obtain ethical clearance are available online at http://www.seed.manchester.ac.uk/medialibrary/Education/ethics/MIE_Ethical_Practice_Policy_and_Guidance_2013-14.pdf.

Ethical considerations helped me gather data with caution. I was reminded to avoid any actions that could harm or abuse either the participants or myself. Indeed, I expect the data obtained from this study to give rise to an academic publication. Hence, the participants were informed that the results of this study will be disseminated, and consent from the participants regarding this matter was obtained prior to the data gathering process.
CHAPTER 3
RESEARCH FINDINGS

This chapter explains an analysis of the qualitative data obtained from several methods. The first part will describe classroom observations data that were gathered in the science classrooms of secondary school students. Regarding this, the primary focus is how science teachers teach science in a classroom, and these data will be linked with the first research question. Although simple quantitative data (see Appendix 8) are not described, it can be used as evidence to support the explanation of an analysis of the qualitative data obtained from classroom observations.

The second part will show themes that emerged from semi-structure interviews with secondary science teachers. This summarises perceptions of the secondary science teachers on the changes happened after the reform was introduced and the difficulties that concerned them and were seen as obstacles that limited the effectiveness of implementation of the student-centred learning approach. These data will answer the second and the third research question.

The third part will offer themes that emerged from the focus group interviews with students in secondary level. This presents the students’ attitudes on several topics around learning science, and these data will help scrutinise how students are able to learn science.

3.1 Analysis of Science Classroom Observation

An observation tool used in this study has been developed from the Ofsted criteria. The Ofsted guidance is used for inspecting maintained schools which emphasise effective teachers’ planning and activities implementation as well as appropriate assessment and effective feedback (Ofsted, 2011, 2012). I extracted the main elements from the Ofsted criteria and divided them into 4 themes. Some key activities are added to represent the quality of teaching (Ofsted, 2011) and characteristics related to student-centred teaching (Bansberg, 2003; McCombs & Miller, 2007).
Prior to describing the findings that emerged from the science classroom observations, definitions, terms, and framework relating to concepts and criteria used to analyse the observation data will be established. These details include a concept of the student-centred earning approach, a concept of the traditional teaching approach, the so called ‘Teacher-Centred Learning Approach (TCL)’, as well as student-led and teacher-led activities. Apart from these details, other terms and definition that relate with the student-centred learning approach including concepts of several instructional approaches e.g. problem-based learning (PBL), enquiry-based learning (EBL), as well as formative assessment have been described in the literature review chapter.

A concept of the student-centred Learning has been implemented in many countries as it was seen as a way to increase students’ achievement and motivate students (Klenowski, 1995; O’Sullivan, 2004; Pedersen & Liu, 2003). The word ‘Student-Centred’ can be understood as ‘Learner-Centred’ as learner in a particular classroom is a student. The definition of ‘Student-Centred’ is then depicted as ‘Learner-Centred’.

(McCombs & Whisler, 1997, p.9) defined ‘Learner-Centred’ as the perspective that combines a focus on individual learners – their heredity, experiences, perspectives, backgrounds, talents, interests, capabilities and needs – with a focus on the best available knowledge about learning and how it occurs and about teaching practices that promote the highest levels of motivation, learning, and achievement for all learners.

The definition of student-centred learning that was applied to the secondary education also emphasised an involvement and a participation of learners, equality between learners, full responsibility for one’s own learning, learners’ prior knowledge and experiences, and the role of teacher as facilitator (Brandes & Ginnis, 1986).
An opposite concept to the student-centred learning approach is the Teacher-Centred Learning Approach. It is a traditional instruction that has been summarised by (Mascolo, 2009, p.4) as

The teacher is (a) the dominant leader who establishes and enforces rules in the classroom; (b) structures learning tasks and establishes the time and method for task completion; (c) states, explains and models for the lesson objectives and actively maintains student on-task involvement; (d) responds to students through direct, right/wrong feedback, uses prompts and cues, and, if necessary, provides correct answer; (e) asks primarily direct, recall-recognition questions and few inferential questions; (f) summarises frequently during and at the conclusion of a lesson; and (g) signals transition between lesson points and topic areas

Details and definitions described above can be used as a scheme to determine the extent of the implementation of the Teacher-Centred Learning approach in participating science classrooms. Activities that demonstrate the emphasis of teachers’ authority, dominant role of the teachers in science classroom as well as instructional methods that enable teacher-centred activities to be implemented were recorded. I used this as criteria to analyse data obtained from the observation schedule. Various incidents that occurred in individual science classrooms were extracted and categorised into 2 main topics including student-led activities and teacher-led activities. A student-led activity refers to an activity that relies on students’ decision, one in which students play a major role and more actively participate than teachers. Teachers are a facilitator and play a role in giving students guidance to accomplish various tasks. A teacher-led activity is an activity where the teacher is more active and students are more passive; they carry out tasks according to teachers’ directions, e.g. dictation or copying from notes teachers provided (Wellington, 2000).

In addition, I also analysed the effectiveness of practical work by using the analytical framework developed by Abrahams and Millar (2008). Following this framework, specific practical task and practical skills of students and their abilities to understand and make links between objects and ideas were assessed. Data obtained
from this analytical framework were expected to be used as information to review current practice in performing practical work. Moreover, the data obtained can be used for further design of practical work or activities that favour effective learning of students. Abrahams and Millar categorised the effectiveness into 2 levels, the ‘doing’ level (1) and the ‘learning’ level (2). Furthermore, each level was also divided into 2 domains including the domain of observables (o) and the domain of ideas (i). In total, there are 4 cells including level 1: o, level 1: i, level 2: o and level 2: i where each cell has indicators, for instance, Level 2: i is an ability of students to apply ideas to other situations. However, all of these 4 cells cannot be clearly distinguished as some tasks could be effective at both level 2: i and level 1: i (Abrahams & Millar, 2008).

3.2 Results from the Analysis of Science Classroom Observation Data

Data obtained from science classroom observations were brought to carefully extracted activities that represent the student-centred teaching (SCL) approach and the teacher-centred learning (TCL) approach (data shown in Appendix 8). After the extraction was finished, I then categorised the observed science classrooms into 3 types including 1) science classroom with a combination of SCL and TCL but with a tendency SCL, 2) science classroom with a combination of SCL and TCL but likely to be more TCL and 3) TCL

3.2.1 Combination of SCL and TCL with a Tendency towards SCL

This category describes the science teachers who implemented both SCL-based and TCL-based activities in their classrooms. However, the majority of total activities implemented were likely to lean towards student-centred orientation which values active participation of students as the heart of learning process; e.g., problem-based learning approach, asking open-ended questions. The teachers here acted as facilitators rather than dictators.

There were four teachers who demonstrated more student-centred orientation. Several approaches that represented student-centred modality were implemented
including enquiry-based learning, problem-based learning, and practical work. The teaching characteristics of each teacher will be described below.

1) Teacher (JP) is a middle-aged male teacher who had been a teacher for over 20 years. He obtained a bachelor’s degree in Education with specialisation in Agriculture. He had been a teacher in his school (KS) since the late 1990’s. In one of his lessons observed, the teacher asked students to allocate and group themselves into 3-4 groups. Unfortunately, there was not enough classroom space at that time, so he implemented a problem-based learning (PBL) approach and students were then asked to sit on the floor in front of a computer room. He implemented PBL approach as he postulated a situation where he was about to go on vacation and would have to leave home for 3 days but he had 2 flower pots to look after. He intended to use a watering machine to water the flowers but he needed students to help him design this machine. Students were asked to do this work in a group, all materials were provided. Before letting students do their work, the teacher guided students’ general ideas by writing a picture on a stand-up foldable whiteboard in order to design the machine; e.g., what should be used to hold water tubes. The teacher also asked students open-ended questions; e.g., what will happen when you punch two or more holes at the bottom of water reservoir? In addition, the teacher also asked students to work jointly. Moreover, in a different lesson but conducted in a proper classroom, the same teacher assigned students to do practical work in groups. He facilitated students’ activities by introducing the main ideas to students, then observed them closely, asked students to work jointly, gave students more explanations about experimental procedures, pointed out problems that can be emerged and asked group members to discuss how to avoid those problems. Most of the students seemed to focus on their assigned tasks, which they had discussed among group members from time to time. However, some students did not involve themselves in assigned tasks, but they finally got back on track when friends from the same group prompted them. Practical work lessons observed were likely to be more ‘teacher-led’ lessons as students carried out tasks following a direction and found out answers by
using ideas provided by the teacher. However, it was quite difficult to examine if students were able to establish the linkage between observations and ideas. Nevertheless, according to the analytical framework of Abrahams and Millar (2008) that considers the effectiveness of a practical task, this would be explained as 1:o in which students were able to follow the direction, carry out the tasks and were able to use an ammeter to read the magnitude of electric currents as the teacher intended. The teacher also gave students a lecture as he observed how they used an ammeter and provided an explanation of the basic principles of electric current.

2) Teacher (SK) is a male teacher in his early 30s who had been a teacher for almost 10 years, and he graduated with a Bachelor’s degree in Education with science specialisation. The classroom was a proper classroom that had 11 tables, 30 chairs, 2 book shelves and it also had two big equipment storage cabinets located at the back of the classroom. The teacher implemented enquiry-based teaching as he set out a learning project about the atmosphere and categorised it into 4 sub-topics including 1) classification of atmospheric layers, 2) relation of temperature and atmosphere, 3) relation of humidity and evaporation with atmosphere, 4) relation of pressure and height with atmosphere. He asked students to allocate themselves into 4 groups, and each group had to produce 3 pieces of work which were a brochure describing general information, a leaflet drawing some key facts, and a learning aid tool; for instance, quizzes or games. This activity was classified as a student-led activity as the teacher allowed students to choose sub-topics according to their interests and could be freely grouped with peers. Learning aid tools from each group were examined by peers from other groups who were allowed to ask questions and discuss such learning aid tools. During a period that students carried out the assignment, open-ended questions related to experiment results were asked to stimulate students’ critical thinking; e.g., why are pressure and height related? Most of the students seemed engaged with the assignments and interactions between the teacher and students as well as between group members were quite active. However, some students
showed off-task behaviours and the teacher called their name as a warning and asked them to get back to assigned tasks. At the end of the lesson, formative assessment was undertaken as the teacher asked students what kind of problems they had encountered and how they solved them. In another lesson observed, the teacher asked students to allocate and group themselves into 8-10 groups and each group must have both boy and girl members, and should work jointly. He gave students a lecture when he started the lesson in order to outline what students were going to learn, the principles, and necessary information. Subsequently, the teacher assigned students a practical group work on convex and concave lenses and what kind of images these lenses produce, and they had to subsequently present and discuss the results with their peers. However, students were instructed to strictly follow experiment directions. Open-ended questions that were used to stimulate critical thinking and problem solving skills, originated from problems that arose during the experiments. The teacher let students choose who they were going to work with. The teacher also provided books and necessary information; e.g., names of webpages and information sheet to facilitate students’ enquiry. Students were intended to practice critical thinking and problem solving skills through these tasks and it was mandatory for all students in a group to get involved in the practical work. Before the teacher let students do the task, he clarified the experimental directions step by step, using a whiteboard and asked students to follow the directions. It can be clearly seen that the teacher facilitated students in defining the main concepts of this practical work. For example, the teacher told students to use his drawing shown on the whiteboard as a starting idea for the characteristics of images given by the convex lens.

Again, the effectiveness of this practical task would be justified as 1:0 in which students undertook the practical work and used the starting idea given by teacher to discover a correct answer. Mind mapping was also a strategy the teacher used to help students conceptualise lesson contents. At the beginning of the lesson, the teacher usually asked students about what concepts and ideas students got from a previous lesson. At the end of a
lesson, the teacher asked about a connection between contents of the previous and contents of the current lesson and assigned students to do mind mapping. This teacher made use of open-ended questions to stimulate discussion and he also asked students to reflect on their own work. These strategies correspond with the requirements of assessment for learning that were suggested by (Black, Harrison, Lee, Marshall, & Wiliam, 2002).

3) The teacher (WD) is a 50-something female teacher and she was expecting to retire early in next 2 years. She graduated with a Bachelor’s degree in Education with science specialisation. However, she was assigned to teach outside her specialisation for more than 25 years and was just appointed to teach science 2 years ago. In her lessons observed, the teacher asked students to allocate and group themselves into 3-4 groups. In addition, the teacher asked group members to work jointly. The classroom was a proper classroom that had 6 tables, 18 chairs, and 3 equipment storage cabinets located at the back of the classroom. An illustration of enquiry-based learning project was a project that teacher (WD) asked students to design and construct a wind propeller by using papers and materials provided. In addition, the teacher reviewed the previous lesson which was about general ideas of wind in order to provide a foundation for this project. Although working in groups was seen as a general strategy to practice critical thinking skill, problem solving skill, and encourage sense of collaboration and individual accountability, nearly all group work observed were originated and directed by the teacher. Practical work was implemented in a lesson about light and colour. The teacher asked students to layer the different coloured cellophane papers to make white light when a torch was shone on them. The teacher provided coloured cellophanes and gave students a clue to make white light; for instance, the teacher explained that the combination of green light with blue and red light would give rise to white light. This can be clearly explained that the teacher guided students to complete the tasks. There were some noticeable off-task behaviour from students but most of the students seemed to focus on the assigned tasks, work collaboratively and an active discussion
with the teacher as well as among group members could be clearly observed. However, some students tried to speak with friends from a different group but I was not sure if they were off-tasks as their conversation could not be heard clearly. According to the analytical framework from Abrahams and Millar (2008), the effectiveness of this practical work would be justified as 1:o in which students carried out tasks according to the teacher’s command and produced data that corresponded to the teacher’s purpose.

4) The teacher (SP) is male teacher in his 20s. He graduated with a degree in Physics, and he had obtained a diploma in teaching. He was a tutor when he was an undergraduate student and became a teacher 2 years ago. The classroom was a proper classroom that had 7 tables, 28 chairs and 2 equipment storage cabinets located at the back of the classroom. In one of his lessons observed, the teacher asked the students to allocate and group themselves into 3-4 groups. A worksheet was used by the teacher (SP) to enable students to recognise ideas about genetics. The teacher asked the students to do the worksheet in groups and present answers and discuss actively in front of the class. In another lesson, the teacher asked the students to split into 3 groups and assigned them to do practical work on lens and mirror following the directions. In addition, the teachers also asked all group members to work jointly. The teacher observed each group of students closely and guided them to what type of image was given by different kinds of lens and mirrors. There were some noticeable off-task behaviour from students but most of them seemed to focus on the assigned tasks and a discussion among group members could be clearly observed. The teacher called their name and asked them to get back to the assigned tasks. The effectiveness of this practical work would be justified as 1:o, as students carried out the practical work with materials provided and followed the directions the teacher provided, and produced data according to the teacher’s directions.
Even though the students were asked to strictly follow the experiment directions, in some lessons the teachers showed an emphasis on students’ prior knowledge and experiences. The teachers went on and specified several main topics and let students freely choose what they wanted to do for their group work. In general, the students were assigned to work in groups to solve the problems and then present solutions or answers in front of the class. Equipment and necessary tools were also provided. Mind mapping was also seen by the teachers as an approach to help students sum up key ideas. In conclusion, all of the teachers emphasised on students’ experiences in doing practical works and encouraged learning through diverse teaching approaches. However, they still gave students a lecture or reviewed previous lessons in order to prepare the students for practical work.

3.2.2 Combination of SCL and TCL with a Tendency towards TCL

This category describes participant science teachers’ practices that exhibited both SCL-based and TCL-based activities. However, a majority of total activities implemented were likely to be created from teacher-based orientation.

There were three teachers with more teacher-centred orientation than student-centred orientation. From the observation data obtained, these teachers were likely to implement lecture and lesson revision at a higher frequency than the teachers whose lessons have been previously described. However, these observation data were obtained from different lessons and at different periods of time. Therefore, the amount of student-centred activity implemented may depend on the objectives of the particular lessons. Teaching characteristics of each teacher will be described below.

1) Teacher (KP) promoted critical thinking and problem solving skills to some degree, asking such open-ended questions as why we cannot see a rainbow at night. This can be considered a strategy to guide and facilitate students to discover new knowledge. However, the lessons observed were teacher-led learning as most of the incidences that occurred in the classrooms were directed by teachers. The students were also assigned an assignment in a form of observation tasks to observe the type and to identify morphology of cloud. Students conducted the tasks according to the information sheet provided. However, those tasks were not accomplished because there was no
cloud during the lesson. Teacher-centred activities were also clearly seen, as the teacher asked the students to listen to a review of previous lessons, a lecture and assigned students to read their handbook and copy the description of ‘electrical transmitter’. In addition, the teacher asked the students to take down dictation.

2) Individual work sheets, about force and direction of forces, were also provided to students, as this was seen by the teacher (WT) as a way to review students’ understanding of particular lesson contents. A review and a lecture were given in which the students needed to do some calculation before undertaking an individual worksheet. Therefore, these lessons observed were a teacher-led learning classroom. Practical work was also assigned to groups of students and the teacher mentioned that all group members should work jointly. However, a review of the previous lesson and a lecture were carried out prior to the practical work starts in order to informed students topic of the practical work. The teacher asked students to categorise chemicals provided, conceptualise the contents in a mind map and present their justification in front of the class. The effectiveness of this practical work can be justified as 1:0 because the students conducted practical work assigned by the teacher with materials provided and generated data to answer the questions posted by the teacher.

3) One teacher (RR) lectured and reviewed the lesson contents using games. The students were assigned into 3 groups and were asked to answer questions posed by the teachers, and present the answers together with processes to find those answers in front of the class. The group that gave a correct answer would score. The total scores of each group would be compared. Moreover, in another lesson, the teacher lectured and asked the students to do individual worksheets using books provided. There was no practical work observed in these lessons as it was close to the period of semester examination. However, these lessons were clearly identified as teacher-led learning classroom, as all activities in the classroom were originated by the teacher.
In general, group work can be demonstrated in different ways; i.e., games or completing worksheets in groups. After finishing their group work, the students were then assigned presentations. The students were allowed to choose a representative to give the presentation. Although the presentation was intended to help the students practice presentation skills and stimulate classroom discussion, not all of the students exhibited competence as their presentations looked as if they read their notes out loud. The teacher’s emphasis on students’ prior knowledge and experiences were presented by way of asking the students about their ideas on a topic of interest; e.g., an origin of cloud, usefulness of calcium hydroxide, or lime, in everyday lives. Mind mapping was also regarded as an approach to encourage the students to sum up concepts of the lesson content.

3.2.3 Teacher-Centred Learning (TCL)

The last category represents a group of participant science teachers whose teaching practices were likely to originate from traditional teaching practices which is called ‘teacher-centred’. With regard to this, almost all activities were dictated by the teachers. In addition, few of them assigned students to carry out group work in classrooms, which were considered student-centred activities. On the contrary, those teachers still played a major role in all of the classrooms as the students were expected to undertake activities according to directions from the teachers.

Five teachers used reviewing and lecturing as a main approach. Some of them assigned the students to watch a distance learning TV programme and take notes from the lesson shown. Some lessons were to review previous lessons or previous semester exams. Individual work sheets were also provided to the students and they had to present the answers at the last period of the lesson. Some lessons were spent completing the tasks that had been assigned. Although the group work approach was demonstrated in every lesson, all group works observed were to follow instruction with no interaction between the teachers and students, and students worked only on an assigned task individually. Discussion among group members could not be observed. Moreover, presentation in front of the classroom was an activity that was recognised by the teacher as the way to stimulate classroom
discussion. However, students still did not exhibit competency in presentation as they just read their hand written notes out loud. A limited amount of practical work was undertaken and all of them were teacher-led activities. The first practical work was about humidity and temperature and its correlation. The teacher asked the students to complete the task in groups, using wet bulb and dry bulb thermometer outside the classroom in order to obtain data from the atmosphere with the effect of heat from the sun. Another practical work was on heat convection in which the teacher asked the students to carry out the task by boiling water for 4-5 minutes and then adding potassium permanganate. Two of thermometers were fixed in a container that contains boiled water. One thermometer was fixed in a position with a glass bulb at the bottom of the container and another one was fixed with a glass bulb at the surface of the water. From the data described, it was clear that the students completed the tasks with materials provided, followed directions from the teachers and produced data that the teachers expected.

3.3 Analysis of Science Teachers Interviews

Key participants are secondary science teachers in schools located in Samutsongkram province. Some of them have been teaching for more than 10 years. However, not all of them taught science since an early stage of their career. Furthermore, there were also newly appointed science teachers participating in this study.

Questions asked were mainly related to their perceptions regarding the changes that have emerged from the implementation of the reform, difficulties they encountered as well as their opinions in regards to the current situation of Thai education. In addition, information relating to their educational background, motivations to become a teacher as well as their career paths were obtained.

The examples that demonstrate the process of theme analysis are shown in Tables 5-7 and these processes were applied with all themes generated. Results from the theme analysis can be divided into two main topics according to the perspectives: firstly on the reform and secondly on its implementation. They are described below.
3.3.1 Perspectives on the Reform

The first part of the analysis of science teacher interviews was based on the teachers’ responses to questions asked about their perceptions on the designated way of administration and management that had been put into action and on the factors influencing the success of the reform. Teachers’ comments about actions of policy makers and key actors who were involved or played a role in the reform were also considered. The teachers’ views on the role of parents and parental responsibility for children were also counted, as the quality of parenting had a direct influence over the quality of students which, as a consequence, helped facilitate the reform.

Teachers’ responses that emerged from the interviews with secondary school science teachers regarding their perception on the reform are categorised into four main themes, and examples of the responses are shown as follows:

3.3.1.1 Policy Failure

Issues about failure of education policies have been drawn out and are described below.

Inappropriate policies that did not correspond to the indigenous contexts and current social and economic conditions of Thailand were reflected as follows:

We (Thailand) didn’t position ourselves on our own context. We (Thailand) just copy (policies) from others. I think we should take it (other countries’ policies) only as a guideline because our context is different from others. For Thai children, we (Thai people) still need to keep eye on them as closely as possible because there is the decline of morality among people in the Thai society and this affects children directly. It is very easy for Thai children to be led astray because they have grown up in a way that they won’t be able to differentiate between right or wrong, and they don’t have a sense of abstention. Nowadays, the government has offered tablet for elementary students (Year 1 or Pratom 1) with an intention to enhance students’ learning with IT. It would be good for students if they use the tablet in an appropriate way.
In addition, the same interviewee clarified ‘an appropriate way’ as

It would be good if they could be able to set their own schedule and set priority. Teachers can be able to keep eye on them only when they are at schools but not at home.

An interviewee raised an issue concerning failure in policy development. In support of that, the interviewee stated that policy makers established the framework that was not applicable to every social and economic perspective of the entire country.

They (policy makers) didn’t consider the overall picture…policy makers set up policy from what they have seen around them which existed only in urban areas, how about actual circumstances that actually happen in rural areas, do they consider this?

Vision of the government and the ministry were also an issue as the interviewees mentioned that the government and the ministry did not consider the difference in learning abilities of students in urban and rural areas.

Previously, everyone was taught based on the same curriculum which originated from the ministry. Nowadays, every school has to develop an individualised school curriculum (which is adapted from the core curriculum). However, accomplishment of learning objectives from the national science curriculum is still mandatory. The problem is students were taught according to individualised school curriculum but they were tested using the national test. Do you think this is a good idea to mandate students to do the same test while they were taught in different conditions with different curriculum? Even though learning objectives...
are the same, in a school like this (SEO), we adapted school curriculum to be suitable for our students. But they were finally tested by O-NET.  

(Interview, science teacher KS from school BN)

The interviewee from a normal school (not a SEO) also saw that some government’s schemes or initiatives for improving Thai education did not solve actual problems, but rather possibly create another problem.

I think policy makers or the minister might think increasing students’ activities is the way to improve. If they found something missing, activities related with those missing items will be performed excessively. For example, if there is emergent information about a king in previous times whose name has disappeared or never been mentioned, the minister will set up a campaign to promote this new information. Then, schools have to respond to the campaign and every related department has also to set up an activity or lesson to promote this. The problem is, especially in small schools, as this school, there is only one social studies teacher and the campaign has increased that teachers’ workload. Then, other teachers with different specialization have to help the social studies teacher to lighten the workload. Do you think that is going to be successful? I think this is not a problem for large scale schools in city centres, but for my school, it’s a problem. Actually, the idea is great but it does not fit with my school’s context.  

(Interview, science teacher PM from school TS)

Sure, another thing is a policy to cut down the amount of homework. Personally, I think assignment or homework is a good strategy to help students review lessons as well as to draw their attention away from undesirable things, as they have to be at home to do homework.  

(Interview, science teacher KS from school BN)
Two teachers thought that key actors did not exhibit sincerity and determination in implementing the reform, but rather regard the political benefits that they will gain as their first concern.

Politics involves with everything. The government has launched a populist policy in order to get an increasing number of strongholds. The reform wasn’t a success because the government did not exhibit sincerity and determination to carry out the reform. I mean they aim to improve only the quality of schools but they didn’t emphasise on the quality of factors surrounding schools that could affect the students as well as families and teachers.

(Interview, science teacher and head of department NL from school LP)

Sure, the minister didn’t know anything about education and teaching. He is a politician and he got an assignment from the cabinet to become the minister, then what he did or what he has planned were based on the intention to get more votes for the next election. This affects the commission of the Sub-district Authority Organization (SAO) as SAO has to work for serving the political purposes (many of chief administrators of SAO are campaigners for the government party). Local budget has to be spent on activities that could gain more popularity of the government. For example, posters campaigning against drugs on sports days has to show the name of the politician as a supporter. Whilst an enormous amount of money was spent to create social activities and serve political purposes, the budget allocated for community development was less than expected.

(Interview, science teacher PM from school TS)

Interviewees also expressed their concerns related to the influence of politics over Thai education, as there have been frequent changes in the position of the minister of education due to the instability of the political situation.
There have been changes in policies and plans every time the reform was undertaken. In addition, when the minister was changed, the policies were also changed. It was not connected with previous ones.

(Interview, science teacher RR from school DJ)

I think politics has caused the instability of the cabinet. This leads to the lack of coherent policies. In addition, I think, we have an excess number of scholars and each group of them told a different story, and proposed different schemes, and the cabinet or education minister wanted to take all those schemes to be implemented! I think we can’t have the best of all those schemes. Why don’t choose only one to be fully implemented. It is possibly not the best practice but, at least, we did it earnestly. It might take us 6-7 years to see results but it should be better than to keep changing. If it’s not that successful, we could learn from failure. I don’t know if this is right but this is what I think.

(Interview, science teacher TR from school TS)

Government policies have changed according to politics and it keeps changing, changing and changing. If the minister’s position was changed, there must be something changed as well. (I think) it will be a different story

(Interview, science teacher JP from school KS)

The issue about political virtue and morality was also mentioned as an interviewee saw the government scheme/policy that favours corruption has affected the reform because a budget was spent without consideration of necessity.

I think it has sensible objectives but an issue that will be a problem is the implementation. Recently, I got a budget for 300,000 baht for purchasing scientific equipment. Do you believe that I can’t buy equipment that is necessary for a teaching? A list and specification of equipment have been fixed and also all purchasing processes must be finished within one
month otherwise the money will be recaptured! Companies who were selling equipment were coming from Bangkok to see me and want to join bidding. I told them that I got all of equipment in the list and I showed them my list. They said equipment I need were now out of stock. I felt like I was forced to buy those unnecessary equipment, despite the fact that those equipment were useless.  
(Interview, science teacher PM from school TS)

An interviewee expressed her concern about a complication in bringing policy into action as there was a mismatch between a master plan and designed practice.

Well, it’s partially improved. There are some contradictions; for example, the government has launched a campaign to help increasing students’ learning by allocating a tablet for every year 1 (Pratom 1) student. Obviously, a tablet doesn’t help improve writing skill but the policy has emphasised an evaluation of writing skill. Do you think that sound sensible?  
(Interview, science teacher WS from school KG)

Interviewees also expressed their worries regarding issues about the inexperience in actual teaching practices of policy makers and other related stakeholders. One interviewee saw that experience in actual teaching was crucial for policy makers.

