Towards an increase in the supply of physics teachers

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Towards an increase in the supply of Physics teachers

by

Mary Stewart

BSc  BA  Dip Ed  CPhys  M Inst P

A Master's Thesis submitted in partial fulfilment of the requirements for the award of M Phil of the Loughborough University of Technology, 1990

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This research aimed to assess the current situation with regard to the staffing and uptake of physics courses in schools; to determine the attitudes of physics undergraduates, physics PGCE students and teachers of physics towards a career in teaching; to investigate the factors which may affect these attitudes and from this information to suggest ways in which the supply of physics teachers may be increased. In the short-term, if the curriculum time allotted to physics is to be maintained, it may be necessary to devise teaching schemes involving less class contact time for physics teachers or the use of underqualified teachers of physics. In this context the learning method generally called supported self-study is described.

The analysis of questionnaires issued to physics undergraduates indicated that most of them did not find the prospect of working with young people appealing. However, in this respect there was a significant difference between the attitudes of males and females, with the latter being much more likely to be attracted to such work. This conclusion was reinforced by the results of subsequent questionnaires issued to physics PGCE students and physics teachers where the percentages of females in these groups (20.3% and 18.5% respectively) were considerably higher than in the physics undergraduate population (13.5%).

In order to increase the supply of physics teachers more physics undergraduates should be encouraged towards a career in teaching and/or more people, both from school and from non-standard backgrounds, should be encouraged to undertake physics degree courses. A small-scale, but apparently successful, peer-tutoring scheme whereby physics undergraduates acted as classroom helpers in local schools was set up to encourage these undergraduates to consider a career in teaching. At the same time Government initiatives, such as the payment of a bursary to students training to teach physics and
the opening up of a direct route - the articled teacher scheme - into teaching for new graduates were investigated. If the pool of physics undergraduates from which to draw trainee teachers were to be increased then it would be possible to increase the supply of physics teachers even if the proportion of new physics graduates entering teacher training remained the same. Thus, investigations were made of ways in which more school pupils in general and more female pupils (who may be more likely to choose teaching as a career) in particular may be encouraged to study physics at 'A' level and beyond. The effects of science for all in the National curriculum and proposed changes in 'A' level syllabuses to make physics attractive to a wider audience were considered.

Awareness of the potential for the recruitment of mature and other non-standard entrants onto physics degree courses led the researcher to become involved in several access initiatives with her own institution and on a wider inter-institutional scale. The implementation of schemes such as the introduction of a Foundation Year for non-standard entrants and the production of a flexible access package is dependent on funding being made available.

The use of schemes of supported self-study, whereby pupils are encouraged to work independently with the teacher's role being that of a tutor and resource manager rather than an instructor, may provide a short-term solution to physics teacher supply problems. Less class contact time is required and teachers considered inadequately qualified for traditional style teaching may run such schemes successfully.
ACKNOWLEDGEMENTS

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Members of the academic staff at Loughborough University of Technology have provided support and encouragement. Particular thanks must go to Dr R. Perrin of the Physics Department and Mr D. Blease, Dr P. Wild, Professor J. Hough and Professor L. Cantor of the Education Department.

Dr A.T. Jones of Chelsea College provided ideas for the presentation of the thesis.

The research was facilitated by the willing co-operation of pupils, teachers, students and lecturers at the institutions involved in the surveys.

Mrs L. Thornhill provided invaluable secretarial assistance.
RECOMMENDATIONS

1. Further research should be undertaken to determine the percentages of female physics students and teachers who attended single-sex schools.

2. Further investigations should be undertaken to determine whether mixed Comprehensive Schools provide a suitable environment in which to encourage more females to study Physical Sciences.

3. Peer tutoring schemes should be initiated at all H.E. Institutions where physics is taught and wherever possible assessed Science Education courses should become an integral part of all physics degree courses.

4. The Bursary Scheme should be retained, and the sum paid to trainee physics teachers should be increased.

5. New physics teachers should be given a considerably reduced timetable throughout their first year of teaching.

6. Teachers' pay should be increased and their class contact time reduced.

7. There should be an investment in new equipment for school physics laboratories.

8. Access to higher education should be widened, and a Foundation Year introduced into H.E. Institutions to enable non-standard entrants to be admitted to physics degree courses.

9. Consideration should be given to the fact that large numbers of physics teachers are not qualified to teach Balanced Science to GCSE level and would prefer and are better qualified to teach Maths as a second subject.
10. There should be a reconsideration of moves towards an increase in the number of 11 - 16 schools and Sixth Form Colleges with the resulting concentration of inadequately qualified teachers in the 11 - 16 schools.

11. The production and dissemination of schemes of Supported Self-Study in physics should be encouraged.

12. Physics syllabus writers and course planners should consider the greater person-orientation of females than males, and aim to produce courses that are girl-friendly.

There are considerable cost implications to several of the above recommendations. However, two potentially highly effective proposals, peer-tutoring and girl-friendly science courses, could be put into effect at very little cost. Peer-tutoring has been shown to encourage undergraduates towards a career in teaching, and females have been shown to be more likely than males to choose teaching as a career.

Therefore, if girl-friendly science courses were to become widely used in schools, the result should be an increased uptake of physics degree courses by girls, and a corresponding increase in the number of students undertaking physics PGCE courses. This number should be further boosted if peer-tutoring schemes, with their consequent positive effect on the attitudes of physics undergraduates towards teaching, were made more widely available.
# CONTENTS

<table>
<thead>
<tr>
<th>ABSTRACT</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>iv</td>
</tr>
<tr>
<td>RECOMMENDATIONS</td>
<td>v</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xiv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xviii</td>
</tr>
<tr>
<td>LIST OF ABBREVIATIONS</td>
<td>xix</td>
</tr>
</tbody>
</table>

**CHAPTER 1: PHYSICS TEACHER SHORTAGES**

1.1 INTRODUCTION 1

1.2 TYPES OF SHORTAGES 2

1.2.1 Overt Shortages 2

1.2.2 Hidden Shortages 3

1.2.3 Suppressed Shortages 3

1.3 PREDICTED SHORTAGES 3

1.4 EDUCATION IN PHYSICS 4

1.5 PERSONALITY ISSUES 4

1.6 STUDENTS' ATTITUDES TO TEACHING 6

1.7 GOVERNMENT INITIATIVES 6

1.8 RESEARCH AIMS 6

1.9 OVERVIEW OF SUCCEEDING CHAPTERS 7

**CHAPTER 2: SCHOOL PHYSICS SURVEY**

2.1 INTRODUCTION 10

2.2 SURVEY SAMPLE 10

2.3 OVERVIEW OF RESULTS 10

2.4 PUPIL DATA 11

2.4.1 GCSE Level 11

2.4.2 'A' Level 12

2.5 TEACHER DATA 13

2.5.1 GCSE Level 13

2.5.2 'A' Level 14

2.6 GENERAL SUMMARY AND COMMENTS 14

**CHAPTER 3: PLANNING, IMPLEMENTATION AND ANALYSIS**

3.1 INTRODUCTION 16

3.2 SAMPLE CHOICE 16
CHAPTER 6: SURVEY OF 2-YEAR B.ED. STUDENTS

6.1 INTRODUCTION 52
6.2 METHODOLOGY 52
6.3 OVERVIEW OF RESULTS 52
6.4 MAIN REASONS FOR UNDERTAKING THE COURSE 53
6.5 ATTRACTIONS OF A TEACHING CAREER 53
6.6 ANTICIPATED PROBLEMS OF A NEW PHYSICS TEACHER 54
6.7 BREAKDOWN BY SEX AND AGE 54
6.8 SCHOOLS ATTENDED BETWEEN THE AGES 11 AND 16 54
6.9 SCHOOLS ATTENDED FOR 16+ EDUCATION 55
6.10 QUALIFICATIONS 55
6.11 GENERAL SUMMARY AND CONCLUSIONS 55

CHAPTER 7: PGCE FOLLOW-UP QUESTIONNAIRE

7.1 INTRODUCTION 57
7.2 OVERVIEW OF RESULTS 57
7.3 ATTRACTIONS OF A TEACHING CAREER 58
7.4 ANTICIPATED PROBLEMS 58
7.5 DESIRE TO TEACH 60
7.6 PREFERRED TYPE OF SCHOOL 60
7.7 BURSARY EFFECTS 61
7.8 PREFERRED SECOND SUBJECT 62
7.9 AGE AND SEX DIFFERENCES 63
7.9.1 Desire to Teach 63
7.9.2 Preferred Type of School 63
7.9.3 Bursary Effects 64
7.10 GENERAL SUMMARY AND CONCLUSIONS 65
7.11 FURTHER INFORMATION 66

CHAPTER 8: RECRUITMENT OF PHYSICS TEACHERS

8.1 INTRODUCTION 67
8.2 INITIAL TEACHER TRAINING 67
8.2.1 Shortened B.Ed. 67
8.2.2 Conversion Courses 68
8.2.3 TASC (Teaching as a Career) 68
8.2.4 Peer Tutoring 68
8.2.5 Taster Schemes 69
8.2.6 Work Experience 69
11.3.3 Enrolment of Students 90
11.3.4 Initiation of the Scheme 90
11.4 EVALUATION OF THE STUDENT-TUTOR SCHEME 91
11.4.1 School Visits 91
11.4.2 Pupil Questionnaires 91
11.4.3 Teacher Questionnaires 93
11.4.4 Student-Tutor Questionnaires 93
11.4.5 Summary and Comments 95
11.5 FUTURE PLANS 96
11.6 GENERAL SUMMARY AND CONCLUSIONS 96

CHAPTER 12: INCREASING PARTICIPATION IN 'A' LEVEL AND FIRST DEGREE PHYSICS COURSES 97
12.1 INTRODUCTION 97
12.2 UPTAKE OF 'A' LEVEL PHYSICS 97
12.2.1 The National Curriculum 98
12.2.2 Scientist in Residence 98
12.2.3 Changes in 'A' Level Syllabuses 99
12.2.4 SPISE (Select Programme in Science and Engineering) 99
12.2.5 Peer Tutoring 100
12.3 WIDENING ACCESS TO HIGHER EDUCATION 101
12.3.1 The Vocational Route to Higher Education 101
12.3.2 Equality of Opportunity 102
12.3.3 Links Between F.E. and H.E. 104
12.3.4 Mature Entrants 104
12.3.5 Course Development 105
12.4 GENERAL SUMMARY AND CONCLUSIONS 107

CHAPTER 13: GENDER ISSUES 108
13.1 INTRODUCTION 108
13.2 REASONS FOR SEX DIFFERENCES IN SCIENCE ACHIEVEMENT 108
13.2.1 Biological Differences 108
13.2.2 The Influence of Society 109
13.2.3 Pupils' Attitudes 110
13.2.4 The Influence of School 110
13.3 RECOMMENDATIONS 112
13.3.1 Changes in the Classroom 112
15.7 THE USE OF SUPPORTED SELF-STudy TO
COMPENSATE FOR TEACHER SHORTAGES 139

CHAPTER 16: CONCLUSIONS AND RECOMMENDATIONS 141
16.1 INTRODUCTION 141
16.2 CONCLUSIONS 141
16.3 RECOMMENDATIONS 143
16.4 FINAL COMMENTS 144

APPENDIX A: SCHOOL SURVEY 145
APPENDIX B: UNDERGRADUATE QUESTIONNAIRE 147
B1 Text of Questionnaire 148
B2 Comparison Between Two Universities 150
B3 Full Results of Question 3 160

APPENDIX C: PGCE QUESTIONNAIRE 163
C1 Text of Questionnaire 164
C2 Full Results of Question 3 171
C3 Full Results of Sex and Qualifications

Comparisons 174

APPENDIX D: PGCE FOLLOW-UP QUESTIONNAIRE 176
APPENDIX E: FIRST DESTINATION OF PHYSICS PGCE STUDENTS 179
APPENDIX F: PHYSICS TEACHERS' QUESTIONNAIRE 180
APPENDIX G: STUDENT-TUTOR SCHEME QUESTIONNAIRES 183
G1 Tutor Questionnaire 184
G2 Teacher Questionnaire 187
G3 Pupil Questionnaire 189

APPENDIX H: THE 'FLAP' PACKAGE 191
H1 Desired Course Content 192
H2 The Specification Process 199
H3 Form and Content 201
H4 'FLAP' Flexible Learning Approach to Physics 204
H5 Full Results of 'FLAP' Questionnaire 218

APPENDIX I: PUBLICATIONS 223
I1 List of Publications 224
I2 Stewart and Perrin 1989 225
I3 Stewart 1989a 227
I4 Stewart 1989b 230
I5 Stewart 1990a 232
I6 Stewart 1990b 234

