TABLE OF CONTENTS

Abstract ii
Abstrak v
Acknowledgements viii
Table of Contents x
Appendices xiii
List of Tables xiv

CHAPTER 1 : BACKGROUND OF THE STUDY

1.0 Introduction 1
1.1 Background of the Study 2
1.2 Biology Education in Malaysian Secondary Schools 6
1.3 Purpose of the Study 7
1.4 Research Questions 8
1.5 Conceptual Framework of the Study 9
1.6 Significance of the Study 12
1.7 Definition of Terms 13
1.8 Limitations of the Study 14

CHAPTER 2 : REVIEW OF RELATED LITERATURE

2.0 Introduction 16
2.1 Students’ Conceptions in Science 16
2.2 The Two-tier Multiple Choice Diagnostic Test
2.3 Students’ Conceptions in Diffusion and Osmosis
2.4 Formal Reasoning Ability and Science Achievement
2.5 Gender and Achievement in Science
2.6 Summary

CHAPTER 3: METHODOLOGY

3.0 Introduction

3.1 Procedure of the Study

3.2 Subjects of the Study

3.3 Instrumentation

3.3.1 The Understanding of Concepts in Diffusion and Osmosis Diagnostic Test (DODT)

3.3.1.1 Validity of the DODT

3.3.1.2 Reliability of the DODT

3.3.2 Test of Logical Thinking (TOLT)

3.3.2.1 Validity of the TOLT

3.3.2.2 Reliability of the TOLT

3.4 Pilot Study of the Instruments

3.5 Data Collection and Procedures
CHAPTER 4: RESULTS AND DISCUSSIONS

4.0 Introduction 52

4.1 Descriptive Statistics of Subjects of the Study 53

4.1.1 Distribution of Gender of Students 53

4.1.2 Scoring Procedure and Categorization of Formal Reasoning Ability Groups 54

4.1.3 Distribution of Students’ Formal Reasoning Ability Groups 54

4.2 Scoring Procedure for the DODT 56

4.3 Form Four Biology Students’ Conceptions and Alternative Conceptions of Diffusion and Osmosis 57

4.3.1 Conceptions of Students of Item 1 59

4.3.2 Conceptions of Students of Item 5 60

4.3.3 Conceptions of Students of Item 2 62

4.3.4 Conceptions of Students of Item 3 63

4.3.5 Conceptions of Students of Item 6 65

4.3.6 Conceptions of Students of Item 8 66

4.3.7 Conceptions of Students of Item 10 68

4.3.8 Conceptions of Students of Item 4 69

4.3.9 Conceptions of Students of Item 9 70

4.3.10 Conceptions of Students of Item 7 71

4.3.11 Conceptions of Students of Item 11 72

4.3.12 Conceptions of Students of Item 12 73

4.4 Form Four Biology Students’ Common Alternative Conceptions in Diffusion and Osmosis 75

4.5 Form Four Biology Students’ Recurring Alternative Conceptions in Diffusion and Osmosis 80

4.6 Form Four Biology Students’ Understanding of concepts in Diffusion and Osmosis by formal reasoning ability 82

4.7 Form Four Biology Students’ Understanding of concepts in Diffusion and Osmosis by Gender 84

4.8 Summary of results 85

xii
CHAPTER 5: SUMMARY OF THE FINDINGS, IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>Introduction</td>
<td>87</td>
</tr>
<tr>
<td>5.1</td>
<td>Summary of the Findings</td>
<td>88</td>
</tr>
<tr>
<td>5.2</td>
<td>Limitations of the Study</td>
<td>92</td>
</tr>
<tr>
<td>5.3</td>
<td>Implications of the Findings</td>
<td>93</td>
</tr>
<tr>
<td>5.4</td>
<td>Suggestions for Future Research</td>
<td>99</td>
</tr>
<tr>
<td>5.5</td>
<td>Conclusion of the Study</td>
<td>100</td>
</tr>
</tbody>
</table>

SELECTED BIBLIOGRAPHY

APPENDICES:

Appendix I: Diffusion and Osmosis Diagnostic Test

Appendix II: Diffusion and Osmosis Diagnostic Test - Bahasa Melayu Version

Appendix III: Test of Logical Thinking

Appendix IV: Test of Logical Thinking – Bahasa Melayu Version

Appendix V: Letter of Approval to Conduct the Study

xiii
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1.1</td>
<td>Main topics in the Malaysian Biology KBSM Syllabus</td>
<td>7</td>
</tr>
<tr>
<td>Table 2.1</td>
<td>Percentages of Responses by College Biology Non-majors and Majors with Specific Misconceptions detected by the Diffusion and Osmosis Diagnostic Test</td>
<td>28</td>
</tr>
<tr>
<td>Table 3.1</td>
<td>Sample item of Diffusion and Osmosis Diagnostic Test that assesses the Particulate and Random Nature of Matter</td>
<td>43</td>
</tr>
<tr>
<td>Table 3.2</td>
<td>Propositional Knowledge Statements Required for Understanding Diffusion and Osmosis</td>
<td>44</td>
</tr>
<tr>
<td>Table 3.3</td>
<td>Item number, Propositional knowledge statements and topic areas tested by the DODT</td>
<td>45</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Distribution of Gender of Students</td>
<td>53</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Categorization Scheme of TOLT Score</td>
<td>54</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Frequency of the raw score obtained in each group of formal reasoning Ability</td>
<td>55</td>
</tr>
<tr>
<td>Table 4.4</td>
<td>Distribution of Students’ Formal Reasoning Ability</td>
<td>56</td>
</tr>
<tr>
<td>Table 4.5</td>
<td>Concepts, number of items and the maximum score awarded in DODT</td>
<td>57</td>
</tr>
<tr>
<td>Table 4.6</td>
<td>Frequency and Percentage of Students’ Response of Item 1</td>
<td>59</td>
</tr>
<tr>
<td>Table 4.7</td>
<td>Frequency and Percentage of Students’ Response of Item 5</td>
<td>60</td>
</tr>
<tr>
<td>Table 4.8</td>
<td>Frequency and Percentage of Students’ Response of Item 2</td>
<td>62</td>
</tr>
<tr>
<td>Table 4.9</td>
<td>Frequency and Percentage of Students’ Response of Item 3</td>
<td>63</td>
</tr>
<tr>
<td>Table 4.10</td>
<td>Frequency and Percentage of Students’ Response of Item 6</td>
<td>65</td>
</tr>
<tr>
<td>Table 4.11</td>
<td>Frequency and Percentage of Students’ Response of Item 8</td>
<td>66</td>
</tr>
<tr>
<td>Table 4.12</td>
<td>Frequency and Percentage of Students’ Response of Item 10</td>
<td>68</td>
</tr>
<tr>
<td>Table 4.13</td>
<td>Frequency and Percentage of Students’ Response of Item 4</td>
<td>69</td>
</tr>
<tr>
<td>Table 4.14</td>
<td>Frequency and Percentage of Students’ Response of Item 9</td>
<td>70</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

| Figure 1.1 | Conceptual Framework of the Study | 11 |