Policy makers are at the top of an ivory tower and they are not the implementers, so they don’t have an idea about the actual problems, even though they did it with good will.  
(Interview, science teacher TM from school TS)
The problems have arisen because persons who design the science curriculum didn’t have teaching experience and they don’t know how to draft curriculum. (Interview, science teacher BP from school TR)

It is probably because of policies. The minister and policy makers have framed policies but it is too hard for schools and teachers to implement those policies. For example, year 2001 national science curriculum has given schools authority to arrange the order of contents to be taught within key stage (year 7-9 or Mattayom1-3). Then, a particular lesson will be taught in any level but within the same key stage. This was different between schools. Let me give you more examples. A lesson about the solar system was taught in the second semester of year 8 (Mattayom 2) in ‘school A’. Another school did lessons on the solar system as well but for the first semester of year 7 (Mattayom 1); let’s say it’s ‘school B’. If there is a student who currently studies in year 8 (Mattayom 2) in School A in the first semester and will leave for school B in the second semester, then this student will never study about the solar system because it was completed since year 7 (Mattayom 1) in school B. It has created a problem because teachers in school B can’t conduct an extra tutorial class only for one student. They can’t do anything but just let it go…and the current science curriculum (2008) is changed again to be the same as year 1990 science curriculum. I don’t understand why they keep changing. I’m really fed up with this. (Interview, science teacher WT from school LY)

Context or other intrinsic factors, such as students’ characteristics or students’ behaviour that do not favor the implementation of changes can be seen in a normal school. It seems these deterrent factors might be the consequences of an implementation of a particular government policy or scheme.
There are some students who can’t read even though they had passed elementary level (because of the implementation of ‘no zero policy’). Thai Language teachers have to arrange an extra tutorial class for those students. These tutorial classes have run smoothly only at the beginning but were stopped as students gradually disappeared because the students don’t really want to put the effort into the improvement of their weak point.

(Interview, science teacher OC from school SW)

Processes related to administrative and/or management tasks are still unreliable and not supportive, and an interviewee believed this was a result of the influence of politics over Thai education.

Of course, for example, quality of teaching-aid tools or equipment. Lists of equipment and specification are fixed beforehand even though their costs are more expensive than other equipment that I can adapt or find in a local shop. As you know, a hot plate is 7,000 baht each but its quality is worse than an electric saucepan which is only 990 baht, but I can’t buy the saucepan even though it’s usable. Finally, I only have one hot plate instead of 10 electric saucepans.

(Interview, science teacher SK from school DM)

The interviewees, as implementers, complained that they were not working in a school condition that enabled them to cope with the changes. In addition, supports for teachers to implement changes or the new policy were not fully provided. An example that reflected this issue is

I think we (Thailand) adopted the reform’s concepts from developed countries but our implementers, I means teachers and students, are still not ready. It is obvious in many rural schools that teachers have to carry out non-teaching jobs.

(Interview, science teacher RR from school DJ).
One young science teacher expressed her worry about teachers’ practice as she saw that the policy did not emphasise solving problems regarding the issues around the improvement of teachers’ practice.

When I was student, there was no one who couldn’t read or did not know how to do a simple calculation such as dividing, but what has happened now? There must be something wrong. If it is about incompetency of the teacher or a teacher who is not able to motivate students to learn. Shall we consider looking at the development of the professional teachers. Does it work well? How come students can’t read? These issues should be linked together.

(Interview, science teacher WS from school KG)

Another young science teacher acknowledged there was a lack of systematic evaluation and monitoring system after the implementation of the reform.

The reform has to be implemented by every stakeholder, and evaluation and monitoring systems are required. Many teachers were excited and keen to implement the new policies, but that was only at the beginning because they were not tracked or inspected literally. The inspector hasn’t turned up at school to inspect teachers’ practice but rather observed only documents which the school provided.

(Interview, science teacher RR from school DJ)

Experienced science teachers conceded that Thai education emphasised passing the national exam as the main objective for the study of science, rather than focusing on increasing the students’ critical thinking and scientific literacy.

Because the national tests emphasise only on scores, then we have to teach in a way that help students pass the minimum level and get as high a score as they can in the national test in order to get more chance to join high-ranking universities, but this does not correspond with the learning
objectives described in the science curriculum, as they didn’t examine students’ life skills.

(Interview, science teacher UN from school TW)

There is another point that I want to reflect. NIETS (National Institute of Educational Testing Service) has decreased the level of challenge in the national tests when a number of students got very low scores. I was wondering, should we have a standard for the national tests? Do we emphasis on higher exam scores rather than what students get from lessons in a classroom?

(Interview, science teacher and head of department NL from school LP)

Interviewees also indicated that tension was created due to teachers and school staffs having to spend an enormous amount of time, both inside and outside school periods, preparing documents for National Educational Standard and quality assessment processes.

Ohhh. Everyone doesn’t want to think about that. It makes us feel like we are watched attentively for a mistake.

(Interview, science teacher SN from school LP)

The ministry should build teachers’ morale by letting us work joyfully and lessen pressure from document-based evaluation system. Actually, it’s a good thing but it creates an emotional tension. Teachers previously spent time after school hours coaching students about morality and disciplines, but teachers are not able to do that anymore because they have other missions to accomplish which is the preparation for the evaluation processes.

The same interviewee also reflected opinions of her colleagues regarding this issue:

It’s too much and this has driven many teachers to apply for an early retire scheme. They can’t take it anymore. I know because I had spoken
with many of them. They had been teaching with high spirits but not anymore
(Interview, science teacher PAM from school LP)

3.3.1.2 Social/Economic Failure

Several issues around social and/or economic failure were drawn out and are described below.

Deterioration of current social and economic circumstances which massively influenced Thai education seemed to be of more concern to the interviewees.

I think, there has been no change...Stick with the same old textbooks and no accountability from parents. I can understand that this situation (no accountability) has happened because of an economic reason. Parents have to work very hard and leave their child with grandparents, and of course, grandparents are not able to monitor children’s behaviour closely due to the age gap between the generations. From what I observed, children whose parents stay together are not likely to exhibit unpleasant behavior. They pay attention to lessons and usually accomplish assigned tasks. In contrast, children who have separated families usually exhibit unpleasant behaviour.
(Interview, science teacher BY from school TS)

Yes, especially family. From my experiences, students from complete and warm, close-knit families are likely to behave in a good way. They have good discipline and focus within lessons. In contrast, students from broken families are not inspired to learn. Someone (student) said to me ‘no point to study; it’s worthless’.
(Interview, science teacher BP from school TR)

The living conditions surrounding children are very important. If children are living in a good environment, I think they will grow up with quality. A Problem that is frequently found in schools like this (SEO) is teenage pregnancy. This problem has existed since the previous
generation, I mean their parents. There is a student who was born when her mother was only fifteen years old, and her mother and father have separated. When the family unit isn’t strong enough, many social problems may arise, for example, drugs, teenage pregnancy, and these can be obstacles that prevent Thai education from being improved. 

(Interview, science teacher KP from school WP)

There are many students whose parents are farmers or factory workers. The parents leave home for work very early in the morning and come back home very late in order to get extra income from overtime work hours. Then, the parents will have less opportunity to meet their children, and they don’t have any idea if their children go to school or just leave home with the uniform on but are absent from school. Moreover, when school is over, the children will not be observed or monitored by teachers. Then, they will possibly spend time with friends, and no one can observe their behaviour. This can lead to many problems including drugs, premature sex and teenage pregnancy, and many more problems.

(Interview, science teacher KS from school BN)

I think regression in social and economic states of Thailand has let many undesirable consequences happen. Materialisation has affected the students’ perception, so they don’t realise the real benefit of studying. They just want to finish school at the mandatory level and get a job in order to get money to buy smart phones or other gadgets and it’s even worse when they do the work without moral consideration. They don’t have any ideas about their future career, and they just want to have a lot of money to heighten their social status. The government doesn’t have an intention to solve social problems. This is reflected in the social and economic conditions which are not improved to facilitate students’ learning. Thai media still don’t play a role in improvement of Thai education but the other way round.

(Interview, science teacher and head of department NL from school LP)
I think social factors do influence the reforms. Nowadays, people tend to be more selfish as they are pressured from many difficulties surrounding them. Previously, Thailand’s economy was based on agriculture. We could earn a living without any high academic qualification. Today, studying in a school seems not enough because it’s very highly competitive to get a position in a high-ranking university. Extra tuition then becomes a must, and of course, it’s not free. Students whose parents are be able to afford these expenses will have an advantage over others. The truth is the other parents want an opportunity for their children to take extra tutorial as well. Thus, they have to work very hard in order to earn more money to pay for the extra tuition. This leads parents to spend less time with their children and let school look after their children solely.

(Interview, science teacher PM from school TS)

Economy of families can also be an issue, as students from low social and economic families tend to spend time helping their parents work, resulting in their sometimes not being able to attend a lesson, do homework or lose focus on a lesson due to extensive working periods.

From my experiences, income of low social and economic families is very low and students have to pay contribution to this by doing a part-time job in order to gain more money to support their families. Sometimes, the students have to work at night to help their parents prepare stuff for a street stall which will be opened from 4 AM. This leads to the students not being able to concentrate on lessons due to tiredness from the lack of sleep. There are also some students who spend time during weekends or after school hours working in order to get an extra income.

(Interview, science teacher RR from school DJ)
Separated families is another factor that an interviewee pointed out that has direct impact on students’ behaviour and achievement.

Parents is another factor. I can guarantee that 90% of the students here have a separated family. They live either with mom or dad or neither. I know it because I’m also working on student records. I know who is living with either mom or dad or not living with parents. Two out of 11 students in this class have their parents living together. The rest are living with grandparents. Their parents’ marriages were broken. Dads have new girlfriends and moms also have new boyfriends. Parents left them with grandparents....I went to their homes because those students didn’t turn up at school, but their grandparents told me they saw their grandchild leave home in uniform. 

(Interview, science teacher and head teacher SN from school DD)

An interviewee addressed existing inequity in gaining experiences from attending an extra-tutorial lesson between students who live in distant areas and students who live in urban areas.

I think economic status affects students’ learning opportunities. I can guarantee that 100% of the students from this school are not able to take extra tutorial classes outside school because their parents can’t afford the extra costs. Someone said this kind of tutorial class is not necessary but a lot of students take this extra tutorial class and get a place in high-ranking universities, and I think students who join international physics Olympiads are also taking extra tutorials. Taking an extra tutorial class is not forbidden in this country. If parents can support it, no one can blame them. In addition, it’s better for students if their parents can buy them computers. They can use computer to support the learning, but most of all, it has to be guided by parents. These reflect the importance of economic status of families, and, of course, the gap between students in the cities and outside the cities has widened.

(Interview, science teacher TR from school TS)
3.3.1.3 Teacher/School-Related Factors

Issues related to implementers can be extracted and are described as follows. However, what interviewees mainly mentioned was related to teachers’ practice.

An interviewee stated from her observation that the school principal or school leader did not give serious consideration to implement changes. This was reflected in the conversation regarding displeasure in assigned workload.

It’s quite embarrassing because (I think) the principal didn’t realise the importance of teaching within specialization and the appropriate amount of teachers’ workload. The reform will not succeed as long as teachers have to do non-teaching jobs as well as teaching outside their specialization.

The same interviewee also gave further clarification by providing examples of situation that explain her observation.

Let me give you an example. Two months ago, a grocer came to school to drop off food stuff for the free luncheon project while I was teaching. At that time, I was a purchaser, and that was my responsibility to check the quality of food stuff purchased. So the class was paused, and I had to go and inspect and finish all purchasing processes. In addition, this didn’t happen only once but many times…recently, my school has many teachers who retired early but hasn’t recruited any replacement of teachers yet. This caused an increasing workload on existing teachers because there were not enough teachers while the lesson timetable still remained the same, and I think every school (SEO) has the same problem.

(Interview, science teacher and head of department WD from school KK)

However, an interviewee saw teachers, themselves, as a weak point. Regarding this, the interviewee saw that teachers did not dedicate enough of their time and efforts in implementing the student-centred learning approach.
There are some teachers whose major considerations were money and academic position, and then they keep producing their portfolio. Actually, it would be great to produce quality works and give benefits to students, but, in fact, those teachers didn’t bring their works to implement in the classroom and the time they spent in doing their portfolios, sometimes, interfered with teaching periods.

(Interview, science teacher TM from school TS)

Another issue relating to teachers themselves as a weak point is an unpreparedness as well as idleness of the teachers.

There are teachers who resist changing. They are sticking with what they did or their preferences. They feel comfortable to lecture only.

(Interview, science teacher RR from school DJ)

I think the first one who has failed is the teachers because teachers in this generation became teachers without a determination. It’s hard to find one who really wants to be a teacher with strong devotion, a teacher who considers the students’ livelihood and considers how to cultivate discipline and morality into students.

(Interview, science teacher and head of department JP from school KS)

### 3.3.1.4 Parental Attitudes and Understanding

Family and environment can influence quality of students, as several issues around these factors were raised by interviewees and are described below.

Some interviewees saw that a poor education background and attitude of parents make them unable to guide and/or command their children to be disciplined as well as unable to monitor and/or determine their children’s talents or abilities in learning.
Students who have a good background are usually disciplined and yearn to learn. Their parents look ahead and supervise their children on further education as well as career path. In contrast, uneducated parents are likely to leave these missions only to teachers and wait until their children finish compulsory education and leave school for work in order to support the families.

(Interview, science teacher PAM from school LP)

I asked one of them what will you be if your parents passed away, and he said ‘I then live with my brother’ (because he finished school and will get a job), and his mother said ‘I can't force him. Would you (the teacher) please force him to go to school?’ There is another student whose home I visited to discuss his absence. His mom said ‘if I force him, he won’t go to school but may take drugs’. I then ask where he is now and the mom said ‘they would be at the temple playing with his friends because the temple is not far from here (his house)’. At that time, a question popped up in my head –‘Are you sure your son will not be away from the temple?’

(Interview, science teacher OC from school SW)

Some interviewees also described the lack of control or monitoring system from parents in students’ after-school activities.

Today is another story. Parents are away working in Bangkok or other towns. Some leave their children with grandparents but some don’t. They are off to work early in the morning and leave daily expenses for their children on the dining table, and they come home again at bedtime. The problem has arisen because the children don’t see anyone at home when they come home. Then, there is a tendency for children to spend time outside home with friends, computer games, etc., and then the closeness between parents and their children has decreased or disappeared.

(Interview, science teacher WT from school LY)
When their children are back home, they just let the children have dinner and watch TV, that’s it. Parents don’t ask if their children have finished their homework. So there’s no opportunity for the students to review lessons, and it’s even worse if the students didn’t focus on the lessons while they were in the classroom.

(Interview, science teacher PY from school KS)

3.3.2 Perspectives on Implementation

This theme was analysed based on teachers’ responses to the questions relating to difficulties they encountered during implementing the student-centred learning approach. This includes factors they saw that would affect their practices, both directly and indirectly, as well as other teachers’ practice that they saw would have negative impact on the implementation of the student-centred learning approach.

Below are examples of conversations which reflected participants’ perceptions and experiences on the implementation of the SCL approach. They can be categorised into four main themes as follows.

3.3.2.1 Issues Related to School Organisation and Management

Issues about school organization and management have been drawn out and are described below.

Shortage in human resources produced many undesirable consequences, as many of the teacher participants stated that their difficulties in implementing SCL emerged from the inadequate number of teachers and administration personnel and that they had to do non-teaching jobs, for instance, purchasing school’s equipment. In addition, there was an interviewee who had to teach a non-science subject. Furthermore, there was a continuously increasing number of teachers retiring early without adequate replacement teachers. This caused an increase in the teachers’ workload.
I can teach anyway, but the thing I hate most is (point at a pile of documents on her table in front of a classroom). I have to come here (school) on weekends to do these things instead of writing a lesson plan!
(Interview, science teacher WT from school LY)

I also have to teach Chemistry for the upper secondary level, apart from teaching science for the lower secondary level. I, then, have to plan lessons for this semester and also for the next semester, which will be used in all those levels. This causes me trouble, as I can’t finish preparing lessons beforehand because I have to prepare 3 different lessons which will be taught in one day.
(Interview, science teacher BY from school TS)

I’m actually a science teacher but I have to teach Buddhist Studies as well because we don’t have enough teachers. I then have to spend even more time preparing Buddhism lessons. Sometimes I had information overload and it made me very exhausted.
(Interview, science teacher RR from school DJ)

When I was in the previous school (she had been teaching here for 1 month), there was a problem over there about a shortage of teachers and administration personnel because many teachers applied for an early retirement scheme. There were no replacement positions for teachers who left schools early, I as the youngest teacher, had to do many tasks which are not related to teaching. I was barely teaching at that time.
(Interview, science teacher KS from school BN)

I really wanted to do it (a lesson plan) but I don’t have time. It’s actually very good to do it according to what we learnt from the teacher training school. You have to understand the curriculum, you have to plan a lesson, and you have to prepare materials for activities in the classroom.
However, I’ve got too many classes that I have to teach, then there is no time left for sitting down and doing a lesson plan, but at least, I still have some spare time to read a textbook before I go to bed because I’m single. Let’s imagine others who have children and husband or wife. I’m sure that they have to spend time with families or teach their children some homework.

(Interview, science teacher PY from school KS)

Interviewees also expressed their worries regarding inadequate teaching-aid tools; e.g., computers and projectors as well as laboratory equipment and chemicals. Furthermore, appropriate maintenance programmes for existing equipment were also omitted.

We need more IT equipment to assist science teaching. I think students need to practice an enquiry skill using this stuff. Even we have a computer and a projector in our school, those apparatuses are not placed here, I mean not in classroom. Instead, they are in the reading room. It shouldn’t be like that. Other important things are equipment and chemicals supplies as well as particular budgets that are allocated only to support teaching science at the secondary level.

(Interview, science teacher PAM from school LY)

I still can’t find any materials from local shops to be used as a replacement for scientific instrument. This can cause a difficulty in which students didn’t have direct experience in conducting practical work. Moreover, it took several months to obtain some scientific apparatus, such as pre-fixed cell slides, after you have purchased them.

(Interview, science teacher WS from school KG)

It’s about money, in some cases. We didn’t get all of what we requested, and several pieces of existing equipment need to be repaired as well. Actually, we have ten microscopes but half of them are not working right
now. Some of the basic chemicals ran out and we still haven’t got any replacement.
(Interview, science teacher OC from school SW)

The second issue is a lack of IT instruments. It is a problem because I can’t find IT stuff or spare parts from the local shops. It’s not the same as the lack of materials that I use for conducting practical work because I can find those materials from the local shops.
(Interview, science teacher KS from school BN)

Some interviewees saw inappropriate prioritisation of budget allocation of school principals, and problems in disbursing money to purchase equipment or chemicals also caused difficulty in implementing SCL.

It’s about priority. I mean there are other things such as administrative related tasks or landscape improvement jobs that need money for support as well, and the school principal seems to see that those things are quite important.
(Interview, science teacher and head of department NL from school LP)

There are chemicals which were kept on a shelf and have already expired. Some are not usable as their labels have disappeared. So I have to throw all those chemicals away and order replacements. However, it took me 2 years to get a bottle of alcohol.

The same interviewee gave further clarification regarding difficulty in obtaining the chemical supply;
That alcohol has to be bought together with the purchasing orders of general supplies from elementary and kindergarten departments. It’s about minimum order and the school’s management of budgets.
(Interview, science teacher and head of department WD from school KK)
Limitation in implementation of SCL was also extra-curricular activities which were excessively assigned by school principals, resulting in less mandatory lesson periods.

There are too many activities which were not related to teaching. We wanted to teach according to our plan but we don’t have enough time to achieve it. Students’ IQ is another issue but time also matters. Sometimes, we have to do a lot of things within a limit of time in order to let those activities run smoothly. We then compel students to have an extra tutorial class within school in order to prepare them for an exam.

(Interview, science teacher and head of department BP from school TR)

The first factor is activities which are not related to teaching. Nowadays, those activities affect teaching because lesson periods are allotted specifically to carry out those activities. It causes less teaching time than normal.

(Interview, science teacher RR from school DJ)

I emphasise on lecturing; otherwise, I wouldn’t be able to finish lessons as I have planned. There are a lot of activities which are not related to teaching. If you compare the time you and the students spend on lessons and those activities, I’m very sure that you will see teachers and students spend more time attending those activities than studying and teaching.

(Interview, science teacher TM from school TS)

There is a problem when we have to participate in several events hosted by the local authority; for example provincial athletics game. My school joined this event by sending students as athletes to participate in this game and they also had to do a parade. This caused a reduction in lesson periods and it was difficult to ask the students to join extra tutorial class during weekdays because they had 8-9 lessons per day which was very tough for them.

(Interview, science teacher UN from school TW)
It’s about time. Classroom timetables were fixed but, as you see, there are a lot of events and those events are conducted inside or outside school. This causes less time for students to carry out practical works. Recently, officers from the Ministry of Health asked teachers to perform teeth inspection at school. Teachers have to join the training for teeth inspection at a local health station, and other than the ministry of health, there are other government bodies who are asking teachers to join their campaign.

(Interview, science teacher and head department TN from school BN)

There are a lot of extracurricular activities. Every local authority in this area aims to get supporting expenses. They then create various activities such as drug prevention training in order to get more supporting money from central government and expect to gain more popularity among the local people (many of administrators of Sub-district Administration Organization are election campaigners of political parties). Many times, the number of participants is smaller less than what the host has expected, so students are asked to join an event. This creates difficulties because I had planned lessons and assigned tasks but they can’t be accomplished because the lessons are interrupted.

(Interview, science teacher PM from school TS)

Inappropriate classroom timetable arrangement was regarded by interviewees as something that would have an impact on student’s readiness.

Students can’t concentrate on science lessons taught after sports lessons. They look exhausted and lose their attention. In some cases, students have to learn Mathematics followed by Science. I can notice that students don’t want to study anymore. There is too much information for them.

(Interview, science teacher RR from school DJ)
I don’t want students to change classroom every time each lesson ends. Students are likely to spend too much time walking to another classroom and enter the classroom quite late.

(Interview, science teacher UN from school TW)

The examples that demonstrate the process of generating these themes are shown in Tables 5-7.

3.3.2.2 Issues Related to Teachers

Issues about teacher can be extracted and are described as follows:

Some teacher interviewees pointed out that some teachers, especially those with long term teaching experiences are strongly attached to their preferred teaching strategy and resist or fear to change.

I think teachers fear changes (to use SCL approach as the main approach). They feel unhappy to implement it and are still attached to the same old teaching style. That’s why we don’t see that much change.

(Interview, science teacher BY from school TS)

Teachers with no specialisation in science can be a factor that causes difficulties to teachers in implementing the SCL approach.

That is very difficult for a teacher who does not specialise in Science like me. Science curriculum contents were updated and rearranged and I have to deal with this alone because I’m the only one Science teacher (at that time). I had to prepare lesson for students from all of the secondary level (year 7-9 or Mattayom 1-3) while science teachers in large-scaled schools (most of which specialise in Science) prepare lesson for only one time because they teach only one specific level. It has given me a really
hard time, not only because of the workload but also the difficulty in not being specialised in science.

(Interview, science teacher and head of department SN from school DD)

Yes. It’s necessary for teachers to teach according to their specialisation. This reflects my experiences when I was assigned to teach chemistry to upper secondary students. That was a mess. I’m able to teach chemistry only for lower secondary students and I felt stupid when I had to teach chemical equations to high school students which are more complicated than basic chemical equations for the lower secondary school level.

(Interview, science teacher and head of department OC from school SW)

An interviewee thought that the personal attitude of teachers toward teaching could also cause a difficulty in implementing SCL, as she noticed some teachers did not prioritise students’ benefits.

Child-centred teaching requires good support in equipment as well as qualified teachers with strong devotion. However, I think we don’t have many of this kind of teachers. Some of them still have no idea what good science teaching is.

(Interview, science teacher and head of department NL from school LP)

3.3.2.3 Issues Related to Students

Although examples of teachers’ responses, which are described below, were related to characteristics and unpleasant behaviours of students that caused difficulties in implementing SCL, all of those characteristics and behaviours of students seemed to be outcomes of teacher’s malpractices and complete control over their children by authoritarian parents.

Some interviewees saw that students who had limited or low level necessary skills, including reading and numerical literacy as well as scientific investigation and critical thinking skills, were a factor that created a difficulty in implementing SCL.
I think the problem is with the students. They don’t have skills. I mean they didn’t regularly practice logical thinking skills and critical thinking skills with elementary teachers. They are here at the secondary level with no idea about those necessary skills.

(Interview, science teacher and head of department SK from school DM)

Students don’t have a logical thinking system. I think it should be cultivated from the first year of schooling. I mean proceeding gradually. It seems that they haven’t practiced this skill until they are here, at the secondary level. Then, I’m supposed to start developing students’ logical thinking skill.

The same interviewee gave further explanation regarding issue as I mean logical thinking and critical thinking skills and other necessary skills. The issue is students haven’t had a chance to do group work and practice presentation with confidence until they are at the secondary level. It is very difficult for me to assign them group work and also difficult for them to complete an assigned task.

(Interview, science teacher and head of department SN from school DD)

An interviewee stated that there are students who lost their opportunity to study because they had to get married at a very young age (14 years old) according to their parents’ religious beliefs.

30% of students in this school are Muslims and they have many rules and regulation to follow. They have to join religious school at 4.30 PM every day. So they will get exhausted from studying for too long a period. These students are quite rebellious because rules and regulations applied in religious school are far stricter than in a normal school. They feel stressed and don’t want to be forced anymore. Some Muslim students left and broke away from schools. Some got pregnant. As I know, there are some Muslim students whose parents forced to get married even though they are just 14 years old.
An interviewee saw that parents made their children strictly follow their orders and directions. Therefore, the children did not have an opportunity to think critically or solve a problem by themselves.

(I use) both TCL and SCL because Thai students are not trained to think logically and critically. Actually, thinking processes should be cultivated by parents when students are at home as well. I’ve seen that many parents still keep commanding their children or never let their children make a decision or think for themselves. They even button up a shirt for their children.

(Interview, science teacher and head of department SK from school DM)

Several interviewees also described that students lacked motivation to study science (and maybe other subjects as well) as they did not realise the importance and benefits of learning science.

Students in those schools (large scale and well known schools) are willing to learn. They pay attention and put the effort into learning in the classroom. Students in this school are not like that. They do not want to go to school. They do not come to school of their own free will and sometimes teachers have to track them at home because they don’t turn up. These students couldn’t pass an entrance exam of other schools and they are not willing to study. Basically, they are forced to go to school.

(Interview, science teacher and head of department OC from school SW)

Another problem is that students who live in a farm or paddy field like this have no ambition. They don’t want to know anything, don’t want to study and don’t want to join in any activity; they just come to school and sit. I feel like they don’t have inspiration. No one can be their role model. There aren’t many alumni who can attend high-ranking universities.
Some of the students said to me ‘no point to study as I will end up being a farmer’, albeit they are quite wealthy. They think they don’t need to study because they have to carry on the families’ farms anyway.

(Interview, science teacher TM from school TS)

I think the shortage of equipment would have an impact in some extent, and another factor which is quite important is students themselves. They just aim to finish school without any intention to make their performance great, and that’s it. The idea about further study is not in their head. Some of them are quite intelligent but they have no motivation. They really want to spend time with friends and play computer games.

(Interview, science teacher KP from school WP)

Students’ behaviour including laziness, truancy and delinquency were factors that impeded the implementation of SCL approach. The students were not interested in doing homework or assignments by themselves but, potentially, would rather copy from friends who had done homework or assignments from home.

Students are also important. Some students can’t recognise what I just taught them an hour ago; they can’t remember. I wonder what’s wrong with them. I try to repeat what I just said and spent many hours to get them to understand. I then think that it’s also about readiness of students. One student listens to what I told her/him while another student keeps chatting with others, and some students are likely to skip class. I would rather ask them to come to see me after class and discuss their difficulties or things that bother them. I think effective teaching requires all students to get along together.

(Interview, science teacher WS from school KG)

Children are at the centre, but the truth is not like that. Most students don’t want to participate. I, as a teacher, have to stimulate them all the time. I actually want to give them a worksheet and information sheet and let them see the overview by themselves, but the truth is they don’t even
take a look at those worksheets. I have to command them to read those worksheets. I personally think that it would be better to teach students one by one because when students are grouped together, they don’t care what I asked them to do, but it’s impossible to teach student one by one in a classroom anyway.

(Interview, science teacher and head teacher SN from school DD)

Some students don’t like to think and solve a challenging task. They just leave a sheet blank. There is no attempt at all. So I only assign them basic and easy tasks such as simple calculations. If you assign them a task that does not require an enquiry skill, they usually do it well. In contrast, if you assign a task that they have to think a lot and gather data. They are not willing to do so. They prefer to learn passively.

(Interview, science teacher and head teacher UN from school TW)

It’s about delinquency of students. For example, at the end of each lesson, I usually give them a take-home message relevant to the lesson and ask them to think about it and come back to discuss this again in the next lesson, but it seems this strategy is not really working. They come back to the next lesson with nothing.