BIBLIOGRAPHY 237

xiii
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GCSE Pupils (Fifth Year)</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>'A' Level Pupils (Sixth Formers)</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>GCSE Teachers</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>'A' Level Teachers</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Attitudes (Broken Down by Sex) (Undergraduates)</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>Attractions (Broken Down by Sex) (Undergraduates)</td>
<td>23</td>
</tr>
<tr>
<td>7</td>
<td>Problems (Broken Down by Sex) (Undergraduates)</td>
<td>25</td>
</tr>
<tr>
<td>8</td>
<td>Handedness (Undergraduates)</td>
<td>27</td>
</tr>
<tr>
<td>9</td>
<td>'A' Level Physics Grade (Undergraduates)</td>
<td>27</td>
</tr>
<tr>
<td>10</td>
<td>Reasons for Studying Physics (Undergraduates)</td>
<td>28</td>
</tr>
<tr>
<td>11</td>
<td>Reason for Undertaking PGCE</td>
<td>33</td>
</tr>
<tr>
<td>12</td>
<td>Attractions of a Teaching Career (PGCE Students)</td>
<td>33</td>
</tr>
<tr>
<td>13</td>
<td>Features of Great Importance (PGCE Students)</td>
<td>34</td>
</tr>
<tr>
<td>14</td>
<td>Anticipated Problems of a New Physics Teacher (PGCE Students)</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>Stage at Which Teaching was Chosen (PGCE Students)</td>
<td>36</td>
</tr>
<tr>
<td>16</td>
<td>Friends and Relatives in Teaching (PGCE Students)</td>
<td>37</td>
</tr>
<tr>
<td>17</td>
<td>Mixed or Single Sex Schools 11 - 16 (PGCE Students)</td>
<td>38</td>
</tr>
<tr>
<td>18</td>
<td>Type of School (11 - 16) (PGCE Students)</td>
<td>38</td>
</tr>
<tr>
<td>19</td>
<td>Mixed or Single Sex 16+ Schooling (PGCE Students)</td>
<td>38</td>
</tr>
<tr>
<td>20</td>
<td>Type of School for 'A' Levels (PGCE Students)</td>
<td>39</td>
</tr>
<tr>
<td>21</td>
<td>Transfer for 16+ Studies (PGCE Students)</td>
<td>40</td>
</tr>
<tr>
<td>22</td>
<td>'A' Level Physics Grade (PGCE Students)</td>
<td>41</td>
</tr>
<tr>
<td>23</td>
<td>Degree Subject (PGCE Students)</td>
<td>41</td>
</tr>
<tr>
<td>24</td>
<td>Class of Degree (PGCE Students)</td>
<td>42</td>
</tr>
<tr>
<td>25</td>
<td>Other Qualifications (PGCE Students)</td>
<td>42</td>
</tr>
<tr>
<td>26</td>
<td>Type of School 11 - 16 Broken Down by Sex (PGCE Students)</td>
<td>43</td>
</tr>
<tr>
<td>27</td>
<td>Mixed or Single Sex School 11 - 16 Broken Down by Sex (PGCE Students)</td>
<td>44</td>
</tr>
<tr>
<td>28</td>
<td>Type of School for 'A' Level Broken Down by Sex (PGCE Students)</td>
<td>44</td>
</tr>
<tr>
<td>Table</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>29</td>
<td>Mixed or Single-Sex School for 'A' Levels</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Broken Down by Sex (PGCE Students)</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Sex v. Reason for Doing PGCE</td>
<td>45</td>
</tr>
<tr>
<td>31</td>
<td>Type of School 11 - 16 (PGCE Students) Broken Down by Age</td>
<td>47</td>
</tr>
<tr>
<td>32</td>
<td>Mixed or Single-Sex School 11 - 16 (PGCE Students) Broken Down by Age</td>
<td>47</td>
</tr>
<tr>
<td>33</td>
<td>Type of Establishment for 'A' Level (PGCE Students) Broken Down by Age</td>
<td>48</td>
</tr>
<tr>
<td>34</td>
<td>Mixed or Single-Sex School for 'A' Level (PGCE Students) Broken Down by Age</td>
<td>48</td>
</tr>
<tr>
<td>35</td>
<td>Age v. Degree Subject (PGCE Students)</td>
<td>49</td>
</tr>
<tr>
<td>36</td>
<td>Reason for Undertaking the B.Ed.</td>
<td>53</td>
</tr>
<tr>
<td>37</td>
<td>Attractions of a Teaching Career (B.Ed. Students)</td>
<td>53</td>
</tr>
<tr>
<td>38</td>
<td>Anticipated Problems (B.Ed. Students)</td>
<td>54</td>
</tr>
<tr>
<td>39</td>
<td>Attractions of a Teaching Career (PGCE Follow-Up)</td>
<td>58</td>
</tr>
<tr>
<td>40</td>
<td>Anticipated Major Problems (PGCE Follow-Up and Comparison)</td>
<td>59</td>
</tr>
<tr>
<td>41</td>
<td>Desire to Teach (PGCE Students)</td>
<td>60</td>
</tr>
<tr>
<td>42</td>
<td>Preferred School Type (PGCE Students)</td>
<td>61</td>
</tr>
<tr>
<td>43</td>
<td>Bursary Effects (PGCE Students)</td>
<td>61</td>
</tr>
<tr>
<td>44</td>
<td>Preferred Second Subject (PGCE Students)</td>
<td>62</td>
</tr>
<tr>
<td>45</td>
<td>Preferred Type of School (PGCE Students)</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Broken down by Age and Sex</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Bursary Effects (PGCE Students) Broken Down by Age and Sex</td>
<td>65</td>
</tr>
<tr>
<td>47</td>
<td>Attractions of a Teaching Career (Physics Teachers)</td>
<td>76</td>
</tr>
<tr>
<td>48</td>
<td>Major Problems (Physics Teachers)</td>
<td>77</td>
</tr>
<tr>
<td>49</td>
<td>Preferred Second Subject (Physics Teachers)</td>
<td>78</td>
</tr>
<tr>
<td>50</td>
<td>Number of Years Teaching (Physics Teachers)</td>
<td>79</td>
</tr>
<tr>
<td>51</td>
<td>Reasons for Seeking Work Outside Teaching (Physics Teachers)</td>
<td>80</td>
</tr>
<tr>
<td>52</td>
<td>School Type (Physics Teachers) Broken Down by Sex</td>
<td>81</td>
</tr>
<tr>
<td>53</td>
<td>Attractions of a Teaching Career (Comparisons)</td>
<td>84</td>
</tr>
<tr>
<td>Table</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>54</td>
<td>Major Problems of a Teaching Career (Comparisons)</td>
<td>85</td>
</tr>
<tr>
<td>55</td>
<td>Breakdown by Sex (Comparisons)</td>
<td>85</td>
</tr>
<tr>
<td>56</td>
<td>Pupils' Opinions of Lessons</td>
<td>92</td>
</tr>
<tr>
<td>57</td>
<td>Pupils' Opinions of Learning</td>
<td>92</td>
</tr>
<tr>
<td>58</td>
<td>Benefits of Student-Tutoring</td>
<td>94</td>
</tr>
<tr>
<td>59</td>
<td>$\chi^2$ Values for Anticipated Problems of a New Physics Teacher (Physics Undergraduates Opinions)</td>
<td>151</td>
</tr>
<tr>
<td>60</td>
<td>University 1 Undergraduates Sex v. Shortage of Free Periods</td>
<td>161</td>
</tr>
<tr>
<td>61</td>
<td>University 2 Undergraduates Sex v. Frees</td>
<td>161</td>
</tr>
<tr>
<td>62</td>
<td>University 1 Undergraduates Sex v. Unfamiliar Equipment</td>
<td>161</td>
</tr>
<tr>
<td>63</td>
<td>University 2 Undergraduates Sex v. Unfamiliar Equipment</td>
<td>161</td>
</tr>
<tr>
<td>64</td>
<td>University 1 Undergraduates Sex v. Work in Evenings</td>
<td>161</td>
</tr>
<tr>
<td>65</td>
<td>University 2 Undergraduates Sex v. Work in Evenings</td>
<td>161</td>
</tr>
<tr>
<td>66</td>
<td>University 1 Undergraduates Sex v. Indiscipline</td>
<td>161</td>
</tr>
<tr>
<td>67</td>
<td>University 2 Undergraduates Sex v. Indiscipline</td>
<td>161</td>
</tr>
<tr>
<td>68</td>
<td>University 1 Undergraduates Sex v. Working With Other Teachers</td>
<td>162</td>
</tr>
<tr>
<td>69</td>
<td>University 2 Undergraduates Sex v. Work with Others</td>
<td>162</td>
</tr>
<tr>
<td>70</td>
<td>University 1 Undergraduates Sex v. Pupils' Personal Problems</td>
<td>162</td>
</tr>
<tr>
<td>71</td>
<td>University 2 Undergraduates Sex v. Pupils' Personal Problems</td>
<td>162</td>
</tr>
<tr>
<td>72</td>
<td>University 1 Undergraduates Sex v. Class Size</td>
<td>162</td>
</tr>
<tr>
<td>73</td>
<td>University 2 Undergraduates Sex v. Class Size</td>
<td>162</td>
</tr>
<tr>
<td>74</td>
<td>University 1 Undergraduates Sex v. Inadequately Equipped Labs</td>
<td>162</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Physics Student Pyramid 1983-84</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Survey Planning</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Social Groups</td>
<td>103</td>
</tr>
<tr>
<td>4</td>
<td>Mature Students</td>
<td>106</td>
</tr>
<tr>
<td>5</td>
<td>SWOT Analysis of Proposed Bridging Package</td>
<td>119</td>
</tr>
<tr>
<td>6</td>
<td>Marketing Strategy</td>
<td>120</td>
</tr>
<tr>
<td>7</td>
<td>Proposed Structure of Package</td>
<td>122</td>
</tr>
<tr>
<td>8</td>
<td>Supported Self-Study</td>
<td>134</td>
</tr>
<tr>
<td>9</td>
<td>Attitudes to a Career in Teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 1</td>
<td>152</td>
</tr>
<tr>
<td>10</td>
<td>Attitudes to Career in Teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 2</td>
<td>153</td>
</tr>
<tr>
<td>11</td>
<td>Pluses of Teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 1</td>
<td>154</td>
</tr>
<tr>
<td>12</td>
<td>Pluses of Teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 2</td>
<td>155</td>
</tr>
<tr>
<td>13</td>
<td>Anticipated Problems of New Physics Teachers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 1</td>
<td>156</td>
</tr>
<tr>
<td>14</td>
<td>Anticipated Problems of New Physics Teachers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 2</td>
<td>157</td>
</tr>
<tr>
<td>15</td>
<td>Gender of Physics Students</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 1</td>
<td>158</td>
</tr>
<tr>
<td>16</td>
<td>Sex of Physics Students</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physics Undergraduates University 2</td>
<td>159</td>
</tr>
</tbody>
</table>
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>'A' Level</td>
<td>Advanced Level</td>
</tr>
<tr>
<td>APPIL</td>
<td>Advanced Physics Project for Independent Learning</td>
</tr>
<tr>
<td>APU</td>
<td>Assessment of Performance Unit</td>
</tr>
<tr>
<td>BTEC</td>
<td>Business and Technician Education Council</td>
</tr>
<tr>
<td>CAL</td>
<td>Computer Assisted Learning</td>
</tr>
<tr>
<td>CET</td>
<td>Council for Educational Technology</td>
</tr>
<tr>
<td>CNAA</td>
<td>Council for National Academic Awards</td>
</tr>
<tr>
<td>CSE</td>
<td>Certificate of Secondary Education</td>
</tr>
<tr>
<td>DES</td>
<td>Department of Education and Science</td>
</tr>
<tr>
<td>FE</td>
<td>Further Education</td>
</tr>
<tr>
<td>FLAP</td>
<td>Flexible Learning Approach to Physics</td>
</tr>
<tr>
<td>GCSE</td>
<td>General Certificate of Secondary Education</td>
</tr>
<tr>
<td>GIST</td>
<td>Girls Into Science and Technology</td>
</tr>
<tr>
<td>HE</td>
<td>Higher Education</td>
</tr>
<tr>
<td>HMI</td>
<td>Her Majesty's Inspectorate</td>
</tr>
<tr>
<td>IBM</td>
<td>International Business Machines</td>
</tr>
<tr>
<td>ICI</td>
<td>Imperial Chemical Industry</td>
</tr>
<tr>
<td>IOP</td>
<td>Institute of Physics</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>IV</td>
<td>Interactive Video</td>
</tr>
<tr>
<td>KIT</td>
<td>Keeping in Touch with Teaching</td>
</tr>
<tr>
<td>LEA</td>
<td>Local Education Authority</td>
</tr>
<tr>
<td>NEC</td>
<td>National Extension College</td>
</tr>
<tr>
<td>NERIS</td>
<td>National Educational Resources Information Service</td>
</tr>
<tr>
<td>'O' Level</td>
<td>Ordinary Level</td>
</tr>
<tr>
<td>OU</td>
<td>Open University</td>
</tr>
<tr>
<td>PGCE</td>
<td>Post Graduate Certificate of Education</td>
</tr>
<tr>
<td>PIT</td>
<td>Pool of Inactive Teachers</td>
</tr>
<tr>
<td>SPISE</td>
<td>Select Programme in Science and Engineering</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistics Package for the Social Sciences</td>
</tr>
<tr>
<td>SSS</td>
<td>Supported Self-Study</td>
</tr>
<tr>
<td>STIMULUS</td>
<td>Science, Technology, Informatics and Mathematics: Undergraduate Links between University and School</td>
</tr>
<tr>
<td>TASC</td>
<td>Teaching as a Career</td>
</tr>
<tr>
<td>UGC</td>
<td>University Grants Committee</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Educational Scientific and Cultural Organization</td>
</tr>
<tr>
<td>WIT</td>
<td>Women in Training</td>
</tr>
</tbody>
</table>
1.1 INTRODUCTION

The shortage in the supply of physics teachers is a well documented subject which has had considerable media coverage. However, the problem is not entirely new. Ebison and Davies (1986) wrote of a "catastrophic and worsening shortage of physics teachers" and stated that "schools cannot improve the supply of physics and engineering students because of the chronic shortage of physics teachers". They pointed out that such shortages have been described in reports dating from 1918 onwards. Thompson (1988) traced the origins of the present difficulties, in part at least, to the changes in the education system since the 1960s. "The disappearance of grammar and technical schools and their replacement with comprehensive schools, many now without sixth forms, reduced the availability of some of the more challenging and rewarding teaching posts......".

The Institute of Physics (1987) stated that "Teaching is unattractive as a profession to graduate physicists--------it offers much less than other areas of employment both in pay and in the extent to which support services make possible a professional engagement with science and modern technology".

According to the Institute of Physics (1986) 5% of the 1983/4 cohort of physics graduates entered teacher training. This compared with 31% of them entering employment in industry and 8% entering commerce. Smithers and Robinson (1988) found that in 1986 over 11% of new English graduates entered teacher training, and this was true for only 5% of new physics graduates. Personality issues (Section 1.5) play a part in the percentages of male new graduates entering teacher training (English approximately 8%, Physics approximately 4%). However, Smithers and Robinson found that very similar percentages of female new graduates of English and Physics entered teacher training (approximately 13% and approximately 12% respectively). The main reason for the disparity between the figures for the recruitment to
teacher training of new English and Physics graduates seems to be the fact that whereas more than 2/3 of new English graduates are female, this is true of only approximately 1/6 of new Physics graduates (Smithers and Robinson 1988).

The demands of the National Curriculum, requiring all pupils to study science up to the age of 16, mean that more science teachers (including physicists) will be needed. Demographic changes in the 1990s will also tend to exacerbate current problems. "The age groups entering the graduate employment market will shrink in number, whilst the secondary school population, and therefore the demand for teachers, will rise" (D.E.S. 1986).

1.2 TYPES OF SHORTAGES

It is possible to distinguish three types of shortages. Overt shortages are the most visible because they are measured by the unfilled vacancies in the subject. Hidden shortages occur where tuition is given by teachers who are considered to be inadequately qualified in the subject. These shortages are more serious than overt shortages (Dunn 1988). There are also suppressed shortages where a subject becomes under-represented in the timetable because of a lack of suitable teachers.

1.2.1 Overt Shortages

The D.E.S. (1986) calculated a shortage index relating the "raw vacancy figures to the number of teaching posts in each subject". This indicated that it was almost twice as difficult for schools to fill a vacant post in physics as it was for secondary subjects in general and the relative position appeared to be deteriorating.

The figures for overt shortages, that is for unfilled vacancies, mask the true extent of the problem of physics teacher shortages. Vacancies may be filled by underqualified staff, or the subject may be allocated less curriculum time.
1.2.2 **Hidden Shortages**

Hidden shortages occur where there is a poor match between a teacher's qualifications and the subject taught. The 1984 Secondary School Staffing Survey indicated that 18% of timetabled tuition in physics was provided by teachers with no higher education qualifications in the subject (D.E.S. 1986). It was also found that the proportion of tuition given by teachers with physics as the main subject of a degree was 57%. Smithers and Robinson (1988) found that "the maintained sector generally is less well provided for than the independent". The researcher (1989b) surveyed approximately 25% of the 1988-89 cohort of physics PGCE students and suggested that "a disturbingly large proportion of these students will be increasing hidden shortages when they join the teaching force", because of their wide ranging qualifications.

1.2.3 **Suppressed Shortages**

Up to the present time it has been possible to alter the proportion of the school timetable given to each subject in accordance with the availability of specialist staff. With the advent of the National Curriculum containing science (with a specified amount of physics) as a Core Subject, this will no longer be possible.

1.3 **PREDICTED SHORTAGES**

It is very difficult to produce an accurate prediction of shortages in teacher supply. There are many variables and many uncertainties. The relationship between supply and demand must be calculated. The Times Education Supplement (1990a) lists some of the variables such as the numbers of teachers already in the post, those expected to leave, pupil-teacher ratios, special needs requirements, the demands of the National Curriculum, recruitment, returners, part-time posts and mature and overseas entrants. "Assumptions have to be made about all these variables, and some are particularly hard to predict".
Howarth (1989) gave a prediction that there would be a shortfall of 1,500 physics teachers by 1995. By making different (but plausible) assumptions about wastage rates and recruitment Smithers and Robinson (1988) produced both optimistic (1,607 shortfall) and pessimistic (3,720 shortfall) predictions. However the calculations are made, it seems clear that the demand for physics teachers is, and will remain for the foreseeable future, considerably greater than the supply.

1.4 EDUCATION IN PHYSICS

In common with all subjects, there is a loss of physics students at each stage of their education - option choices (until the advent of the National Curriculum), G.C.S.E., 'A' level and degree level. Figure 1 gives an indication of this effect for the academic year 1983-4. Under the provisions of the National Curriculum all students will study some physics up to the age of 16. It will be interesting to note any consequent changes higher up the pyramid once the National Curriculum is fully established.

Since the majority of physics teachers are drawn from students in the top section of the pyramid in Figure 1, it would be advantageous to the supply of physics teachers to increase the numbers participating in each educational level. It is clear from the pie charts that, above the most basic level, the proportion of girls falls with each advance towards degree level, and this is a problem, which is particularly acute in the physical sciences, and one that must be addressed urgently.

1.5 PERSONALITY ISSUES

Teaching is a person-oriented profession, but "people attracted to the abstractions of physics..... may have little interest in working with young people" (Smithers and Hill 1989). In general, women are more person-oriented than men (Smithers and Hill 1987), and surveys amongst sixth formers (Smithers and Hill 1987) and physics undergraduates (Stewart and Perrin 1989) found that females have a much more positive attitude towards teaching than do males.
FIGURE 1

PHYSICS STUDENT PYRAMID

1983-84

Age /years

21
20
19
18
17
16
15
14
13
12
11

UNIVERSITY
ALEVEL
O-LEVEL
C.S.E.
3rd YEAR OPTIONS

Boys
Girls
Boys
Girls
Girls
Boys

Source IOP

HUNDREDS OF THOUSANDS
OF STUDENTS
Two problems emerge. Firstly, there seems to be a lack of person-orientation amongst physics specialists and secondly, women are greatly under-represented amongst students of physics. Both of these factors lead to difficulties in the recruitment of physics teachers.

1.6 STUDENTS' ATTITUDES TO TEACHING

Wellington (1980, 1982) undertook qualitative studies of physics undergraduates' attitudes towards a career in teaching. He found that a large majority of the students interviewed had a negative attitude towards a career in teaching. Apart from the personality issues examined in Section 1.5, he found that many students felt that physics was an unpopular and difficult subject in schools; that career prospects in teaching were not good; that they were over-qualified for school teaching and that they disliked the prospect of facing the sort of people they had been surrounded with at school.

1.7 GOVERNMENT INITIATIVES

In July 1986, the Department of Education and Science published a consultation document entitled 'Action on Teacher Supply in Mathematics, Physics and Technology'. Funding was subsequently made available for new courses of initial and inservice training, taster schemes for mature graduates, tutoring schemes for undergraduates, the setting up of the Teaching as a Career Unit (TASC) and for a nationwide publicity campaign.

1.8 RESEARCH AIMS

The main aims of the research were:

1. To assess the current situation with regard to the staffing and the uptake of physics courses at school.

2. To determine the attitudes of physics undergraduates, Post Graduate Certificate of Education (PGCE) Students and physics teachers towards a career in teaching.
3. To determine the educational background of physics PGCE students.

4. To investigate the effects of gender issues in physics education.

5. To investigate, and wherever possible implement, methods whereby participation in physics courses at advanced and higher levels, including teacher training, may be increased.

6. To use the information gained from 1 to 5 above to recommend, or implement if possible, ways in which the supply of physics teachers may be increased.

A large proportion of the research follows the recommendations of a recent and comprehensive report on teacher supply (Smithers and Robinson 1988). The relevant recommendations from that report are listed below.

"That ways be found of attracting back into teaching qualified teachers who have left for other employment or elsewhere."

"That further research is required to establish the reasons for the apparent reluctance of ............ physics graduates to become teachers, even when they have trained to become teachers."

"That further study be undertaken to establish the composition of the entry to teacher training courses in terms of sex, age, subject of degree, class of degree and other characteristics."

"That consideration should be given to ways of increasing take-up by girls of post-G.C.S.E. ............ physics ............"

1.9 OVERVIEW OF SUCCEEDING CHAPTERS

The results of a data gathering exercise from schools in one Local Education Authority (LEA) are given in Chapter 2. The aim of the exercise was to provide information about the staffing and the uptake of physics courses.

Chapter 3 describes the principles of questionnaire design which lay behind the planning of the surveys of physics undergraduates, PGCE
students and B.Ed. students, the results of which are the subjects of Chapters 4, 5, 6 and 7.

In order to maintain adequate staffing levels, there must be a balance between recruitment and wastage. Thus it is important to retain physics teachers once they have been recruited. Chapters 8 and 9 concern recruitment and retention of physics teachers and include the results of a survey of physics teachers in one LEA.

When the responses to the undergraduate, PGCE and teacher questionnaires had been analysed, it was possible to make some comparisons between them. This is the subject of Chapter 10.

Peer Tutoring, whereby undergraduates act as classroom helpers in their local schools, appears to have a positive effect on students' attitude towards a career in teaching (Hirst et al 1989, Stewart 1990b). Chapter 11 describes the background investigation, the implementation and the evaluation of such a scheme.

One way of increasing the supply of physics teachers is to increase the size of the pool from which they are drawn. Chapter 12 is concerned with the methods of increasing participation in 'A' level physics and widening access to physics courses in Higher Education.

A recurring theme throughout any investigation of physics education is the under-representation of females. Chapter 13 addresses the important topic of gender issues in physics education.

Chapter 14 describes the developments resulting from collaborative ventures between Higher Education Institutions. Particular emphasis is given to the 'proposed FLAP (Flexible Learning Approach to Physics) package.

In the short term it is necessary to alleviate the problems encountered in schools due to the shortage of physics teachers. One such measure, Supported Self-Study, is described in Chapter 15.