(Interview, science teacher SP from school DD)

Students with low learning ability who lost their hope and got frustrated were also seen as an issue.

Another difficulty is that students can’t read properly. It’s partially because of parents. Parents whose children have low learning ability (learning disabilities) symptoms keep emphasising to everyone that their children has a problem in learning. This causes children to lose their confidence and self-esteem and in turn avoid studying.

(Interview, science teacher KG from school BN)
Students feel frustrated, and then quit school. Currently, there is one student who quit school because he can’t bear studying. However, if he keeps coming to school, I think everyone is ready to support him. (Interview, science teacher and head teacher JP from school KS)

The issue about students who cannot concentrate for a whole lesson was also raised.

I want my students to be able to learn from practical works. Hands-on experiences could help them with this. It is quite difficult for students in School of Expanded Opportunity to understand theory or principle. They are not interested or do not respond to what I tell them, and then the best way is to make them do practical tasks by themselves. (Interview, science teacher PY from school KS)

3.3.2.4 Issues Related to Families

Issues about parents have been extracted and are described below.

Parents neglected to supervise and monitor their children’s behaviour. They did not realise they had these major roles to play, apart from providing means for living; e.g., house, food and money. Presumably, they leave these missions (supervising and monitoring) solely to school. This causes a difficulty in implementing SCL because effective SCL classroom requires students to actively engage with lessons and to think critically and logically, and the interviewees saw that those abilities needed to be practiced at home with close monitoring from parents as well.

Actually, it should be practiced when the children are at home with family. Parents are their first teachers, but now parents no longer stay with their children because parents come back home at bedtime and go off to work before their children get up. This is the reason why children feel lonely, as their parents are not there for them and they haven’t felt warmth. They get money and spend it on whatever they want. Therefore,
they lack an opportunity to think logically and critically. Teachers are with students for only six hours a day, so parents must be take care of their children. Parents shouldn’t leave this duty solely with teachers. (Interview, science teacher and head teacher BP from school TR)

Parents don’t support student to develop enquiry skill; I don’t know why. It is probably because the parents didn’t recognise that they could play a role in developing this skill for their children. It’s even worse that some students are neglected by their parents and also there are some students who have to help parent work.

(Interview, science teacher and head teacher JP from school KS)

3.3.2.5 Other Factors

Other factors that caused concern for the science teachers have been drawn out and are described below.

The science curriculum contained too many contents and expected outcomes, and these were difficult to achieve, and also limited students’ opportunity to develop critical thinking.

We have testing process and its time frame is about 20 weeks, but within 20 weeks, we have to finish teaching for all learning objectives. I think SCL needs a greater amount of time. More lesson time is also needed for allowing students to have discussion but several limitations are still there, including time frame, learning objectives and national tests. All of these factors could prevent the success of SCL implementation.

(Interview, science teacher and head teacher TR from school TS)

SCL requires time but the science curriculum has too much content. It’s too tight. I’m sure that I can’t finish teaching all of the lessons.

(Interview, science teacher and head teacher UN from school TW)
The science curriculum contents were too difficult for students who lived in remote areas as they were less prepared in learning than students who lived in urban areas.

Science curriculum contents are too difficult for students. Sometimes, science classroom needs multimedia such as internet as a teaching-aid tool.

(Interview, science teacher BY from school TS)

3.4 Analysis of Student Focus Group Interviews

Key participants are thirty groups of junior secondary school students from ten different schools located in Samutsongkhram province. The students studied science as a core subject and each group consisted of four to five students. All of them were asked to discuss and share opinions regarding to topics relating to learning science in the classroom.

Students’ responses that emerged from student focus group interviews have been grouped into eight themes and examples of the responses are shown below.

3.4.1 Students’ Attitudes on Learning/Studying Science and its Importance or Usefulness

This discussion topic was raised in order to examine students’ perception on the rationale of studying science as well as their justification towards an importance of studying/learning science. The interview questions were relevant to their views on why science was important, how science benefited them and why they had to study science.

It was not surprising that the students said that learning science was for proceeding to further studies and getting a job in an industrial sector.

I think science can be used as basic knowledge for students to learn other subjects, for example, health education.

(Year 7 student from school DD)
Because science is a main subject that is included in a national exam. Then science is important for further studies. (Year 7 student from school DD)

For our future...I mean for further studies and to get a good job. (Year 8 student from school DJ)

I think...it can benefit our future careers... (such as) knowledge about electrics is required for an electrician who has to fix and maintain electrical appliances. (Year 9 student from school WP)

I think science can be used as basic knowledge for further studies. (Year 9 student from school WP)

Students said that knowledge obtained from learning science could be used in real life especially knowledge related to their livelihood.

Because knowledge obtained can be used in daily lives. (Year 7 student from school TS)

Two year 7 (Mattayom 1) students from the same school gave an example regarding knowledge they gained from learning science.

Student 1: Action force and action-reaction pair
Student 2: Chemical reaction
(Two of year 7 students from school TS)

It can be adapted to everyday lives. (Year 8 student from school DJ)

Another year 8 (Matayom 2) student from the same school gave an example regarding knowledge he gained from learning science.
Um...knowing weather condition such as temperature and humidity would help determine if it is safe to travel.
(Year 8 student from school DJ)

It can be used in everyday lives.
(Year 9 student from school KS)

Two year 9 (Matayom 3) students gave an example regarding knowledge they gained from learning science.

Student 1: for example, chemical properties. It helps me recognise if particular substances can harm you.
Student 2: for example, electrics.
(Two of year 9 students from school KS)

Students believed learning science helped them catch up with new innovation and technologies.

Because knowledge obtained can be used in everyday lives. Although I still haven’t fully recognised what is a main benefit of studying science at this moment but I’m sure it will benefit me in the future. At least, I can keep abreast with new technologies which are recently introduced to our society.
(Year 9 student from school BN)

I think science helps me widen my perspectives toward changes. I can obtain more knowledge.
(Year 7 student from school DD)

Relationship of science and general knowledge seemed to be recognised by some students, as they considered learning science helpful in understanding natural phenomenon; e.g., tsunami and heat wave.
It helps me gain more understanding on what was happened around me, for example, natural phenomenon, atmosphere as well as atmospheric ingredients.

(Year 8 student from school KK)

It helps me recognise what has happened around me? For example, natural phenomenon, what makes this phenomenon happen?

(Year 8 student from school DM)

Benefits of science on health was also acknowledged, as student said that learning science could help them understand how the human body functions and how to keep themselves healthy.

Knowledge obtained especially from a lesson about our health can help me understand how the human body functions and how to avoid being sick....for example protect yourself from malaria-carrying mosquitoes.

(Year 7 student from school LP)

Studying science was perceived by students as helping them practice analytical skill, enquiry skill and problem solving skill.

Study science helps us practice an analytical skill as well as observation skill.

(Year 9 student from school TS)

problem-identifying and solving skill as well.

(Year 9 student from school TS)

It helps me practice enquiry skill as well as planning skill.

(Year 8 student from school LP)
It helps me develop analytical skill and helps me practice enquiry skill as well.

(Year 8 student from school LP)

Few students knew learning science is important but they didn’t have any idea about how science was important to them.

I think yes… (it’s important) but I don’t know how because I never had any experiences as such.

(Year 7 student from school WP)

for everyday lives... (silence and shake one’s head when ask him to provide example)

(Year 8 student from school DD)

Student perceived that there was a link between science and other subjects, for instance, English and mathematics.

To learn science, it requires knowledge from other subjects including Thai language, Mathematics, English, etc. We, then, have to focus on every subject....; for example, there is a relationship between science and physical education. In the past, I didn’t realise that relationship existed until I asked a teacher. That helped me gain more understanding on both subjects.

(Year 8 student from school BN)

3.4.2 Students’ View on Teaching Science

This topic was found in a theme analysis of conversations regarding topics about activities and assignments which were assigned by the science teachers in classrooms and degree of students’ appreciation of the teaching of their science teachers as well as those tasks/activities assigned. Questions regarding this topic were relating to their experiences in doing activities in science classrooms: what kind
of activities that their teachers assigned in classrooms and how they managed to finish the assigned tasks.

All groups of the students described that the teachers assigned them to carry out an activity; i.e., practical work in a group manner and most of them had to present their findings to peers.

Doing an experiment in a group manner... and the teacher will come and discuss with us directly.
(Year 7 student from school TS)

Doing a practical group work by following direction in a textbook... there was a list of tasks which will be allocated to everyone in a group. In addition, these tasks will be allocated to other members in the group in the next activity.... Sometimes everyone was needed to present but sometimes only the group presenter did that job.
(Year 9 student from school DJ)

Doing group work... we listed tasks and every task was allocated to everyone. Moreover, those tasks will be allocated to other members in the group in the next activity.... We voted one of us as a presenter to present in front of the class.
(Year 8 student from school DD)

Doing group work... everyone has their own task and these tasks will be allocated to other members in the group in the next activity... and I have to present my results in front of the class.
(Year 7 student from school KK)

Practical work demonstration by outstanding students and do assignment in a group manner.
(Year 8 student from school BN)
We did practical work in a group manner ... and everyone was assigned an individual task.

(Year 9 student from school LY)

Although some groups of students were allowed to allocate members freely, there was a group of students that teacher had allocated them into a group.

We did a lot of practical work in the past, but not for now... The teacher did that (allocated group members) and also asked us to present findings to peers.

(Year 7 student from school WP)

A group of students revealed that most of the practical works were described in a textbook and they just followed the step-by-step directions that were in the textbook.

We conduct practical work as they were described in a textbook, usually at the end of every chapter.

(Year 8 student from school TS)

Some groups of students revealed that they did not carried out practical work very frequently or previously carried out practical work often but not for now.

Student 1: Not really (frequently carried out practical work)
Student 2: It’s rare (to carry out practical work)

(Two of year 7 students from school TS)

We did a lot of practical works, but in the past.

(Year 8 student from school WP)

Several schools encouraged students to do science projects. With this regard, varieties of science projects were conducted by students. In addition, in one school a
teacher asked for collaboration and support from other government bodies to provide a specialist who was able to give a suggestion regarding a particular topic.

It (the science project) is about our world. I have been searching about the origin of our world, how human and animals were originated.

(Year 8 student from school LP)

What I did was a survey project. I listed names and characteristics of medicinal plants in my area.

(Year 8 student from school LP)

Our project is to produce effective fuel from local materials. At the beginning, the teacher invited a specialist from the Ministry of Energy to give us a lecture on the process of fuel production and types of materials that were usable as fuel. The following step was to choose what materials would be the best materials to produce effective fuel, and also reusable. Then, we brought information gained from the lecture and from our investigation as sources for designing the project.

(Year 7 student from school KK)

However, in the same school and the same education level, the activities assigned to students involved worksheets, tests, and mind maps.

Well, the teacher usually asks us to do a pre-test, post-test and worksheet.

(Year 8 student from school LP)

The teacher asked us to do group work. We had to produce a concept map and had to present it to peers.

(Year 8 student from school DM)
One student said that her enjoyment in learning science was related to how well the teacher made a lesson fun and exciting. The students appreciated science teachers whose teaching style was fun and motivating.

I like the science teacher. Her lesson is fun and I can bring what I get from the lesson to use at home. It’s really useful.
(Year 8 student from school LY)

A few groups of students described how they conducted science demonstrations and science projects and also how they did the activities.

We conducted a science project on making a product (shampoo) from local medicinal plants. I extracted a water-like solution from local medicinal plants and then mixed it with a detergent solution.
(Year 9 student from school DJ)

We did a science show on floating a shirt button on water and punching a balloon by a needle but a balloon didn’t burst.
(Year 7 student from school DJ)

Students recognised that practical works could help them gain experiences from hands-on activities.

An experiment is what I could do myself. It is hands-on experience.
(Year 7 student from school LP)

Student 1: (I like doing experiments) because I can see with my eye what has happened.
Student 2: (I like doing experiments) because it is hands-on experience.
(Two of Year 7 students from school DD)

Moreover, a student felt excited when conducting practical work.
I found it very exciting when conducting practical work and wondered if the results would be the same as it was described in the textbook.
(Year 7 student from school KK)

Some students said that their homework or assignments were assigned in a form of drawing a picture or a concept map.

The teacher mostly assigned homework in form of drawing a picture or map to sum up ideas from lesson learnt.
(Year 8 student from school WP)

Ummm... That (homework) was a picture of the human body. I drew an arrow pointing to each organ and explained their functions.
(Year 8 student from school DD)

A student described that she and her classmates had to do not only homework for the science subject, but also for other subjects.

It (homework) was not only for the science subject. I have to do homework for other subjects. Sometimes I got ten assignments.
(Year 7 student from school BN)

A student said that the teacher didn’t assign them homework but rather asked them to finished assignments within classroom period.

The teacher asked us to finish the assignments within classroom period because we won’t be able to finish them at home due to loads of homework including other subjects.
(Year 8 student from school LP)

However, there was a student who didn’t do homework.

I didn’t do homework.
(Year 7 student from school KS)
The same student did not give further explanation about why he did not do homework. He only laughed.

3.4.3 Students’ View on Learning/Studying Science

This discussion topic was introduced to a group of students to explore the level of enjoyment in studying/learning science. To stimulate the discussion regarding this topic, the first question asked was whether they enjoyed studying science. In addition, students’ responses on difficulties they encountered during science lessons and their efforts to bring knowledge obtained into action were also investigated.

Some of the students regarded their level of appreciation in studying science as neutral; i.e., they neither liked nor disliked it. They took science because it is mandatory and they felt that they enjoyed science lessons only when they carried out practical work or experiments in the classroom.

Student 1: Neither like nor dislike (studying science)… it’s neutral.
Student 2: I like it only when we do an experiment.
Student 3: I like doing only an experiment as well; I don’t like to commit to memory.
(Three of Year 9 students from school BN)

Student 1: I like it but not the most.
Student 2: I like only when I’m doing an experiment.
(Two of Year 9 student from school KK)

Student 1: It’s neutral, neither like nor dislike.
Student 2: It’s OK for me but not that exciting.
(Two of Year 7 student from school TS)

Some of the students disliked science, as they regarded it as detailed, complicated and hard to capture its concepts.

Not really like it. It’s hard… really hard to understand.
(Year 9 student from school KS)
No... I don’t like (to study science) at all. I have to read a lot… I don’t like it.

(Year 7 student from school KS)

Some students appreciated studying science because they found that carrying out experiments was exciting and motivating. In addition, they appreciated hands-on experiences as those practical activities could help them gain more understanding in science lessons.

Student 1: Yes. I like it (science subject). Doing an experiment is fun.
Student 2: Yes. I like to hypothesise and make a prediction.
(Two of Year 8 students from school KS)

Yes. I like doing an experiment. It helps me understand the content more easily and stimulates long-term memory.

(Year 7 student from school LY)

Yes. I like doing an experiment. It’s fun and exciting. I like it.

(Year 9 student from school LY)

I like to do experiments. It’s fun and motivating. Learning from hands-on activities helps me gain more understanding.

(Year 8 student from school DM)

Umm. I like studying science especially when conducting an experiment and I get many ideas from this, such as the relation of expected results and actual results. This has happened when the actual results that I got from the experiment were different from the expected results. I could compare and think critically about a possibility that allowed the differences to happen.

(Year 8 student from school LM)

When asked about their attempts to utilise what they learnt in science classrooms in everyday lives, they responded in different ways.
No, haven’t brought it (what I learnt) to implement it yet.
(Year 8 student from school KK)

Student 1: I observe morphology of clouds for weather forecast.
Student 2: I carefully read precautions when using household chemicals.
(Two of Year 7 students from school DD)

I tried to make a natural pesticide but it seems my parents were not so convinced.
(Year 9 student from school DD)

I had organised and relocated household chemical substances. Acidic substances were kept away from their counterparts that would make the acidic substances explode.
(Year 8 student from school KS)

3.4.4 Students’ Strategy to Inquire

This topic was generated from an idea that it is sensible to examine levels of students’ interests in studying/learning science. The levels of students’ interest can possibly be indirectly determined from how the students inquire or search for explanations regarding their queries. Therefore, the students were asked what they did when they could not understand a lesson during class.

When students could not understand a lesson during class, a few of them chose to ask the teachers immediately when they were confused by lesson contents or an assignment that the teachers assigned.

I will ask teacher right away.
(Year 9 student from school WP)

I ask teacher right away.
(Year 9 student from school DM)
On the other hand, a student would rather ask the teachers at the end of lesson than do it immediately when they were confused by lesson contents or an assignment.

I will ask the teacher but I will wait until the class has finished.
(Year 7 student from school DD)

However, a student preferred not to ask her teacher at all.

I will do nothing.
(Year 8 student from school KS)

Students described their attempts in learning science in different ways; e.g., they tried to obtain more insight into the lesson contents by reading a textbook, searching for an answer using the internet, asking friends or asking the teachers in the next lesson.

I will try to read through a textbook first. If I still couldn’t comprehend the lesson, I will ask the teacher afterward.
(Year 9 student from school DD)

I’ll ask friends first. If they couldn’t help me, I will ask the teacher then.
(Year 7 student from school LP)

I would search through an internet to obtain more explanations.
(Year 8 student from school LY)

3.4.5 Students’ View on What Made Science Attractive to Them

With regard to a previous theme, it is also interesting to investigate topic/lessons that motivate or draw students’ attention to study science. Regarding
this, the students were asked about their favourite topics in science and what attracted them to that topic.

Students were fascinated by topics that were related to their everyday lives and could somewhat benefit their community.

I like topics about chemicals. It’s fun. What I did was put a coin into a glass of coca cola and leave the coin for a while. You will see the coin brightened because an acidic property of soda in Coca Cola erodes and washes away grimes on the coin.
(Year 9 student from school KK)

For me, I like the topic about renewable energy and environmental protection. I think it’s interesting because it benefits my community.
(Year 9 student from school KK)

I like topics about force and friction. I think these are benefiting me in everyday lives.
(Year 9 student from school LP)

Topics related to things that cannot be seen with the naked eye were attractive to students, for instance, human and animal cells.

I like biology. It is exciting to know what’s different between humans and animals and why humans and animals are different.
(Year 9 student from school TS)

I like the topic about cells of both animals and plants. It’s exciting when I see these cells under a microscope.
(Year 7 student from school BN)

I like the topic about cloning. Because it can make this (pointing to a picture of one sheep) to become like this (pointing to a picture of a group of sheep) and they are all exactly the same. It interested me.
(Year 8 student from school LY)
However, a student had no topic of interest or favourite topic.

I have no idea…

(Year 7 student from school WP)

3.4.6 Students’ Ways/Strategies to Manage Revision or Carry out Science Homework

These topics were generated from an idea that it was possibly useful to obtain data to reflect the extent to which students concentrated or made an effort in carry out assigned tasks and how they managed to finish them. Therefore, question to initiate discussion of this topic was about the first things they did when they arrived home.

Many students managed to finish housekeeping tasks prior to proceeding to doing homework.

I will clean my house and do homework after that.

(Year 8 student from school KK)

I will help mom do housework. I will do homework after that.

(Year 9 student from school TS)

I will do cleaning and others housework and do homework after that.

(Year 7 student from school DD)

Conversely, there were students who wanted to finish homework before doing other tasks.

I will do homework first and then do housework later.

(Year 7 student from school TS)

I will do homework first when I arrive home.

(Year 7 student from school LY)
A student spent time before going to bed doing homework or assignments as she also had to attend religious school in the evening.

As I’m a Muslim, I have to attend a religious class until 6PM and I also have to do housework when I get home. That’s why I spend time late at night doing homework.

(Year 8 student from school KK)

However, there were students whose activities at home were not related to revising lessons or doing homework at all.

Student 1: I will watch TV and play around.
Student 2: I will ask for money from my grandparent to buy sweets and watch TV, sleep and do homework when I get up. If I can’t finish it, I will ask my friends at school later.

(Two of Year 7 students from school BN)

Apart from doing homework, a few students spent time at home reviewing lessons or inquiring for further understanding from what they had learnt in the classrooms. However, they did not carry out these activities on a regular basis.

Student 1: I review lesson only when there was nothing to do.
Student 2: I review lesson only when I get a new textbook.

(Two of Year 7 students from school WP)

While doing homework, students asked friends or sought an answer from books or the internet when they got stuck.

I try to find an answer from textbook or search from the internet.

(Year 8 student from school TS)

I phone my friend and discuss this with him/her.

(Year 7 student from school DD)
A few students asked their parents or family members when they got stuck doing homework.

Student 1: I ask my brother (to help me do homework).
Student 2: Me also.
(Two of Year 7 students from school LP)

Yes. I usually ask my brother.
(Year 8 student from school KS)

However, a few students would leave their homework blank and they planned to ask the teachers on the following day.

I think... keep it and ask the teacher later is the best way...
(Year 8 student from school WP)

I will ask my teacher to explain it again on the next day.
(Year 8 student from school DD)

3.4.7 Students’ Views on Tests/Exam in Science

This topic was raised to observe how students from participating schools saw the assessments performed by their schools and the government and to what extent they were able to accomplish these assessments. This could be extended to reflect teachers’ practices as well. The students were asked about their views regarding the national exam and school exams in science that took place regularly.

Many students mentioned that the national (O-NET) test was complicated; questions were full of details, were difficult to understand and required critical thinking skills to carry out the test.

Student 1: It (O-NET) was difficult. It required students to memorise details.
Student 2: O-NET is complicated and full of details. It required students to think critically and analyse problems.

(Two of Year 9 students from school LP)

(O-NET is) a bit difficult for me. I was not able to understand a problem asked. I had to re-read the problem many times. The test also asked to use logical reasoning to describe a consequence of a particular event. If you couldn’t identify the main point, then you couldn’t do this test.

(Year 9 student from school DD)

It was complicated and it also required students to think critically while undertaking the exam.

(Year 9 student from school KS)

Some students mentioned that some topics had never been taught in the classroom or were beyond the expectation. These situations made them struggle to do the national (O-NET) test.

It was beyond my expectation. I thought the exam would emphasise knowledge about electrics but it wasn’t like that. The exam contained many questions about chemistry and biology.

(Year 9 student from school TS)

The exam contained some topics that haven’t been taught. I think because our teacher has specialisation in physics.

(Year 9 student from school TS)

The test was not in accord with what we were informed during the extra tutorial.

(Year 9 student from school WP)
Only a few students felt confident and thought they were able to do the national test.

I think I’m ok with that. It was all about environment around me. I’m familiar with that.
(Year 9 student from school KS)

Um...I think I could do it.
(Year 9 student from school DD)

One student did not find the national test difficult.

It was neither too difficult nor too easy. It’s normal as the test was about what I learnt from lessons in a classroom. I admitted that we couldn’t finish all of the lessons on time because we did too many activities which were not related to the lessons. However, I did a test based on logical reasoning.
(Year 9 student from school BN)

Support from teachers were provided to students in form of an extra tutorial session. However, the support only relied on the past exam papers.

She (the teacher) gave us the past exam and showed us how to calculate or how to determine what should be a reasonable answer, but she didn’t tell us what exactly an answer was.
(Year 9 student from school KS)

Some students saw that the school exam was not too difficult.

That was ok for me.
(Year 9 student from school KK)

Yes, that was ok.
(Year 8 student from school DJ)

That was ok for me
(Year 7 student from school LP)

A student said that there were questions that appeared in the school exam which were not related to the practical work or scientific method that they had undertaken.

Not really (difficult) but I could understand the lessons after the exam had passed. But I could do some, anyway... (doing experiment does help) to some extent, I think. However, not many experiments were included in the exam.
(Year 8 student from school DM)

In some schools, the teachers provided support to students by offering them an extra tutorial session. However, like tutorials for the national exam, these sessions provided only ready-to-use information to students.

The teacher will tell us what would be asked in the exam and what page in a textbook that has necessary details.
(Year 7 student from school DJ)

We do extra tutorial classes when the exam is approaching.
(Year 8 student from school BN)

3.4.8 Students’ Future Plans

This discussion topic was generated to investigate how students designed their career path and the degree of their motivation to continue further studies. Regarding this, the students were asked about their plan after they finished the lower secondary level.

Some students would enroll in vocational education.

Student 1: I will attend vocational school.
Student 2: I will attend polytechnic.
Student 3: I will attend vocational school as well.
(Three of Year 9 students from school DJ)

I don’t think I will attend high school. I want to attend a vocational school.
(Year 8 student from school KS)

Some students would attend high school and proceed to higher education. It was interesting that some students aimed to take a job that required undertaking science as a core course. Studying science may influence their choices of further studies or preferred occupations.

Student 1: Attend High school. I want to be a science teacher
Student 2: Me also but I want to be a nurse.
(Two of Year 9 students from school TS)

I’ve planned to proceed to high school.
(Year 8 student from school TS)

Some male students aimed to attend other types of further education; e.g., police cadet academy or army cadet.

Student 1: I will proceed to high school and then attend a police cadet academy.
Student 2: At the beginning, I want to be a soldier but now I’ve changed my mind. I want to be a pilot instead.
(Two of Year 8 students from school LY)

Some year 9 students aimed to leave school for a job, for example:

Student 1: I have to leave school and work as an employee in a local business.
Student2: I have to help my parents earn more money, so I have to leave school and find a job.

(Two of Year 9 students from school BN)

Some year 8 and 9 students had not planned about their future careers or studies yet.

I have no idea.

(Year 9 student from school WP)

I haven’t thought about it yet.

(Year 8 student from school DD)

In summary, an analysis of the observation data points out that the science teachers did not implement only the SCL in their classrooms. Rather, a combination of the SCL and the TCL were also carried out. In addition, the TCL classrooms could be observed. Findings from teacher interviews reflect not only schools themselves but also key components surrounding them involving students, teachers and parents have influenced the reform and the implementation. Nevertheless, the government policies, social and economic conditions of the country were also crucial and have an impact upon the reform and the implementation. Findings from student focus group interviews demonstrate students have recognised benefit and importance of studying/learning science in some degree. The level of student’s enjoyment in studying science was proportionate to how teachers make lesson fun and motivating. Lessons that offered direct experiences in conducting activities or experiments in classrooms were appreciated by the students, as they found those hands-on experiences could help them gain more understanding in the lessons. Students also pointed out that there was a disconnection between contents appearing in the national test and what they were taught in classrooms.
CHAPTER 4
DISCUSSION

Thailand education reform is a major area of interest within the country. Within the reform, the key mechanism that has been introduced to classrooms and believed to be the best way to help improve Thai education and increase the quality of students is a western approach called ‘Student-Centred Learning’. However, many education researchers and scholars recognised that the reform has not exhibited a sign of success. On the other hand, results of academic testing, both domestically and internationally, have clearly shown the performance of Thai students falling below standard and following further behind other nations. In addition, critics have reported difficulties and pitfalls that prevent such reform from succeeding (Hallinger & Bryant, 2013; Hallinger & Lee, 2011).

Apart from issues raised by critics, it is important to obtain teachers’ opinions and attitudes regarding the reform and the implementation of SCL approach, especially from those teachers who are based in schools in rural areas. This is because those schools tend to be neglected by the central government or have less opportunity to equally and fairly receive educational welfare from the government (Thailand Development Research Institute, 2014).

In this chapter discusses the findings from the interviews and observations and their analysis. This chapter begins with a summary of themes discovered from the interview and observation programmes and the discussion of these themes in the light of the literatures. These themes were unexpected in that they took me away from the classroom issues which were thought to be the major concern. Along with these themes, the national social and economic context, the reform context and school contexts will be discussed. The last section addresses specifically the research questions and presents the analysis and interpretation of the findings of the research questions.

The situations and the literature described in the beginning of this thesis led to the identification of the first three of research questions. These research questions
aim to investigate teachers’ current practices in schools located in rural areas, and perceptions of those teachers regarding the changes that emerge from the implementation of the major reform and the difficulties they encountered which they perceive as impediments to effective implementation of the SCL approach. In this chapter, these three research questions are presented according to its scope, and the discussion will be arranged as thus:

1) What do heads of science departments and science teachers think about the changes?

2) Has science teaching in these schools changed since the third reform? How has it changed?

3) What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?

Classroom observations were carried out to gather data that represented teachers’ practices in science classrooms. Another set of data that illustrates perceptions of the teachers regarding the changes that have emerged from the implementation of the reform and the implementation of SCL approach was obtained using the semi-structured interview method. In addition, student focus group interviews were also undertaken to generate data that manifest students’ attitudes about learning experiences in science and their perceptions on how studying science benefits them. After conducting the data analysis, in the following section, the discussion will address two aspects. The first strand is an illustration of major issues that emerge and correlate those issues with various literatures, and the second strand will be based on the first three research questions, and how findings respond to those questions. The fourth research question will be addressed in the next chapter in a form of policy recommendations. Because the Thai policies do not really reflect the developing literatures and thinking about science teaching elsewhere, what will be discussed here are particular aspects of the reform.

From the literature review chapter, science education contexts in three other countries were described. The reason why those particular three countries were selected is that between them they represent examples of more developed and less
developed countries than Thailand. Though I did not have an intention to conduct a comparative study, I wished to draw on experiences from countries at different stages of development, so that I could gain some sense of where current practices in Thailand fitted into the overall pattern of science education internationally. When we consider an economic index such as the GNI per capita of the US or of England and Wales, these two countries are clearly different from Thailand. The main difference is that two highly developed countries that possess mature economies have a solid industrial base, and where science integrates very much into citizens’ everyday lives. On the other hand, if we look at the position of African countries, it is clearly shown that they are under developed countries. Actually, the Republic of Malawi is similar to Thailand in many ways, though it is obviously much poorer than Thailand. Consequently, we might expect to learn from the developed countries practices that could improve science teaching in Thailand, but actually it is clear that we can learn from the African example too, which suggests that Thailand has a very long way to go before it can be happy with the science education it provides to its children.

4.1 Major Emerging Issues

This section is a discussion of data in the light of literatures reviewed. Major issues that emerged from the interview data obtained and overlapped with the literatures can be identified and divided into three main areas as follow:

4.1.1 National, Social and Economic Context

Several of my interviewees made references to the problems emerged from the social and economic impairment of the country and the changing of pattern of work and family life that changed the contexts of communities. Some interviewees talked about problems caused by neglectful as well as separated families. Furthermore, the quality and background of parents were mentioned by some interviewees. To discuss these issues raised by the interviewees, it is necessary to review the literatures, and those issues will be scrutinised below.

One of major reasons that the teacher participants believed that the education reform was relatively ineffective was the deterioration of current social and economic circumstances. It was possible that this difficulty had arisen due to a
shifting in the government’s principle manifesto toward capitalism. This corresponds with Chiengkul’s (2010) critique that capitalist policies had been wildly implemented by the Thai government. With this regard, legislation that supported exporting, foreign direct investment and large-scale investment had been prioritised. The Thai government focused on an increasing of the GDP more than decentralising and disseminating resources and promoting development throughout the country. These factors made service economy and urban industry become dominant over agricultural economy (Cheangkul, 2010). Hence, the industrial growth rate and an employment rate of urban areas were higher than in the villages, which were still based on agriculture. As a result, situations described had widened the income gap (Cheangkul, 2010).

An aftermath of the shifting economic structure is that farmers escaped from agriculture zone, particularly those from the northeastern part of Thailand that has the lowest income levels, to industrial and economic zones in order to obtain more employment opportunities (Cheangkul, 2010). Critics observed that this had made the relative number of total residents in the cities increase. In addition, the remaining farmers changed their agricultural practices from integrated farming to monoculture in order to increase the amount of agriculture products which would be generated for trading. As a consequence, their patterns of living had also changed from extended family to single family (Cheangkul, 2010). The migration of working-aged farmers had also affected parental practice, as parents had to leave their hometown for work in companies or factories, and not in all cases did both mother and father work in the same company or factory. As a result, children were left with grandparents and the number of separated families had increased as well. Transformation of the economy and the way of living of farmers or village people, who relocated to urban area and business zones, had affected both population structure and children and youth’s learning (Cheangkul, 2010).

From this point of view, it is in agreement with an issue raised by a science teacher in an interview in which she noted that parents who were working in factories normally left their children with grandparents. It seemed reasonable for the parents to leave children with the grandparents, but, in fact, age gap between two
inconsecutive generations had negative effects on the children’s schooling. In addition, it is necessary for children to be raised and supervised by good parents in order to make them become a disciplined person. This requires an effort from parents – monitoring of children’s after school activities, discussion with children, both formal and informal on a daily basis, is an important support to learning, but many children do not have this support. According to the science teachers’ comments, it would possibly be elaborated that problems these children experiences; e.g., premature pregnancy and loss of inspiration, were consequences of a lack of ‘real’ parenting.

The socioeconomic status of people in a country also has an impact on the country’s education. By and large, level of school involvement has a positive relation with socioeconomic backgrounds of parents. In other words, parents with high socioeconomic status were believed to engage in their children’s schooling in a higher extent than parents with lower socioeconomic status (Hill & Taylor, 2004). Particularly, parents who obtained university degrees attempt to support their children to have a place in honours courses and also actively supervise their children about education (Baker & Stevenson, 1986). There are many more obstacles that have been identified as factors that restrict opportunity of low socioeconomic parents to involve with their children’s schooling including lack of resources, restricted work schedules, terrible transportation condition and stress arisen from living in underprivileged community (Hill & Taylor, 2004).

When considering the Thai context, socioeconomic status (SES) of students has become an issue that affect the implementation of changes, and, unfortunately, the government policy also accelerate degree of difficulties of the reform. Chiengkul (2009) criticised that there was no equality of educational opportunity for disadvantaged people. That is to say, those disadvantaged people usually study in schools that have less quality than schools for middle class or high SES people. Therefore, the current Thai education did not helped solve problems in poverty and inequality of income distribution (Cheangkul, 2010). In addition, the relatively high number of disadvantaged students who have interrupted their schooling and have left schools is believed to be a consequence of the government’s initiatives which have
not focused on the support for those disadvantaged students. Rather, the government has implemented education policies that aim to provide equal services throughout the country, for instance, free or low paid schooling for elementary, secondary or vocational education (Cheangkul, 2010). Apart from expenses for schooling, the government also provided support in general expenses; e.g., text books and stationery. However, these government policies did not fully support the low SES parents, and, as a consequence, the low SES parents still have to struggle with the payment of the additional expenses. This is because the relative amount of those additional expenses, when compared with the income, is still higher (Cheangkul, 2010).

The additional expenses that the parents have to provide to support their children’s education also include transportation cost and daily expenses. These require considerable amount of money and limit the children’s opportunity, as they could study only at schools in a village, which obviously have poor quality of education (Cheangkul, 2010). Frequently, children from disadvantaged families have left schools before finishing high schools. Several explanations were brought to mention include poverty, school and community atmosphere that do not support and motivate students to learn and carry out further studies (Cheangkul, 2010). Furthermore, according to conversations with the science teachers, some students aged under 15 contributed to their own education and well-being of families by working as a freelance after school hours in order to gain an extra income. This caused students difficulties in schooling due to exhaustive part-time work, tiredness from inadequate sleep and transportation between workplace and home; as a consequence, those difficulties affected the student’s academic performance and attainment.

Roles of Parents were mentioned in plenty of studies related to student achievement, school outcomes, attainments and student behaviour. Parental involvement was identified as a crucial factor that played roles in the construction of students’ self-concepts (Gonzalez-pienda et al., 2002). Neglectful Parents is a factor the teacher participants saw as an obstacle that contributed to less effectiveness in the implementation of the SCL. This point of view also corresponds with plenty of
research in field of cognitive development and student achievement. Characteristics of neglectful parents have been described as neither demanding nor responsive, failing to monitor child behaviour and also failing to supervise their children. Furthermore, the neglectful parents tended to show a lack of support or encouragement in children’s self-regulation (Maccoby & Martin, 1983) and have displayed non-controlling attitude and uninvolvment (Baumrind, 1991; Maccoby & Martin, 1983). Neglectful home was mentioned as it could cause lack of self-regulation in children and may lead to more impulsive behaviour of students (Barber, 1996). Moreover, a research suggested that there was an association between children’s and adolescents’ underachievement and neglectful parental style (Onatsu-Arvilommi & Nurmi, 1997). Evidence from several researches also showed that adolescents from neglectful families exhibited poor academic competence (Baumrind, 1991; Lamborn, Mounts, Steinberg, & Dornbusch, 1991; Maccoby & Martin, 1983). Undesirable behaviours that interfered with adolescents’ activities in everyday lives and their ability to participate in and adjust themselves to particular environments were also found in adolescents from neglectful families (Baumrind, 1991; Lamborn et al., 1991). In addition, these behaviours which were described as expectation failure, task-avoidant and passive behaviour, and lack of self-enhancing attributions were found in adolescents from neglectful families (Aunola, Stattin, & Nurmi, 2000; Maccoby & Martin, 1983; Steinberg, Lamborn, Darling, Mounts, & Dornbusch, 1994). As described in many studies, parental practices have a relationship with academic performance and behaviours of students. This claim corresponds with data obtained from the teacher interviewees as the issue related to neglectful parents was articulated with a limit in the development of enquiry skill and lack of self-regulation of children.

Social classification of a family was also strongly related to parental involvement (Ho Sui-Chu & Willms, 1996). At the same time, parental involvement influenced students’ educational achievement. Therefore, parental involvement was assumed to be a working link between students’ achievement and social class (Sacker, Schoon, & Bartley, 2002). Social and economic indicators, including income, education and occupation, were significant in that these indicators had a relationship with better parenting. Furthermore, the better parenting with skill-
building activities and school behaviour affect school achievement of children (DeGarmo, Forgatch, & Martinez, 1999). In addition, parental involvement was linked with social and economic status, as Luster and colleagues (1989) described in their study that there was a connection between parental practices of low socioeconomic status family and low level of parental involvement (Luster, Rhoades, & Haas, 1989). Several evidences showed a link between early high school drop-outs and low parental expectations, early initiation of sexual activity and low SES of parents (Battin-Pearson et al., 2000). Furthermore, goals, values and aspirations which were indoctrinated to children by low socioeconomic parents may have less chance to be achieved due to the limit in supplying educational resources as well as available time to monitor and get involved in their children’ education (Spera, 2005). Therefore, it can be suggested that socioeconomic condition of parents definitely has an impact on students’ education. Cognitive development of student since infancy until middle childhood was also found to strongly relate to SES of parents (Bradley, Corwyn & Whiteside-Mansell, 1996). The numbers of years of schooling and school attendance of students were influenced by the SES of families as well (Brooks-Gunn & Duncan, 1997; Haveman & Wolfe, 1995). This claim supports data obtained from the teacher and student interviewees because, according to the interviews, the students from participant schools, whose majority of students were from poor or low socioeconomic families, were absent schools due to that fact that they were required to pay contribution to the family incomes and to help maintain or improve economic status of their families.

Activities after school hours which should be monitored by parents was found to be a factor related to student achievement (R. M. Clark, 1993) and doing homework with parental assistance was said to have positive relation with the amount of time adolescent children spend on their homework (Hewison, 1998; Keith, Reimers, Fehrmann & Fehrmann, 1986; Muller & Kerbow, 1993). Parents also influence children’s attitudes and choices; e.g., academic goals, school and college attendance, choices of course enrolment and intellectual accomplishment, through their discussion with their children about aspirations, goals and values (Astone & McLanahan, 1991; Crandall, Dewey, Katkovsky & Preston, 1964; Keeves, 1972; Pugh, 1976; Singh et al., 1995).
A strong relationship between practices initiated by parents and school outcomes has been recognised by many researchers (Epstein & Sanders, 2002; Hess & Holloway, 1984; Hill et al., 2001). In particular about the science subject, there was evidence that showed a positive relationship between parental sharing of positive attitudes and student achievement in science in a way that the more degree of sharing a positive attitude about science of parents, the higher student achievement in science (George & Kaplan, 1998).

Mechanisms of parental-school involvement that had a positive impact on student achievement were described in two areas. The first area was explained in terms of benefit of parental-school involvement that enhanced parents’ skills and obtained information. Ability of the parents to assist their children to carry out school-related activities were believed as a consequence of parental-school involvement. By the parental-school involvement, parents would obtain an opportunity to gain knowledge about the school’s expectation regarding behaviour of students and homework and an approach that the parents could help increase students’ learning at home and assist their children to do homework (Lareau, 1996). In addition, the parental-school involvement is believed to be a strategy to establish communication among parents. With respect to this, the parents can share their experiences and discuss school policies and practices. In turn, teachers could take this opportunity to ascertain about expectation of parents on them and on children (Lareau, 1996).

The second area was described in terms of advantage of parental-school involvement that could enable social control. The social control is a product of interactions between families and schools. With this regard, both families and schools would obtain opportunities to establish consensus about children’s behaviours, and this can be transferred to students both at home and schools (McNeal Jr., 1999). Goals related to students’ behaviours and academics generated according to the consensus established would serve as a strategy to guide and supervise students to behave appropriately. Students expected that they would receive messages without any unclear information due to the fact that they obtained the similar messages across settings; i.e., from both at home and schools (Hill &
Taylor, 2004). Level of children’s competence, motivation and school engagement were expected to increase through supports from these two mechanisms since children would perceive the importance of schooling (Grodnick & Slowiaczek, 1994).

Parental-school involvement is not a peculiar concept. Conversely, it inevitably has causal connections with socioeconomic status, ethnicity, cultural context of parents and students as well as parental characteristics (Hill & Taylor, 2004). Furthermore, parental-school involvement can be implemented not only through one set of activities but rather diverse kinds of activities such as parents-teachers communications, voluntary parents in a classroom or involvement of parents in academic-related activities while students are at home (Epstein & Sanders, 2002).

Parental-school involvement is also affected by psychological conditions of parents. A scholar claimed that a number of studies indicated that mothers with depression or anxiety symptoms were likely to be involved in preparing of young children for schooling in a lesser extent than mothers with normal a psychological state (Hill & Taylor, 2004). Self-perception of a parent also has an effect upon parental-school involvement. Parents with low level of self-esteem may not want to expose themselves and create a connection with their children’s schools. Additionally, parents’ confidence in their intellectual abilities also counted as a predictor for level of school involvement (Eccles & Harold, 1996). Poverty is also an issue that involved, to some extent, parental-school involvement. Direct effects of poverty on parents’ mental health were described. As a result of poverty, mental stress was increased in parents due to their abilities to make ends meet. As a consequence of the parents’ stress, the level of parental-school involvement was expected to decline and subsequently effect children’s early school outcomes (Hill & Taylor, 2004).

Another factor that influences parental school involvement is parents’ experiences as student. Experiences those parents gained while they were students are likely to be recalled and may affect their understandings and practices on their children’s schooling (Taylor, Clayton & Rowley, 2004). With this regard, positive
school experiences of the parents are believed to have a linkage with an increasing of parents’ involvement and quality of interactions with their children’s schools (Hill & Taylor, 2004). Furthermore, there was an evidence stating that the marriage status of parents is another factor that has impact, although modestly, upon children’s inability to pay attention in a classroom (Lengua, 2006).

Issue related to parental-school involvement was also illustrated by the teacher participants. They stated that most parents perceived that students’ achievement relied only on the quality of schools and teachers. From the literatures above, I then agrees that it is necessary to promote parents’ understanding of their roles and responsibilities in their children’s education. They should recognise that they can work collaboratively with schools and teachers in order to raise their children’s academic achievement.

Reports from the Office of the National Economic and Social Development Board (NESDB) stated that Thailand had encountered various societal and economic problems including 1) an increase of unemployment rate and a decrease of employment rate, 2) a growing number of serious offences despite the total number of crime cases decreasing, 3) the tendency of crime cases against life, bodily harm and sex related be more violent, 4) malnutrition and underdevelopment problems of children at early age, particularly those in disadvantaged areas, 5) inequity in ability to access to social protections; e.g., before pre-school programme (0-2 years old) and quality of child development centres, particularly for low socioeconomic children, 6) fewer opportunities for children aged 3-5, particularly those from low SES families, to receive provisions of either food or skill development (NESDB, 2014). As the reports described, it is clear that inequity in opportunities to receive four requisites of children in disadvantaged areas still remained as consequences from social and economic disparity. Thus, the data presented by these reports supply further evidences to assert that recent Thailand’s social and economic conditions have obstructed the education reform.

Another critic also acknowledged that cultural context was another factor that affected the process of improvement of Thai Education. Thai people did not emphasise that the Thai education requires mutual understandings and collective
efforts from every related stakeholders, but rather considered it the government’s duty only. Possible explanation of this situation was identified as unity and harmony among the people in the country which had been decreased (Chareonwongsak, 2007). Another possible cultural factor that obstructs the quality improvement of the Thai education is characteristics of the Thais that tend to be fun-loving and easy-going. These characteristics have made the Thais prone to place entertainment and recreational activities as the first concern rather than emphasising studying or gaining knowledge (Chareonwongsak, 2007). The critic also pointed out that the patronage system had been embedded across the Thai society for a long time and had influenced the Thai education through the government policy. Using the patronage system, the autocrats sought benefits from people and it was even worse when the patronage system, which had been used to facilitate the cronyism of those autocrats, could not be interrupted. Unfortunately, the decentralisation of Thai education system is believed to be a possible mechanism that supported the cronyism and had led corruption (Chareonwongsak, 2007). The same critic also reported that Thais had not been encouraged to think logically and critically, and to accept difference in perceptions and ideas of others. Conversely, the Thais tend to see others who think differently as opponents. As a consequence, a confrontation happened without using of reasoning, but rather emotions. This is a major obstacle that prevented the improvement of quality of learners as they were not trained to think for themselves (Chareonwongsak, 2007). Although the teacher participants did not clearly specify that cultural context has influenced Thai education, cultural context should not be overlooked according to the criticism described above.

4.1.2 The Reform Context

According to the teacher interviews, some teachers pointed out that the context-unrelated policies caused difficulties which impeded the reform. Failure of testing and quality assurance system was also referred to by some of teachers as factors that prevented successful reform. Additionally, some teachers described that the obstacles to the successful reform were low level or no accountability of parents and influences of politics. Regarding the implementations of newly introduced teaching approach, some teachers said that inapplicability of the new curriculum,
lack of students’ self-discipline and students’ critical thinking skills had made the implementation unsuccessful. All of the issues described above were linked with the literatures as below.

A critique from TDRI researcher pointed out that education policies of Thailand were not constructed on the basis of local needs. The TDRI researcher stated that the main ideas of several education policies were borrowed from western countries and this would lead to ‘impractical education’. This condition has also been mentioned as a cause of wastage of investment in education of Thai society (Suebnusorn & Chalamwong, 2011). Issue related to an adoption of foreign approaches in order to implement the reform has also been addressed by Hallinger (2010). In his publication, Hallinger drew examples of Asian countries who had embraced the ideas that was globally executed in order to keep up with their neighbours as a result of globalisation, and one of which was Thailand (Hallinger, 2010). As mentioned in the literature review, other Asian countries had also responded with this global movement, and impact of the globalisation has influenced education policies of those neighbour countries as well. According to the Hallinger’s claim, the Thai government has not acknowledged the significance of local context upon the implementation of an idea particularly the SCL. Additionally, when this coupled with the lack of resources which helped develop an understanding of meaning and intention of the SCL before the implementation took place, the changes often occurred slowly (Hallinger, 2010). These criticisms are in agreement with the teacher participants’ perceptions. With this regard, the teacher participants saw that Thailand education (by policy makers) adopted a western approach which is SCL without a consideration of how this western approach will be fitted with the Thai context.

One policy that was mentioned by the teacher participants was Thailand’s policy to provide every child with a tablet PC. This policy was launched in 2012, and the Thai government allocated 1,600 Million Thai Baht (29 million pounds approximately) for the purchase of the tablet PCs. By this policy, the tablet PCs were distributed to schools affiliated with the Office of the Basic Education Commission (OBEC), the Office of the Private Education Commission (OPEC) and the Office of
the Higher Education Commission (OHEC). With this regard, main users were primary students of these schools (Wong-anannon, 2012). Actually, benefits of using of tablet PCs as a teaching-aid tool were identified as there was a study that examined impacts of tablet PCs on the students in UK during 2004-2005. This study described positive impacts of a tablet PCs as it could help stimulate students’ learning and resulted in an increase of students’ achievement and promoting of the development of IT-based curriculum (Twining et al., 2005).

In addition, as described in the literature review, an emphasis of using IT to support teaching and learning is one common trend in education development that has been stressed by, not only Thailand, countries in Asia Pacific region. However, a study undertaken by the collaboration of the Office of Education Council (OEC) of Thailand and a Thai education researcher showed that the distribution of tablet PCs without consideration to develop students’ cognitive learning did not created sustainable learning to students (Vatcharaboon cited in ASTV Manager Online, 2011c) . In addition, a member of the House of Representative members argued that using tablet PCs could not help primary school students develop writing skills (Wong-anannon, 2012). Furthermore, using tablet PC from an early age may affect students’ sight and vision and temptations displayed on the internet could also create negative impacts on primary school students as the primary students were too young to think logically and critically and their emotional maturity were not fully developed (Wongtra-ngarn cited in ASTV Manager Online, 2011a). These critiques correspond with the teacher participants’ argument that using tablet PCs since primary age would not always promote desirable outcomes in development of essential study skills.

Not only issues related to impact on students, other criticisms have also been pointed out by researchers about tablet PCs for every child policy. One of those criticisms was unpreparedness of the implementation of this policy. The reason for the researchers’ criticism was that a tablet-based curriculum had not been developed in Thailand while this policy was introduced to the target schools. Moreover, teachers have not been prepared to comprehend using tablet PCs for academic purposes. Deficiency of teachers support services was also an issue, as a
maintenance agency and maintenance scheme was not fully functioned (Preechaphornsakul cited in Isaranews, 2014). Misappropriation of using tablet PCs by students was also regarded by a team of researchers. Regarding this, the researchers revealed that most students preferred to use a tablet PC for an entertainment purpose rather than an academic purpose (Lathapipat, 2011; Srifah, 2011 cited in Wong-anannon, 2012). Although these issues were not mentioned by the teacher participants, however I strongly agrees that it is essential for policy makers to take serious consideration regarding these issues as well because use of IT can either benefit or harm students, depending on how they make use of it.

Another issue raised by the teacher participants was the implementation of ‘no zero’ or ‘no fail’ policy. The Ministry of Education obliged ‘no fail’ policy in 2001, and this policy has been implemented for more than 10 years. By this policy, students cannot fail exams or get grade zero. At the end of the school year, students whose exam scores do not meet the cutoff scores will be required to attend special classes or programmes prior to retaking the exams. Consequences of the implementation of this policy have been widely discussed, particularly in a symposium in 2010 which was held by OEC. The main objective of this symposium was to discuss and gather opinions from teachers, heads of school departments and school principals on the effects of no fail policy on the quality of students. Some symposium participants agreed that it was essential that schools give grade zero to students who could not achieve the cutoff scores and allow students to retain for another year. Those participants saw that the permission of the schools to allow very poor performance students to proceed to the next level created difficulties; for instance, students may not focus on a lesson because they know that they can precede to the next level regardless their performances (Komchadleuk News, 2011). Furthermore, the secretary of OEC also discussed the necessity of allowing schools to give grade zero to students, as it could be a mechanism to hold students’ attention in a lesson. Not surprisingly, these criticisms are in agreement with the teacher participants’ perceptions. However, the secretary also mentioned that allowing the zero scoring system is not an absolute solution. Rather, close monitoring of schools, particularly on students with learning problems, and co-operative working between
teachers and parents were more importance than the retention system (Komchadleuk News, 2011).

However, a symposium participant saw that zero scoring and retention system were not critical solution and did not hit the actual target. She identified the root of all issues as the teachers because shortage of teachers and lack of continuous in teacher training and/or teacher productions remained a problem (Komchadleuk News, 2011). Issue related to shortage of teachers was also mentioned in the literature review; the deficiency of science teachers has been persisted and the vacant positions of science teachers could be calculated as 12.5% of the total vacant positions. Another participant explained that applying zero scoring and retention system would have to be considered case-by-case because it would be a factor that limited students’ opportunity in their further studies (Komchadleuk News, 2011).

The weakness of the testing system has also been regarded by the student participants during student focus group interviews. O-NET or Ordinary National Educational Test was developed by the NIETS (National Institute of Educational Testing Services). The NIETS employs ONET to assess academic proficiency of students grade 6 (Pratom 6), grade 9 (Mattayom 3) and grade 12 (Mattayom 6) which are in line with objectives indicated in the national educational curriculum. ONET consists of 8 subject areas which include 1) Thai Language, 2) Social Science, Religion and Culture, 3) English Language, 4) Mathematics, 5) Science, 6) Health and Physical Education, 7) Art and 8) Career and Technology. This test comprises of two types of testing which are objective testing (80-90% of total score) and subjective testing (10-20% of total score) (National Institute of Educational Testing Service [NIETS], 2012). The NIEST believes that the results obtained from the test can be utilised for serve diverse purposes; e.g., education quality assurance, evaluation of students’ learning outcomes, school improvement and effectiveness, and can be criterion to determine students’ proceeding to the next level of study (NIETS, 2012). The emphasis of using academic testing or standards to ensure the quality of education and build accountability of schools have also been recognised by the US government as Project 2061’s science for all Americans was introduced to respond with the standard-based reform.
Issues related to the quality and appropriateness of the ONET has been widely discussed. In 2010, a major argument was addressed by a grade 12 student who undertook the ONET in Art. She explained that she could not answer questions about ballet dance because her school, as a public school, did not provide ballet dance classes for students (ASTV Manager Online, 2010). Moreover, several students described their difficulties in doing the ONET. According to those students’ experiences, there was a contradiction between the pattern of questions in the ONET and the investigation of the answers for the test. While questions proposed in the ONET are generated based on curriculum objectives, its answers are expected to be a single and specific answer. It is a requirement that students have to find answers to those questions subjectively by synthesising and integrating knowledge from diverse subjects (ASTV Manager Online, 2010). In my opinion, it is clear that Thailand’s educational testing system needs to readjust because the education reform will not succeed if Thailand did not invent and implement an effective educational testing system that reflects the actual learning outcomes of Thai students. Rather than assessing students’ performance by emphasising on the scores students obtained, we should, instead, focus on what students have actually possessed and learnt through multiple forms of assessment (Darling-Hammond, 2009).

The issue about discrepancy between skills essential for doing the national test or ONET and skills which students actually practiced in typical classrooms in Thailand was also raised by an educational researcher. Although the student-centred concept was introduced many years ago but, in fact, the general classroom practice is still mainly based on rote-learning (Jitradub cited in Thairath Online, 2014b). This situation creates difficulty because the ONET which is introduced by the NIETS requires logical and critical thinking of students, particularly in Mathematics, Science and English, but students have not considerably practiced logical and critical thinking skills. The discrepancy is believed to be a reason why students got low score (20-30% of total scores) and why the overall results of the ONET were not that impressive (Jitradub cited in Thairath Online, 2014b).

The effect of political instability was mentioned by the teacher participants and this corresponded with what Hallinger studied in 2010. With respect to this,
Hallinger stated that political instability enormously affected the implementation of change. The Thai respondents of Hallinger’s study stated that the frequently substitution of the education minister could create continuous changes which resulted in unclear direction of policy implementation as well as fragmentation in the efforts (Hallinger, 2010). With this regard, the Thai respondents explained reason underneath this claim that each minister had personal interpretation on the reform according to his/her own preference and the meaning of the reform would be reinterpreted every time the change of the ministry happened (Hallinger, 2010).

The Office for National Education Standards and Quality Assessment (ONESQA) is a public organization that was established in 2000 by the obligation of the National Education Act 1999. Its responsibilities are to provide, manage and supervise quality assessment of educational institutions and such assessment will be normally held once every 5 years (Nakornthap, 2008). Quality Assurance (QA) framework, which was developed by ONESQA, consists of external QA for public accountability and internal QA for continuing improvement (Nakornthap, 2008). With this regard, ONESQA considers using descriptive and comprehensive standards and key performance index (KPI) that encompass school inputs and student outcomes as fundamental strand of the assessment process, and this will be applied with every level of education (Nakornthap, 2008). Although ONESQA has been operating for more than 10 years, performance of this agency is still being questioned. An educational researcher (Norngmak, 2002 cited in ASTV Manager Online, 2014) presented his point of views regarding difficulties in implementation of educational quality assessment including

1) Problems related to perceptions on the quality assessment system

School personnel perceived tasks related to quality assessment as additional workload. They understood that those tasks were ad hoc jobs which had been set up according to initiatives from the ministry or leaders. In addition, they did not recognise benefits of quality assessment. Conversely, they saw those tasks as trivial and did not produce any significance improvement. The researcher concluded that the misunderstanding of school personnel on rationale of quality assessment
could be a result from lack of examples of schools that had successfully improved quality according to suggestions from ONESQA.

2) Problems related to the implementation of quality assessment system

Documents related to operational approaches that schools provide for ONESQA’s inspection did not parallel with their actual practices. Moreover, schools tried to impress inspectors by copying operational approaches from schools that had been classified as improved schools, rather than describing their practice according to the truth.