Chapter 16 draws together the threads from the preceding chapters and
an attempt is made to draw some conclusions and make recommendations which, if implemented, may lead to an increase in the supply of physics teachers.
SCHOOL PHYSICS SURVEY

2.1 INTRODUCTION

The 1984 Secondary School Staffing Survey showed that 57% of physics tuition in schools was provided by physics graduates (DES 1986). In 1986 the Institute of Physics published a document entitled 'Statistics Relating to Education and Physics'. This document contained information about the numbers of pupils studying physics at each level ('O', 'A', degree) and the proportion of males to females in each of these groups.

During the period September to November, 1988 a survey was undertaken, by the researcher, to assess the current situation with regard to the staffing and the uptake of school physics courses. The full text of the survey is found in Appendix A.

2.2 SURVEY SAMPLE

A postal survey, within one English L.E.A., of all state schools offering courses to GCSE and/or 'A' level standard was conducted. Replies were received from 31 schools, representing a response rate of 66%.

2.3 OVERVIEW OF RESULTS

Problems were encountered during the analysis because some schools offered separate sciences, some offered a mixture of separate sciences and double-certificate science and others only offered double certificate science at GCSE level. The main effect of this was to make it very difficult to obtain data concerning physics teachers at GCSE level. As a result the GCSE teacher data concerns teachers of subjects with a substantial physics content.

Section 2.4 concerns the data gathered about the physics pupils and
Section 2.5 concerns their teachers.

2.4 PUPIL DATA

It was possible to determine the percentage of all pupils studying physics and the ratio of males to females in physics groups at both GCSE and 'A' level.

2.4.1 GCSE Level

Table 1 supplies information about the number of pupils studying GCSE physics and double-certificate science. The information is broken down by sex.

Table 1  GCSE Pupils (Fifth Year)

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3744</td>
<td>3841</td>
</tr>
<tr>
<td>No. studying physics</td>
<td>528</td>
<td>1406</td>
</tr>
<tr>
<td>No. studying physics or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>double-certificate science</td>
<td>828</td>
<td>1727</td>
</tr>
<tr>
<td>Percentage studying physics</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td>Percentage studying physics or double-certificate science</td>
<td>22</td>
<td>45</td>
</tr>
</tbody>
</table>

The overall percentage of fifth years studying GCSE physics was found to be 25%. Only 14% of fifth year females in the survey were studying GCSE physics, whereas the corresponding figure for males was 37%. An additional 8% of both sexes were studying double-certificate science. The Institute of Physics (1986) produced a figure of slightly less than 50% for the percentage of all fourth and fifth year pupils studying physics in English schools in the academic year 1983-4. However, the 1989 GCSE results reported in the Times Educational Supplement (1989a) produced a figure closer to 30% for fifth year physics pupils as a percentage of the year group.
The ratio of males to females studying GCSE physics in the fifth year was 2.7:1. If this was calculated as the ratio of the percentage of all boys to the percentage of all girls studying GCSE physics in the fifth year it would be 2.6:1. This is similar to the Institute of Physics ratio of 3:1 for fourth and fifth year pupils studying 'O' level or CSE physics in English schools in the academic year 1983-4.

The results in Table 1 yield a ratio of 2.09:1 for the number of males to females studying GCSE physics or double-certificate science. If this was calculated as the ratio of the percentage of all males to the percentage of all females studying these subjects in the fifth year, it would be 2.05:1.

### 2.4.2 'A' Level

Table 2 supplies information about the number of sixth formers studying 'A' level physics. This information is broken down by sex.

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3116</td>
<td>3017</td>
</tr>
<tr>
<td>No. studying physics</td>
<td>230</td>
<td>747</td>
</tr>
<tr>
<td>Percentage studying physics</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

The overall percentage of sixth formers studying 'A' level physics was found to be 16%. Only 7% of sixth form females in the survey were studying 'A' level physics, whereas the corresponding figure for males was 25%. The Institute of Physics (1986) found that approximately 25% of sixth formers in English schools were studying physics during the academic year 1983-4.

The ratio of sixth form males to females in the survey studying
for 'A' level physics was 3.25:1. If this was calculated as the ratio of the percentage of all males to the percentage of all females in the sixth form studying 'A' level physics, it would be 3.35:1. This is similar to the Institute of Physics figure of approximately 3.8:1 for sixth form physics students in the academic year 1983-4.

2.5 TEACHER DATA

The data obtained were subdivided to give information about teachers of courses with a high physics content at GCSE level and teachers of 'A' level physics.

2.5.1 GCSE Level

Table 3 gives information about teachers of courses with a high physics content at GCSE level.

### Table 3 GCSE Teachers

<table>
<thead>
<tr>
<th>Teacher Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number</td>
<td>112</td>
</tr>
<tr>
<td>No. with physics degree</td>
<td>48</td>
</tr>
<tr>
<td>Percentage with physics degree</td>
<td>42</td>
</tr>
<tr>
<td>No. of males</td>
<td>81</td>
</tr>
<tr>
<td>No. of females</td>
<td>31</td>
</tr>
<tr>
<td>Percentage males</td>
<td>72</td>
</tr>
<tr>
<td>Ratio males:females</td>
<td>2.6:1</td>
</tr>
</tbody>
</table>

Only 42% of these teachers had a degree in physics. Chemistry was the most common other degree. There were twelve 11-16 schools in the sample. In these schools, only 34% of teachers of courses with a high physics content at GCSE level had a degree in physics. The overall ratio of males to females was found to be 2.6:1.
2.5.2 'A' Level

Table 4 gives information about teachers of 'A' level physics courses.

Table 4 'A' Level Teachers

<table>
<thead>
<tr>
<th>Teacher Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number</td>
<td>68</td>
</tr>
<tr>
<td>No. with physics degree</td>
<td>47</td>
</tr>
<tr>
<td>Percentage with physics degree</td>
<td>69</td>
</tr>
<tr>
<td>No. of males</td>
<td>54</td>
</tr>
<tr>
<td>No. of females</td>
<td>14</td>
</tr>
<tr>
<td>Percentage of males</td>
<td>79</td>
</tr>
<tr>
<td>Ratio males:females</td>
<td>3.9:1</td>
</tr>
</tbody>
</table>

At this level 69% of the teachers had a degree in physics. Engineering was the most common other degree. There were four Sixth Form Colleges in the sample with 16 physics teachers, 15 of whom (94%) had a degree in physics. The overall ratio of males to females teaching physics at this level was found to be 3.9:1.

2.6 GENERAL SUMMARY AND COMMENTS

The overall percentage of fifth years in this sample studying GCSE physics was found to be 25%, and the ratio of males to females in this group was 2.7:1.

The availability of the option to study double-certificate science at GCSE level appears to increase the proportion of girls studying a subject with a substantial physics content. It is too early to assess the possible knock-on effect of producing an increase in the number of girls studying physics to 'A' level and beyond.

It is difficult to attach much significance to the figure of 42% of
teachers of subjects with a substantial physics content at GCSE level actually possessing a degree in physics, since it would be expected that teachers of science subjects of a combined or integrated nature would have a variety of science qualifications.

The overall percentage of sixth formers in this sample studying 'A' level physics was found to be 16%, and the ratio of males to females in this group was 3.25:1.

The value of 69% for the percentage of 'A' level physics teachers with a degree in physics is disturbingly low. The amount of physics studied at higher level (post 'A' level) by the other 31% of teachers was not determined, but it seems reasonable to assume that a considerable number of these teachers were contributing to the hidden shortage (see Chapter 1) of physics teachers.

In terms of qualifications, the 11-16 schools, with only 34% of teachers of courses with a substantial physics content possessing a degree in physics, were the least well staffed. The Sixth Form Colleges, where 94% of 'A' level physics teachers had a degree in physics, had the most appropriately qualified staff. The presence of under-qualified staff in the 11-16 schools may result in less pupils opting to study physics at 'A' level. Further research is required to determine if this is indeed the case.

It is interesting to note from this sample that amongst pupils studying GCSE subjects with a substantial physics content, 68% were male and 72% of their teachers were male. Amongst 'A' level physics students 76% were male and 79% of their teachers were male. It seems that there was a considerable match between the percentage of physics pupils at each level who were male, and the percentage of their teachers who were male. However, it is not possible to imply a cause and effect relationship. It seems equally valid to say that more males than females study physics because there are more male than female teachers to act as role models, or that there are more male than female physics teachers because more males than females choose to study physics.
CHAPTER 3

PLANNING, IMPLEMENTATION AND ANALYSIS OF QUESTIONNAIRES

3.1 INTRODUCTION

A major part of the information acquired by the researcher was gleaned from responses to questionnaires. According to Cohen and Manion (1980) the advantages of a questionnaire over an interview are that "it tends to be more reliable; because it is anonymous, it encourages greater honesty; it is more economical .... in terms of time and money; and ..... it may be mailed". However, there are certain disadvantages, such as the fact that the response rate may be low. There may also be ambiguities which could be explained by an interviewer and the respondent may complete the questionnaire hurriedly and carelessly.

Each questionnaire must have a clearly defined aim; it must be targeted at a suitable sample of the population; it must be designed to maximize the completion and return rate and it must be amenable to subsequent data analysis.

3.2 SAMPLE CHOICE

A researcher generally attempts to choose a representative sample of the total population from whom to collect information. If this is not possible, then the researcher must be careful not to generalize his results beyond the sample.

Since, in this study, there was only one researcher available and there were restrictions of time, cost and accessibility, it was necessary to use a method of non-probability sampling. Thus convenience sampling (Cohen and Manion 1980) was chosen.

The sample sizes must be adequate for valid statistical analysis to be undertaken. Cohen and Manion (1980) consider a minimum number to be 30. Obviously the larger the number of categories into which the data are to be broken down, the larger the sample size must be to produce
reliability.
In most of the surveys undertaken by the researcher, the sampling method chosen meant that the validity of generalizing the results beyond the survey would be in doubt. However, in the case of the survey of PGCE Students, the sample size represented over one quarter of the total population. In this case, generalization to the total population is acceptable.

3.3 QUESTIONNAIRE DESIGN AND IMPLEMENTATION

It was important to design a questionnaire which was relevant, comprehensive, comprehensible, in a form appropriate for data analysis, feasible and of a good layout (OU 1981).

Most of the questionnaires used in this research were designed for self-completion and postal return. However, the initial PGCE questionnaire was designed to be completed in a group setting with the researcher present. The main reasons for this were to enable the researcher to clarify any ambiguities and, by discussion with the students, to discover any further points worthy of investigation, so that the follow-up questionnaire could be designed as both an improvement on and an extension to the initial one.

Wherever possible, the questionnaires were designed to have a variety of question styles to make them more interesting to the respondents. The routine questions on personal data were placed near the end, preceded by a short explanation (OU 1981). The structured or closed questions, with a limited range of prompted answer categories, which were pre-coded, were used for ease of analysis. These questions yielded data of both nominal and ordinal form, depending on their style. The open-ended questions were more difficult to analyse because the allocation of answer categories had to be carried out after the questionnaires had been returned. Nevertheless, they were valuable because they made the questionnaires more interesting by allowing respondents to air their views, and they occasionally yielded factors suitable for further research.

The presentation was an important factor in eliciting a good response rate. Every effort was made to produce clearly worded, attractive,
spacious questionnaires of a simple, clear design.

It was essential to devise answer categories that were clearly defined, exhaustive and mutually exclusive and independent (OU 1981).

Wherever possible, the questionnaires were piloted on an appropriate group of students at the researcher's host university. This generally pointed up ambiguous, or otherwise faulty questions, which were subsequently modified before the main surveys were undertaken. It was also possible for further answer categories, or even further relevant questions to be suggested for inclusion in the main survey.

3.4 QUESTIONNAIRE ANALYSIS

The data obtained from the questionnaires were checked, coded and entered onto coding sheets in preparation for computer analysis. Two mainframe statistical packages had been investigated (SPSS and Minitab) and the decision was made to use Minitab. It was much simpler to learn and yet adequate for the task required of it and, more importantly, it could be used interactively.

3.5 GENERAL SUMMARY

The most important factors in the planning of this type of research are (a) a clearly defined aim, (b) a suitable sample and (c) a well designed questionnaire, to maximize response rate and simplify analysis.

The essential stages in the planning, implementation and analysis of surveys are illustrated in Figure 2.
define objectives

decide information needed

review existing information on topic and area
decide preliminary tabulations, analysis programme and sample

decide sample
choose survey method

structure and wording of questions
design questionnaire
choose data processing method

pilot survey
amend questionnaire and sample

send explanatory letter for postal questionnaire

MAIN SURVEY

send reminders

edit and code decide final tabulations

tabulate and analyse

Adapted from Cohen and Manion (1980)
CHAPTER 4

UNDERGRADUATE QUESTIONNAIRE

4.1 INTRODUCTION

Physics graduates seem to be reluctant to become teachers. A recent study (Smithers and Robinson, 1988) stated that only 57% of physics graduates go on to teacher training. This is about half of that for mathematics or English graduates. One relevant factor producing these variations is the very low proportion of females - who are more likely to go on to teacher training - (Smithers and Hill, 1989) on physics courses.

Given these statistics, it appears that it would be desirable to increase the total number of physics undergraduates and the proportion of female undergraduates and at the same time increase the proportion of physics graduates who choose to train as teachers. Widening access to physics degrees is discussed in greater detail in Chapter 12 and ways of interesting physics undergraduates in a teaching career are discussed in Chapter 8. This chapter identifies the reasons why undergraduates choose to study physics and investigates their attitudes to a career in teaching.

4.2 METHODOLOGY

The method used to obtain relevant information from physics undergraduates was to accumulate anecdotal evidence from informal discussions with physics students and from that, to construct a questionnaire of fixed-alternative, tick the box style for ease of completion and simplicity of analysis (Cohen and Manion 1980).

The questionnaire was designed to be brief, unambiguous and easy to complete, in order to maximise the response rate. The undergraduates were asked if they were considering a career in teaching; which factors made teaching an attractive career; what problems they expected to be faced by a new physics teacher; why they...
chose to study physics; and a minimum amount of personal details. The full text of the questionnaire is given in Appendix B.

The questionnaire was piloted on a 'captive audience' of a small number of students in a laboratory class. The researcher was in attendance, in case any problems arose. In fact, no problems were encountered and thus no revision of the questionnaire was necessary.

The sample consisted of all the physics undergraduates at two Midlands universities. Replies were received from 275 students. This represented a response rate of 81% and a sample size of approximately 4% of the total population of physics undergraduates in England.

4.3 OVERVIEW OF THE RESULTS

The results from the two universities were compared and there were found to be no statistically significant differences between the attitudes of the students at the two universities (Appendix B). Thus, it seemed reasonable to combine the two sets of results to produce a sample which seemed likely to be representative of the wider population of physics undergraduates, despite the non-random sampling technique employed. These results are reported in the seven succeeding sections. The undergraduates' attitudes to a teaching career are reported in section 4.4. Their opinions of the pluses and problems of teaching are reported in sections 4.5 and 4.6. The sex, handedness and 'A' level physics grades of the students are reported in sections 4.7, 4.8 and 4.9. Finally, in section 4.10 the undergraduates' reasons for studying physics are reported.

4.4 ATTITUDES TO A TEACHING CAREER

The undergraduates were asked if they were considering a career in teaching. The results were broken down by sex to enable comparisons to be made.

Very few students were actively considering a career in teaching and many more would not consider it at all. Table 5 shows the results of this question, and illustrates the overall negative attitude towards a career in teaching.
Table 5  Attitudes (Broken Down By Sex) (Undergraduates)

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Male (%) N=232</th>
<th>Female (%) N=36</th>
<th>Overall %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actively considering teaching</td>
<td>2.6</td>
<td>5.6*</td>
<td>3.6</td>
</tr>
<tr>
<td>Teaching is a possibility</td>
<td>27.6</td>
<td>33.3</td>
<td>28.1</td>
</tr>
<tr>
<td>Teaching is a last resort</td>
<td>47.0</td>
<td>50.0</td>
<td>47.6</td>
</tr>
<tr>
<td>Teaching would not be considered</td>
<td>22.8</td>
<td>11.1*</td>
<td>20.7</td>
</tr>
</tbody>
</table>

* unreliable due to small numbers

A large proportion of both males and females consider that a teaching career would be a last resort. It is difficult to make further comparisons because the number of females in the first and last category of Table 5 is insufficient for reliability. However, it does appear from these results that a female is more likely to consider a teaching career and less likely to have closed her mind to the idea than a male.

4.5 PLUSES OF TEACHING

The students were given a list of possible attractions of a teaching career and asked to indicate which features they felt were applicable. The results were broken down by sex to enable comparisons to be made.

Table 6 shows the results of the question concerning the attractions of teaching. It must be noted that percentages do not add up to 100, since the students could tick several boxes.

The fact that 'long holidays' is the most popular choice and 'good pay' and 'promotion prospects' are considered to be attractions of a
teaching career by few students, seems to re-emphasise the negative attitude exhibited by physics undergraduates towards teaching, which was reported in section 4.4.

Table 6 Attraction (Broken Down by Sex)(Undergraduates)

<table>
<thead>
<tr>
<th>Attraction</th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%N=232</td>
<td>%N=36</td>
<td>%</td>
</tr>
<tr>
<td>Long Holidays</td>
<td>81.0</td>
<td>72.2</td>
<td>80.0</td>
</tr>
<tr>
<td>Job Satisfaction</td>
<td>62.1</td>
<td>69.4</td>
<td>62.9</td>
</tr>
<tr>
<td>Work with young people</td>
<td>32.3</td>
<td>63.9</td>
<td>36.7</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>29.7</td>
<td>8.3*</td>
<td>26.9</td>
</tr>
<tr>
<td>Good pay</td>
<td>11.2</td>
<td>5.6*</td>
<td>10.5</td>
</tr>
<tr>
<td>Promotion Prospects</td>
<td>9.9</td>
<td>2.8*</td>
<td>9.1</td>
</tr>
</tbody>
</table>

*unreliable due to small numbers

The most striking difference between the opinions of males and females in this sample is that females are twice as likely as males to find 'work with young people' an attraction. It has been pointed out before that women are generally more person-oriented than men and males are less interested in working with children than are females (Smithers and Hill 1987; Stewart 1989a).