3) Problems related to an application of inspection’s results

The inspectors from ONESQA appease schools by providing an untrustworthy inspection report whose contents deviated from what they truly found in the schools. Furthermore, schools did not magnify an outcome from the inspection report to adjust their practice and did not bring comments for improvement from the inspectors to implement (Norngmak, 2002). An issue related to neglect in utilising the inspection or assessment report would be explained by using evidences described in the literature review. With respect to the review, a researcher from the TDRI stated that ONESQA did not include an interpretation of evaluation outcomes in the report. Rather, the report showed only evaluation scores, without further analysis. Furthermore, ONESQA had not suggest the process required for improving quality of schools. Because of these neglects from ONESQA, schools would not recognise usefulness of the report and this resulted in their ignoring to adjust their practices.

Critiques related to quality assessment were also raised by an educator who categorised the assessment into 2 stances; e.g., internal and external assessment. For external assessment, the educator stated that some educational institutions saw it as a factor that increased their workload and also created tension and stress to school personnel. This could be a result of poor communication; some schools did not consider an importance of the external assessment because ONESQA and system leaders did not inform those schools on the rationale and objectives of the external
assessment throughout the country (Sirirattanajit, 2014 cited in ASTV Manager Online, 2014). However, external assessment had a positive impact on the level of personnel’s enthusiastic, to some extent, as the personnel had to keep improving the quality of their practices (Sirirattanajit, 2014 cited in ASTV Manager Online, 2014). For internal assessment, in contrast, schools seemed to understand the role and importance of the internal assessment as it was described in the national standard and schools had to undertake it regularly. Moreover, the educator remarked that there was incoherence between assessment criterion of internal and external assessment. In addition, ONESQA did not exhibit their sincerity to improve their practices as they did not show acceptance to suggestions from public hearing (Sirirattanajit, 2014 cited in ASTV Manager Online, 2014).

When considering points of views described above, based on the data obtained from the teacher interviews, the problem related to poor perceptions, particularly of teachers on quality assessment system is clearly reflected. Although issues related to the implementation and the inspection results were not regarded by the teacher participants, I suggest that it is also necessary to consider them along with the issue related to the perceptions in order to systematically improve the quality assessment system.

Although the issue related to decentralisation of management structure has not been mentioned by the teacher participants, it would be worthy to regard this and illustrate significance of bottom-up efforts from a successful model. Integrated Pest Management (IPM) is an example of successful local curriculum implementation which was introduced within highly bureaucratic system. This curriculum illustrates many of the important features accentuated in the education reform of Thailand; e.g., local community involvement and integration of local wisdom concept and SCL (Hallinger & Bryant, 2013). An initial idea of this curriculum was generated from a teacher. Interestingly, the senses of ownership, commitment as well as motivation to carry out this curriculum were displayed by the teachers and these important attitudes also inspired and transmitted to other teachers involved in this curriculum. This was claimed that it had demonstrated an importance of bottom-up effort on the implementation of innovative curriculum (Hallinger & Bryant, 2013). Moreover,
encouragement and support from organisation outside school is another key to success. Thailand Education Fund (TEF) is a non-government organization that provided technical supports during the earliest stage of the development of this curriculum – the process of identifying and adapting the curriculum. Morale supports were also arranged by the TEF in form of encouragement. Not only at the earliest stage that the TEF played role, the subsequent stages were also emphasised as TEF provided training and follow-up support when other schools began to adopt the curriculum (Hallinger & Bryant, 2013).

Significance of top-down structure support was also regarded. Stakeholders who engaged in the IPM curriculum were legitimated and supported by the vision embedded in the National Education Act 1999. Moreover, the fundamental concept of this curriculum; e.g.; SCL, integration of local wisdom concept, involvement of the community and consideration of indigenous knowledge, were also reinforced by the reform act (Hallinger & Bryant, 2013). Top-down structure support also played a critical role in disseminating and scaling-up successful innovations. Regarding this curriculum, regional network that was generated from restructuring of the education system was key mechanism facilitating the augmentation of the IPM curriculum (Hallinger & Bryant, 2013). Support from the law could also be reflected from the requirement for teachers and principals to participate in management tasks of schools and also in a process of development of school’s learning programme as well as actively engaging in professional development (Hallinger & Bryant, 2013).

By taking the first step through the bottom-up approach along with the systematic supports from the TEF, the IPM curriculum implementation has produced positive impacts over schools who involved in this programme (Hallinger & Bryant, 2013). Results from an evaluation of the IPM curriculum implementation demonstrated advantages of the SCL over the traditional approach in several ways. First, the IPM curriculum facilitated the connection of the learning contents as well as learning process to student’s everyday lives. Consequently, student’s motivation and engagement increased. Second, as a result of the emphasis on student’s self responsibility of the IPM curriculum, students’ effort to accomplish tasks was found increased. Three, the utilisation of necessary skills which are including problem-
solving skills, learning and decision-making skills were began apparent in the students (Kantamara, Hallinger, & Jatiket, 2006). Moreover, the IPM curriculum demonstrated that SCL, integration of local wisdom concept and development of local curriculum that helps solving community problems were successfully functioning in the developing countries like Thailand (Hallinger & Bryant, 2013).

Recently, the government has proposed an initiative to close down or merge schools in rural areas. Not surprisingly, there has been a debate regarding this initiative. A researcher from TDRI has elaborated on this debate and developed a claim regarding disproportion of the number of teachers versus the number of students in small schools (Sasiwuttiwat, 2013). According to the claim, in a past few years, data from OBEC show that the number of teachers in small schools (41-60 students) was five times less than the number of teachers in large schools (500-1,499 students). That means the number of teachers will not enough for small schools to provide teaching in every subject, and then teachers’ workload will be increased as they will have to teach more than two or three subjects in each year.

According to this, the TDRI researcher did not show a strong opposition with the initiative but rather suggested the education ministry consider issues on quality. With this regard, the TDRI researcher saw that the small school mergers were not always a pledge to ensure that quality of learning would be heightened. Alternatively, the consideration to merge schools should be made on a case-by-case basis (Sasiwuttiwat, 2013). Although close down or merge schools initiative has not been mentioned by the teacher participants, it is interesting to reflect issue related to the propriety of the policy from this claim. The government attempts to narrow the education gap by merging small schools in rural areas, but it cannot ensure that this initiative will best suit the context of schools in rural areas. As one problem was resolved, it may let another problem emerge, such as difficulty in transportation of students from schools when those schools are terminated. Therefore, any policy initiative should be scrutinised before bringing it to action.

Even though the Thai government has increased budget to improve education, a researcher from TDRI also affirmed that education in Thailand still did not exhibit satisfactory outcome (TDRI, 2014). Quality of education is still absent as
well as inequality still existed. Schools which lack resources obtain the same budget as schools where students exhibit low academic performance and teachers and leadership are not able to retain those students in their schooling. In addition, some of these schools lack an authority to choose their own teachers and also obtain inadequate amount of funding which does not cover the actual cost for support the management of quality education (TDRI, 2014).

With this regard, the TDRI researcher suggested the education budget allocation would have to embrace a new approach. By collaboratively working with the World Bank’s researcher, the TDRI researcher introduced the funding formula which took an account of academic performance of students, socioeconomic status of families and school environment. With this formula, the TDRI researcher claimed that small schools in rural areas would receive a higher amount of funds per head (of students) than schools in urban areas. However, it would not be possible for the government to increase funding for every small school due to limited budget. Therefore, the TDRI researcher suggested the government establish a new system in which the small schools should be grouped and the government provides support to those groups of schools with policy tailored for each group of school (TDRI, 2014). This is an example of policy initiative that has been proposed based on consideration of local context with carefully examination of possibility to obtain desirable outcomes. However, explicit government scheme that support this suggestion has not yet been proposed.

Researchers team from TDRI has also been conducted a research involving the education reform in Thailand. Reflecting on their research outcomes, several problems seemed to be more serious and impeded the reform. One of those problems was lack of accountability from key stakeholders in Thailand’s education system. In addition, Thailand also lacks of mechanisms to create it (Tangkitvanich, 2013). The researcher claimed that there was no or little consideration from the stakeholders on poor learning performance of Thai students, the curriculum that mainly focuses on students’ memory of lessons taught in classrooms and teachers’ difficulties in performing the best possible teaching (Tangkitvanich, 2013). According to Tangkitvanich’s claim that corresponds with the experiences of the teacher
participants in which parents who are key stakeholders do not engage in activities related to their children’s learning, I then suggest that the strategic policy which clearly defines the accountability of each related stakeholder including parents and facilitates the mechanism to create the accountability should be established and implemented in the near future.

Tangkitvanich (2013) also argued that one of several problems that seemed to be serious and impeding science education reform was that Thai students had not been encouraged to think for themselves, as well as to do research and think critically. The curriculum focuses on testing students’ memories of what they were taught, regardless of students’ understanding on a subject. In addition, massive detailed contents of the curriculum could also give teachers a hard time. The teachers were expected to provide lessons that covered the detailed contents fixed by the Ministry of Education and also had to prioritise them (Tangkitvanich, 2013). Therefore, he suggested that the curriculum would need to restructure and adjust its contents. To prepare our children to live in the modern century successfully, we need to train them to develop critical thinking skill, teamwork and communication skill and other necessary skills, through an appropriate curriculum. This suggestion was raised due to the fact that the Ministry of Education compelled teachers to follow and cover all designated contents and meet all objectives required by the curriculum. Therefore, there is less chance that true learning will be happened because most of the time has been spent trying to accomplish those curriculum requirements as the first priority (Sasiwuttiwat, 2013; Tangkitvanich, 2013). These points raised in the literature support the view that during the reform teachers attended overmuch to curriculum content and expected outcomes. But, as described in the literature review, other countries have emphasised the understanding of science and the process of science as essential elements that contribute to the development of scientifically literate citizens who can apply a scientific approach in learning, reasoning, and thinking, making decisions and solving problems. To cultivate those essential skills in our children, it would not be sufficient if the government only states those essential skills as objectives to be achieved in the curriculum. Rather, the Thai government needs to increase lay emphasis on the concept of process of science through strategic mechanisms.
The issue about over detailed contents of the curriculum has led to another issue: school assignment writing services. Jitradub (2014) gave an explanation why the school assignment writing services became popular among school students. His justification was that the national core basic curriculum comprised of 8 different subjects. As a result, a magnitude of the amount of homework is increased because the teacher of each subject teach and assign homework individually. This creates tension and stress to students due to the homework overload and they cannot finish these homework and assignments on time. In addition, the current curriculum puts more emphasis on achieving learning standards and indicators of each subject rather than focusing on improving students’ learning processes (Jitradub, 2014 in Thairath Online, 2014a). Obviously, studying 8 subjects is a time-consuming task. Therefore, spare time for students to carry out extracurricular activities is decreased or disappears. Moreover, one major aim of the current curriculum is to prepare students for further studies. Thus, it seems that the main objective of schooling is to pass a university entrance exam rather than building students’ capacity to use logical reasoning and to think critically. Jitradub suggested that Thailand may need to refocus the aim of Thai education and schooling (Jitradub, 2014 in Thaipost News, 2014).

With regard to the issue on homework overload, Jitradub (2014) also suggested that the Ministry of Education and heads of 8 departments of each school work collaboratively to set up a plan that integrates the content of homework from each subject. Furthermore, the assessment and evaluation process should be considered along with learning development process of individual student. Punishment is required for students who use school assignment writing services instead of doing homework by themselves (Jitradub, 2014 in Daily News, 2014). Furthermore, the same scholar proposed the structure of a new curriculum that comprises of 3 main areas including 1) encouraging patriotism, cultural and religion believes 2) cultivating students’ conscience to pursue an honest occupation and 3) developing necessary skills to catch up with globalisation, innovation and technology. However, the biggest challenge is drafting the new curriculum that has less studying period and supports extracurricular activities of students (Jitradub, 2014 in Thaipost News, 2014).
Another obstacle mentioned by a teacher participant is insufficient ability of students in remote areas to deal with difficult and complicated curriculum contents. The participant saw that students in remote areas had limited preparedness in learning. Thus, I consider this an outcome of educational gap which still remains, and the gap has affected the learning ability of students who live in remote areas.

England and Wales’ the concept of science for all that focuses on providing access to science education for all citizens in a country regardless of gender, abilities, ethics, race, religion, and economic background has also been recognised by the Thai government. Key effort of Thai government that has served this concept is the inclusion of science subject into the national curriculum and regards it as a core subject. Therefore, all children will have an opportunity to learn science, as it is mandatory for all schools to teach science according to the national curriculum.

The establishment of Schools of Expanded Opportunity during the period of the second reform is also the government’s effort to allocate access to compulsory education to children in rural areas. This was perceived to help eliminate or alleviate educational disparity between urban and rural areas. Out of this effort, children in rural areas are expected to receive compulsory education just like others and gain knowledge to improve their quality of life.

Although the government has attempted to bridge the gap or mitigate an effect of the educational disparity through several efforts, according to the data obtained, it seems the gap has not been lessened. In my point of view, this would be a consequence of the existing social and economic disparity. As education, social conditions and economics are strongly tied together, impact of each element will inevitably influence the others.

4.1.3 School Context

Diverse arrays of factors that hinder the implementation of newly introduced teaching approach were identified. These factors include practices of leadership in which supports provided for teachers were less emphasised. Difficulty in disbursing money to purchase equipment was described by interviewees. Several of the interviewees also pointed out issues related to shortage in equipment as well as
teachers and school personnel. In addition, some interviewees regarded improper teaching practices and attitudes of teachers that refused to change their teaching practices as obstacles that hindered successful implementation. These issues are tied in with the literatures as follows.

The first research question of this study sought to determine whether a science teacher’s practice in classroom had changed after the reform. Therefore, science classroom observations was a strategy to gather data, and the observations were conducted in 10 different schools and 12 different teachers. Moreover, the observation within particular schools was undertaken according to the schedule suggested by the science teachers. Some lesson observations were carried out at the beginning, middle, or at the last period of the second semester. Therefore, incidences observed in the classrooms might vary according to the time contexts of each individual school. I noticed that more student-centred instruction and activities were implemented in lessons during the first two months of the second semester. On the other hand, larger proportion of lecturing and reviewing were implemented during the last two months of the second semester. These happened due to the fact that teachers had to spend the last two months of the second semester preparing students for Ordinary National Education Test (O-NET) and semester examination. Furthermore, some schools were requested to send students to participate in events organised by local communities. Some of these events were held during school hours and resulted in absence of some students. Following this, lecturing became the primary strategies instead of practical works or other student-centred learning approaches to continue the lessons.

From the analysis above, lecturing and reviewing can be seen in many lessons. These approaches were implemented to communicate ideas, meanings of scientific words and languages used in science. For instance, teacher JP introduced characteristics of an animal and plant cells as well as the differences between them. This corresponds with the concepts of science lessons given by Sutton (1992) in which science lessons should consider the meanings and ideas of nature that people have said. An idea of Sutton can be demonstrated and quoted from his book as;
The main objective of interpretive activity should be not the circuit itself, but what someone has said about the circuit, not the events in the test tube alone but someone’s way of talking about them (Sutton, p.72, 1992).

Sutton (1992) also stated that practical works played a role in providing students evidences to support scientific ideas and meanings and enabling students to gain more understanding of such concepts (Sutton, 1992). This claim has also been supported by conversations during student focus group interviews. The student participants said that they enjoyed carrying out practical works because it was fun and helped them comprehend lessons in the greater extent than reading textbooks or listening to explanation from teachers. However, it is inconclusive whether the practical works observed literally helped increase the understanding of the student participants because the conceptual development of the students was still difficult to assess. This is in line with what Millar (2004) pointed out. According to Millar (2004), an enquiry-based approach such as practical work produced outcomes that were hard to measure, and it was difficult to claim that students had acquired an enquiry skill (Millar, 2004). This issue is one of the challenges researchers face when measuring and evaluating the impact of practical work on students (Dillon, 2008).

Information Technology (IT) was recognised as a useful tool for supporting practical work. A proper use of computer and its peripherals for gathering and analysing data from an experiment allows students to observe, reflect, construct, and conceptualise knowledge underlying that experiment (Lunetta, Hofstein & Clough, 2007). However, there was a recommendation from the House of Lord Science and Technology Committee in which a website dedicated to practical work should be verified by the government in order to make the website feasible and stimulating to students (House of Lords Science and Technology Committee, 2006). From the classrooms observed, there was no use of IT in practical works to support and stimulate students’ learning. The teachers used only their personal laptops to assist their lectures. For example, teacher KP used his laptop to show students the universe and planets on Youtube. This is probably because most schools participated in the
study are in disadvantaged areas that has a problem related to shortages of funding for IT equipment.

Formative assessment is believed to be an essential element for increasing of quality of teacher-student interactions, raising students’ responsibility for their own learning, enabling students to acquire life-long learning, and helping students improve their performance and attainment (The Organisation for Economic Co-operation and Development [OECD], 2005). Discussion is one of many formative assessment strategies that allow teachers to assess, react and guide students’ thinking and also provides opportunities for students to communicate their understanding with the teachers and peers (Black, 1998). From the observations, discussions were conducted in various patterns; e.g., discussion with peers and that with the whole classroom. In addition, the discussions were usually initiated by the teachers through open-ended questions; e.g., teacher WT asked the students to describe their ideas about the situation in everyday life that could cause resistance forces. This could benefit the students as Black (1998) stated that there was no right/wrong answer for the open-ended questions and this resulted in a lesser extent of students’ fear of failure to answer them. Poor or wrong answers to right/wrong questions given by students may engender the losing of confidence of students and probably decrease the students’ learning effort (Black, 1998).

Feedbacks to individual students are inconclusive, as it requires further evidence such as written assignment feedback, to examine if teachers give students feedback in a way that facilitates an improvement of students’ learning. Black (1998) stated that quality of feedback that helped improve students’ learning required teachers’ emphasis on guiding students to recognise strengths and weaknesses of the works they produced. Therefore, further evidence such as task-involving written feedback would give more insight to the quality of feedback (Black, 1998).

According to the incidences on the problem-based learning described above, the problems observed were quite well-structured and relevant to everyday experiences. This corresponds with suggestion of Hung (2009) in which teachers should propose problems relevant to everyday life as this is the way to improve quality of problems used in PBL approach (Hung, 2009). However, characteristics of
problem that teachers used in PBL lesson need to be refined as Savery (2006) recommended; the careful selection of ill-structured problem is vital for the implementation of PBL approach (Savery, 2006). Moreover, teachers are expected to allocate time at the conclusion period of PBL lesson for debriefing, encouraging students to reflect on what they experienced and what they learned (Barrow, 1988 cited in Savery, 2006). However, one of the classrooms observed was the introduction lesson for PBL and the debriefing process was not implemented at the time. Therefore, data that reveal an effective of debriefing process as well as reflections from students were not produced.

According to the literature review, the relevance of science in everyday life has also been stressed in science education of various countries. Although each country has interpreted this concept differently, all of those countries have shared common perception regarding this concept, as they have recognised significance of practical application of science and the participants of this study has recognised the same.

The role of group or peer discussion or group elaboration was described in a research by van Blankenstein and colleagues (2009). Results from this research indicated that the benefit of group elaboration is not limited to only facilitating learning through a process of problem-related texts but also rendering a capability of long-term memory (van Blankenstein, Dolmans, van der Vleuten & Schmidt, 2011). In addition, there is a relationship between elaboration and prior knowledge (Schmidt, Rotgans & Yew, 2011). While conducting the PBL approach, prior knowledge is activated and elaborated through problems assigned and in a small-group setting. Furthermore, it can produce even more desirable effect in facilitating an understanding of problem-related information when students learn from one another and share information among them (DeGrave et al., 1985 cited in Schmidt, Rotgans & Yew, 2011). From the science classrooms observed, group discussion activity was seen in the PBL classroom; e.g., in teacher JP’s PBL classroom when he asked each group of students to discuss and think critically about the problem the teacher proposed, identify its relation with contents of previous lessons, and arrange an order of expected tasks that needed to be carried out to solve the problem.
Moreover, group discussion was usually carried out after practical works had finished. Therefore, the implementation of group discussion is likely to be a strategy the teacher used to enhance students’ learning.

From the analysis of classroom observations, science lessons that implemented PBL approach were conducted in a group manner. This incidence benefited students to some extents because it is in accordance with an overview of PBL approach given by Savery (2006), which described group collaboration as crucial in providing an opportunity to develop collaboration skill which enables students to work with others when they get jobs (Savery, 2006). Moreover, group collaboration was also mentioned by Schmidt and colleagues (2011) as one of two factors that equally contributed to the extent of learning in PBL, apart from knowledge acquisition of individual learner (Schmidt et al., 2011).

The role of tutors or teachers was also emphasized as a key actor who facilitate students’ learning by providing a framework to support students to construct their own knowledge (De Grave et al., 1985 cited in Schmidt et al., 2011). Moreover, teachers are also expected to facilitate activeness of students’ learning and encourage active participation of all students during group works, monitor students’ progresses, and get involved if necessary (Maudsley, 1999; Mayo, Donnelly & Schwartz, 1995; Wetzel, 1996). These expected characteristics of the teacher could be observed in PBL science lesson as the teacher guided and supported students by providing necessary ideas before asking students to solve the problems. For instance, teacher JP guided students by asking them what should be used to hold water tubes and what are the characteristics of tube holder.

The findings from science classroom observations show that the science teachers implemented SCL approach in diverse ways. However, apart from the observation data obtained, further evidence is also needed from interviews with the science teachers in order to gain data regarding their perceptions on the changes that have emerged from the introduction of the major reform and the implementation and also obstacles they encountered. By the end of the teacher interview periods, interview data were gathered from twenty-two science teachers. After interview
transcripts were analysed, issues as well as concerns with respect to the reform and the implementation of SCL approach were grouped as follows.

4.1.3.1 School Factors

Factors supporting the implementation of the reform in Thailand were identified in an empirical study (Hallinger & Lee, 2011). Those factors include school leadership, policy support and communication. Yet, powerful obstacles to the change were also identified, which include the complexity of the changes, financial support, staff skill and the school’s prior experience with the changes. The same study also suggested that the complexity of the changes significantly impeded the implementation of the reform in teaching and learning, with the larger extent than the implementation of ICT and school management system (Hallinger & Lee, 2011).

Results from the same empirical study also emphasised the issue related to Thai school principals’ attitudes. Regarding this, consequences of leadership’s lack of coalitions with Thai cultural norms can create additional complications to implementation of several initiatives; e.g., the student-centred learning and school-based management, apart from change in attitude and skills of teachers, students and communities (Hallinger & Lee, 2011). These critiques support the science teacher participants’ claim that a cause of unsuccessful the implementation of SCL approach is the leadership neglect to take serious consideration. That is to say, leadership plays roles in accommodating and providing good supports for teachers to implement the SCL approach. Without such quality support with an appropriate strategy from leadership, the implementation of SCL approach would be hard to succeed.

Factors that make situations of small schools (having 120 students or less than) in Thailand worsen have been characterised. These factors are a decrease in student population size, an increase of student mobility in rural area as a consequence of the improvement of rural transportation, and failure to attract qualified teachers from urban area (Nakornthap, 2008). Moreover, shortage of facilities, such as computers and high-speed internet as well as inadequate supervision from the distant Educational District Office, was also identified as problems for small schools (Nakornthap, 2008). The latter comment of this scholar
corresponds with the teacher participants’ opinions. They saw the lack of necessary
teaching aid-tools and apparatus as factors that restricted or hindered the
implementation of the SCL approach.

With regard to problems related to the implementation, example of practices
from other countries such as the UK would be used as an initial idea to construct a
framework of practice suitable to the Thai context. In a western country like the UK,
higher Education and local stakeholders play roles in teacher training. Teacher
training in the UK is supported by a government agency called National College and
Teaching and Leadership (NCTL). NTCL provides supports to schools in order to
improve the quality of in-service educational workforce by school-to-school support
strategy (National College for Teaching and Leadership [NCTL], 2013). School-to-
school support is a strategy that provides opportunity to schools to develop high
quality local network. Teaching schools will be supported to be a centre of local
hubs of excellence. With this regards, the teaching schools will work with teaching
school alliance. Teaching school alliance can be a group of schools that receive
benefits from the support and other strategic partners including schools, universities,
private sectors and local authorities. By collaboration with strategic partners and the
leadership of the teaching schools, school-to-school support will offer diverse ranges
of professional development opportunities that meet the needs of 1) schools within
alliance and 2) teachers and staffs who working in the partner schools (NCTL,
2013). School-based continuing professional development programme will be
delivered by the teaching schools. Regarding this, the best leaders and teachers who
are experts from across strategic partners will be recruited to share and transfer their
experiences (NCTL, 2013). According to benefits of network and collaboration
strategies described, I recognises that school-to-school support and collaboration can
be a practical strategy for Thai schools to improve quality of teachers and their
teaching practices. However, monitoring and evaluation mechanisms of this strategy
are also needed in order to assure that desirable outcomes will be obtained.

Teachers and schools are inextricably interwoven factors in which changes in
teaching and learning practices may be perceived by stakeholders as ‘a change of
culture’ rather than a technical change (Rogan & Grayson, 2003). Fullan (1998,
p.226) addressed the significance of re-culturing schools. According to his point of view, re-culturing refers to ‘transform[ing] the habits, skills and practices of educators and others toward a greater professional community that focuses on what students are learning and what actions should be taken to improve the situation’.

To effectively implement the curriculum, classroom cultures should also be emphasised. Squire and colleagues (2003) found that assimilation of the curriculum implementation process into the classroom culture contributed to successful implementation of innovative curriculum. The idea that innovation curriculum is adapted based on the consideration of teacher needs, pedagogical beliefs, experiences, aims at producing curriculum that matches cultures, needs, constraints, and issues related to each classroom supports this claim. In regard to this, a classroom culture that occupies the broader school’s culture can serve as an important determination of the way in which curriculum is implemented (Squire, Makinster, Barnett, Luehmann, & Barab, 2003).

To make curricula fit in with a local context, consideration regarding flexible curricula should to be taken into account. As previously described in the literature review, more opportunities in developing locally relevant curricula should be offered to schools and teachers to make them more relevant. To motivate the teachers within these schools, they should be given more opportunity to participate in decisions about implementation, and be directly involved in the modifications to meet local needs and solve local issues.

There should be flexibility in the adaptation of curricula that allows curricula to be responsive to local needs. There should also be support for teachers to redesign the learning environment (Schwartz et al., 1999 cited in Squire et al., 2003). Squire and colleagues (2003) also supported the idea of curriculum designers developing tools and resources to assimilate the local context. They explained that this will make curricula more useful and meaningful and offer students ‘locally grounded learning experiences’.

To support the adaptation that arises from encouragement and shared ideas, collaborative communities where researchers and teachers engage in collaborative work are essential (Avery & Carlsen, 2001 cited in Squire et al., 2003). A society that
facilitates collaboration can be regarded as a ‘collegial culture’. Other cultural features can also be found in a collegial culture such as (D. H. Hargreaves, 1995):

1. Members have strong senses of morale, a mutual commitment to share a vision, and those in which a clear purpose and direction are communicated to teachers.

2. Members emphasise the establishment of a consistent environment and expectations for teachers and students by using a coordinated policy that is systematically formulated.

3. Members consider the improvement of curriculum continuity and progression for students in order to avoid unplanned repetition or omission of the curriculum.

4. Members emphasise and support discussion related to teaching and learning, develop practises that assist mutual classroom observation, and encourage reflection and the sharing of experiences, practises, and constraints.

5. Members acquire a method to adjust the demands of professional development to be in line with those of school development.

It is clearly seen from the data obtained from the classroom observations and teacher interviews that environment and general practices of participating schools in this study were not supporting the development of the collegial culture. The participant teachers were assigned to undertake non-teaching jobs; therefore, their workloads were added up from their regular teaching practices and this became burden for them. In addition, many of them struggled due to the requirement for producing reports as well as supplementary documents for the external education quality assessment undertaken by ONESQA. These two situations cause difficulties to the teachers in focusing on the improvement of their regular teaching practice as time for lesson preparation was lessened. Furthermore, the school principal excessively assigned extracurricular activities to students. Therefore, classroom periods were reduced, hindering the teachers from changing their ineffective practices. All of these situations described do not facilitate the teachers to implement
student-centred learning approach and also do not encourage the teachers to seek for an opportunity to discuss topics relating to teaching and learning as well as to reflect upon their practices due to their overloaded assigned tasks and reduced classroom period. As a result, the implementation of the new curriculum was constrained because the school culture did not support the teachers to change their practices, and hence there was no apparently change in teaching practice of the teachers.

A community of practice is considered by several researchers to be an essential element to effectively implement a curriculum that facilitates the transformation of a reform agenda into actual practice (Loucks-Horsley et al. 1998; Richardson & Placier, in press cited in Powell & Anderson, 2002). Powell & Anderson (2002) define a community of practice as ‘a supportive school culture that is characterised, in part, by sustained collegial support from administrators, fellow teachers, and other educators’ (p.130). This, once again, stresses the significance of school culture.

To achieve effective curriculum implementation in a context of developing country, Grayson and his colleague (2003) proposed three constructs that require consideration during every stage of the implementation process. The three constructs include the profile of implementation, the capacity to support innovation, and outside support. It is also worth noting that these constructs are interwoven. Thus, each construct requires information from the other and, above all, the primary goal of the intended educational change must remain the focal point.

According to Rogan and Grayson (2003), the profile of implementation represents a map of the learning area that offers possible routes leading to a number of destinations. This benefits curriculum planners at the school level because it helps them identify their position and recognise their current strengths. Key aspects that appear in the profile of implementation include 1) descriptions of what the teacher does, and what students do, in the classroom, 2) the application and nature of practical science work, 3) the inclusion of science in society, and 4) the assessment practice pattern (Rogan & Grayson, 2003).

Indicators of the capacity to support innovation are categorised into four groups, including: 1) physical resources that influence the capacity, 2) teacher
factors that are related to background, experiences, confidence, dedication, and engagement in teaching, 3) learner factors that are related to background, strengths, and weaknesses exhibited during learning situations, and 4) the school’s ecology and management (Rogan & Grayson, 2003).

According to Rogan and Grayson (2003), outside agencies refer to organisations outside the school. The outside support profile is developed with the intention of providing descriptions regarding the kinds of actions undertaken by outside agencies and how they disclose their intentions. To develop such a profile, the types of support provided by each type of organisation need to be taken into account (Rogan & Grayson, 2003). In addition, issues of authority and credibility regarding the organisations should not be overlooked because these are directly involved with the ability to support or pressure actors involved to bring about change (Rogan & Grayson, 2003).

The support provided can be divided into material and non-material. The material support is also divided into: 1) physical resources, e.g. buildings and books, and 2) direct support for learners such as learning spaces. Non-material support is usually offered in the form of professional development (Rogan & Grayson, 2003); however, the profile of outside support that is created should only be applied to individual organisations because different organisations apply different types of force and offer different types of support. Therefore, it would not be practical to try and average all of the efforts received from all of the organisations that interact with schools (Rogan & Grayson, 2003).

When the process of curriculum change is seen as a cultural change, the construction of outside support becomes a necessary element. The supporters need to acknowledge and accept that cultural values are a product that is shared among the members of the community with which they are interacting (Rogan & Grayson, 2003). Although individual members might adopt new values, acceptance, commitment, and understanding from the majority of the community is mandatory if the goal is to embed innovation within a system. It is therefore necessary to assist in a community of practice development and that such development must be recognised and performed by outsiders who wish to promote innovation within a school (Rogan
Within the system, a community of practice influences and possesses the authority as they examine current practices and also authorise and promote the adoption of new and shared cultural values. In addition, there is a need to support this community while they implement innovation to enable a shift in cultural values (Rogan & Grayson, 2003).

The zone of feasible innovation (ZFI) is what Rogan and Grayson (2003) refer to as a place where development occurs. This definition was analogised from Vygotsky’s zone of proximal development. According to Vygotsky (1978), the zone of proximal development is the ‘distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers’ (Vygotsky, 1978, p. 86).

According to Rogan and Grayson (2003), the practices that teachers currently hold must be identified because good curriculum implementation strategies should be furthered ahead of the current practices within the zone of feasible innovation. Moreover, Rogan and Grayson (2003) recognised that the current level of classroom interaction and the current capacity to support innovation are factors that contribute to the effective implementation of curriculum. To proceed from the current developmental level, Wood, Bruner, & Ross (1976) also mentioned ‘scaffolding’ as an assistance tool. Rogan and Grayson (2003) explained that this is involved with ZFI, in which some sort of scaffolding is called for when the innovation takes place within ZFI. Later, the scaffold can be removed when the capacity to support innovation increases.

Rogan and Grayson (2003) also hypothesised that there is a relationship between the profile of implementation and capacity to support innovation. Thus, curriculum designers or related actors should not overlook either the profile of implementation or capacity to support innovation if they expect their efforts to bring about change (Rogan & Grayson, 2003).

The profile of implementation and capacity to support innovation also offer an indication as to the provisioning of support from outside schools. Examples of this notion were given by Rogan and Grayson (2003) who explained that, if schools
do not have electricity, it is not practical to provide computers. Another example given explained that, if schools lack laboratories or equipment, it is pointless to provide workshops on laboratory work for teachers. They also described an example of this notion in which support was of a non-material type. Rogan and Grayson (2003) illustrated that, when school resources are unavailable and teachers lack knowledge regarding content, performance assessments in the laboratory are useless or irrelevant. Instead, the level of implementation that teachers see as relevant and ultimately situate within ZFI should be a major concern that professional development should pursue (Rogan & Grayson, 2003).

To enable meaningful learning, knowledge should be constructed by the learner. This can be applied to the implementers as well. When others originate and decide upon changes, and then demand that implementers put these changes into effect, the implementers must recognise what those changes mean to them in their own context at that particular point in time (Rogan & Grayson, 2003).

Successful implementation requires effective alignment between the three constructs and the level of learning experiences that currently exist. Therefore, there is a need to accurately identify learning experience levels (Rogan & Grayson, 2003).

To improve school management or teacher competency, stakeholders must make every effort to emphasise the improvement of learning experiences. This notion also extends to innovation capacity. As Rogan and Grayson (2003) stated, the capacity to innovate is enhanced when schools have operable laboratory equipment; however, if that equipment still resides within boxes, then it has no effect on the learning experience.

Again, teachers’ actions, assessments, and use of resources are required and all implementers and stakeholders should consider how well these factors enrich the learning experiences of students. Innovative teaching approaches that are implemented by a teacher in a classroom may not be beneficial if students do not acquire any learning experiences or learn more effectively. Consequently, the classroom experiences that are described in the profile of implementation will not encourage and respond to the primary focus of the intended change (Rogan & Grayson, 2003).
4.1.3.2 Teachers-Related Factors

According to the conversations with the teacher participants, issue related to the shortage in human resources were found to strongly affect the quality of learners, and this issue was also recognised by the Office of the Education Council (OEC). Therefore, OEC introduced several strategies in order to enhance the quality of newly recruited teachers and in-service teachers that serve the implementation of teaching techniques, raise the effectiveness of teaching and conform to individual specialisation (OEC, 2013a). The Office of the Basic Education Commission (OBEC) and Office of The Teacher Civil Service and Educational Personnel Commission (OTEPC) took part in this mission by reconsidering a process of assignment and appointment of teachers and readjusted it to respond to the problems of teacher shortage in main subjects; e.g., English, math, science and Thai. Thus, teachers were expected to be assigned according to their specialisation and schools’ demand, and improve their competencies continuously through an appropriate training. Schools where teachers have to teach outside their specialisation are expected to develop in-school training system as well as supporting and mentoring system in order to improve the quality of teaching skills (OEC, 2013a).

There was also a consideration to improve the process of teacher production. OEC suggested that government bodies including OBEC, OTEPC, Office of the Higher Education Commission (OHEC) and others related stakeholders should work cooperatively in order to readjust and plan the process of teacher production according to subject and context of areas where the school is located. These works were also expected to implement explicitly with the inclusion of the process of appointment as well as professional development programme (OEC, 2013a). In addition, a strategy was specifically developed to solve issue about teacher shortage in main subjects. With this regard, OHEC, others related stakeholders as well as education departments from higher education cooperatively arranged the teacher production framework which must be consistent with the demand (OEC, 2013a). Moreover, the continuous monitoring and evaluating quality of teacher trainees were also crucial. Several requirements were also indicated, including an improving and strengthening of teaching profession curriculum (OEC, 2013a). Expected outcomes
were productions of teachers with 1) competency in curriculum development, 2) innovative skill in development of instruction media, 3) good psychology and skill in classroom management, and 4) good conducts and etiquette as well as teaching spirit. Furthermore, the problem related to teachers’ workload was not overlooked. To respond this, OBEC, OTEPC and related stakeholders have been assigned to develop time management skills of teachers (OEC, 2013a). However, the literature pointed out another possible explanation regarding an issue about shortage of teachers. As described in the literature review, there are 900,000 (approx.) of licensed teachers but not all of them belonged to educational organisations. Therefore, ineffectiveness of teacher recruitment would be another issue that requires close attention.

According to the conversations during the teacher interview, the application of ‘Early Retirement Scheme’ has worsened the issue of teachers’ shortage. Data from the Office of Civil Service Commission indicated that 8,381 teachers retired from service during October 2011-September 2012, and the government cabinet responded to this circumstance by granting the restoration of those vacant positions to the Ministry of Education (Office of the Civil Service Commission [OCSC], 2013). However, it seemed that the government’s response has not made a noticeable change. The reason why the situation has not fully recovered is that the procedures of teacher recruitment, assignment and appointment are time-consuming and those procedures are still under the process of implementation.

The issues related to ‘no fail’ or ‘social promotion’ policies have been raised and widely discussed (Halligan, 2011). With this regard, the Ministry of Education by OEC (Office of Education Council) arranged a symposium opened for public as well as for scholars and educators to discuss and share ideas. In this symposium, causes of failure in quality of students were discussed. The issues related to the quality of teachers, pre-service teachers and teachers’ practices were also mentioned. The topic of teacher education and pre-service teachers programme was also raised. One participant saw that pre-service teacher education was undertaken using traditional approach; e.g., lecture. Therefore, newly appointed teachers conduct their teaching according to what they were taught in university (ASTV Manager Online,
2011b). Unbalance between the use of technology-based and conventional teaching instrument was also an issue. For instance, when teachers heavily employ computers and the internet to carry out their lessons, it would possibly results in a decline of opportunity for students to practice writing skill (ASTV Manager Online, 2011b). These issues, although not specifically related to what the teacher participants described, could imply that suitable teacher education curriculum and good practice of teacher are required for the effective implementation of the SCL approach. Moreover, when classrooms solely rely on IT and its apparatus, it is obvious that school improvement budget is mostly allocated for purchasing those stuff and a small portion of the budget is left for improving the quality of teaching and teachers’ practice (ASTV Manager Online, 2011b). This issue has directed my attention to another concern which is management skills of school leadership. To make the best use of school budgets, school leadership, particularly of the small schools, need to carefully examine and prioritise purposes of budget spent and manage to obtain the well spent of each portion of the budget.

As the issue related to teachers’ practice has been widely discussed and several problems have also been raised, it is essential to depict a strategy that was proposed to deal with these problems. A scholar suggested that teachers’ learning communities are vital for teachers to alter their practices from traditional classroom practices to innovative practices. Within teachers’ learning communities, teachers who are members can learn from their own point of view as well as from others’ practices and experiences, obtain more opportunities to exert different forms of teaching technology and take part in different types of social relationships with other teachers in different community settings (Mclaughlin, 2005). Communities and networking become the approaches that policymakers have emphasised as strategies for generating knowledge as well as creating knowledge-shared environment regarding practice and implementing new curricula framework (Darling-Hammond & Mclaughlin, 1996). Again, collaboration and networking strategies were emphasised, as these strategies can take part in the development of quality teacher practices.
Consideration regarding inappropriate teaching practices and pedagogy of the teachers was mentioned by the science teacher participants. This corresponds with a report from the Office of the Educational Council of Thailand (ONEC) that stated that this problem was a factor preventing successful implementation of National Curriculum (B.E 2001). ONEC discussed that the problems which could cause difficulties in implementing National Core Curriculum in 7 different topics including 1) problems about students, 2) problems about teachers, 3) problems about curriculum, 4) problems about teaching practice, 5) problems about instruction media, 6) problems in evaluation and assessment practices and 7) problems in the process of promotion and support from all related stakeholders. With this regard, lack of study skills in students (e.g. reading, writing, communicating, listening, numerical skill and systematic thinking) was seen as a major problem that could impede students’ learning and management of learning process (OEC, 2013). In response to this problem, the national curriculum was adjusted in 2008 by implementing Brain Based Learning idea in order to improve study skills of students. However, the problem still exists (OEC, 2013). Therefore, teacher development has become a major focus and issues related to the quality of teachers are expected to be resolved (OEC, 2013). Reflecting on the interviews with secondary science teachers, I suggests that several strategies that aim to improve practices of an elementary teacher should be implemented, including 1) providing training in childhood education to in-service elementary teachers whose specialisation falls outside such area, 2) recruiting and increasing the number of graduated teachers who specialise in elementary education, and 3) ensuring an assessment criteria to permit students to pass to the next level, as these will be more practical.

The issue about teachers’ salaries and allowance has been recognised by the government agency. Generally, the ceiling level of teachers’ salaries and allowance are still low compared with other professional disciplines; i.e., medical doctors and engineers. In addition, there are an increasing number of problems about teachers’ debts as a result from financial struggle (Cheangkul, 2008). Regarding this, the teachers have attempted to seek extra income by doing part-time tutoring or other part-time jobs. This subsequently results in the reduced time the teachers spend in lesson planning or the teachers’ loss of motivation to teach (Cheangkul, 2008).
Although the Salary, Allowance for Academic Status and Position Allowance Act 2011 was implemented and resulted in changes in the ceiling level of salary (OEC, 2013b), those problems still exist. In June 2013, ONEC proposed several strategies to improve the system of teachers’ salaries and allowance, and resolve financial problems of teachers. Those strategies include reviewing and adjusting salaries and allowance scales for current and newly recruited teachers, debt moratorium and debt refinance. Furthermore, operational guidelines were introduced consisting of 1) arranging necessary amenities, tools and other facilities for teachers in order to allow them to keep their prestige of the teaching profession; 2) investigating recent situations of teachers’ debts and studying factors that facilitate teachers’ incurring debts; and 3) examining outcomes of the debt moratorium and debt refinance programme for further recommendations (OEC, 2013b). Another issue that concerned ONEC is prodigality of the teachers. Although this issue cannot be solved rapidly, ONEC and other related stakeholders have attempted to 1) offer a resolution to the teachers by orientating them on the application of ‘sufficiency economy’ concept which was introduced by His Majesty the King Bhumiphol as a way to generate teachers’ resilience and avoidance of debt recurrence; 2) provide special allowance and means for living, e.g. housing and transport costs, for teachers in areas of risk and remote areas; and 3) provide compensation for families of teachers who lost their lives on duty in the southernmost provinces and other areas of risks by establishing a compensation fund (OEC, 2013b).

Several explanations regarding the resistance in changing practices of teachers or teachers refusing to implement a new approach were identified. Some teachers believed that didactic approach offered better outcomes in terms of the delivery of the information which was in line with the examination syllabus (Morris, 1985). In addition, a dilemma emerged when the objectives of the curriculum reforms were to develop enquiry skills and attitudinal change as well as open-ended activities through the introduction of the new teaching style, but the recollection of lower level cognitive knowledge became a focus of examinations instead. This dilemma created tension to teachers as their own and their students’ formalistic expectations of exam-oriented teaching often influenced over their practices and contradicted with the curriculum objectives (Guthrie, 2011). Furthermore, the
resistant teachers saw that a new approach could not enable students to achieve objectives of the syllabus and failed to cover the syllabus and, as a result, those teachers got blamed from the failure of students (Morris, 1985). Inappropriate working conditions especially in remote or disadvantaged areas were also mentioned as factors that impeded the change in teaching practice. These included the lack of space and equipment as well as fixed classroom furniture that limited a variety of science-related activities (Guthrie, 2011).

Time spent implementing the change also raised another issue. Implementation of a new approach requires an enormous time for preparing lessons, teaching, marking and supervising. In addition, time those teachers devote for families and community group is also important. This would be a reason why teachers might not have enough time in a day to carry out the implementation of a new approach (Thaman, 1987 cited in Guthrie, 2011). The implementation of a new approach can also be problematic due to the added-up cost from the requirement of varieties of books and supporting materials (Beeby, 1966 cited in Guthrie, 2011).

Several authors agreed that beliefs played a role in the resistance to change of teachers. Beliefs prevented change even when that change was initiated for clearing up misconceptions (Tynjala et al., 2001 cited in Cruickshank, Jenkins & Melcalf, 2011; Nettle, 1998). Teachers who lack believe and keep complaining about students’ ability, e.g. students are not able to learn, are prone to exhibit several negative responses which include 1) allowing students less time to answer a question, 2) not encouraging and supporting students to answer a question, 3) being prone to criticism, 4) providing less demanding works as well as less friendliness with students (Good & Brophy, 2003). On the other hand, teachers who has high respect for their students’ ability were prone to spend more time teaching and introduced more warm atmosphere to the classroom, allow students more opportunity to response as well as provide more feedback (Rosenthal, 2003).

Beliefs that teacher trainees hold before they experience practical teaching still dominates their beliefs even after they already finish practical teaching. However, radical changes in teacher trainees’ belief can be observed (Nettle, 1998). A researcher claimed that novice or beginning teachers tended to change or accept
innovations more easily. This claim may simply refer to the beginning stage of being a teacher as being less discerning (Barnes, 1987 cited in Cruickshank et al., 2011).

As previously described in the literature review, the implementation of change is influenced by the perceptions and attitudes of the teacher. In regard to this, the knowledge and beliefs that teachers have serve as important factors in terms of understanding changes in teacher practices when curriculum reform is introduced. According to Schon (1983), teacher practices are regulated by the knowledge they use while they are teaching. Thus, he suggests that teachers should not overly rely on academic knowledge in decision making, but rather, the accumulated experiences that those teachers collect along their career path (Schon, 1983 cited in Powell & Anderson, 2002).

In the relationship between teacher beliefs and the classroom, beliefs serve as the grounds that teachers use to interpret classroom situations. In addition, beliefs help teachers adjust when they encounter challenges, dilemmas, or constraints. Prawat (1992) identified several criteria that facilitate changes in beliefs. These criteria include: dissatisfaction in regard to their current beliefs; the need for an alternative method that is meaningful and useful; and the need to explore a link between earlier ideas and new beliefs (Prawat, 1992).

The impact that school has on teacher practices has also been recognised. As mentioned by Cohen (1989), changes in teacher practices require new knowledge that can be constructed from any discussion of reform. A discussion is a form of transmission of knowledge about practices, such as critiques in regard to topics, views and ideas about the reform, and ideas about better practices. A school system can be a place where the transmission of knowledge occurs; therefore, school systems obviously affect teacher practices (Cohen, 1989 cited in Powell & Anderson, 2002).

Changes in teacher practices are also affected by the self-efficacy of teachers. For a teacher, self-efficacy can be described as ‘a strong sense of being good as a teachers and then feeling that one could learn new strategies for teaching and do them well’ (Powell & Anderson, 2002, p.129). De Mesquita & Drake (1994) found a strong relationship between self-efficacy and the ability of teachers to implement
reform-based curriculum materials. Smylie (1988) also noted that teachers with a strong sense of self-efficacy are more likely to be willing to try a new practice and change practises from those that they know and/or are comfortable using. This is another factor related to teacher cognition that affects their changing of practises.

According to Fullan (2007a), professional development that includes workshops, courses, programmes, and related activities that are provided to teachers with the intention to develop skills and new ideas is not substantial for enabling effective changes in teacher practises. To make more functional improvements, this researcher acknowledged that ‘learning to do the right thing in the setting where you work’ is more practical. The opportunity for teachers to continuously engage in ‘learning to do the right thing’ is also required (Fullan, 2007a). Deprivatisation could enable activities that allow teachers to observe other teachers and be observed by others, as well as allow them to participate in debates related to the issue of effectiveness in terms of their practises (Fullan, 2007a). The same researcher also claimed that this could change culture and practises; however, it would be difficult to make this happen. The deprivatisation of teaching could serve as a foundation for collaborative work to improve teacher instructions and is worth an attempt (Fullan, 2007a).

To effectively implement curricular innovation, the structure of existing curricula and assessment processes should also be taken into consideration. Difficulties in changing teaching practises and learning methods would emerge if course syllabi and assessment procedures are maintained. Hence, there is a demand to fit organisational culture that emphasises collaboration and collegial reflection with both characteristic of innovation proposals and its implementation procedures (Reinmann-Rothmeier and Mandl, 1999 cited in Altrichter, 2005).

To change teaching practises among teachers, the ‘pre-active planning’ stage should be focused upon. Such planning requires support from curriculum material through the supplying of a clear orientation in terms of the teaching task (Akker, 1988). The critical characteristics of lessons should be provided and there should be guides in regard to how to deal with problems that may arise during the teaching process (Akker, 1988). A balancing of interplay between the influence of a situation
and personal intentions during a task will be vigorous when a person wishes to encourage a more precise and reasonable plan for action. Consequently, this will create a rigid base for reflection on the process and each individual role in the learner (Akker, 1988). These activities that use meta-cognitive ability will enhance the potential of the learner to drive their own learning process (Akker, 1988).

According to Akker (1988), this concept has been applied to the teachers. Teachers should be provided with clear directions on the orientation of their tasks during the first stage when learning about new programmes or instructions. Therefore, appropriate curriculum materials designed for initial use by teachers should include ‘procedural specifications’ that contain clear and precise advice about elements of the curriculum that need to be emphasised (Akker, 1988).

According to Fullan (1991), the process of change is also influenced by the process of vision building (Fullan, 1991 cited in Powell & Anderson, 2002). A change in teacher beliefs and knowledge about science, teaching, and learners is required when implementing new curricula and using standards-based curriculum materials. Vision building must be the first task to accomplish when selecting and implementing any new programme or curriculum. In regard to this, a vision that is specific to science education should be linked with the school’s vision (Powell & Anderson, 2002). Through the implementation of this process, school communities will be able to acknowledge both the direction and goal of the reform. In addition, a vision that is constructed with assistance from the community will create a reform effort that can be sustained because people will recognise the relevancy between the reform, the plan of community, and the educational mission of a community (Powell & Anderson, 2002).

Bell & Gilbert (1996) proposed another reason for teachers to change their practices. They suggested that for teachers to change their practices, they are required to be able to envision what other choices might look like in the classroom. The opportunity to discover the practical aspects of the alternative theory and to investigate that part of the theory that the implementers found to be useful and meaningful should also be offered to those implementing the curriculum (Rogan & Grayson, 2003).
The issue related to teachers’ beliefs and the resistance to change have been pointed out by the interviewees. Obviously, these issues are quite difficult to find a solution for as a strong character of those teachers was established along their long-term working experience. Several things that we can do include cultivating attitudes in accepting changes in teacher trainees, creating passions of newly recruited teachers to continuously acquire new knowledge, and creating a school culture that encourages collaboration as well as reflection and sharing of individual knowledge, apart from providing them with the development of teachers’ competencies.

Another important issue that has been raised is teachers’ lack of practical experiences in implementation of SCL and teaching approach. These issues were also pointed out by ONEC in 2013 (OEC, 2013) and were also mentioned in the literature review which describes the issue regarding the lack of experience of teachers in implementing a newly introduced curriculum. Again, ONEC suggested ways to improve these situations by calling for a cooperation of the Office of the Basic Education Commission (OBEC) and others related stakeholders (OEC, 2013). Those government bodies are expected to impose a standard of teaching that corresponds with curriculum contents of each key stage and regulate in-service teachers to improve their teaching practices according to the standard of teaching of each key stage. Regarding this, the teachers will be accommodated to be able to comprehend contents of curriculum using a diverse array of approaches, e.g. self-learning and training in specific topic (OEC, 2013).

The concept of Pedagogical Content Knowledge (PCK) was proposed by Shulman in 1986. According to Shulman, PCK refers to an outcome of an interaction of content and pedagogy. Teachers who possess PCK are able to transform subject matter knowledge into a form of knowledge that students are able to access (Shulman, 1986). PCK consists of knowledge of 1) what factors contribute to specific learning difficulties or what makes the topic difficult or easy to understand, i.e. students’ preconception about the topic, 2) strategies to eradicate students’ misconceptions and adjust students’ understanding, and 3) a diverse array of effective strategies for communicating subject matter knowledge, for example, topic analogies, illustrations or demonstrations (Shulman, 1986).
The inability of science teachers is a consequence of the teachers’ shortage, particularly of teachers who have specialisation in the science subject. Non-science teachers have to teach science and this result in poor practices in teaching or the inability to motivate students to learn science. This issue has also been discussed and linked with PCK, as a study stated that experiences and thorough and clear understanding of subject matter were required for the development of PCK (van Driel, Verloop & de Vos, 1998). When conducting lessons in unfamiliar topics, teachers tend to exhibit sign of misconceptions as well as struggling in teaching which is a consequence of limit in knowledge to specify student problems and preconceptions (Hashweh, 1987). These can be observed from the way in which teachers talk in an extended period and usually pose questions that require low cognitive levels of knowledge to find an answer (Carlsen, 1993).

Suggestions regarding the development of PCK in pre-service teachers were generated. Regarding this, there is a need to build teacher trainees’ awareness to acknowledge children’s alternative views of scientific phenomena even after students have got used to the instruction (Geddis, 1993). Moreover, teacher trainees need to reflect on how knowledge about children’s ideas can be used as guidance for the transformation of subject matter knowledge content. Hence, teacher education programme should increase more attention on the role of PCK and entail the transformation of subject matter knowledge (Geddis, 1993). A teacher training programme that provides more opportunity to use PCK in teaching situations as well as studying that emphasises on the structure and evolution of students’ ideas on particular topics should be implemented in order to improve teachers’ subject matter knowledge (Clermont, Krajcik & Borko, 1993; Shymansky et al., 1993). With this regard, a training course on topics related to PCK is expected to include activities related to 1) reviewing school books critically, 2) scientific experiments and 3) studying students’ responses (van Driel et al., 1998). Then, teachers were expected to be able to integrate these activities and reflect on both academic subject matter and classroom practices through specific assignments and discussions (van Driel et al., 1998).
Currently, the teacher development monitoring system is still unsystematic. Thus, ONEC recommended that the government bodies who played a role in teacher development should keep evaluating and monitoring the teacher development training programmes systematically and continuously by reflecting on learners’ outcomes (OEC, 2013a). In addition, those outcomes should be linked with a progression of teaching professions. Moreover, OBEC and higher education are expected to play a role in establishing a monitoring and assistantship system for teachers who undertake a training programme in order to enable teachers to successfully improve their teaching practices (OEC, 2013a). Furthermore, other local stakeholders related to teacher development within particular educational district, i.e. educational supervision committee, should keep following up, monitoring and supervising those teachers and other educational-related personnel individually (OEC, 2013a).

4.1.3.3 Student Related Factors

From the interviews with the science teachers, students are also an important factor that affects the reform and the implementation of SCL approach. Because children are raised by families and grown-ups within a community, the conditions of families as well as neighbourhoods have influenced characteristics of students. The low level in self-regulation of students is related to socio-demographic background of the students and their families, for instance, gender and socioeconomic status. Students who have grown up in low-income families are possibly exposed to circumstances that do not contribute to quality of living, for example, neighbourhood violence, communal insecurity and domestic violence (NICHD Early Childcare Research Network, 2005).

Several scholars have explored the requirements of an effective studying, which are skills and practices that enable students to collect, organise, absorb and employ information. In addition, effective studying needs students’ willingness to study as well as appropriate behaviour of individuals. Finally, effective studying is related to self-regulation during the beginning of development of study skills as well as applying the study skills outside classroom (Damon, 1991; Gettinger & Seibert, 2002; Kucan & Beck, 1997; Zimmerman, Bonner & Kovach, 1996). Low levels of
motivation and engagement of students as well as lack of supports from families are identified as causes of unpleasant behaviours that contribute to failure in effective engagement in a classroom. Therefore, volition and motivation are necessary for students who want to become academically competent students (Getttinger & Seibert, 2002). Effective studying influences students’ motivation in a way that academically competent students recognise their ability to regulate their academic performance. Hence, strong devotion and attention to study of those students will come up, as a result of motivation, from those who know they have academic competency (Schunk & Zimmerman, 1994).

Before proceeding to discuss a relation of motivation, academic performance of students and the reform, it is sensible to define the term ‘motivation’. Motivation is defined as

the act or process of motivating; the condition of being motivated; a motivating force, stimulus, or influence (as a drive or incentive); something (such as a need or desire) that causes a person or student to act and the expenditure of effort to accomplish results (DuBrin, 2011, p. 389; Merriam-Webster Online, 2015).