A Chi-squared test to compare the response of males and females to the attraction of working with young people was undertaken. The Yates' correction for 2 x 2 tables was applied with a resulting value of $\chi^2$ of 12.0571. This indicates a statistically significant difference beyond the 1% level.
Using anecdotal evidence acquired from conversations with students and teachers, a list of eight anticipated problems to be faced by a new physics teacher was drawn up. The undergraduates were asked to respond on a five point Likert-type scale, ranging from major problem, through neutral, to no problem. The results were further broken down by sex to enable comparisons to be made.

Table 7 shows the results of the question concerning anticipated problems faced by a new physics teacher. The full results are shown in Appendix B, but for the purpose of displaying the results clearly and simply, the following table indicates the percentage of students rating the problem as major, or fairly major (1 and 2 on the scale).
Table 7 Problems (Broken Down by Sex) (Undergraduates)

<table>
<thead>
<tr>
<th>Major/Fairly Major Problem</th>
<th>Male%</th>
<th>Female%</th>
<th>Overall%</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=232</td>
<td></td>
<td>N=36</td>
<td></td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>77.6</td>
<td>86.1</td>
<td>78.9</td>
</tr>
<tr>
<td>Large class size</td>
<td>64.7</td>
<td>80.6</td>
<td>66.9</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>62.5</td>
<td>66.7</td>
<td>64.0</td>
</tr>
<tr>
<td>Making/preparation in evenings</td>
<td>45.3</td>
<td>38.9</td>
<td>44.4</td>
</tr>
<tr>
<td>Dealing with pupils' personal problems</td>
<td>28.0</td>
<td>16.7*</td>
<td>26.5</td>
</tr>
<tr>
<td>Insufficient free periods</td>
<td>37.5</td>
<td>16.7*</td>
<td>18.1</td>
</tr>
<tr>
<td>Working with unfamiliar equipment</td>
<td>14.7</td>
<td>16.7</td>
<td>14.9</td>
</tr>
<tr>
<td>Working with others</td>
<td>5.6</td>
<td>5.6*</td>
<td>5.6</td>
</tr>
</tbody>
</table>

*unreliable due to small numbers

From these results it appears that the undergraduates felt that working with inadequate equipment was the main problem facing a new physics teacher. Clark and Vere-Jones (1987) have pointed out that replacement and upgrading of equipment are important factors in the recruitment and retention of physics teachers. Other major problems were thought to be coping with large classes and dealing with indiscipline. The factors thought to be least likely to be major problems were working with other teachers and with unfamiliar equipment.

Problems of comparison occur because of the small total number of female undergraduates leading to unreliability. However, it appears
from these figures that females expect 'large class size' to be more of a problem than do males, and males expect 'insufficient free periods' to be more of a problem than do females. Nevertheless, there is no discernible difference in the rank order of these problems.

4.7 BREAKDOWN BY SEX

Amongst the personal details gathered was the sex of each respondent. Seven students did not specify their sex. Of those who did, 232 (86.57%) were male and 36 (13.57%) were female. These figures are similar to those recently published (IOP 1988) suggesting that the sample chosen was not unrepresentative in this respect. A further consideration of gender differences is undertaken in Chapter 13.

4.8 HANDEDNESS

The researcher has an interest in the effect of handedness upon specific skills - leading to subject choice. Thus, a question was included on the questionnaire to determine the handedness of the physics undergraduates. Amongst the general population the incidence of left-handedness is about 10% (Springer & Deutsch 1981), with a slightly higher percentage of males than females (Clark 1957). The students in this survey were asked to state if they were dominantly left-handed, dominantly right-handed or ambidextrous.

The overall results are similar to those of the general population. It was found that 11.6% of these undergraduates were left-handed, 85.1% right-handed and 3.4% were ambidextrous.

Caution must be exercised when attempting to draw conclusions about the gender-related differences in handedness because of the small total number of females involved (36). However, it is most interesting, and worthy of more extensive research, to note that whereas 9.9% of the males were left-handed, a surprising 22.2% of the females possessed this characteristic. The full results are shown in Table 8.
Table 8  Handedness (Undergraduates)

<table>
<thead>
<tr>
<th></th>
<th>Left Handed</th>
<th>Right Handed</th>
<th>Ambidextrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>9.9%</td>
<td>86.6%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Female</td>
<td>22.2%</td>
<td>75.0%</td>
<td>2.8*%</td>
</tr>
<tr>
<td>Overall</td>
<td>11.6%</td>
<td>85.1%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>

*unreliable due to small numbers

A chi-squared test to determine the difference between the left or right handedness of males and females gave a value of $\chi^2$ of 3.43681, which was just short of being statistically significant at the 5% level.

4.9 'A' LEVEL PHYSICS GRADE

The students were asked to state their 'A' level physics grade. The median grade was found to be B. The full results are given in Table 9.

Table 9  'A' Level Physics Grade (Undergraduates)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage of Undergraduates (N = 259)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Grade A</td>
<td>41.3%</td>
</tr>
<tr>
<td>Grade B</td>
<td>39.1%</td>
</tr>
<tr>
<td>Grade C</td>
<td>15.7%</td>
</tr>
<tr>
<td>Grade D</td>
<td>3.5%</td>
</tr>
<tr>
<td>Grade E</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

*unreliable due to small numbers
There was no statistically significant difference between the 'A' level grades of the males and females in the sample ($\chi^2 = 7.034$ with 4 degrees of freedom).

4.10 REASONS FOR STUDYING PHYSICS

The only open-ended question in this survey was to determine the undergraduates' reasons for studying physics. Even after the small pilot study, it was difficult and perhaps undesirable to determine a small number of fixed alternatives. A coding frame was devised after the completed questionnaires had been returned. The method used was to take a random sample (of approximately 10%) and generate a frequency tally of the range of responses. This frame was used in the full analysis, and additional responses were added to the coding frame if necessary (O.U. 1981).

Table 10 gives the results of the question to determine why the undergraduates chose to study physics.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage of Undergraduates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Interest</td>
<td>46</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>30</td>
</tr>
<tr>
<td>Career Prospects</td>
<td>27</td>
</tr>
<tr>
<td>Ability</td>
<td>13</td>
</tr>
<tr>
<td>Challenge</td>
<td>4</td>
</tr>
</tbody>
</table>

*unreliable due to small numbers
Percentages do not add up to 100 because undergraduates could give more than one response.
The most important reasons seemed to be that the subject was found to be interesting and enjoyable. The prospect of a good career at the end of the course was also an important factor.

The figures for the females cannot be considered to be very reliable because of the small numbers involved. However, the most commonly quoted reason for studying physics given by both males and females was that they found the subject interesting.

4.11 GENERAL SUMMARY AND CONCLUSIONS

The survey results indicate that, in general, the undergraduates had a negative attitude towards a teaching career. In fact, 68% of the students would only consider teaching as a last resort, or not at all. The major findings are summarized below.

Very few students were actively considering a career in teaching, although it appears from these results that females had a more positive attitude towards teaching than did males.

The main attractions of a teaching career were found to be 'long holidays', 'job satisfaction', and 'work with young people'. However, females were very much more likely to consider 'work with young people' an attraction than were males.

'Good pay' and 'promotion prospects' are two features which were considered attractions of a teaching career by very few students.

The undergraduates anticipated that the main problems facing a new physics teacher would be 'inadequate equipment', 'large class size' and 'indiscipline'. Both males and females ranked the problems in the same order.

The population of physics undergraduates was found to be overwhelmingly male. Of those who specified their sex, 86.5% were male and 13.5% female.

The proportion of left to right handers was similar to that found
in the general population. However, the discrepancy between the male and female statistics (in the opposite direction to that of the general population) requires further investigation.

The median 'A' level grade was B, with 42.1% of the sample having a grade A and only 4.7% having a grade D or E.

A majority of the undergraduates found physics interesting and more than a quarter of them chose to study physics because it would lead to good career prospects.
CHAPTER 5

PGCE INITIAL QUESTIONNAIRE

5.1 INTRODUCTION

A recent comprehensive report (Smithers and Robinson 1988) concerning the shortage of physics teachers contained amongst its recommendations that "further research is required to establish the reasons for the apparent reluctance of physics graduates to become teachers, even when they have trained to become teachers" and that "further study to be undertaken to establish the composition of the entry to teacher training courses in terms of sex, age, subject of degree, class of degree and other characteristics".

This chapter presents the results of a survey, undertaken by the researcher, of 123 physics PGCE students, during the first term of their course, at eight universities and two polytechnics. This sample represented 27% of the total number of physics PGCE students in England and Wales at the time (September - December 1988).

The main aims of the survey were to determine the factors affecting the students' decision to undertake a PGCE; their attitudes towards a teaching career; their educational background and personal data for comparison.

5.2 METHODOLOGY

The method used for obtaining information from the students was to issue questionnaires to them during a timetabled session with the researcher in attendance. In this way, the return rate was maximized and any problems encountered could be resolved by the researcher.

The majority of the questions were of fixed-alternative, tick-the-box style. However, where appropriate, space was left for additional comments from the students. The full text of the survey can be found in Appendix C.
The questionnaire was piloted on a small group of students at the researcher's host institution. One question was found to contain categories which were not mutually exclusive and was subsequently omitted from the questionnaires produced for the full survey. No other alterations were deemed necessary.

5.3 OVERVIEW OF RESULTS

The results of the survey are reported in twelve sections. The students' reasons for undertaking the PGCE course are reported in section 5.4. The pluses and minuses of teaching are reported in sections 5.5 and 5.6. Sections 5.7 and 5.8 concern careers guidance, whilst sections 5.9 and 5.10 report the stage at which teaching was chosen as a career and the number of friends and relatives of the students who are teachers. The sex and age of the respondents are reported in section 5.11. The educational background of the students is the concern of sections 5.12 - 5.14. Finally, section 5.15 reports on sex and age differences in the responses to the questionnaire.

5.4 MAIN REASONS FOR UNDERTAKING PGCE

The students were asked to indicate their main reason for undertaking a PGCE, from a list of fixed alternatives. However, they were provided with an opportunity to give another reason if appropriate.

Only just over half of the students in the sample gave a 'definite desire to teach' as their main reason for undertaking the PGCE, almost a third were using the PGCE 'to try out teaching'. The full results are given in Table 11.
Table 11  Reason for Undertaking PGCE

<table>
<thead>
<tr>
<th>Reason</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite desire to teach</td>
<td>54</td>
</tr>
<tr>
<td>To try out teaching</td>
<td>30</td>
</tr>
<tr>
<td>To change career</td>
<td>14</td>
</tr>
<tr>
<td>Lack of success in job applications</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

Examples of 'other' reasons were: - "My age precludes many jobs. Teaching is my main preference in what is available"; "To gain new skills"; and "For VSO in the future".

5.5 Attractions of a Teaching Career

The students were asked to rate six possible attractions of a teaching career in order of importance. Since these data are ordinal it is valid to compare median values.

Table 12 lists the median value for each possible attraction of a teaching career. It should be noted that the lower the median value, the greater the importance.

Table 12  Attractions of a Teaching Career (PGCE Students)

<table>
<thead>
<tr>
<th>Attraction</th>
<th>Median Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Job satisfaction</td>
<td>1.0</td>
<td>Most Important</td>
</tr>
<tr>
<td>Work with young people</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Long holidays</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Promotion prospects</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Good pay*</td>
<td>6.0</td>
<td>Least Important</td>
</tr>
</tbody>
</table>

33
Table 13 gives an analysis of each feature in terms of the percentage of students considering it to be of importance (1 to 3 on the 6 point scale).

Table 13  Features of Great Importance (PGCE Students)

<table>
<thead>
<tr>
<th>Attractive Feature</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job satisfaction</td>
<td>96.0</td>
</tr>
<tr>
<td>Work with young people</td>
<td>83.3</td>
</tr>
<tr>
<td>Long holidays</td>
<td>49.9</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>44.2</td>
</tr>
<tr>
<td>Promotion prospects</td>
<td>19.3</td>
</tr>
<tr>
<td>Good pay*</td>
<td>8.4</td>
</tr>
</tbody>
</table>

*Some students commented that they wished that the pay was better, but they were prepared to put it at a low priority compared with other attractions such as job satisfaction.

Job satisfaction and work with young people were seen as the most important attractions of a teaching career, whereas promotion prospects and good pay were given a low priority.

Amongst other factors of importance three students mentioned mobility of employment area, two mentioned the variety of the work and two mentioned the possibility of changing society or influencing young people.

5.6 ANTICIPATED PROBLEMS OF NEW PHYSICS TEACHERS

The students were asked to give individual ratings on a Likert-type scale for a set of features which a new physics teacher may find to be problems. There was also the opportunity for them to specify any other major problems which may face a new physics teacher.

The full results are shown in Appendix C but for the purpose of
displaying the results clearly and simply it was decided to show the percentage of students who had rated the problems on the two points of the scale indicating a major problem (1 and 2). These reduced results are shown in Table 14.

Table 14 Anticipated Problems of a New Physics Teacher

(PGCE Students)

<table>
<thead>
<tr>
<th>Major Problem</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate equipment</td>
<td>72.9</td>
</tr>
<tr>
<td>Large class size</td>
<td>66.4</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>56.2</td>
</tr>
<tr>
<td>Insufficient free periods</td>
<td>52.5</td>
</tr>
<tr>
<td>Marking/preparation in evenings</td>
<td>38.8</td>
</tr>
<tr>
<td>Unfamiliar equipment</td>
<td>32.8</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>22.3</td>
</tr>
<tr>
<td>Working with others</td>
<td>9.0</td>
</tr>
</tbody>
</table>

The median scores for 'inadequate equipment', 'large class size' and 'indiscipline' are all 2. The mean scores (although not strictly valid for ordinal data) of 2.05, 2.25 and 2.48 respectively echo the results of the above table.

The features considered major problems by the highest proportion of students were those of inadequate equipment, large class size and indiscipline. Few students considered that working with others or dealing with pupils' personal problems would be major problems.

Amongst other anticipated problems the ones most commonly quoted were inadequate knowledge of the syllabus, the low status of teachers in society, the difficulty of pitching work at the right level and the possibility of having to teach balanced science.

5.7 CAREERS GUIDANCE AT SCHOOL

Of the 78% of students who had received careers guidance at school,
72% stated that it had not been helpful and only 23% stated that
teaching had been suggested as a career. Caution must be exercised
when attempting to draw conclusions about the current state of careers
education in schools from these figures, because for a considerable
proportion of the students in the sample many years had elapsed since
their schooldays.

5.8 CAREERS GUIDANCE DURING HIGHER EDUCATION

Of the 77% of students who had received careers guidance during their
period of higher education, 36% stated that it had not been helpful,
51.6% said it was quite helpful and 12.6% said it was very helpful.
In reply to the question about whether teaching was suggested as a
possible career 58% said that it was not suggested and 42% said that
it was.

5.9 STAGE AT WHICH TEACHING WAS CHOSEN

The students were asked at what stage they had chosen teaching as a
career. This question was intended to help determine whether a
teaching career had been a long term aim for many of the students.

The majority of students had chosen a career in teaching after they
had spent some time working in another career. Table 15 shows the
full results of the question.

Table 15 Stage At Which Teaching Was Chosen (PGCE Students)

<table>
<thead>
<tr>
<th>Stage</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to secondary education</td>
<td>0.8</td>
</tr>
<tr>
<td>During secondary education</td>
<td>5.7</td>
</tr>
<tr>
<td>During higher education</td>
<td>30.9</td>
</tr>
<tr>
<td>After another career</td>
<td>52.0</td>
</tr>
<tr>
<td>Still undecided</td>
<td>8.1</td>
</tr>
<tr>
<td>Other</td>
<td>2.5</td>
</tr>
</tbody>
</table>
The three people who chose the 'other' category all stated that they had chosen a career in teaching after their period in higher education.

More than half of the students had another career prior to choosing teaching, and almost a third had chosen a teaching career during their period of higher education. Approximately one student in twelve was still undecided.

5.10  CLOSE FRIENDS AND RELATIVES IN TEACHING

In an attempt to discover whether friends and/or relatives had any effect on the students choice of career, they were asked - in two separate questions - if they had any close relatives (defined as grandparents, parents, brothers, sisters, aunts, uncles and cousins) who were, or had been teachers, and if they had any close friends who were currently teaching. The results of this question are given in Table 16.

<table>
<thead>
<tr>
<th>No. of Friends/Relatives</th>
<th>Friends</th>
<th>% of Students</th>
<th>Relatives</th>
<th>% of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>41.5</td>
<td>42.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 - 3</td>
<td>40.6</td>
<td>42.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 3</td>
<td>17.9</td>
<td>15.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results for friends and relatives were remarkably similar. In each case there were approximately 40% of the students with no friends/relatives teaching and 40% with between one and three friends/relatives teaching.

5.11  BREAKDOWN BY SEX AND AGE

The sample population was 79.7% male and 20.3% female. The mean age
was 27 years, with a range of 33 years (from 21 to 54) and the median age was 25.

5.12 SCHOOLING 11 - 16

The students were asked what type of school they had attended for the majority of their education between the ages of 11 and 16, and also whether that school was mixed or single sex.

Tables 17 and 18 show the results of the question concerning schooling between the ages of 11 and 16.

Table 17 Mixed or Single Sex School 11 - 16 (PGCE Students)

<table>
<thead>
<tr>
<th>School</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>63.4</td>
</tr>
<tr>
<td>Single Sex</td>
<td>36.6</td>
</tr>
</tbody>
</table>

Almost two thirds of the sample had attended mixed schools between the ages of 11 and 16.

Table 18 Type of School (11 - 16) (PGCE Students)

<table>
<thead>
<tr>
<th>Type of School</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>48.8</td>
</tr>
<tr>
<td>Grammar</td>
<td>24.4</td>
</tr>
<tr>
<td>Independent</td>
<td>16.3</td>
</tr>
<tr>
<td>Secondary Modern</td>
<td>7.3</td>
</tr>
<tr>
<td>Other</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Almost half of the students had attended comprehensive schools and
SCHOOLING FOR 'A' LEVEL OR EQUIVALENT

The students were asked what type of school they had attended for 'A' level, or further educational studies and if such an establishment had been coeducational, or not. Tables 19 and 20 give the results of the question concerning sixth form or further educational studies and Table 21 illustrates transfer between establishments for 16+ studies.

Table 19 Mixed or Single Sex 16+ Schooling (PGCE Students)

<table>
<thead>
<tr>
<th>School</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>73.2</td>
</tr>
<tr>
<td>Single Sex</td>
<td>26.8</td>
</tr>
</tbody>
</table>

Almost three quarters of the students in the sample had attended co-educational establishments for their 16+ education.

Table 20 Type of School for 'A' Levels (PGCE Students)

<table>
<thead>
<tr>
<th>Type of School</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>31.7</td>
</tr>
<tr>
<td>Grammar</td>
<td>19.5</td>
</tr>
<tr>
<td>F.E. College</td>
<td>18.7</td>
</tr>
<tr>
<td>Sixth Form</td>
<td>13.0</td>
</tr>
<tr>
<td>Independent</td>
<td>12.2</td>
</tr>
<tr>
<td>Other</td>
<td>4.9</td>
</tr>
</tbody>
</table>
Almost one third of the students attended Comprehensive schools for their 'A' level, or 'A' level equivalent, studies and an equal number of students attended College (F.E. or Sixth Form)

Table 21 Transfer for 16+ Studies (PGCE Students)

<table>
<thead>
<tr>
<th>16+ Establishment</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-16 School</td>
<td>Comprhsve. Grammar Indept. F.E. V1TH Other</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>63.3</td>
</tr>
<tr>
<td>Grammar</td>
<td>3.3 73.3</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
</tr>
<tr>
<td>Modern</td>
<td>- 11.1* 33.3* 33.3* 22.2*</td>
</tr>
<tr>
<td>Independent</td>
<td>- 5.0 70.0 15.0 5.0 5.0</td>
</tr>
<tr>
<td>Other</td>
<td>- - - 75.0* 25.0*</td>
</tr>
</tbody>
</table>

Percentages may total 100 ± 0.1 due to rounding errors.
*Unreliable due to small numbers.

Almost a quarter of the students who had attended Comprehensive School between the ages of 11 and 16 transferred to F.E. Colleges for their 16+ studies. There was very little transfer between Independent and Comprehensive Schools.

5.14 QUALIFICATIONS

The students were asked to supply details of their 'A' level physics grade, the subject and class of their degree and any other relevant qualifications. Tables 22 to 25 show the results of this question.
Table 22 'A' Level Physics Grade (PGCE Students)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28.7</td>
</tr>
<tr>
<td>B</td>
<td>25.3</td>
</tr>
<tr>
<td>C</td>
<td>20.0</td>
</tr>
<tr>
<td>D</td>
<td>10.4</td>
</tr>
<tr>
<td>E</td>
<td>13.0</td>
</tr>
<tr>
<td>Other</td>
<td>2.6</td>
</tr>
</tbody>
</table>

The median grade was B.

Over half of the students had an 'A' level physics grade of A or B.

Table 23 Degree Subject (PGCE Students)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>38.5</td>
</tr>
<tr>
<td>Joint Physics/other science</td>
<td>22.1</td>
</tr>
<tr>
<td>Engineering</td>
<td>20.5</td>
</tr>
<tr>
<td>Materials Science</td>
<td>4.1</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3.3</td>
</tr>
<tr>
<td>Other</td>
<td>11.5</td>
</tr>
</tbody>
</table>

The category 'Other' included Geophysics, Health Physics, Biological Science, Geology, Economics, Biochemistry, Marine Biology, Philosophy and Psychology.

Only 60.6% of the students had a degree in physics or joint physics and another science. One in five of the students had an engineering degree. The Department of Education and Science (1986) stated that
according to the 1984 Secondary School Staffing Survey 57% of school physics tuition is given by teachers having the subject as a main qualification of a degree course. This figure is similar to the sum of the first two categories in the table above.

Table 24 Class of Degree (PGCE Students)

<table>
<thead>
<tr>
<th>Class</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>5.9</td>
</tr>
<tr>
<td>Upper Second</td>
<td>24.4</td>
</tr>
<tr>
<td>Lower Second*</td>
<td>34.5 *Median Class</td>
</tr>
<tr>
<td>Third</td>
<td>21.9</td>
</tr>
<tr>
<td>Pass</td>
<td>13.9</td>
</tr>
</tbody>
</table>

Approximately 65% of these students had first or second class honours degrees.

Table 25 Other Qualifications (PGCE Students)

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.Sc.</td>
<td>8</td>
</tr>
<tr>
<td>Diploma in Physics*</td>
<td>7</td>
</tr>
<tr>
<td>HNC</td>
<td>5</td>
</tr>
<tr>
<td>HND</td>
<td>4</td>
</tr>
<tr>
<td>Ph.D</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
</tr>
</tbody>
</table>

*Year 1 of two-year PGCE
The overall results given in the preceding eleven sections may have masked differences between the results due to the age or sex of the respondents. The aim of this section is to break down the previous results by age and/or sex where appropriate in order to determine if such differences exist.

5.15.1 Sex and School Type

Tables 26 to 29 show the type of school attended between the age of 11 to 16 and for 'A' level or equivalent, and whether these establishments were co-educational.

Table 26 Type of School 11 - 16 (PGCE Students) Broken Down by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comprehensive Grammar Secondary Independent Other</td>
</tr>
<tr>
<td>Male</td>
<td>50.0 23.5 7.1 16.3 3.1</td>
</tr>
<tr>
<td>Female</td>
<td>44.0 28.0 8.0* 16.0* 4.0*</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

Half the males and 44% of the females had attended comprehensive schools.
Table 27: Mixed or Single-Sex School 11 - 16 (PGCE Students)  
Broken Down by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed School</td>
</tr>
<tr>
<td>Male</td>
<td>66.3</td>
</tr>
<tr>
<td>Female</td>
<td>52.0</td>
</tr>
</tbody>
</table>

χ² = 1.762

Almost half of the females, but only one third of the males had attended single-sex schools. However, the differences were not statistically significant at the 5% level.

Table 28: Type of School for 'A' Level (PGCE Students)  
Broken Down by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comprehsve.</td>
</tr>
<tr>
<td>Male</td>
<td>28.6</td>
</tr>
<tr>
<td>Female</td>
<td>44.0</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

Further Education Colleges provided an attractive alternative to school for the males in particular.
Table 29 Mixed or Single-Sex School for 'A' Levels (PGCE Students) Broken Down by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed School</td>
</tr>
<tr>
<td>Male</td>
<td>76.5</td>
</tr>
<tr>
<td>Female</td>
<td>60.0</td>
</tr>
</tbody>
</table>

$\chi^2 = 2.773$

Less than one quarter of the males, but two fifths of the females had attended single-sex establishments at this stage of their education. However, there was no statistically significant difference at the 5% level.

5.15.2 Sex and Reason for Doing PGCE

Table 30 shows a breakdown of the reasons for doing the PGCE compared with the sex of the respondent.

Table 30 Sex v. Reason for Doing PGCE

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Definite desire to teach</td>
<td>53.1</td>
</tr>
<tr>
<td>To try out teaching</td>
<td>31.6</td>
</tr>
<tr>
<td>To change career</td>
<td>13.3</td>
</tr>
<tr>
<td>Other</td>
<td>2.0</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

The results for males and females are very similar.
5.15.3 Sex and Qualifications

There was no statistically significant difference between the 'A' level grades of males and females in the survey ($\chi^2 = 3.373$ with 5 degrees of freedom). A slightly higher percentage of males (55%) than females (48%) had grades A or B.

It was found that the percentages of males and females in this survey with degrees in physics or joint physics and another science were very similar (60% and 64% respectively). However, 25% of the males and only 4% of the females had degrees in engineering.

The degree classes of the females were better than those of the males. It was found that 75% of the females, but only 62% of the males had first or second class honours degrees. However, the differences were not statistically significant ($\chi^2 = 3.278$ with 4 degrees of freedom).

A full breakdown of these results is given in Appendix C.

5.15.4 Age and School Type (PGCE Students)

Tables 31 to 34 show the type of educational establishments attended by the students between the ages of 11 and 16 and for their 'A' levels or equivalent, and whether these establishments were co-educational.
Table 31  Type of School 11 - 16 (PGCE Students)  
Broken Down by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compnsve Grammar Secondary Independent Other</td>
<td></td>
</tr>
<tr>
<td>Modern</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 25</td>
<td>23.1 34.6 13.5 23.1 5.7</td>
</tr>
<tr>
<td>25 &amp; Under</td>
<td>67.6 16.9 2.8 11.3 1.4</td>
</tr>
</tbody>
</table>

Over two thirds of the younger age group (25 and under) had attended Comprehensive Schools between the ages of 11 and 16, but as would be expected from the changes in the educational system over the last twenty years, this was true for less than one quarter of the over 25 year olds.

Table 32  Mixed or Single Sex School 11 - 16 (PGCE Students)  
Broken Down by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed School</td>
<td>Single Sex School</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Mixed School</th>
<th>Single Sex School</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 &amp; Under</td>
<td>73.2</td>
<td>26.8</td>
</tr>
<tr>
<td>Over 25</td>
<td>50.0</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Almost three quarters of the 25 and under age group, but only half of the over 25 year olds, had attended mixed schools between the ages of 11 and 16.
Table 33 Type of Establishment for 'A' Level (PGCE Students) Broken Down by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Comprehensive Grammar</th>
<th>Indept.</th>
<th>F.E.</th>
<th>VITH</th>
<th>Other Coll</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 &amp; Under</td>
<td>47.9</td>
<td>14.1</td>
<td>8.5</td>
<td>12.7</td>
<td>11.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Over 25</td>
<td>9.6</td>
<td>26.9</td>
<td>17.3</td>
<td>26.9</td>
<td>15.4</td>
<td>3.8</td>
</tr>
</tbody>
</table>

The over 25 year olds seemed to have found F.E. Colleges an attractive alternative for 16+ studies.

Table 34 Mixed or Single Sex School for 'A' Level (PGCE Students) Broken Down by Age

<table>
<thead>
<tr>
<th>Age</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed School</td>
</tr>
<tr>
<td>25 &amp; Under</td>
<td>80.3</td>
</tr>
<tr>
<td>Over 25</td>
<td>63.5</td>
</tr>
</tbody>
</table>

If this Table is compared with Table 32, a transfer of students from single-sex to mixed schools for 16+ studies is indicated.

Overall, these results show the change from single-sex selective schools to comprehensive schools over the last 20 years.

5.15.5 Age and Degree Subject

Table 35 shows the degree subject compared with the age of the PGCE students in this sample.
Table 35 Age v. Degree Subject (PGCE Students)

<table>
<thead>
<tr>
<th>Degree Subject</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 &amp; Under</td>
</tr>
<tr>
<td>Physics</td>
<td>43.7</td>
</tr>
<tr>
<td>Joint physics/other science</td>
<td>26.8</td>
</tr>
<tr>
<td>Engineering</td>
<td>9.9</td>
</tr>
<tr>
<td>Materials Science</td>
<td>4.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>5.6</td>
</tr>
<tr>
<td>Other</td>
<td>9.8</td>
</tr>
</tbody>
</table>

Over 70% of the students aged 25 and under had degrees in physics or joint physics and another science, whereas only just over 47% of those aged over 25 fell into this category.

5.15.6 Summary

It appears that the females in this sample were more likely to have attended single-sex schools than the males. However, the chi-squared values show that the differences are not statistically significant at the 5% level.

The males and females have very similar reasons for undertaking the PGCE course.

F.E. Colleges seem to be successful in attracting students away from the more traditional types of schooling.

These results also reflect the trend away from single-sex selective schools towards mixed comprehensives during the last twenty years.

Over 70% of the students aged 25 and under had degrees in physics or joint physics and another science, whereas only just over 47% of those aged over 25 fell into this category.
One quarter of the males and one in twenty five of the females had a degree in engineering.

5.16 **GENERAL CONCLUSIONS AND COMMENTS**

Just over half of the students were undertaking the PGCE course because of a definite desire to teach. This rather low figure may be a partial explanation of the findings of Smithers and Robinson (1988) that 'one in three of the trained graduates in physics did not make themselves available for teaching'.

The feature of a teaching career which was considered an attraction by the largest proportion of the students was 'job satisfaction' (96%). The second most important feature was 'work with young people'. The students seemed to afford pay levels and promotion prospects a low priority.

The major problems facing a new physics teacher were anticipated to be 'inadequate equipment', 'large class size' and 'indiscipline'. The students did not anticipate that working with other teachers would pose much of a problem. Additional major problems mentioned by some students were inadequate knowledge of the syllabus, the low status of teachers in society, the difficulty of pitching work at the right level and the possibility of having to teach balanced science.

It appears that these students found careers guidance during their period of higher education much more helpful than that during their schooling. However, since the median age of these respondents was 25, the period of schooling for many of these students ended 10 or more years ago. The current situation may be very different.

Over half of the students had chosen teaching after having experience of another career and 8% were still undecided. Almost a third of the students chose a teaching career during their period of higher education. These results suggest that disillusionment with the current career situation may have been a motivating factor in the choice of undertaking a PGCE for a considerable number of the students, but further research is required to determine if this is in
fact a contributory factor.

Since almost equal numbers of students had no friends or relatives teaching and 1-3 friends or relatives teaching, it was not possible to draw any conclusions about the possible influence of such people on the students choice of undertaking a PGCE. Comparisons could be made between these results and those of a control group of similar students who had not chosen to undertake a PGCE.

The sample population was almost 80% male, with a median age of 25. Almost half of the students had attended comprehensive schools between the ages of 11 and 16 and 63% of them had attended mixed schools. During their period of 'A' level or equivalent studies, a further 10% of the students had attended mixed schools. F.E. Colleges seem to provide an attractive alternative to traditional types of schooling.

The median 'A' level grade was a B and the median class of degree was a lower second, with approximately 65% of the students having first or second class honours degrees. This latter figure compares unfavourably with those for the majority of subjects quoted by Sommers (1986), but compares very favourably with the figure for physics quoted in the same article.

Only 61% of the students had a degree in physics, or joint physics and another science. It could be argued that a disturbingly large proportion of these students will be increasing hidden shortages (i.e. non-specialists teaching physics) when they join the teaching force.

It appears that a female is more likely to have attended a single-sex school than is a male. It has been shown before that more girls choose to study physical science if they attend single-sex schools (Small B. 1984).
CHAPTER 6

SURVEY OF 2-YEAR BEd STUDENTS

6.1 INTRODUCTION

At one of the institutions used for the PGCE survey there was a group of mature students on a two-year course leading to a BEd in physics plus qualified teacher status. Despite the fact that there were only 11 students undertaking the first year of the course, it was felt that it may be useful and informative to investigate the educational background, the attitudes towards teaching and personal information such as age and sex of these students.

6.2 METHODOLOGY

On economic grounds it was decided to issue these students with the same questionnaires that were used for the PGCE survey, and subsequently to extract the relevant information. This fact was explained to the students immediately prior to the questionnaire completion exercise.

6.3 OVERVIEW OF RESULTS

The results are presented in seven sections. The students' main reasons for undertaking the course are the subject of Section 7.4. Their perceptions of the pluses and minuses of teaching are reported in Sections 7.5 and 7.6. The statistics relating to the age and sex of these students are given in Section 7.7. Finally, their educational backgrounds are the subject of Sections 7.8 to 7.10.

It should be noted that, in this chapter, results are given in terms of the number of students rather than as a percentage since it is advisable not to "present percentages when the base N is less than 20" (OU, 1981).
6.4 **MAIN REASON FOR UNDERTAKING THE COURSE**

Less than half of the students gave "a definite desire to teach" as their main reason for undertaking the course. Table 36 shows the full results.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite desire to teach</td>
<td>5</td>
</tr>
<tr>
<td>To try out teaching</td>
<td>2</td>
</tr>
<tr>
<td>To change career</td>
<td>4</td>
</tr>
</tbody>
</table>

6.5 **ATTRACTIONS OF A TEACHING CAREER**

The students were asked to rate six possible attractions of a teaching career in order of importance, with 1 signifying the greatest importance and 6 the least. Table 37 lists these features and shows the number of students considering each to be of importance (1 to 3 on the scale).

<table>
<thead>
<tr>
<th>Important Attraction</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Satisfaction</td>
<td>9</td>
</tr>
<tr>
<td>Work with young people</td>
<td>7</td>
</tr>
<tr>
<td>Long holidays</td>
<td>6</td>
</tr>
<tr>
<td>Promotion prospects</td>
<td>4</td>
</tr>
<tr>
<td>Good pay</td>
<td>3</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>2</td>
</tr>
</tbody>
</table>
Job satisfaction and work with young people were seen as the two most important attractions.

6.6 **ANTICIPATED PROBLEMS OF A NEW PHYSICS TEACHER**

The students were given a list of problems which may be faced by a new physics teacher. They were asked to note each one on a five point Likert-type scale. Table 38 indicates the number of students who considered each feature to be a major problem (1 and 2 on the scale).

<table>
<thead>
<tr>
<th>Major Problem</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate equipment</td>
<td>10</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>7</td>
</tr>
<tr>
<td>Large class size</td>
<td>5</td>
</tr>
<tr>
<td>Work in evenings</td>
<td>3</td>
</tr>
<tr>
<td>Unfamiliar equipment</td>
<td>3</td>
</tr>
<tr>
<td>Insufficient frees</td>
<td>2</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>1</td>
</tr>
<tr>
<td>Working with others</td>
<td>1</td>
</tr>
</tbody>
</table>

A large proportion of the students anticipated that working with inadequate equipment and dealing with indiscipline would be major problems, but very few considered that dealing with pupils' personal problems or working with other teachers would be problematical.

6.7 **BREAKDOWN BY SEX AND AGE**

There were nine males and two females in the sample. The median age was 34 years with a range of 28 years from 22 to 50.

6.8 **SCHOOLS ATTENDED BETWEEN THE AGES 11 AND 16**

Six students had attended secondary modern schools, two had been at
grammar schools and there was one student who had been at a secondary technical school, one at a comprehensive and one at another unspecified establishment. Six of the above schools were mixed and five were single-sex establishments.

6.9 SCHOOLS ATTENDED FOR 16+ EDUCATION

Five students undertook their 16+ studies at FE Colleges and there was one student who had been at a Grammar School, one at a comprehensive, one at a Sixth Form College and one at a Secondary Technical School. Two students were at other unspecified establishments. At this stage of their education nine of the eleven students attended mixed establishments.

6.10 QUALIFICATIONS

Only three of the students had 'A' Level physics. One student had an HND in Applied Physics, one was a Licentiate of the Royal Society of Chemistry (pass degree equivalent), one had five sixths of a maths/physics degree, three students had HNCs and three students had ONCs or City and Guilds.

6.11 GENERAL SUMMARY AND CONCLUSIONS

Less than half the students stated that their main reason for undertaking the course was because of a definite desire to teach, and more than a third of them gave their main reason as a desire for a change of career.