There are several clues that signal whether students are motivated to study. These include immediate response of students when teachers assign tasks, students focus and pay attention with tasks or lessons, students reply and ask questions, students’ enthusiastic and eager to study (Palmer, 2007). These reactions from students were seen during the classroom observation, not from entirely classrooms but, at least, some of them exhibited such reactions. In addition, student participants’ responses during focus group interviews, regarding question about how they tackle problems arising during lessons, have illustrated that they were motivated to some degree because those students claimed that they usually asked the teachers every time they were confused or did not understand the teachers’ explanations.

Internal motivation is the most critical factor that has an impact on students’ performance in a classroom (Georgiou, 1999). Based on this assumption, some
students who exhibit high academic performance will not be affected by others who also exhibit great academic performance. Hence, the internal motivation would possibly be a key to their great performance. How individual students perceive themselves has influenced the individual’s self-concept. As House stated in 1997 that one’s self-concept will be influenced positively when one perceives oneself as competent. Conversely, one’s self concept will be influenced negatively when one perceives oneself as lacking competence. In addition, students’ academic performance has been described as having significant relationship with the level of competence and self-concept (House, 1997). Conversations from the student focus group interviews revealed that some students studied science unwillingly and they had to do it because it was mandatory. This suggests that willingness and motivation to study science are urgently needed in Thai students, and self-regulation was also encouraged to develop in Thai students at an early age in order to enable them to undertake effective studying. In addition, successful reform will be occurred when students become active learners and able to acquire knowledge using logical reasoning and critical thinking. However, achieving all of those capacities requires students’ desire to learn and practice. Therefore, enhancing students’ motivation becomes a mechanism that cannot be avoided when successful reform is our goal.

The perception of students that perceived science and/or physical science as difficult subjects was pointed out by several studies as a factor that has an impact on students’ subject choice. Another research undertaken in the UK by Cheng (1995) also revealed that students’ grades in science and mathematics in GCSE have significant correlation with students’ uptake of physical sciences (Cheng, 1995 cited in Osborne et al., 2003). Scholars interpreted outcome of this research in the way that science subject is intentionally chosen by students who do it well (Osborne et al., 2003). Difficulty of the science subject was also mentioned by the student participants. However, further evidence related to students’ decision to uptake the science subject in high school and their exam scores in science subject are still required to affirm that the perception of the student participants has a correlation with their choices to uptake science subject.
Characteristics of low academic achievement students who exhibit ineffective study skills were discussed by several scholars. These characteristics include showing a passive role in learning and requiring assistance from others in modulating their study. Those low academic achievement students usually hesitate to examine their understanding of lessons and also fail to recognise the purpose of study. In addition, they are unable to devise a strategy or mechanism to correct inaccurate understanding of lessons (Gettinger & Seibert, 2002). Moreover, low academic achievement students fail to recognise importance of choosing good study strategy but rather keep carry out the same study strategy with all learning tasks, whether or not those learning task are difficult, rich in details or complicate (Decker, Spector & Shaw, 1992 cited in Gettinger & Seibert, 2002). Results obtained from the student focus group interviews revealed that many of participant students refused to complete homework by themselves. Rather, they usually asked others to help them complete the homework or copied it from others’ homework. This passive role in learning clearly reflects ineffective study skills of those students and this is also an evidence to reaffirm that initiative to promote willingness, motivation and self-regulation of Thai students, especially those who live in disadvantaged areas, need to be implemented immediately.

What will be described below is a presentation of the second strand of the discussion that, as aforementioned, will be built upon only the first three research questions and will describe how findings respond to these research questions. The reason to not refer to the fourth research question is that what can be done to improve the situation or policy recommendations which could be the answer of the fourth research question will be presented in the next chapter.

4.2 Research Questions

Generally, I should discuss issues related to science teaching in Thailand, as it is directly connected to the research questions. Unfortunately, I am struggled by how little of the reform appears to reflect what is going on elsewhere in the world. That is to say, I am struggled by how little the society talks about contents, skills and contemporary issues in science education. All over the world seems to be talking about these topics but they are not found in our policies. In addition, the teacher
interviewees did not talk about modern themes in science teaching which reflected that they really needed training. Furthermore, as those things do not appear in discussion, they should be mentioned in policy recommendations. Data obtained will be reflected in the following discussion.

4.2.1 What do heads of science departments and science teachers think about the changes?

The reform, according to the teacher interviewees’ point of views, does not seem to exhibit a major contribution to the change for the better in Thai education. Many of the difficulties have been portrayed by the teacher interviewees, all of which hinder the improvement of Thai education. Those difficulties can be explained in terms of the backwash of social transformation. In the past, social and economic conditions of Thailand were based on agriculture. Nowadays, this status has changed to capitalism, and globalisation has become a concept that holds great concern from every part of the Thai Society and also influences the social and economic development of countries around the world including many Asian countries. This transformation has led to emergence of many situations; one of those situations that could be a starting point of other subsequent conditions is a widening of income gap.

When there is a significant difference of income levels between economic areas and business zones in cities and rural areas, it is obvious that people tend to migrate to the place that they can ensure quality of living. Therefore, those economic areas and business zones are likely to be packed with people who are non-residents. In contrast, the place where those people left are nearly vacated and only elderly people and young children are left. This has made a change in pattern of living from extended families to simple families.

According to the conversations with the science teachers, in many cases, children are left with grandparents, but their expenses are provided by parents. In order to provide the children with the same quality of living and education as others, parents have to work very hard to obtain expected and desirable income. However, in fact, many parents cannot afford quality supports for their children and families because of their poor education backgrounds that limit their opportunity to gain adequate income. It could not be surprising that an accountability of parents has now
decreased or disappeared due to the fact that they have been struggling with hard work to obtain adequate income. Teenage parents is another type of parents that cannot support their children and families. Rather, they create problems. Immature parents have exhibited low level of accountability due to their immaturity and inability to support their children.

Parents’ misjudgement of their role is also a factor that hinders the effective implementation of the reform. From the findings, parents insist that it is the teachers’ job to help their children practice study skills, critical thinking skill as well as problem-solving skill. They have taken for granted that their only job is providing home and money to their children. As a result, children are monitored by no one after schools, resulting in children spending too much time with enticement and neglecting to do homework or, worse, straying and then exhibiting wild and reckless behaviour. All of the above affect students’ attainment.

Within the Asia Pacific region, the idea of decentralisation has been adopted and implemented as a strategy to respond with the changes in society and economics after the Asian economic crisis in 1997. With this regard, educational institutions have been targets for decentralisation in order to improve their management practices. However, decentralisation in Thailand, in terms of development and resource dissemination, has not been implemented substantially and explicitly. This has created disparity in obtaining resources; e.g., social welfare, government supports and job opportunity. The disparity has subsequently produced considerable effects on socioeconomic status, and those effects are responsible for the widening of an education gap. Apart from the disparity as a result of insignificant implementation of decentralisation, effects of ineffective decentralisation were also described in the literature review. The transformation of management structure, as a consequence of decentralisation, has created many issues that affect organisational management and the utilisation of human resources.

The SCL approach has been considered a western education approach. Moreover, several policies; e.g., tablets for every child policy, that were introduced to the Thai Education is another western idea. It seems that the policy makers make a great effort in bringing such a sophisticated approach to implement. However, the
policy makers appear to overlook or neglect, whether intentionally or unintentionally, to construct a solid platform or scaffold that supports the implementation of this reform policy. Apparently, an arrangement of provisional programme to equip education personnel to understand and cope with newly introduced approaches has not been applied throughout the country. In addition, the teacher interviewees believed that policy makers did not focus on consociating with local teachers. Thus, it is possible that those policy makers could not realise actual circumstances and difficulties emerging in schools in rural areas.

Improvement of Thai Education inevitably requires accountability from every stakeholder. However, the teacher interviewees mentioned only the role of parents in increasing childrens’ learning ability and academic performance. But to make the change more explicit and successful, it needs every stakeholder to recognise their role and take it as their duty.

Failure of evaluation and testing system was also extensively mentioned by the teacher interviewees. According to their views, the main focus of evaluation and testing system in Thailand relies heavily on exam results rather than a combination of the results and knowledge students obtained. As a consequence, the emphasis on practicing of basic study skills has been neglected. Furthermore, exam results cannot be used to reflect students’ academic performance. When the conversations during the teacher interviews were scrutinised, possibly it indicated that the science teacher interviewees viewed that the systematic teaching quality assurance system that focused on the improvement of actual classroom practices has not been fully implemented. Rather, the system heavily relies on document reports provided by inspected schools. Therefore, transparency and reliability of the reports have been questioned. In addition, it was possible that outcomes of the inspections have not been used for improvement purposes and education personnel who were inspected still could not understand the purposes of quality assurance system and how it could benefit them. Effects of the extensive production of evaluation report by the inspected schools, which has become a burden for teachers and has affected time spent in developing students’ attainment, are mentioned in the literature review as well. In addition, the critique from a TDRI researcher mentioned in the literature
review indicated that the assessment system, particularly the external assessment, was not conducted according to the actual circumstances of the inspected schools. Rather, the inspected schools have adjusted their environments to be responsive with the assessment criteria. Thus, the assessment outcomes would not reflect what has actually happened in the inspected schools.

Effect of indigenous societal characteristics of Thailand; i.e., patronage system or political instability on the reform, were mentioned by the teacher interviewees and in the literatures. Those characteristics have been hindering the improvement of Thai education to some extent. However, these issues are beyond the teachers, as the implementers, to make immediate changes. Rather, it requires changes in mindsets of the Thais which are difficult and will take time.

4.2.2 Has science teaching in these schools changed since the third reform? How has it changed?

It is clear from the findings and literatures that there are changes in teaching practices. However, as revealed in the first part of the discussion, science teaching has not changed much. The major change is an introduction of practical works or activities that allow students to gain hands-on experiences from science classrooms. In both the USA and England and Wales, consideration of using experimental works in science teaching has been clearly shown. From many of science lessons observed, I speculate that practical works were undertaken on the basis of the science teachers’ intention to practise students’ scientific skills as well as problem solving and critical thinking skills. However, SCL was not an absolute approach that the science teachers brought to implement in the observed classroom. A combination of the student-centred and the teacher-centred learning approaches was the most popular strategy, but there were differences in the balancing of the use of those two approaches among the science teachers. Within those classrooms where the science teachers implemented combination approaches, the Teacher-Centred Learning Approach was radically implemented in few lessons, particularly in a lesson on calculation. When the data obtained from science classroom observations along with conversations with science teachers are scrutinised, the possible explanations of the science teachers’ choice to implement the combination of the student-centred and the
teacher-centred Learning approaches are the teachers’ increased workload and students’ characteristics which have been intrinsic. That is, they have become passive learners since an early-age. The teachers’ workload has been increased due to the fact that those science teachers are assigned to perform such non-teaching jobs as purchasing goods. Consequently, available time for lesson preparation for the teachers has been reduced and resulted in their utilisation of the traditional approach that allows the teachers to complete the whole contents of each lesson chapter more easily. Characteristics of passive learners in students, such as following teachers’ directions and performing only what is required, have been promoted in students by surrounding environments; e.g., parents. This limits an opportunity for the science teachers to implement SCL approach because such approach requires students to be active learners.

There were some science teachers whose practice entirely relied on Teacher-Centred Learning Approach which included dictation and copying. The possible explanations would be the teachers’ resistance to change and, again, an enormous amount of teachers’ workload due to their extra jobs unrelated to teaching. Another explanation constructed from the conversations with science teachers is that students were assigned excessive extracurricular activities by the school principal. This affects teachers’ practice in that classroom period which was reduced and allocated for those extracurricular activities. Therefore, the teachers had to perform the traditional approach in order to finish a lesson within the reduced classroom period.

Some teachers possibly misinterpreted the concept of SCL approach. What those teachers did in the classrooms was asking students to carry out tasks which required students to strictly follow directions indicated in textbooks. According to the definition of SCL, those hands-on activities performed would not be exactly characterised as SCL approach because, as observed, it did not take account of students’ prior knowledge and did not allow students to learn according to their interests. It only provided opportunities to students to practice scientific skills and team-working skill. Moreover, characteristics of an active learner were not encouraged. Rather, most of the students in those science classrooms were occupied with activities that induced students to become passive learners; e.g., strictly
following experiment directions indicated in a textbook. This is in agreement with the issue described in the literature review that teachers’ unfamiliarity with the new curriculum causes diffidence in a science lesson planning and the curriculum implementing of teachers. Apart from activities that encouraged hands-on experiences, other kinds of student-centred pedagogy were also implemented; for instance, problem-based learning approach was brought into action. In addition, student participation was encouraged although only to some extent. This can be seen when the tasks assigned were requested by teachers to be conducted in a group and everyone in a group was expected to contribute to the task assigned.

4.2.3 What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?

Factors the teacher interviewees perceived that could prevent effective implementation of SCL were issues around school and related stakeholders. Leaderships and teachers were factors that directly influenced the implementation of SCL. According to the conversations with the teacher interviewees, it was the principals’ idea to arrange extensive extra-curricular activities for students. In fact, such activities benefit students in terms of building interactions with the community. However, too much or extensive of such activities can affect periods of study and, sometimes, result in lessened classroom period. For example, in some cases, the teachers had to omit a class and asked the students to join an event held by the community. The effect of leaderships was also reflected in terms of budget allocation. Some teacher interviewees expressed their worries regarding an initiative of principals to allocate school budgets to improve school’s landscape whilst teacher-aid tools were still deficient.

Shortage of school personnel is likely seen as major difficulty of implementation of SCL. In almost all small schools, teachers have also carried out non-teaching jobs, such as purchasing and accounting. This crucially affects teachers’ practice as the time they spend in teaching and preparing lessons has been reduced. Thus, it could be seen as a factor that directly impedes the implementation of SCL. Shortage of teachers with specialisation in science was also regarded as difficulty in implementation of SCL, and, as previously stated in the literature
review, this issue is agreed by Thai educators that it has obstructed and hindered the implementation of the enquiry approach. In fact, not only does science require teachers with corresponding specialisation but other subjects would also require teachers with an appropriate knowledge background. According to the teacher interviewees’ point of view, a strong attachment with teaching preference style of teachers also generated obstacles in implementing SCL. In other words, teachers, particularly those with long term teaching experiences, refused to change their teaching practice from teacher-led to be student-led. When the literatures and interview data were scrutinised, the factors that influence strong characteristics of those teachers are usually related to perceptions of teachers themselves and situations of surrounding environment, for instance, time limitation, enormous curriculum contents and syllabus, and shortage of teaching facilities.

Insufficiencies of school counselling and impotent primary education are seen by the teacher interviewees as cause of students’ lack of study skills as well as motivation to study. The teacher interviewees stated that ineffective implementation of SCL was an outcome of an impracticality of education policy, particularly ‘no fail policy’. This policy has produced undesirable outcomes in that students who are unable to pass the school test are still able to proceed to the next education level. Those students, without solid background in fundamental study skills, will encounter difficulties in studying because they have not practiced those necessary study skills in the previous education level. Subsequently, low level of literacy in primary students will inevitably affect the studying of core subjects, such as science.

Lack of self-regulation and motivation in students has also been regarded by the teacher interviewees as factors preventing effective implementation of SCL. Counselling from both school and parents is a vital mechanism that has been neglected. Without realisation of goals for study, students would feel lost and frustrated with what they have to do in school. Furthermore, conversations from student participants demonstrated that many of them have envisioned what will be their future occupation, but not many of them know how to achieve that goal and what kind of study programme they should take in order to reach that point.
Overly detailed and overmuch expected outcomes of a current curriculum were also issues that the teacher interviewees regarded as consequences of misjudgement of the policy makers. As the result, it has created difficulties in the implementation of SCL. By and large, teachers spend nearly all of classroom periods achieving all details and lessons suggested by the curriculum. Thus, classroom periods those teachers can utilise for practicing critical thinking and problem solving skills would be reduced, and students would have less opportunity to practice those necessary skills.

In fact, according to the research questions proposed, the contents of this discussion should be heavily linked with the student-centred learning approach. At the beginning, I started to look at evidences of the implementations of SCL in Thailand, but I found that there are little available evidences related to the SCL approach. Therefore, what I ended up describing what problems surrounding the issue in a greater extent, rather than problems directly related to the SCL approach.

In fact, there are sets of problems related to the reform itself and the situations in schools and all of the things described above, but according to what teachers said in the interviews, they themselves were also big obstacles. An explanation is that when the reform was not properly implemented, the teachers thought that nothing could be done. Then nobody tried to improve the situations as a result of the negative perceptions in their minds.

As described above, I have found out the themes that respond to my research questions. Before proceeding to the next chapter which is the conclusions chapter, it is sensible to remind the reader that what is described here is supposed to be common for a policy-related research project. This study started with a set of ideas with justifications made in the process, and, as a result, those elements have led to the construction of research questions. After conducting this study, I found that the themes discovered were more complicated and involved several factors. Some of those factors getting in the way of the successful reform are at the national level, perhaps also involving the economy and the world. It is very hard to identify how to approach those factors in the conclusion chapter. Therefore, the best choice is to talk about what we might do. The teachers being better prepared could be the one thing.
Parents and their attitudes are also problems but, in fact, recommendations cannot be made about that because those factors could not really be managed. Alternatively, suggestions are made regarding other things which are governable; such as, teachers should be better trained, they should be hired by an organisations located in rural districts, and all of them should be better skilled than they were.
CHAPTER 5
CONCLUSIONS AND POLICY RECOMMENDATIONS

This study investigated current science teaching practices and the personal perceptions and judgements of science teachers in rural schools regarding the educational reform in Thailand, which seek to establish a revised science curriculum along with new teaching approaches. In the final chapter, the main findings will be summarised and recommendations will be made that might improve the situation. Prior to that, readers are reminded that this was a small-scale study and, like all small-scale studies, the sampling of the schools and teachers may not be representative of the overall situation. In addition to size of samples, in conducting this study I was confronted by several additional problems.

Other limitations emerged during the period of data gathering. To investigate the change in science teaching practice, textbooks, lesson plans or related documents which were used prior to the reform would provide substantial data to illustrate previous science teaching practices. Unfortunately, not many of participating schools and participating science teachers retained these documents. Thus, possible sources of data were restricted to what others have described in their publications. Although the majority of participants in this study are science teachers, this study also conducted interviews with students in rural schools to investigate their perceptions and experiences in learning science. The sample of the students were provided by schools. Therefore, the experiences and perceptions of selected students may not exhibit the full range of issues, as the teachers tended to choose proficient student interviewees who were able to communicate with me and achieved relatively good academic performance.

The study set out to examine the changing science teaching practice in rural schools after Thailand has undergone a programme of major education reform. Following this reform, a more ‘western’ approach to science teaching has been prescribed, which involves the adoption of a more student-centred learning approach (Office of the National Education Commission [ONEC], 2002). In addition, several other government policies have also influenced what is happening in schools, for
example, the decentralisation of management of education-related organisations. By and large, these government strategies have been expected to be implemented throughout the country. With respect to this, those schools with sufficient resources to implement the policies are most likely to be schools in urban areas. Unlike those urban schools, most of the rural schools have encountered difficulties in implementation of the strategies due to problems relating to shortages of resources. Consequently, the rural schools that were the focus of this study have progressed more slowly with the implementation of these policies. Nevertheless, this study attempted to map the experiences and opinions of science teachers in rural schools and to gather their reflections upon the reform and the implementation of those recent government strategies intended to improve the quality of education. Consequently, those factors that teachers perceived as restricting effective reform and hampering the implementation were also identified, along with reflections from students in rural areas regarding their experiences when learning science. Thus, the study sought to answer research questions, principally

1) Has science teaching in these schools changed since the third reform? How has it changed?
2) What do heads of science departments and science teachers think about the changes?
3) What factors do heads of science departments and science teachers see as obstacles that limit the effectiveness of implementation?
4) What might be done to improve the implementation and enhance students’ learning experiences in science classes?

This chapter is divided into two parts. First, the main responses emerging in relation to the first three research questions will be summarised, because these questions generated empirical data. The second part will describe policy recommendations which are put forward, based on the responses obtained from the teachers. Below is the first part, in which I offer a brief summary of the findings.

Science teaching practice in rural schools has indeed changed to a degree but not substantially as the new policies require. What was clearly shown and observed
from science classrooms in rural schools was the increasing emphasis on the implementation of practical work, experiments and activities involving science in the classroom. This change was the most evident. The change has been adopted due to the fact that the practical work and experiments provide hands-on experiences to students and help facilitate student-centred learning, that is considered as the key objective of the new science curriculum. However, the traditional teaching approaches, which are dictation and copying from the board, were also frequently used in the observed science classrooms. The data obtained revealed that a combination of the student-centred and the teacher-centred learning approaches formed the teaching strategy that a majority of participating science teachers chose to conduct in their classrooms. The first reason that contributes to those science teachers not abandoning the traditional approach altogether may be the increase of the teachers’ workload, due to the shortage of school personnel and many other tasks that are unrelated to teaching that also require teachers to complete. Because teachers are assigned additional tasks to make sure those non-teaching tasks accomplished, they find themselves having less time for lesson planning and preparation activities. Because teaching using the student-centred learning approach requires considerable time to properly prepare lessons and activities, only partial implementation of the new approach was carried out while the teachers continued to use the traditional approach.

The second reason is related to the dominant characteristics of students in rural schools, as they have been passively taught during their primary schooling, which results in lacking of skills in critical thinking, discussing and solving problems. As teaching using the student-centred learning approach requires students to learn through active participation in activities (Pillay, 2002), due to the habits and characteristics of students, the traditional approach is often seen by the teachers as a more suitable approach than the new one.

There was a small number of science teachers whose practices still predominantly relied on the traditional approach and this indicated other issues. Apart from issues related to the workloads, another issue was that some teachers remained resistant to change. The reason that contributes to those teachers resisting to change may be their long experience in working through traditional methods and
approaches. They have taught using the traditional approach since they started their careers. Therefore, they did not have confidence to implement new teaching approaches, due to the lack of experiences in that area. In addition, a further issue related to the misunderstandings of the concept of the student-centred learning approach was demonstrated by the science teachers.

I speculate that this is probably a result of poor understanding among the science teachers of the purposes and contents of the newly introduced curriculum and the new teaching practices.

Factors that have affected the reform and the implementation of the government’s policies are all elements surrounding the students and schools. These factors include the students themselves and their parents and families, the schools, government practices and social and economic conditions in rural Thailand. In fact, most of these factors are related to socio-economic conditions where the schools are situated and the environment where government policies are implemented is a paramount determinant of success. Socio-economic conditions of Thailand are thereby singled out as the first problem and summarise its impact over the reform and the implementation of the government’s policies.

Transformation of the social and economic condition of Thailand, from an agriculture-based economy to market capitalism, is a factor that contributes to the widening of the income gap between people who live in cities and rural areas. When the market capitalism becomes the dominant economic system, working-aged people migrate from rural areas to business and industrial zones to seek for more opportunity to gain higher income. Consequently, the elderly and young children are often left behind in rural areas, and their living expenses are normally supplied by those working-aged people who have left them to work in the urban areas. This situation affects the patterns of living of people both in urban and rural areas and consequently affected the nurturing and quality of a child raising (Cheangkul, 2010).

A growing emphasis on globalisation is also a significant element that has pressured Thailand to adopt western ideas and approaches in order to keep up with their neighbours. One of the adopted western approaches that have become central to
the education reform is the student-centred learning approach to teaching, but that is an in-school issue. Outside schools, there are many factors at work. Some of these are linked to parents and families.

The implementation of the government’s policies has, for example, been influenced by the migration of working-aged people as aforementioned. When the parents leave home for work in town, opportunities to look after and monitor their children’s behaviour and academic progress have also been reduced and this important duty has often been left to their grandparents instead. The poor educational backgrounds of the parents have also affected their children’s education, due to the fact that the poor education has limited their opportunity to get highly paid jobs. Therefore, the parents have to work very hard in order to obtain enough income to provide basic quality of living to their children. Although free education is offered to all children for 12 years, government provision does not cover other expenses, for example, transportation costs (Cheangkul, 2010). The problems of neglecting by parents or poor parental support because of either poor parent-craft or the disadvantaged socioeconomic circumstances of the parents have also affected the educational progress of children, as such parents tend to place less emphasis on their children’s academic progression.

Further, the effective implementation of new teaching approaches such as student-centred learning requires not only enthusiastic and competent teachers, but also students with self-organising ability and the motivation to study. However, these desirable characteristics of students are not automatically developed. Rather, the students need to learn these things from both parents and school. Without this support, it will be difficult for students to develop the required characteristics and attitudes that enable them to become resilient and active learners.

In fact, the government has introduced quite a lot of new education policies. However, the implementation of those policies does not run smoothly, often creating further problems and controversies (ASTV Manager Online, 2011a, 2011c; Komchadleuk News, 2011; Wong-anannon, 2012). Possible reasons that underlie this difficulty are poor planning by policy-makers and the lack of a solid platform to support the implementation of such government policies. Too much detail of the
prescribed science curriculum reflects the ideas and preferences of the curriculum planners which have in fact restricted the implementation of the student-centred learning approach. Obviously, the student-centred learning approach requires teachers to set aside considerable time in a classroom to facilitate students’ learning by developing their cognitive skills and critical thinking. But to achieve all the objectives indicated in the science curriculum, the time available to implement the student-centred learning approaches will certainly be reduced. A quality assurance system that focuses on an evaluation of documentary evidence that the schools provide themselves rather than monitoring actual practices in classroom and assessing the performance of the schools is another factor that impedes the reform and the implementation of the student-centred learning approach.

Rural schools are usually quite small and have limited funding and resources (Nakornthap, 2008; Sasiwuttiwat, 2013). Existing resources such as human resources like teachers will always be utilised according to their maximum abilities. Thus, many teachers, particularly science teachers in small schools are usually teaching both elementary and secondary students. The situation of rural schools is even worse, when the number of teachers and other school personnel is insufficient. According to this, teachers are assigned other tasks which are not related to teaching, such as purchasing equipment for the school. This causes the increase of those teachers’ workloads and subsequently affects their teaching practices.

Undoubtedly, politics influences the implementation of educational change. The direct effects of politics can be explained in terms of both the political instability and the interference from politicians. Both factors hinder the reform and the implementation of the government’s policies because the functions of the education ministry and education government officers are allocated on the basis of political links and alliances. In addition, the frequent change of education minister, as a result of political instability, makes the process of implementation slow.

It is not surprising, therefore, that issues around society, government practices, policy-makers and curriculum planners, parents, schools and teachers, and students were mentioned by most of the interviewees as factors that have influenced the reform and the implementation of the government’s policies and schemes.
The teacher interviewees also felt that the education system of Thailand has been extensively influenced by political situations. They mentioned that most of the education ministers as politicians who had no or little knowledge about education were given the post due to political reasons. In addition, the political instability that happened in Thailand causes frequent changes of prime ministers and members of the cabinet. Subsequently, the education ministers are perpetually replaced, and education policies underwent discontinuity. The teacher interviewees felt that the frequent change do not support the education system of the country.

The role played by parents was another factor that contributed to ineffectiveness of reform. However, this situation was explained in the teacher interviewees as a result of regression in country’s economy. The parents work very hard to make ends meet, so their children are often raised by grandparents. However, the teacher interviewees felt that the age gap between children and the grandparents could also affect academic progression of the children because the grandparents cannot recognise what engages the interest of the children and cannot easily monitor children’s behaviour. Furthermore, the teacher interviewees identified that children, particularly from low socioeconomic families, often need to work after school hours in order to contribute to family income. The poor educational backgrounds of the parents were also regarded by the teacher interviewees as a factor that made it hard for them to support the education of their children.

Social problems have also been mentioned by the teacher interviewees as factors that influence educational progress. Fragmented families, premature pregnancy and an increasing pursuit of materialism were seen as causes of the social disruption and problems which restrict the effectiveness of the education reform. In addition, declining moral standards and corruption were topics raised in the teacher interviews. They argued that administrative processes, such as the purchasing of goods and equipment, which should support the reform, are affected by these problems, often resulting in ineffective use of government funds to support the reform. Regarding other issues relating to the failures of policy-makers, the teacher interviewees described a range of current educational problems and situations across the country that they felt had not been tackled. A consequence is the feeling that
much needs to be done but that very little is being achieved, and this creates a
difficult environment in schools even for policies that could improve education in
Thailand.

The science curriculum itself was also a source of discontent among the
teacher interviewees. The teachers complained that the science curriculum had too
much content and the content was too difficult to teach to the students in remote
areas because some content needed to be delivered to students using sophisticated
teaching-aids, tools such as multimedia, which were not commonly available. A
recurring theme from these teachers was that the content was designed for a
classroom equipped with resources they do not generally have.