Job satisfaction and work with young people were the two main attractions of a teaching career, although the long holidays associated with teaching also appeared to be a considerable attraction.

The main problems which the students expected a new physics teacher to face were associated with inadequate equipment, indiscipline and large classes. Dealing with pupils' personal problems and working with other teachers were expected to pose little or no problems.
There were nine males and two females amongst the sample and the median age was 34.

More than half of the students had attended secondary modern schools between the ages of 11 and 16. Nevertheless, they had continued their studies at other institutions. The FE Colleges had an important role to play in the provision of further education for a large proportion of these students.

Only three of the students had 'A' Level physics, but the others had a wide range of qualifications from City and Guilds to HND.
CHAPTER 7

PGCE FOLLOW-UP QUESTIONNAIRE

7.1 INTRODUCTION

Since the initial PGCE survey was undertaken near the beginning of the course the students had not begun their periods of teaching practice. Their opinions may have been coloured by their own experiences as pupils and perhaps also by hearsay. Follow-up studies were initiated as the students were nearing the end of their course. A postal survey was undertaken, targeting all the students who had been involved in the initial questionnaire.

There were two main lines of enquiry. One was to obtain quantitative data concerning additional comments made by the students during the first survey. Examples of these are the effects of the bursary and the choice of second subject. The second line of enquiry concerned the determination of any changes in attitudes of the students between the beginning and the end of the course. The full text of this questionnaire is given in Appendix D.

Inevitably the problem of 'sample' mortality' (Cohen and Manion 1980) was encountered. Approximately 9% of the original students withdrew from the course and a further 24% failed to return the questionnaire. The final numbers represented 73% of those of the original sample who completed the course. If the drop-out rate was similar throughout the country, the number of students in the follow-up study represented approximately 20% of the total population of physics PGCE students in England and Wales completing the course.

7.2 OVERVIEW OF RESULTS

The results are presented in seven sections. The pluses and minuses of a teaching career are discussed in Sections 7.3 and 7.4. The students' keeness to teach and the types of schools in which they would like to teach are the subjects of Sections 7.5 and 7.6. Section
7.7 concerns the effect of the Bursary and and Section 7.8 is concerned with the students' preferred second subject. Age and sex differences are the subject of Section 7.9.

7.3 ATTRACTIONS OF A TEACHING CAREER

The students were given the same list of attractions as in the initial questionnaire, but this time they were asked to tick the boxes corresponding to those features which they felt were attractions of a career in teaching. Table 39 gives the results of this question.

Table 39

<table>
<thead>
<tr>
<th>Attraction</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job satisfaction</td>
<td>91</td>
</tr>
<tr>
<td>Work with young people</td>
<td>78</td>
</tr>
<tr>
<td>Long holidays</td>
<td>67</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>32</td>
</tr>
<tr>
<td>Promotion prospects</td>
<td>26</td>
</tr>
<tr>
<td>Good pay</td>
<td>10</td>
</tr>
</tbody>
</table>

Although the style of the answers differed between the initial (see Chapter 5) and the follow-up questionnaire it is possible to make some comparisons since in each case an average of three attractions per person were reported in the results tables. It appears that both before and after their school experience the students saw job satisfaction and work with young people as the main attractions of a teaching career. However, long holidays appear to have assumed a greater importance and less students saw a school as pleasant working environment by the end of the PGCE course.

7.4 ANTICIPATED PROBLEMS

The students were asked a question about the problems that they anticipated a new physics teacher may face. This was identical in form and in the style of answers to the corresponding question in the
initial survey. Table 40 shows the results of this question, with the initial survey results given for comparison.

Table 40 Anticipated Major Problems (PGCE Follow-up and Comparison)

<table>
<thead>
<tr>
<th>Major Problem</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>73</td>
</tr>
<tr>
<td>Large class size</td>
<td>66</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>56</td>
</tr>
<tr>
<td>Insufficient free periods</td>
<td>52</td>
</tr>
<tr>
<td>Work in evenings</td>
<td>39</td>
</tr>
<tr>
<td>Unfamiliar equipment</td>
<td>33</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>22</td>
</tr>
<tr>
<td>Working with others</td>
<td>9</td>
</tr>
</tbody>
</table>

The Summer Term survey was undertaken after the main teaching practice, when the students had first-hand experience of some of the major problems. However, since this survey did not include those who had dropped out of the course, the overall result would be expected to indicate a more positive attitude than that of the Autumn Term survey.

The figures in the above Table indicate that this was indeed the case as far as problems of class management were concerned. The categories of 'class size', 'indiscipline' and 'pupils' personal problems' were seen as major problems by considerably fewer of the PGCE students by the end of the course. Conversely, it appears from these figures that problems of time management had become increasingly important. This is illustrated by the fact that the percentages of students seeing 'insufficient free periods' and 'work in evenings' as major problems were greater towards the end of the course.
7.5 DESIRE TO TEACH

The students were asked how they felt about a career in teaching now that they had spent some time on teaching practice. The answers were on a five-point Likert-type scale, with 1 corresponding to 'keen to teach' and 5 corresponding to 'definitely do not wish to teach'. Table 41 gives the percentage of students responding in each of the five categories.

Table 41 Desire to Teach (PGCE Students)

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keen to teach</td>
<td>52.4</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>32.9</td>
</tr>
<tr>
<td>3</td>
<td>13.4</td>
</tr>
<tr>
<td>4</td>
<td>1.2*</td>
</tr>
<tr>
<td>Do not wish to teach</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

This table shows that over 85% of the PGCE students were keen or fairly keen to teach when they reached the latter stages of their course, and none of them had decided that they definitely did not wish to teach. It must be noted, however, that 9% of the students who completed the initial questionnaire had already dropped out of the course.

7.6 PREFERRED TYPE OF SCHOOL

The students were asked in which type of school they would prefer to begin their teaching career. The results are shown in Table 42.
Table 42  
Preferred School Type (PGCE Students)

<table>
<thead>
<tr>
<th>Type of School</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>69.2</td>
</tr>
<tr>
<td>FE College</td>
<td>9.9</td>
</tr>
<tr>
<td>Sixth Form College</td>
<td>7.4</td>
</tr>
<tr>
<td>Grammar</td>
<td>7.4</td>
</tr>
<tr>
<td>Independent</td>
<td>4.9*</td>
</tr>
<tr>
<td>Secondary Modern</td>
<td>1.2*</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

More than two thirds of the students would choose to teach in a comprehensive school, whereas just over 17% of the students in the sample would prefer to teach the 16+ age group.

7.7 BURSARY EFFECTS

There were two questions regarding the Bursary, which is an additional payment to PGCE students who are training to teach shortage subjects. Firstly the students were asked if they would have undertaken a PGCE if there had been no bursary. Secondly, a similar question asked if the students would have undertaken a physics PGCE if there had been no bursary. The results are shown in Table 43.

Table 43  
Bursary Effects (PGCE Students)

<table>
<thead>
<tr>
<th>Choice</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGCE, no bursary</td>
<td>72.8</td>
</tr>
<tr>
<td>Physics PGCE, no bursary</td>
<td>67.1</td>
</tr>
<tr>
<td></td>
<td>27.2</td>
</tr>
<tr>
<td></td>
<td>32.9</td>
</tr>
</tbody>
</table>
It seems from these figures that just over 27% of the students would not have undertaken any PGCE without a bursary, and almost a further 6% would not have undertaken a physics PGCE if it had not commanded a bursary. These are similar to the results of a study undertaken by researchers from the University of Bath (DES 1988), where it was found that 34% of a sample of physics PGCE students said that the availability of the bursary had affected their decision to undertake a PGCE and approximately 5% of them may have been attracted from other subjects not commanding a bursary.

7.8 PREFERRED SECOND SUBJECT

The final question in this survey sought information about which subject, in addition to physics, the students would prefer to teach. A list of possible choices was supplied and the opportunity was given for the students to supply a subject of their own choice if this was not included in the list. Table 44 shows the results of this question.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balanced Science</td>
<td>38.3</td>
</tr>
<tr>
<td>Mathematics</td>
<td>33.3</td>
</tr>
<tr>
<td>Chemistry</td>
<td>6.2</td>
</tr>
<tr>
<td>Computer Studies</td>
<td>6.2</td>
</tr>
<tr>
<td>Physical Education</td>
<td>4.9*</td>
</tr>
<tr>
<td>Technology</td>
<td>3.7*</td>
</tr>
<tr>
<td>Religious Education</td>
<td>3.7*</td>
</tr>
<tr>
<td>Craft, Design and Technology</td>
<td>1.2*</td>
</tr>
<tr>
<td>Biology</td>
<td>1.2*</td>
</tr>
<tr>
<td>Electronics</td>
<td>1.2*</td>
</tr>
</tbody>
</table>

Percentages total 100±0.1 due to rounding errors.
* Unreliable due to small numbers
Just over one third of the students would prefer to teach Balanced Science as a second subject, but almost as many would prefer Mathematics. The high figure for Mathematics is not unexpected. Many science graduates, particularly physics graduates, do not have 'A' Levels or sometimes not even 'O' Levels in all the sciences (Chapman 1988; Scaife and Wellington 1989). However, physicists will of necessity have a good grounding in Mathematics.

7.9 AGE AND SEX DIFFERENCES

The follow-up sample of students had the same proportion of males to females (80% male, 20% female) and the same median age (25) as in the initial survey. It was possible to subdivide some of the results to determine if age and/or sex seemed to have an effect on the opinions of the students. However, since there were only 17 females in the sample, in the majority of case breakdown by sex would lead to unreliable results due to small numbers.

7.9.1 Desire to Teach

There was very little difference between the opinions of the males and the females about their keenness to teach. The percentages of students who were keen or fairly keen to teach was 84.8% for males and 88.2% for females.

7.9.2 Preferred Type of School

Table 45 shows the results of the question concerning the types of schools in which the students would prefer to begin their teaching career, broken down by age and by sex.
Table 45  Preferred Type of School (PGCE Students)  
Broken Down by Age and Sex

<table>
<thead>
<tr>
<th>School Type</th>
<th>Overall</th>
<th>Male</th>
<th>Female</th>
<th>25 &amp; Under</th>
<th>Over 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive</td>
<td>69</td>
<td>66</td>
<td>82</td>
<td>79</td>
<td>62</td>
</tr>
<tr>
<td>FE College</td>
<td>10</td>
<td>12</td>
<td>0</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Sixth Form College</td>
<td>7</td>
<td>9</td>
<td>0</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Grammar</td>
<td>7</td>
<td>6</td>
<td>12</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Independent</td>
<td>5</td>
<td>5</td>
<td>6*</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Secondary Modern</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Percentages may total 100±1 due to rounding errors.  
* Unreliable due to small numbers

It appears from these figures that the male students in general and the older male students in particular were more keen to teach the 16+ age group than were the female students. Smithers and Hill (1987) showed that males in general and male science specialists in particular are less interested than females in working with young people.

7.9.3 Bursary Effects

Table 46 shows the effects of the Bursary broken down by age and sex of the students.
Table 46  Bursary Effects (PGCE Students)
Broken Down by Age and Sex

<table>
<thead>
<tr>
<th>Choice</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td>PGCE, no bursary</td>
<td>76/24</td>
</tr>
<tr>
<td>physics PGCE</td>
<td>69/31</td>
</tr>
</tbody>
</table>

Approximately one third of the students would not have undertaken a physics PGCE if it had not commanded a bursary. It appears from these figures that students in the younger age group were less likely to have undertaken a PGCE without a bursary than those in the older age group. However, there is a greater difference between the percentage of students who would have undertaken a PGCE as opposed to a physics PGCE amongst the older group than in any of the other categories. A partial explanation for this may lie in differences in the degree subjects of older and younger students as illustrated in Section 15 of Chapter 5. It was shown there that whereas just over 70% of the 25 years and under group of students had a degree in physics or joint physics and another science, this was the case for only just over 47% of the older category.

7.10 GENERAL SUMMARY AND CONCLUSIONS

The students saw job satisfaction and work with young people as the main attractions of a teaching career, and working with inadequate equipment was seen as a major problem by the largest proportion of students.

Caution must be exercised when comparing this survey with the initial survey because of the phenomenon of sample mortality. However, it seems fair to say that the main problems anticipated by the students
had swung away from class management and towards time management. 'Insufficient free periods' and 'work in evenings' were seen as major problems and 'long holidays' were seen as an attraction by a greater percentage of the students responding to the follow-up questionnaire than in the initial survey. Conversely, 'indiscipline', 'large class size' and 'dealing with pupils' personal problems' seemed to have assumed less importance by the time that the follow-up survey was undertaken.

Despite the fact that 9% of the students had dropped out, the PGCE courses appeared to have had a positive effect on the majority of the students. This is indicated by the fact that 85% of the students responding to the follow-up survey were keen or fairly keen to teach and none of them had definitely decided against it.

More than two thirds of the students would prefer to begin their teaching career in a comprehensive school. However, more than one in five of the males would prefer to teach the 16+ age range.

The availability of the Bursary payment for physics PGCE students appears to have attracted one student in three towards a physics PGCE that they would not otherwise have undertaken. The effect is more marked amongst the younger (25 and under) age group.

Only 38% of the students in this sample stated that Balanced Science was their preferred second teaching subject. One third of them would prefer Mathematics.

7.11 FURTHER INFORMATION

Information concerning the pass rate and first destination of the 1988-9 cohort of physics PGCE students may be found in Appendix E.
CHAPTER 8

RECRUITMENT OF PHYSICS TEACHERS

8.1 INTRODUCTION

In 1987, the year in which the bursary scheme giving graduates on teaching courses in shortage subjects a tax free lump sum was introduced, there were 545 students undertaking physics Postgraduate Certificate in Education courses. In 1988, the number had fallen to 456, and the 1989 intake numbered 376 (Lodge 1989a). Because of these obvious recruitment difficulties, it was important to make entry into Initial Teacher Training more attractive and the courses more flexible. This is the subject of Section 8.2. Alternative routes into teaching are the subject of section 8.3. The recruitment of returners from the so-called PIT (Pool of Inactive Teachers) is described in section 8.4 and the retraining of non-physicist teachers is the subject of section 8.5.

8.2 INITIAL TEACHER TRAINING

This section details schemes which aim to increase the intake to Initial Teacher Training. There are two main methods employed. Courses may be made more flexible both in their entry requirements and their mode of study, and both students and people in employment may be made more aware of the possibility of a career in teaching by becoming involved in 'taster' or 'peer tutoring' schemes.

8.2.1 Shortened B.Ed.

Several Higher Education Institutions have initiated two-year courses leading to a B.Ed. plus qualified teacher status. In general, the applicants must be mature people with 'O' level equivalent in Mathematics and English and some form of post-school qualification (such as HNC or HND) in a subject related to physics. Students undertaking such courses are eligible to receive the Bursary (see 8.2.8) during both their years of study.
8.2.2 Conversion Courses

Graduates with a science degree, or a degree involving some study of science at a higher level, together with the usual 'O' level equivalent in Mathematics and English are able to study for a two year PGCE at some Institutions to equip them as physics teachers. They are eligible for receipt of the Bursary (see 8.2.8) during both years.

8.2.3 TASC (Teaching as a Career)

TASC was set up by the Department of Education and Science in April 1987 with the specific aim of increasing recruitment into teaching. The group produces a series of professionally produced attractive brochures, some of which are aimed at undergraduates and some target mature people. Videos are available for loan, a termly bulletin is produced, TASC representatives man stands at graduate careers fairs and, most importantly, TASC members organize roadshows at venues throughout the country. School groups, undergraduates and members of the general public attend the roadshows to learn about the qualifications required and the various routes available for entry into teaching. This initiative is currently funded until 1993.

8.2.4 Peer Tutoring

Since 1975 students at Imperial College, London have been involved in a peer tutoring scheme, acting as classroom helpers in local schools. Evaluation of the scheme has shown that it has encouraged more students towards teaching than it has discouraged (Hirst, Goodlad and Berry 1989). Between 1987 and 1989 several other Higher Education Institutions set up similar schemes in which the peer tutoring may stand alone, or may be a component of an assessed course in Science Education. Peer Tutoring and associated courses are discussed more fully in Chapter 11.
8.2.5 **Taster Schemes**

During the academic year 1988-89 the DES, with the co-operation of ICI devised a programme of four-day taster courses for those interested in teaching mathematics, physics, chemistry, business studies or Craft Design and Technology (CDT). There were ten courses and a total of 200 participants who spent an introductory day in a Higher Education Institution, two days in a school and a final day back in the Institution. According to a TASC bulletin (1989) the "taster course directors reported that courses were a worthwhile initiative and one that could well become part of their annual recruitment drive".

8.2.6 **Work Experience**

Following a pilot scheme in 1989, the Government has initiated a scheme, to run in 1990, whereby second or third year undergraduates may earn £100 per week to spend up to a month in a school "shadowing a teacher, observing lessons, offering practical help and attending staff meetings" (Lodge 1990). The aim of the scheme is to revive interest among students in teaching as a career.

8.2.7 **Part-time PGCE**

There are many prospective PGCE students who would find it impossible to undertake a full-time course. They may be unable or unwilling to live away from home; unable to sustain a year of reduced income; or unable to fit in the hours and pattern of attendance required by a PGCE because of domestic commitments such as the care of pre-school children.

Since January 1988 several Teacher Training Institutions have been using the Open University course "Frameworks for Teaching" as the educational studies element of their part-time PGCEs. Two of these institutions have developed such courses to train prospective physics teachers. The courses last for two years with attendance at college averaging 1½ days per week. The
institutions provide the training in the subject element of the course, the tutoring of the educational studies element, the awarding of qualified teacher status and the supervising of the teaching practice, which is generally arranged in a school near to the student's home.

Mandatory grants plus the shortage subject Bursary are available to the students. These part-time courses should provide a new source of recruits into physics teaching, and may lead to a slight increase in the number of females amongst the physics teaching force, since it is likely that females with family commitments will be the main beneficiaries of such courses.

8.2.8 The Bursary

The government introduced a £1,250 tax-free Bursary in 1987 to entice maths and physics graduates into teaching. In addition to this the International Stock Exchange provided £1,000 bursaries to a number of prospective physics teachers. These measures met with initial success with a rise of more than 60% in the number of physics PGCE students in the first year, but this was followed by a successive fall in numbers in each of the next two years (Lodge 1989a).

Currently the Stock Exchange Bursary is no longer available, but the Department of Education and Science (DES) plans to increase the bursary for physics student teachers to £2,000 from September 1990. The fact that this sum is £600 more than that available to student teachers in other shortage subjects is an indication of the seriousness of the shortage of physics teachers.

8.3 ALTERNATIVE ROUTES INTO TEACHING

In May 1988 the Education Secretary, Mr. Kenneth Baker, put forward proposals to introduce a new status of "licensed teacher" for those aged over 26, which would constitute a third category of teacher between "unqualified" and "qualified". Nine months later he unveiled plans to allow younger graduate candidates to go straight into the classroom as salaried trainees. This developed into the "articled
8.3.1 The Licensed Teacher Scheme

The inaugural IBM Education Lecture at the Royal Society was delivered by Mr. Kenneth Baker, the Education Secretary, in May 1989. This was fully reported in the Times Educational Supplement (1989b). Mr. Baker described the Government's plans for increasing the supply of teachers in shortage subject areas.

One scheme which he described in detail was the licensed teacher scheme. This is aimed at mature people over 26, who have successfully completed at least two years higher education. Such a person may be taken on by a school as a licensed teacher and trained in-post under the supervision of that school. After two years, during which time day-release will have been arranged, the licensed teacher may be granted Qualified Teacher status. Overseas-trained teachers can qualify via this new route after one term.

All the main teacher unions have voiced objections to the scheme because it will lead to a dilution of a previously all-graduate profession. However, by mid-November 1989, 49 of the 97 English Local Education Authorities had put in bids for education support grant cash to train licensed teachers (Lodge 1989b).

8.3.2 The Articled Teacher Scheme

The articled teacher scheme beginning in September 1990 is designed to enable graduates to go into schools direct from first degree courses. After two years articled teachers would receive a PGCE. During the two years at least four fifths of their time would be spent in the classroom under the supervision of an experienced teacher, or teacher-trainer, and they would receive a Bursary equivalent to, or slightly more than, one year of grant plus a year of salary averaged over the two years. Those training in shortage subjects would also receive the shortage subject bursary (£2,000 for physics) each year.
By December 1989, Mr. MacGregor, the new Education Secretary, had approved 12 two-year artled teacher schemes with the intention of training a total of 1,200 graduates over a three-year period.

8.4 RETURNERS TO TEACHING

There are currently approximately 400,000 people in the PIT (Pool of Inactive Teachers). Three quarters of these are women. Recently, increased attention has been paid to the specific needs of these potential returners to teaching. LEAs are beginning to introduce "flexible and generous recruitment packages, designed to entice teachers to their area" (TASC Bulletin, Winter 1990). In May, 1989 the Government announced an Education Support Grant programme for 1990/91 of £2 million for activities to attract more mature new entrants and returners to teaching. "These activities include local advertising, keeping a register of former teachers, introducing flexible working practices such as part-time and job-share, as well as providing childcare facilities" (Times Educational Supplement 1989b).

8.4.1 Women in Training (WIT)

In 1988 the Women in Training (WIT) organization was founded with the aim of attracting women back into the workplace. The organization aims to "contact women who have taken a career break from teaching to provide them with confidence-boosting courses, find out what skills they need to return to work, design in-service training, support them during their first year back in class and help LEAs with recruitment and implementing equal opportunities policies" (Spencer D. 1989).

8.4.2 Keeping in Touch with Teaching (KIT)

The original aim of the West Sussex Keeping in Touch with Teaching project was to explore ways in which LEA support for teachers not currently in paid employment might contribute to reducing the problem of supply cover. KIT groups were established from 1986 onwards. They aimed to combat the loss of information, loss of skills and loss of confidence experienced by teachers during a career break. Such teachers were given access
to LEA In Service Training and advice about returning to work.

8.4.3 Job-Sharing

Formal job-sharing schemes, whereby two people share one post give greater security than part-time or supply teaching posts. Smedley, reported in the Times Educational Supplement (1989c), found that although only 15% of the LEAs responding to a survey had formal job-sharing schemes over 50% of them were considering the idea, or had informal arrangements.

Smedley found that the vast majority of job-sharers were women with young children. Other categories of job-sharers included women near retirement age, women and men looking after relatives, husband and wife teams sharing child rearing and people wishing to combine teaching with other employment.

It seems clear that many of the teachers in the above categories would have found it difficult to return to work, or stay at work, without the availability of such job-sharing schemes.

8.5 RETRAINING OF TEACHERS

There are many courses aiming to retrain practising teachers with an interest in physics into specialists able to teach physics to G.C.S.E. or 'A' level. Certificate courses are generally of one term full-time, or one year part-time duration and Diploma courses are of one year full-time, or two years part-time duration.

An important recent development is the Open University's "Physics for Science Teachers" course. It has great flexibility of use. The course may be studied within a school with an experienced member of staff providing informal tutoring; it may be run on an LEA wide basis with a mixture of self-study and organized tutorials and practical sessions; or it may be incorporated into a course with formal validation run by an H.E. institution.

The distance learning material associated with this course consists of six blocks of text, a video cassette and an audio tape. During the
academic year 1988-89 over 600 teachers studied this material (Whitelegg et al 1989).

8.6 GENERAL SUMMARY AND CONCLUSIONS

Greater flexibility is being introduced into the entry requirements and mode of study of Initial Teacher Training courses.

Taster, peer-tutoring and work-experience schemes whereby participants can gain an insight into life 'at the chalk face' are being initiated and/or extended.

From September, 1990 the bursary paid to physics PGCE students will be increased to £2,000.

Alternative routes into teaching are being developed. These include the 'licensed teacher scheme' and the 'articled teacher scheme'.

Members of the Pool of Inactive Teachers are being encouraged, by the provision of child-care facilities and the flexible working practices, to return to teaching.
CHAPTER 9
RETENTION OF PHYSICS TEACHERS

9.1 INTRODUCTION

Although increasing recruitment into teaching is a vital factor in the attempt to increase the supply of physics teachers, it is equally important to retain those already in the profession; "....attracting people to train as teachers is less than half the battle. It is getting people who are trained into teaching itself and then keeping them there which is now the even greater challenge", (Straw 1988); "Loss from teaching I see as the most important aspect of the problem", (Smithers 1988).

Several recent articles have commented on the low morale of school teachers as a factor in the current staffing crisis (Castle 1989, Smithers, 1989, Hadfield 1989, Sutcliffe 1990, Stewart 1990a). Three contributory factors invariably emerge - low pay, low status and the increased workload due to educational reforms.

This chapter gives the results of a questionnaire issued to physics teachers in one Local Education Authority. The main aims of the survey were to determine the morale of these teachers and their likelihood of leaving the profession. The full text of the questionnaire is given in Appendix F.

9.2 SURVEY SAMPLE

The questionnaire was issued to all teachers who spent at least 50% of their class contact time teaching physics in schools with at least GCSE provision in one Local Education Authority. Replies were received from 54 teachers which represented a response rate of approximately 57%.
9.3 OVERVIEW OF RESULTS

The results are presented in eight sections. The attractions and the problems of a teaching career are the subjects of sections 9.4 and 9.5 respectively. Sections 9.6 and 9.7 are concerned with the type of school in which the respondents would prefer to teach and their choice of second subject. Sections 9.8 and 9.9 concern the length of time that the respondents have been teaching and their future career intentions. A breakdown by age and sex of the teachers in the sample is given in Section 9.10 and attendance at a mixed or single-sex school for the teachers' own education is the subject of section 9.11, in which the data are broken down by sex. However, in general the results presented in this chapter are not broken down by sex because of the small number of females in the sample (10).

9.4 ATTRACTIONS OF A TEACHING CAREER

The teachers were presented with a list of possible attractions of a teaching career and were asked to indicate which factors they felt were applicable to teaching. Table 47 shows the results of this question.

Table 47 Attractions of a Teaching Career (Physics Teachers)

<table>
<thead>
<tr>
<th>Attraction</th>
<th>Percentage of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work with young people</td>
<td>81</td>
</tr>
<tr>
<td>Long holidays</td>
<td>81</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>54</td>
</tr>
<tr>
<td>Good promotion prospects</td>
<td>7*</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>7*</td>
</tr>
<tr>
<td>Good pay</td>
<td>6*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers. Percentages do not total 100 because the teachers could tick several boxes.
A large majority of respondents considered 'work with young people' and 'long holidays' to be positive features, with 'job satisfaction' coming rather a poor third. Only 3 teachers thought that 'good pay' was a feature of a teaching career.

9.5 FACTORS CAUSING STRESS AND/OR DISSATISFACTION

The teachers were given a list of factors which may cause stress and/or dissatisfaction to physics teachers. They were asked to rate each factor on a five point Likert-type scale with 1 corresponding to a major problem and 5 to no problem. They were also invited to list other major causes of stress to physics teachers. Table 48 shows the percentages of teachers who considered each factor to be a major problem (1 or 2 on the scale).

<table>
<thead>
<tr>
<th>Problem</th>
<th>Percentage of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate pay</td>
<td>89</td>
</tr>
<tr>
<td>Low status</td>
<td>81</td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>73</td>
</tr>
<tr>
<td>Large class size</td>
<td>67</td>
</tr>
<tr>
<td>Preparation/marking in evenings</td>
<td>63</td>
</tr>
<tr>
<td>Insufficient free periods</td>
<td>59</td>
</tr>
<tr>
<td>Mixed ability classes</td>
<td>39</td>
</tr>
<tr>
<td>Teaching outside one's specialism</td>
<td>33</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>25</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>15</td>
</tr>
</tbody>
</table>

The major problems faced by the largest numbers of the physics teachers in this survey were inadequate pay, low status and working with inadequate equipment. These practising teachers saw indiscipline as very much less of a problem than did the undergraduates (Chapter 4) or the PGCE students (Chapter 5 and Chapter 7). The most commonly quoted additional major problems (mentioned by 30% of the teachers)
was the pace of new educational initiatives.

Other major causes of stress which were listed by more than 10% of the teachers were: the lack of time; the demise of Physics and the rise of Balanced Science; the amount of administration; and the necessity to undertake pastoral duties or personal and social education lessons.

9.6 Preferred School Type

The teachers were asked to specify the type of school in which they would prefer to teach. The results fell into two main categories: comprehensive (61%) and Sixth Form or F.E. College (37%), with just 2% (1) of the teachers specifying any other type of establishment.

9.7 Preferred Second Subject

The teachers were asked which subject in addition to physics they would prefer to teach. The results are given in Table 49

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>37</td>
</tr>
<tr>
<td>Maths</td>
<td>24</td>
</tr>
<tr>
<td>Chemistry</td>
<td>14</td>
</tr>
<tr>
<td>Technology</td>
<td>8</td>
</tr>
<tr>
<td>Computer Studies</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
</tr>
</tbody>
</table>

Science and Maths were the most commonly mentioned preferred second subjects.

9.8 Number of Years in Teaching

The teachers were asked to specify how many years they had been teaching physics. The results are shown in Table 50.
Almost half of the teachers had been teaching physics for more than eight years.

9.9 FUTURE CAREER INTENTIONS

Two questions were asked to determine whether the teachers in this sample were intending to stay in teaching. In response to a question concerning their intention to stay in teaching for 5 more years (or until retirement, if that was sooner) 69% of the teachers stated that they did intend to stay in teaching and 31% stated that they did not have that intention. A slightly higher percentage (37%) of the teachers stated that they were actively looking for employment outside teaching. Table 51 gives a breakdown of the reasons given by these teachers for seeking other work.
Table 51 Reasons for Seeking Work Outside Teaching
(Physics Teachers)

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage of Those Teachers Who Were Seeking Other Work (N = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor rewards</td>
<td>70</td>
</tr>
<tr>
<td>Low status</td>
<td>45</td>
</tr>
<tr>
<td>Pressure of work</td>
<td>45</td>
</tr>
<tr>
<td>Poor prospects</td>
<td>30</td>
</tr>
<tr>
<td>Deluge of new initiatives</td>
<td>25</td>
</tr>
<tr>
<td>Too much administration</td>
<td>15*</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>10*</td>
</tr>
<tr>
<td>To broaden experience</td>
<td>5*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers

The main reasons for seeking other work were poor rewards (not only financial, but also lack of recognition for a job well done), low status and pressure of work.

9.10 BREAKDOWN BY AGE AND SEX

The dominance of males in the sample (81.5%) was similar to that found in the physics undergraduate survey and the survey of physics PGCE students (Stewart and Perrin 1989). The median age of these teachers was 34 and the age range was from 24 to 53.

9.11 TYPE OF SCHOOL ATTENDED

The teachers were asked if they had attended co-educational schools for their own education between the ages of 11 and 18. The results are shown in Table 52.
Table 52  School Type (Physics Teachers)
Breakdown by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed School</td>
</tr>
<tr>
<td>Male (N = 44)</td>
<td>50</td>
</tr>
<tr>
<td>Female (N = 10)</td>
<td>20*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers

The small number of females in the sample leads to statistical unreliability. However, it is interesting to note the apparent disparity between the percentages of males and females who attended single-sex schools for their own education. To produce results with any statistical reliability a much larger scale study is needed. These results had an initial bias due to the fact that a higher proportion of the females fell into the age category above the median, than did the males. Thus, these females would have attended school at a time when single-sex selective education was much more common than in more recent times.

9.12 GENERAL CONCLUSIONS AND COMMENTS

The two major attractions of a teaching career are seen by the teachers in this sample to be work with young people and long holidays. These respondents appear to be less likely than physics undergraduates (Chapter 4) or PGCE students (Chapter 5) to see job satisfaction as an attractive feature of a teaching career.

The factors causing stress and/or dissatisfaction to high percentages of the physics teachers in this sample were those of inadequate pay, low status and inadequate equipment. An additional major problem specified by 30% of the teachers was the pace of new educational initiatives. The majority of teachers (61%) stated that they would prefer to teach in a comprehensive school. However, 37% would prefer working in a Sixth Form or F.E. College.
Science (37%) and Maths (24%) were the most commonly mentioned preferred second subjects.

Almost half (48%) of the teachers had been teaching physics for more than eight years.

Just over two thirds (69%) of the teachers were intending to stay in teaching for the next five years. The main reasons for considering leaving the profession given by those teachers seeking other work were poor rewards (personal as well as financial), low status and pressure of work.

The sample consisted of 44 males (81.5%) and 10 females (18.5%). This is comparable to the proportions (80% male, 20% female) found in the physics PGCE survey (Chapter 5). The median age of these teachers was 34.

Half the males, but only 2 out of the 10 females, had attended mixed schools for their own education. It is impossible to draw any conclusions from such a small sample, but these results merit further larger scale research.
CHAPTER 10

COMPARISONS BETWEEN UNDERGRADUATE, PGCE AND TEACHER QUESTIONNAIRE RESULTS

10.1 INTRODUCTION

The undergraduate, the PGCE student and teacher questionnaires contained several questions in common. It was thus possible to make comparisons between the attitudes of these groups. The sample sizes of the groups represented widely differing proportions of the total populations, approximately 4%, 20% and 1% respectively (Smithers & Robinson, 1988), and thus minor differences could not be considered significant. The data for the PGCE students were taken from the follow-up questionnaire for two reasons. Firstly, the question concerning the positive features of a teaching career was of the same form as that in the other two questionnaires. Secondly, the responses were received after the students had had first-hand experience in schools.

Section 10.2 shows a comparison of the attitudes of the three groups towards the positive features of a teaching career. Section 10.3 concerns the negative features, and section 10.4 gives a breakdown by sex of the three groups.

10.2 ATTRACTIONS OF A TEACHING CAREER

Table 53 shows the percentages of undergraduates, PGCE students and teachers who considered each of the listed features to be an attraction of a teaching career.
Table 53  Attractions of a Teaching Career (Comparisons)

<table>
<thead>
<tr>
<th>Attractive Feature</th>
<th>Percentage of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergraduates</td>
</tr>
<tr>
<td></td>
<td>N = 275</td>
</tr>
<tr>
<td>Long holidays</td>
<td>80</td>
</tr>
<tr>
<td>Job satisfaction</td>
<td>63</td>
</tr>
<tr>
<td>Work with young people</td>
<td>37</td>
</tr>
<tr>
<td>Pleasant working environment</td>
<td>27</td>
</tr>
<tr>
<td>Good pay</td>
<td>10</td>
</tr>
<tr>
<td>Good promotion prospects</td>
<td>9</td>
</tr>
</tbody>
</table>

Since over 90% of physics undergraduates will not go into teaching (Smithers and Robinson, 1988), the large difference between the figure for the percentage of undergraduates considering 'work with young people' an attraction and the corresponding figures for the other two groups was to be expected.

A comparison between the results for PGCE students and teachers appears to show a degree of disillusionment amongst the teachers since 'job satisfaction', 'pleasant working environment', 'good pay' and 'good promotion prospects' are much less likely to be considered an attraction found in teaching by this group than by the PGCE students. The only feature which is given considerably more votes by the teachers than by the PGCE students is that of 'long holidays'.

10.3 PROBLEMS OF A TEACHING CAREER

The question concerning the problems of a teaching career was not phrased identically in each of the questionnaires and the teachers' questionnaire contained more options in this question. However, each problem was assessed on a five-point Likert-type scale in each case. Thus it was possible to compare the responses in the case of the features which were common to all the questionnaires. Table 54 gives such an analysis. Problems rated 1 or 2 on the five point scale were considered to be major problems. The percentages in the table refer
to these major problems.

Table 54  **Major Problems of a Teaching Career (Comparisons)**

<table>
<thead>
<tr>
<th>Major Problem</th>
<th>Percentage of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergraduates</td>
</tr>
<tr>
<td></td>
<td>N = 275</td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>79</td>
</tr>
<tr>
<td>Large class size</td>
<td>67</td>
</tr>
<tr>
<td>Indiscipline</td>
<td>64</td>
</tr>
<tr>
<td>Work in evenings</td>
<td>44</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>26</td>
</tr>
<tr>
<td>Insufficient free periods</td>
<td>18</td>
</tr>
</tbody>
</table>

The major problem most commonly quoted in all three groups was that of 'inadequate equipment'. Undergraduates seem to be more concerned about indiscipline than are members of the other two groups. Teachers and PGCE students who have had practical experience seem to be concerned about the insufficient amount of non-contact time, as indicated by the higher percentages of these two groups considering 'insufficient free periods' to be a major problem compared with the figure for the undergraduates.