In term of broader scientific literacy, it seems that Thai policymakers focus
largely on areas of science knowledge, but they seem to overlook the need to
develop the children’s understandings of the scientific process. Thus, they are not
actually creating scientifically literate young people. Although students are often
succeeding in what they are trying to do or what the teachers told them to do in the
classroom, they still do not become scientifically literate because they are not
successfully understanding and learning about the processes of science, but simply
absorbing some science content knowledge.

The focus of testing and quality assurance systems was also identified by the
teacher interviewees as factors that contribute to the ineffective implementation of a
more student-centred pedagogy. These teachers felt that the objective of the national
testing heavily emphasises on students’ memorization of facts instead of examining
what students have learnt from their science lessons. The teachers also explained that
the national test has to adjust its level of challenge because the majority of students
were attaining very low scores.

This has raised a question regarding the reliability and quality of the testing
system. The quality assurance system was also described as an issue that affected
teachers’ practice. Because the evaluation process of the current quality assurance
system has extensively relied on documents provided by the schools, the teachers of
the inspected schools must spend considerable time to prepare the documents for the
evaluation. This creates tension and stress among the teachers in the inspected schools. In addition, as a result of document-based evaluation, the interviewees questioned the validity and usefulness of the inspection, as they noticed that the inspectors had often not turned up at schools, but relied on the accounts the schools produced themselves.

School-level policies determined by the principals were also mentioned by the teacher interviewees. They described how some schools prioritised landscape improvement rather than provision of teaching materials and equipment. In addition, the teachers explained that extra-curricular activities to which were assigned by the principal often prevented them spending enough time on preparing the lesson, and this situation has impeded effective teaching.

The practices of the teacher interviewees themselves were also mentioned. Many of them stated that teachers in rural schools always have additional roles and tasks to be accomplished, apart from teaching. These additional activities have eaten into the periods of time that are supposed to be utilised for lesson planning, preparing of teaching materials and equipment. In addition, the shortage of teachers with specialised subject knowledge and the increased workload of current specialist teachers in schools were regarded as a key barrier that had limited the effectiveness of the reform and the implementation of the new teaching approaches. Unprofessional practice from some teachers and also teachers that resisted change were also acknowledged by the teacher interviewees as issues that contribute to the slow progress of the reform.

Undesirable behaviours and attitudes of students were also seen by the interviewees as factors contributing to the lack of progress. These behaviours and attitudes included the lack of essential study skills, the lack of discipline, the lack of motivation to study and the lack of ambition.

Thus, as seen from the above, the empirical findings from this study shed light on why the implementation of the new science curriculum, a key aspect of the education reform initiative, has been unsuccessful in rural schools. It seems clear from the collected data that the reform process has not achieved sufficient
momentum to drive improvement in the quality of science teaching in Thailand. The perceptions and experiences of the interviewees reflect the urgent need to take stock of the current situation in rural junior high schools, reflect on what has gone wrong, and think about what can be done to revive the science reform, and with it the quality of science education available to children in rural schools. Below, a number of suggestions are made regarding where we might start.

In offering these recommendations, I firstly come up with a list of what should be done to improve the quality of science teaching. Obviously, making a list is an easy part, but the hard part is to bring what has been listed into action. Also, some of those things on the list are already being addressed. However, according to the empirical data obtained, I have identified a number of actions that could make science teaching in Thailand more effective. It is necessary to remind the reader that there are a lot of reasons for the present poor situation, and as can be noticed from the interviews. Many of these difficulties stem from lack of resources and lack of any national system of support for science teaching. Thus, it seems sensible to suggest a few priority areas where actions can make a real difference, rather than producing a long list that we will never get around to tackling.

The first action is focused on the reform of teacher training, which is a sensible way to make sure that we are getting good quality graduates as teacher trainees and that they are appropriately trained both in the contents of the subject and the teaching methods and approaches available. Three sub-actions are recommended: improving selection, specifying higher standards for entry, and then improving the quality of training. The first two sub-actions require administrative actions, and perhaps the introduction of some incentives. The third sub-action needs to be addressed through a review of the training itself. Therefore, at least three areas need attention: the trainers, curriculum and the teacher training methods. We have to ensure that the trainers are the best we can find, the curriculum meet the needs of students, higher education institutions and employers, and the great emphasis is placed on the teacher training methods particularly practical trainings in real school setting with appropriate support and monitoring from both school and college staff.
There also needs to be a reorientation of the current teaching force, which will require a major in-service training programme to support developments in teaching skills. We need science teachers that can create physically, mentally and emotionally supportive classroom environments, make lessons interesting and learning fun, and help motivate students so that they find a reason for hard work. In addition, the teachers should eliminate self-egos and negative thoughts, be more approachable, avoid criticizing students, build up good relationship with them, and value students’ ideas and opinions. This means changing the relationship between teachers and students in the classroom, and it cannot be done with a policy; it will need a programme of in-service training, properly resourced and delivered. It is clear that in order to increase students’ performance in science, mechanisms that could help expose children to scientific learning experiences are required. However, these mechanisms have to be facilitated by teachers. Therefore, the sensible recommendation is that we should focus on the improvement of teacher practices. At the same time, the government should focus more on initialising a more effective teacher training and professional development system and generating mechanisms to attract graduates into teaching, particularly in rural schools.

A second area for action is the production of resources for science teaching. This study has shown that there is a shortage of good quality teaching materials, and also that budgets are very limited, especially in the rural areas. We saw, in the literature review, the impact of the Teaching and Learning Using Locally Available Resources (TALULAR), which has been implemented in some African countries as a model to improve the quality of science teaching in rural schools when resources are scarce. There is no reason why such a scheme could not be developed in Thailand. Moreover, it seems African countries have clearer ideas about using resources from local areas and of ensuring children can ‘make sense’ of science in their local context. While it is understandable that no one could expect Thai science curriculum or quality of science teaching to be as good as those of the USA or England and Wales, there is no reason why Thailand should not be as good as poor African nations. Therefore, it is reasonable to suggest that Thailand needs to look closely at what it has been doing, and recognise that there are ideas and approaches in many countries from which we can learn.
I recommend individual teachers or schools develop experiments for teaching particular curriculum goals by looking creatively at what is available, rather than complaining about what is not. It would not require much organisation to build up a bank of such experiments in a local district, with teachers sharing one another’s ideas and approaches. While this is not a long-term solution, it would be a helpful place to start. At the same time, the government needs to actively support local educational authorities (LEAs) to create a stock of science education resources that are also required by the rural schools, possibly looking at systems for sharing resources and equipment from a central resource bank if there are insufficient resources to fully equip every school. To support science teaching particularly in rural schools, practical and explicit government schemes as well as appropriate supports for teachers when the government introduces a new policy are needed. We must recognise that policies in themselves change little; what are needed are the practical and human resources to deliver the policies. This includes teacher training in topics that fulfil the practical requirements of teachers and enhance their competencies followed by systematic monitoring of the system to ensure the training is effective.

In addition, the LEAs could also help improve quality of teachers by facilitating school-to-school collaboration as well as school networks. The rural schools with the support of the leadership and the LEAs could carry out in-school training in the topics that were requested by the teachers.

It does seem also that there is a need for further research to identify the pedagogical content knowledge (PCD) required by the teachers. This should include investigation into how this knowledge can best be transferred to teachers, both in initial teacher training and through the provision of in-service training that would best help the existing teaching force. Higher education institutes can be a key contributor for this. In addition, some applied research with schools in order to develop practical materials—perhaps a Thai version of the TALULAR Project is also important.

There is also scope to develop science content around issues that are directly relevant to the everyday lives of the children. For example, the cow and how to keep cows healthy is a good starting point. This topic is expected to attract children
because good management of livestock is essential for people in rural areas of Thailand and losing a farm animal is a major disaster for a rural family. Of course to help children learn how to keep a cow healthy, it will be more successful if you provide hands-on experiences to children by using local facilities to support classroom learning. But it would be possible to teach a biology curriculum around this topic. Similarly, there is a case for developing an environmental science curriculum around preserving the environment in the north of Thailand; otherwise, deforestation will become a major problem. So people have to understand how to manage the environment and stop burning woods or start re-planting. In this way, schools and teachers in rural areas can develop a local science curriculum in which they address important issues that promote understanding of animal husbandry and sustainability.

However, we cannot expect rural science teachers to make such developments on their own. There needs to be appropriate support for science teaching, particularly in remote areas, and practical and explicit government help is needed for teachers. As we have seen, when the government introduces a new policy, much more support than we have seen in the past is required if we expect it to work.

Furthermore, strategies that make schools more interesting places to learn are urgently needed. This is because the socioeconomic situations change rapidly, and this means children’s lives, not only in urban areas but also in rural areas, are now changing. The way children’s lives in rural areas changes is important because what I am looking at is the picture of schools in rural areas and the change in children’s live affects challenges facing those rural schools. Nowadays, even in rural areas children are provided with mobile phones, even when they have little to eat. Tablets and communication devices are cheap and widespread and have drawn young people’s interest away from the dull, teacher-centred traditional school classroom experience. To improve science education in rural schools and enhance student performance, making learning more fun and interesting is demanded because when the options surrounding children are more attractive, education becomes a boring thing and going to school is no longer that enjoyable.
A further way the school could seek to engage young people in science would be to demonstrate the way science relates directly to many of the problems faced daily in the world. We need to think carefully about the kind of science that children need to learn in the twenty-first century. The content of the science curriculum should be made more practical, brought to life by real examples. People can be brought in from local industries to identify essential science-related knowledge that they think their employees need to know, focusing on the content of the science curriculum that relates to real world contexts and demonstrating the relevance of science in everyday lives. Because the learning outcomes of students are directly affected by the students’ motivation and engagement, the strategies to promote student motivation must be employed. Such strategies include the improvement of quality of elementary education, in which essential study skills such as logical reasoning should be cultivated. This is another thing that we can do that will help all students engage with the secondary science curriculum.

The adaptation of the curriculum with the emphasis on the classroom culture and local needs could be a way to contextualise the curriculum and make it more meaningful and relevant to the context of school and classroom. To efficiently enable the adaptation, considerations regarding benefits of the flexible school curriculum should be recognised by every stakeholder. Although the Ministry of Education currently grants schools an opportunity to develop and implement their own school curricula, it seems that such curricula were not able to lead to the change particularly in the participating schools. The extent to which the community plays a role and gets involved in drafting of the school curricula might not achieve enough momentum to produce considerable effects. Therefore, the efforts to increase the community involvement are urgently needed.

The problem in teachers’ resistance to change is difficult to solve, particularly the resistance of those experienced teachers who are required to change their practice, attitudes and beliefs to some extent. Therefore, the strategy that would be the most suitable way to support the change in teachers’ practice is to create a school culture that supports collaboration among teachers, administrators and other educators, as called ‘a community of practices’. The supportive environment for the
teachers, the provision of clear directions on the orientation of their assigned tasks, and advice regarding particular concerns are all vital for the teachers in helping them successfully implement the change. Thus, the curricula materials that supply these elements should be provided to the teachers.

In fact, there have been many changes of government and policy over recent years, and a lot of different schemes have been introduced which were expected to improve the lives of the Thai people. However, we seem to never achieve the goals of these schemes that aim to construct a good base for development of the country. Whether it be developing the economy, attracting international investment, providing a platform for technological advancement, or improving educational standards, little progress has been made.

Against this background many companies are struggling, and there is increasing concern about education and employment. However, one example of an industry that has enjoyed some success against this trend is the oil industry. A major reason why the oil industry is doing better than other industries is that they have set up their own schools – under a ‘factory schools’ scheme that has largely failed in other sectors. But the schools set up by the oil industry seem to be working, and they are producing young people with scientific knowledge and technical skills relevant to the industry, who provide important manpower for the industry.

So the oil industry runs its own training schemes and ‘apprenticeship system’. In addition, there is cooperation between oil companies and they are training these young people together. Those oil companies teach people themselves in their schools and their training programmes and even competitors co-operate together in these programmes. This is because the oil companies know they need these people to retain a supply of skilled manpower, and they all know that the Thai school system does not produce them. The success of the oil industry in arranging their own schools to ensure there is a supply of young people with science knowledge and understanding raises many questions about why the government does not seem able to do that. Why can we not do this nationally, to benefit all children and, ultimately, all industries? The scheme initiated by the oil industry underlines the
importance of science and technology education in the twenty-first century, and also
demonstrates that there is no reason why we cannot improve science education
nationally, within the formal education system, so long as we go about it in the right
way.

Relating to the need for this development at national level, an effective
testing system that emphasises both the scientific literacy and the practical skills of
students should also be a priority for the government. More relevant and meaningful
testing will help increase intrinsic motivation of students which has a causal
relationship with student satisfaction in learning and examination results. Certainly,
we need to devise a testing system that seeks to identify what children know and can
do with their science knowledge, underlining its practical value. The present testing
regime is over theoretical and does not emphasise the links between science and the
real world. Such re-focusing of the examination system would perhaps also create
stronger links between the study of science and the job opportunities this opens up.

Finally, whatever strategies are adopted, there still remains a clear gap
between the educational outcomes of children in urban schools and those in rural
schools. The government’s responsibility is to provide an equitable system of
education in which equal opportunities are available to all; it is clear from this study
that we are a long way from achieving this. While the government should adjust its
policies to be more practical, systematic and contextually relevant, it should also
keep the need to close this attainment gap in mind, and actively promote strategies
that accelerate the quality of science teaching in rural schools. The LEAs and
community could play a role by supporting the government’s initiatives, but we must
look to the government to take a lead.

We might start out by looking more closely at what the gap really is, and
what causes it. An effective quality assurance system with transparency regarding
the practice of inspectors would be a good place to start. With respect to this, careful
review of the appointment process of the inspectors by the education ministry should
be carried out and appropriate training is also needed. In addition, mechanisms to
communicate the significance and importance of quality assurance system to
teachers and school personnel should be generated by the education ministry and
transmitted to the schools by the LEAs. Furthermore, analysis of evaluation outcomes and its explanations and suggestions for improving the quality of science teaching should also be communicated to the schools.

Teachers remain the most important resource, but they cannot supervise and monitor students at all time. Therefore, proper accountability from related stakeholders is also required as effective reform and improvement of quality of Thai science teaching and education system need efforts from every related stakeholder. Although it takes considerable time to make them all realise the significance of their contributions, the government should put an effort to achieve this. Policies initiated by the government which define the accountability of each stakeholder and mechanisms for monitoring the accountabilities should also be brought into action. Above all, government strategies which are created in response with these suggestions should be stated clearly, practically and thoroughly.
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338
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Appendix 1

A Study of Science Curriculum Implementation in Secondary Schools in Thailand

Participant Information Sheet

You are being invited to take part in a research study as part of a PhD research project aiming to explore and describe the perceptions of department heads and science teachers regarding the implementation of new science curriculum, which is based on a student-centred learning approach and what they think would be possible factors limiting the effectiveness of science teaching after Thailand has undergone educational reform for more than 10 years. Moreover, students’ learning experiences in science regarding the new science curriculum will be illustrated. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the study?

Patcharapan Siriwat
PhD Education (4 years)
School of Education
Ellen Wilkinson Building
The University of Manchester
Oxford Road
Manchester M13 9PL

Title of the study

A Study of Science Curriculum Implementation in Secondary Schools in Thailand

What is the aim of the study?

The aim of this study is to examine how the new science curriculum is being implemented and explore factors influencing its effectiveness by exploring perceptions and experiences of head of science departments and science teachers toward the implementation of the student-centred learning approach, and students’ learning experiences in science regarding the new science curriculum in lower secondary classrooms focusing on schools in rural areas of Thailand. It could be used more generally as a resource to further investigate the current understanding and practice of teaching in Thailand.
Why have I been chosen?

There are 20-22 participants in this study, based in 10-14 schools. This school is one of them, and the researcher is seeking to observe science lessons in this school, and to subsequently to interview the members of the Science Department. The schools have been selected because they are lower secondary schools that serve relatively disadvantaged communities in rural areas of the country.

What would I be asked to do if I took part?

As part of PhD research, you will be asked to give your consent to the researcher to observe science classes you teach and you will also be asked to agree to take part in an individual interview. Questions to be asked are about your perceptions and ideas regarding the implementation of new science curriculum and what you think would be possible factors currently limiting the effectiveness of the implementation of the new science curriculum in Thai secondary schools. You are not under any obligation to respond to any questions or take part in any activity that makes you feel uncomfortable.

What happens to the data collected?

This study is for completing a PhD degree. Data will be analysed to examine perceptions and practices of teachers and heads of science departments regarding the implementation of new science curriculum and what they think would be possible factors currently limiting the effectiveness of the implementation of the new science curriculum in Thai secondary schools.

How is confidentiality maintained?

The audio data obtained from interviews, any data in electronic format, and any data set that could reveal your identity will be kept in a password-locked datastick and stored in a locked drawer. The paper copies of data will be stored in a locked drawer, in the researcher’s home accessed only by the researcher. All data collected in connection with this study will be kept for no longer than 1 year after graduation from the programme. The data will then be destroyed.

What happens if I do not want to take part or if I change your mind?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time without giving a reason.
Will I be paid for participating in the study?

You will not be paid for participating in this study.

What is the duration of the study?

The study is part of a research programme for a PhD degree that will be completed in 2015. The classroom observations in your school will cover normal lessons over a period of several weeks. Individual interviews will take 45-60 minutes and will be arranged at times convenient for individual participants.

Where will the study be conducted?

The study will be conducted in classrooms and in meeting rooms within the school.

Will the outcomes of the study be published?

The outcomes of this study will be published in a PhD thesis and the findings may contribute to the writing of academic journals or conference papers.

Contact for further information

If you would like more information, please do not hesitate to contact me at patcharapan.siriwat@postgrad.manchester.ac.uk

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to

The Research Practice and Governance Co-ordinator
Research Office
Christie Building
The University of Manchester
Oxford Road
Manchester, M13 9PL
Tel: 0161 275 7583 or 0161 275 8093
e-mail: Research-Governance@Manchester.ac.uk
Appendix 2

A Study of Science Curriculum Implementation in Secondary Schools in Thailand

CONSENT FORM

If you are happy to participate please complete and sign the consent form below.

1. I confirm that I have read the attached information sheet on the above project and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason.

3. I understand that the interviews will be audio-recorded.

4. I agree to the use of anonymous quotes.

5. I agree that any data collected may be passed to other researchers.

6. I agree that any data collected may be published in anonymous form in academic books or journals.

I agree to take part in the above project.

Name of participant ___________________________ Date ___________________________ Signature ___________________________

Name of person taking consent ___________________________ Date ___________________________ Signature ___________________________

patcharapan.siriwat@postgrad.manchester.ac.uk
Participant Information Sheet

Your student are being invited to take part in a research study as part of a PhD research project aiming to explore and describe the perceptions of department heads and science teachers regarding the implementation of new science curriculum, which is based on a student-centred learning approach and what they think would be possible factors limiting the effectiveness of science teaching after Thailand has undergone educational reform for more than 10 years. Moreover, students’ learning experiences in science regarding the new science curriculum will be illustrated. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish your child to take part. Thank you for reading this.

Who will conduct the study?

Patcharapan Siriwat
PhD Education (4 years)
School of Education
Ellen Wilkinson Building
The University of Manchester
Oxford Road
Manchester M13 9PL

Title of the study

A Study of Science Curriculum Implementation in Secondary Schools in Thailand

What is the aim of the study?

The aim of this study is to examine how the new science curriculum is being implemented and explore factors influencing its effectiveness by exploring perceptions and experiences of head of science departments and science teachers toward the implementation of the student-centred learning approach, and students’
learning experiences in science regarding the new science curriculum in lower secondary classrooms focusing on schools in rural areas of Thailand. It could be used more generally as a resource to further investigate the current understanding and practice of teaching in Thailand.

**Why have your students been chosen?**

There are 28-30 groups of students participants in this study, based in 10-14 schools. This school is one of them, and the researcher is seeking to observe science lessons in this school and to subsequently interview the members of the Science Department and students who are attending this science lesson. The schools have been selected because they are lower secondary schools that serve relatively disadvantaged communities in rural areas of the country.

**What would your students be asked to do if s/he took part?**

As part of PhD research, you will be asked to give your consent to the researcher to interview your students. Questions to be asked are about their learning experiences in science regarding the implementation of new science curriculum. You are not under any obligation to allow your students to take part in any activity that makes him/her feel uncomfortable.

**What happens to the data collected?**

This study is for completing a PhD degree. Data will be analysed to examine students’ learning experiences in science regarding the new science curriculum.

**How is confidentiality maintained?**

The audio data obtained from interviews, any data in electronic format, and any data set that could reveal identity will be kept in a password-locked datastick and stored in a locked drawer. The paper copies of data will be stored in a locked drawer, in the researcher’s home accessed only by the researcher. All data collected in connection with this study will be kept for no longer than 1 year after graduation from the programme. The data will then be destroyed.

**What happens if I do not want my students to take part or if I change your mind?**

It is up to you to decide whether or not to allow your students to take part. If you do decide to allow him/her to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to allow your students to take part, you are still free to withdraw your students at any time without giving a reason.
Will my students be paid for participating in the study?

Your students will not be paid for participating in this study.

What is the duration of the study?

The study is part of a research programme for a PhD degree that will be completed in 2015. Individual interviews will take 30-45 minutes and will be arranged at times convenient for individual participants.

Where will the study be conducted?

The study will be conducted in meeting rooms within the school.

Will the outcomes of the study be published?

The outcomes of this study will be published in a PhD thesis and the findings may contribute to the writing of academic journals or conference papers.

Contact for further information

If you would like more information, please do not hesitate to contact me at patcharapan.siriwat@postgrad.manchester.ac.uk

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to

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e-mail: Research-Governance@Manchester.ac.uk

361
Appendix 4

A Study of Science Curriculum Implementation in Secondary Schools in Thailand

CONSENT FORM

If you are happy to allow your students to participate please complete and sign the consent form below.

1. I confirm that I have read the attached information sheet on the above project and have had the opportunity to consider the information and ask questions and had these answered satisfactorily.

2. I understand that the participation in the study is voluntary and that my students are free to withdraw at any time without giving a reason.

3. I understand that the interviews will be audio-recorded.

4. I agree to the use of anonymous quotes.

5. I agree that any data collected may be passed to other researchers.

6. I agree that any data collected may be published in anonymous form in academic books or journals.

I agree to allow my students take part in the above project.

Name of participant __________________________ Date __________________________ Signature __________________________

Name of person taking consent __________________________ Date __________________________ Signature __________________________

patcharapan.siriwat@postgrad.manchester.ac.uk
## Appendix 5

### Science Lesson Observation Schedule

<table>
<thead>
<tr>
<th>Teacher:</th>
<th>Date/time:</th>
<th>School:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level:</td>
<td>Subject:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical Incidence</th>
<th>Effective Planning</th>
<th>Critical Incidence</th>
<th>Teaching and learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>☐ objective communicated</td>
<td>☐ Ideas and experiences of student is drawn up on</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ good structure</td>
<td>☐ Connect with objectives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ varieties of activities</td>
<td>☐ Clear explanations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ materials are ready</td>
<td>☐ Involve all students directly and respond to them</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ appropriate materials</td>
<td>☐ promote active students’ engagement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ good pace of teaching</td>
<td>☐ Promote problem solving, critical thinking/constructing meaning</td>
<td></td>
</tr>
<tr>
<td>Critical Incidence</td>
<td>Professional knowledge and understanding</td>
<td>☐ Promote collaboration And choices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Good subject knowledge</td>
<td>☐ Encourage students to present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ enthusiastic</td>
<td>☐ Guide all students in assessing their own learning/discover own knowledge</td>
<td></td>
</tr>
<tr>
<td>Critical Incidence</td>
<td>Assessing, monitoring and giving feedback</td>
<td>☐ motivate student to participate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ Detailed and accurate feedback</td>
<td>☐ make connections to real world context</td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ monitor learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ appropriate home work</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>☐ various/ multiple assessments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 6

Interview Schedule for Semi-structured Interview

Thank you for taking part in this study. First of all, I would like to assure you that you will remain anonymous in any written piece of work going out of this study.

1. Can I first ask you about your qualifications/education background? And then probe on.
   - How did you become a teacher?
   - What’s the motivation to become a teacher?

2. What do you think about the reform. What are outcomes of the reform? And then probe on.
   - Why you think that?
   - What makes you think that?

3. What kind of teaching approach you use in the classroom? And then probe on.
   - How do you teach in your classroom?
   - Why do you choose to use this approach?
   - What do you think about the student-centred learning approach?
   - Did you implement student-centred learning approach in your classroom?
   - How do you implement student-centred learning approach in your classroom?
   - What does effective implementation of the student-centred learning approach look like?

4. What kind of constraints have you encountered in your classroom? And then probe on.
   - How do those constraints affect your teaching?

5. Thank you so much for your assistance. Can I finally ask you if you think there is any other aspect related to the reform and the implementation of the
student-centred learning approach that has not been covered in this interview?
Appendix 7

Student Focus Group Interview Schedule

1. Can I first ask you what level you are studying in?

2. Do you like to study science?
   - If ‘no’, probe on.
     - Why don’t you like to study science?
   - If ‘yes’, probe on.
     - Why do you like to study science?
     - What is your favourite topic?

3. What will you do when you don’t understanding lessons or what the teacher has explained? And then probe on.
   - Why do you think that is the best way to gain more understanding?

4. Why do you think we have to study science? And probe on.
   - What makes you think that?

5. What kind of activity do you do in classroom and what activity do you enjoy or like to do most? And probe on.
   - Why do you like that activity?
   - How do you perform that activity?

   - How do you do that activity?

7. What do you think about the O-Net exam? And probe on.
   - What’s the result?
   - How do you prepare yourself for this exam?

8. What do you think about the school exam? And probe on.
   - What’s the result?
- How do you prepare yourself for this exam?

9. Do you have a plan after finish schooling?

If ‘no’, probe on.

- What will you do after finishing school?
- What kind of job will you do after finishing school?

If ‘yes’, probe on.

- What major will you take in high school?
- What kind of job will you do after you obtain the high school diploma?

10. Thank you very much for your help.
Appendix 8

Tally of frequency of teaching approach occurred in the science lesson observations

Number of science lessons observed = 22 lessons

<table>
<thead>
<tr>
<th>Teaching approach</th>
<th>lessons</th>
<th>F*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1  2</td>
<td>3</td>
</tr>
<tr>
<td>(Teacher as) facilitator</td>
<td>I I I I I I I I</td>
<td>7</td>
</tr>
<tr>
<td>encourage student to present</td>
<td>I I I I</td>
<td>7</td>
</tr>
<tr>
<td>Encourage students to work collaboratively</td>
<td>I I I I I I</td>
<td>8</td>
</tr>
<tr>
<td>Encourage students’ active discussion</td>
<td>I I I I I</td>
<td>4</td>
</tr>
<tr>
<td>Emphasis student’s prior knowledge, experiences, interests and choices</td>
<td>I I</td>
<td>2</td>
</tr>
<tr>
<td>Promote critical thinking skill by asking open-ended questions</td>
<td>I I I I</td>
<td>5</td>
</tr>
<tr>
<td>Mind mapping</td>
<td>I I I I I</td>
<td>4</td>
</tr>
<tr>
<td>Formative assessment</td>
<td>I I I I</td>
<td>3</td>
</tr>
<tr>
<td>Enquiry-based teaching</td>
<td>I I I</td>
<td>2</td>
</tr>
<tr>
<td>Problem-based teaching</td>
<td>I</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total SCL teaching</strong></td>
<td>5 6 3 6 6 3 4 2 2 3 1 2</td>
<td>43</td>
</tr>
<tr>
<td>Lecture</td>
<td>I I I I I I I I I I I I I I I I</td>
<td>16</td>
</tr>
<tr>
<td>Review</td>
<td>I I I I I I I I I I I I</td>
<td>12</td>
</tr>
<tr>
<td>Dictation</td>
<td>I I I I</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total TCL teaching</strong></td>
<td>1 1 1 1 3 3 1 2 2 2 1 1 1 1 2 2 2 2</td>
<td>30</td>
</tr>
</tbody>
</table>


## Appendix 9

### Information of teacher interviewees

<table>
<thead>
<tr>
<th>Science teacher interviewees (Pseudonym)</th>
<th>School (Pseudonym)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT (Head Teacher)</td>
<td>LY¹</td>
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Note: ¹School of Expanded Opportunity

²Non-SEO Secondary School