10.4 **BREAKDOWN BY SEX**

Table 55 shows proportions of males and females in each of the three groups under consideration.

Table 55  **Breakdown by Sex (Comparisons)**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Percentage of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undergraduates</td>
</tr>
<tr>
<td>Male</td>
<td>86.5</td>
</tr>
<tr>
<td>Female</td>
<td>13.5</td>
</tr>
</tbody>
</table>

85
These results indicate that the populations of physics students and physics teachers are overwhelmingly male. However, there is also an indication from these figures that a higher proportion of the female physics students enter the teaching profession than do the males (Stewart and Perrin, 1989).

10.5 **GENERAL SUMMARY AND CONCLUSIONS**

Despite the widely differing sample sizes of the three surveys being considered in this chapter, leading to variations in the validity of generalization, some comparisons can be made between the sample populations.

A considerably higher proportion of PGCE students and teachers in these samples consider work with young people to be an attraction of a teaching career than do the undergraduates in the sample population.

Established teachers appear less likely to consider job satisfaction an attractive feature of a teaching career, and more likely to consider long holidays an attraction than do PGCE students.

Both the PGCE students and the teachers in these samples seem to consider time management more of a problem and class management less of a problem than is anticipated by the undergraduates. This is indicated by the corresponding figures for 'indiscipline', 'work in evenings' and 'insufficient free periods' which are respectively highest, lowest and lowest in the case of the undergraduate population.

In each of the sample populations the males greatly outnumber the females. There is, however, an indication that female physics graduates are more likely to choose a career in teaching than are male physics graduates.
CHAPTER 11

PEER TUTORING

11.1 INTRODUCTION

The term 'peer tutoring' is often used to describe schemes within schools or colleges involving older and/or more able students assisting younger and/or less able ones, with resulting mutual benefit. However, in this chapter the tutors referred to are University students and the tutees are school pupils. The term 'peer' is taken to mean 'of equal status' (Goodlad and Hirst, 1989). Both the tutor and the tutees are non-professionals.

Since 1975 students from Imperial College of Science, Technology and Medicine, London, have been involved in peer tutoring in local schools. The students act as classroom helpers assisting teachers in their work. Annual evaluation of this scheme indicates that it is of benefit to teachers, pupils and University students alike. In particular, it was found that more students were encouraged towards teaching than were discouraged (Hirst, Goodlad and Berry, 1989).

Section 11.2 describes recent initiatives to implement schemes, modelled on that running at Imperial College, at several other Higher Education Institutions. The implementation of the scheme at Loughborough University is the subject of Section 11.3, and the peer tutoring scheme at Loughborough is evaluated in Section 11.4. Future plans for the extension of the Loughborough scheme and its incorporation into an assessed course are expounded in Section 11.5.

11.2 RECENT INITIATIVES

In 1987 the UGC (University Grants Committee) instigated an initiative intended to provide financial support for projects aimed at improving the supply of school teachers in mathematics, physics and technology. Funding was available for a period not exceeding three years.

As a result of this initiative Imperial College of Science and
Technology was able to appoint a Research and Project Development Officer whose main role was to disseminate nationally the fruits of the long-standing peer tutoring scheme. Subsequently the universities of Cambridge, Warwick and East Anglia were able to set up similar schemes respectively entitled "S.T.I.M.U.L.U.S." (Science, Technology, Informatics and Mathematics; Undergraduate Links between University and School). "School Experience" and "Taster Scheme", each receiving financial assistance which was available from the UGC Initiative.

In her role as disseminator of information about peer tutoring the Research and Project Development Officer gave a talk at the annual meeting of the Association for Science Education in January 1989. She described the work experience scheme, known as 'The Pimlico Connection', with which she was involved. After an initial training day the Imperial College students on the scheme spent Wednesday afternoons in schools working with teachers who had chosen to have them as assistants. She found that the majority of teachers found the lessons easier to handle when the undergraduates were in attendance, and the experience of tutoring appeared to encourage more of the undergraduates towards teaching than it discouraged.

The same officer organized a Peer Tutoring Conference in April 1989. The organizers of the Peer Tutoring schemes at both Cambridge University and the University of East Anglia gave talks at this conference. They spoke of the positive effects of Peer Tutoring on the teachers, the pupils and the undergraduates and emphasized the importance of close liaison with the participating schools and the necessity for the provision of training and support for the undergraduates.

Attendance at these meetings led the researcher to investigate the feasibility of providing a similar scheme at Loughborough University.

11.3 **IMPLEMENTATION OF THE LOUGHBOROUGH SCHEME**

The main aim of the researcher was to increase the supply of physics teachers. Participation in a peer tutoring scheme was considered to be a valuable taster experience for undergraduates and indeed postgraduates. At the very least it should ensure that students
beginning a PGCE course would do so with their eyes open, and would be less likely to drop out during the course or decide against a teaching career than current figures would suggest (Smithers and Robinson, 1988). This section describes the development of the Loughborough scheme and provides an evaluation of the first two terms of peer tutoring in local schools.

11.3.1 Preliminary Investigations

Discussions were undertaken between the researcher and Science Method lecturers in the Education Department at Loughborough University. The lecturers were interested in being involved in the running of the peer tutoring scheme as a precursor to an assessed course in Science Education for final year undergraduates. In 1968 the Swann Report suggested that the shortage in science teachers may be eased by giving students "a first hand acquaintance with teaching during their University career.". Similarly, in 1976 a report (UNESCO) commented that physics undergraduate courses concentrated predominantly on training prospective research students and suggested that a Physics Education option should be made available. In the light of the current trend towards broader balanced school science the Loughborough team decided to produce a course in Science Education rather than the more narrow Physics Education. There would be the added advantage of being able to offer the course to a wider range of science undergraduates.

Following these discussions the researcher organized a seminar for members of other departments (including careers), the LEA Science Adviser, local teachers and undergraduate representatives. The Research and Project Development Officer from Imperial College gave a talk which was followed by open discussion. The proposal for the initiation of a peer tutoring scheme in Loughborough met with a positive response.

11.3.2 Contact With Schools

Further discussion with the Science Adviser resulted in the drawing up of a list of suitable schools to be approached by
letter. Schools with pupils in the age range 11 - 14 (Key Stage 3) were thought to be the most suitable institutions because pupils of that age tend to be lively and enthusiastic and are generally participating in active learning schemes in science.

Positive responses were obtained from fifteen schools each of which was visited by a member of the course team. It was not possible to determine which schools would be used until the number of student participants was known and information concerning available transport had been acquired.

11.3.3 Enrolment of Students

The Loughborough scheme, which became known as the 'Student - Tutor Scheme' was advertised amongst physics and chemistry undergraduates by talks, posters, mailshots and word-of-mouth. Before the students were asked to commit themselves to a term of tutoring, they attended an initial training afternoon where they watched a video of the Taster Scheme at the University of East Anglia, learnt the basics of the National Curriculum and were given a set of guidance notes. Six of the seven students who attended the training session in the first term and all six of the students at the second term's training session signed up to spend each Wednesday afternoon for one term helping in science classes in local schools.

11.3.4 Initiation of the Scheme

The number of cars and bicycles available for transport made it possible each term for two students to attend each of the three nearest schools where an interest in the scheme had been shown by the Head of Science. Arrangements were made with the schools and the relevant class teachers. It was particularly important to emphasize the fact that these students were not teachers in training, but classroom helpers to the teacher who must always be in attendance.

As a general rule the students were assigned to one class each, as assistants to the teachers, but occasionally they worked in
pairs. Their tasks varied considerably, from assisting with practicals to helping slow learners or giving a talk to the whole class on a topic about which they had specialist knowledge. The students spent each Wednesday afternoon for nine weeks of one term in the chosen schools. There was the option (taken up by one student) of returning to the school for a second term.

11.4 EVALUATION OF THE STUDENT-TUTOR SCHEME

The Student-Tutor Scheme was evaluated by means of observational visits by members of the course team and by analysis of questionnaires based on those used at Imperial College, Cambridge University and the University of East Anglia, issued to teachers, pupils and students. The full text of these questionnaires are given in Appendix G.

11.4.1 School Visits

The researcher and the Science Method lecturers visited the schools being used to see the scheme in action and to have the opportunity to speak to the class teachers involved. The general impression gained was that the students were enjoying their school experience and had been well received by and of benefit to both the pupils and the teachers.

11.4.2 Pupil Questionnaires

The pupils were given a simple one-page questionnaire with a mixture of open-ended and fixed alternative questions. Tables 56 and 57 show the results of fixed alternative style questions and these tables are followed by some typical comments.
Table 56  Pupils' Opinions of Lessons (N = 54)

<table>
<thead>
<tr>
<th>With Student Tutors</th>
<th>Percentage of Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lessons were:</td>
<td></td>
</tr>
<tr>
<td>More Interesting</td>
<td>72</td>
</tr>
<tr>
<td>Less interesting</td>
<td>2*</td>
</tr>
<tr>
<td>About the same as usual</td>
<td>26</td>
</tr>
<tr>
<td>Easier to follow</td>
<td>52</td>
</tr>
<tr>
<td>Harder to follow</td>
<td>2*</td>
</tr>
<tr>
<td>About the same as usual</td>
<td>46</td>
</tr>
<tr>
<td>More enjoyable</td>
<td>74</td>
</tr>
<tr>
<td>Less enjoyable</td>
<td>0</td>
</tr>
<tr>
<td>About the same as usual</td>
<td>26</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers

Table 57  Pupils' Opinions of Learning (N = 54)

<table>
<thead>
<tr>
<th>With Student Tutors</th>
<th>Percentage of Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel that:</td>
<td></td>
</tr>
<tr>
<td>I learned more than usual</td>
<td>59</td>
</tr>
<tr>
<td>I learned less than usual</td>
<td>0</td>
</tr>
<tr>
<td>I learned about the same as usual</td>
<td>41</td>
</tr>
</tbody>
</table>

It appears from these results that the presence of student tutors made the lessons more interesting and more enjoyable, but the
effect on the pupils' learning seems less marked.

Typical comments from the pupils were "They were fun and helpful"; "There was more help"; and "Someone was there all the time so you didn't have to wait". There were very few negative comments, but occasionally the pupils remarked that one tutor told them something and then the other tutor told them something different. The most common response to the question about what the pupils liked least about having the student-tutors was "Nothing".

11.4.3 Teacher Questionnaires

Only two of the five teachers returned their questionnaires. They both stated that having an extra pair of hands in the classroom was an advantage and there were no disadvantages to having student-tutors. They also felt that the presence of student-tutors had made their teaching more enjoyable, the pupils had learnt more than usual and they were interested in having student-tutors in the future (Stewart 1990b).

11.4.4 Student-Tutor Questionnaire

Nine student-tutors returned their questionnaires. Table 58 shows the number of students who indicated that they had benefitted greatly or somewhat from some aspects of the student-tutor experience.
### Table 58 Benefits of Student-Tutoring

<table>
<thead>
<tr>
<th>Way of Benefitting</th>
<th>Number of Students (N = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing knowledge of some aspects of the subject</td>
<td>4</td>
</tr>
<tr>
<td>Getting practice in the simple communication of scientific ideas</td>
<td>8</td>
</tr>
<tr>
<td>Gaining insight into how other people perceive the subject</td>
<td>7</td>
</tr>
<tr>
<td>Increasing self-confidence</td>
<td>7</td>
</tr>
<tr>
<td>Getting to know people from a wide range of social backgrounds</td>
<td>9</td>
</tr>
<tr>
<td>Feeling of doing something useful</td>
<td>9</td>
</tr>
</tbody>
</table>

All the students felt they had benefitted by getting to know people from a wide range of social backgrounds and by feeling that they were doing something useful.

Three of the six tutors who had previously considered a teaching career were keener to teach after their school experience and the other three felt about the same as before. Of the three who had not previously considered a career in teaching, two were somewhat encouraged towards teaching and the other one was not sure.

Five students stated that the student-tutoring had interfered somewhat with their academic studies and the other four said it had not interfered at all.
The most common response to the question concerning what the students liked best about the school experience was that they felt that they were being helpful to the children. When asked to comment on their least enjoyable aspect of the experience, several students stated that they felt in the way on occasions, for example "when the class was just listening to the teacher and the student-tutors were not involved, but merely spectators".

Suggestions of ways in which the student-tutor scheme could be improved included:

"More interaction between us and the teacher."

"...try an older age group."

"...school staff knowing more about the scheme."

Further comments about the scheme included:

"The scheme is excellent."

"...valuable and worthwhile...a brilliant opportunity for anyone who is considering teaching."

"30 rowdy children is a lot to cope with."

11.4.5 Summary and Comments

Peer tutoring (or student-tutoring) seems to offer many advantages to students, pupils and teachers. The undergraduates are removed from their 'ivory towers' for one afternoon a week, providing a link between the community and the university. At the same time they can support science teachers, particularly during practical sessions. The pupils are helped with their learning by getting more attention than one teacher can provide and they may be encouraged, by the presence of positive role models, to consider the prospects of higher education. The student-tutors have generally gained a positive view of a teaching career with a high proportion of them being encouraged
towards teaching and none of them being discouraged (Stewart 1990b).

11.5 FUTURE PLANS

The two tutors who were in their final year have both been accepted on PGCE courses. The final year option in Science Education is to be made available to physicists in October 1990 and extended to chemists from October, 1991. This assessed course will have a compulsory student-tutoring element. The option of experiencing student-tutoring on a voluntary non-assessed basis will still be available.

11.6 GENERAL SUMMARY AND CONCLUSIONS

Peer-tutoring involving university students acting as classroom helpers in schools seemed to make lessons more interesting and enjoyable for pupils, and they benefitted from having more help available.

From the limited information available it appears that the teachers welcomed extra help in the classroom and felt that pupils learnt more when student-tutors were available.

Student-tutors in this sample felt that they had benefitted by getting to know people from a wide range of social backgrounds and by feeling that they were doing something useful.

The student-tutoring experience appears to have encouraged some students towards a teaching career and discourage none of them.

Just over half the students felt that the student-tutoring interfered with their academic studies somewhat.

A Science Education option is to be made available to physics and chemistry undergraduates at Loughborough University. This course will include a compulsory peer-tutoring element. It is to be hoped that some of the participants will be encouraged towards a career in teaching.
CHAPTER 12

INCREASING PARTICIPATION IN 'A' LEVEL AND FIRST DEGREE PHYSICS COURSES

12.1 INTRODUCTION

Currently about 5% of physics graduates go on to teacher training (Smithers and Robinson, 1988). Even if this figure cannot be increased substantially it should be possible to increase the absolute numbers of students training to be physics teachers if the size of the pool from which they are drawn, i.e. the number of physics undergraduates, is increased. This implies a corresponding increase in the number of students studying 'A' level physics. The normal basic qualification for entrance to higher education is two 'A' level passes. This was achieved by 13.6% of those aged 17+ in 1987 (Ball 1989). However, approximately half of all 16 year olds currently leave school and do not continue their education elsewhere, either full or part-time. From these figures it appears that there should be considerable scope for increasing the number of young people who are qualified to enter higher education.

Section 12.2 discusses methods of increasing the uptake of 'A' level physics. Possible methods by which the intake into physics degrees by traditional routes may be increased are the subject of Section 12.3 and means of widening access into higher education for non-standard entrants are given in Section 12.4.

12.2 UPTAKE OF 'A' LEVEL PHYSICS

Recent reports (Times Educational Supplement 1989d; Nash 1990) indicate that the number of entries for 'A' level physics is falling. Demographic changes alone cannot account for this since English, biology and modern languages entries, amongst others, are currently increasing. This section describes some ways in which it may be possible to increase recruitment into 'A' level physics.
12.2.1 The National Curriculum

The 1988 Education Reform Act introduced a compulsory National Curriculum for all children of school age (5 - 16) in maintained schools. Science is one of the compulsory foundation subjects to be studied by all pupils. In all cases the science studied will be broad and balanced. In the majority of cases pupils will be entered for a double certificate GCSE award in Science at the age of 16, although provision is made for some pupils to study a reduced course leading to a single subject GCSE award.

The results of a pilot scheme in which 2,500 pupils in schools in Suffolk studied for a GCSE double award in science, indicate that the number of pupils subsequently staying on to study 'A' level sciences doubled in two years. The actual increases were 130% for biology, 118% for chemistry and 43% for physics (Times Educational Supplement 1988). However, "many among the new breed of 'A' level student will have difficulties owing to their poor grasp of maths......." (Nash 1988).

James (1988) points out that ".....there are potential advantages, not least in increasing the supply of able girls qualified to continue with the physical sciences". In the same vein O'Connor (1989) reports that science for all to the age of 16 ".....ensures that girls.......no longer have the opportunity of dropping out of physical sciences when they are offered options at 14".

Thus it seems that the introduction of the National Curriculum may lead to an increased number of pupils, particularly girls, staying on to study physics at 'A' level.

12.2.2 Scientist in Residence

Staff at Griffith University in Australia have recently introduced a 'Scientist in Residence' programme. University scientists were made available to spend a period of up to a week in a school, "taking classes with a view to motivating students towards taking science in their later high school years and at
university" (Thiel 1990). In general the scheme consisted of lecture-demonstrations to large groups with follow-up activities undertaken in smaller groups.

Thiel reports a positive response to this scheme from teachers and pupils and strong support from the school principals. Consideration has been given to the possible implementation of a similar scheme involving academic staff from the physics department at Loughborough University of Technology.

12.2.3 Changes in 'A' Level Syllabuses

It will be necessary for 'A' level syllabuses to change in order to take account of changes at GCSE level. Already most examination boards have cut the content and are moving towards a syllabus with a smaller core and more options. A recent report (Institute of Physics 1990) recommends that radical changes should be made in 16 - 19 physics education so that courses would become "attractive to a wide range of students". This report emphasises the need for flexibility to allow courses to be tailored to the needs, interests and abilities of particular students, and suggests that the common core "should not be of such a size, or nature, as to inhibit flexibility and a stimulating diversity of approach".

Other recommendations in this report are that there should be greater emphasis on investigative work, problem solving, learning through practical applications and student-centered learning.

It is to be hoped that the implementation of some or all of these proposed changes would result in courses which are attractive to a wider range of students than a present, with a corresponding increase in the number of students choosing to study physics at this level.

12.2.4 SPISE (Select Programme in Science and Engineering)

Females are vastly under-represented in the field of physical sciences. The SPISE project aimed to redress the balance. The
main aim of the scheme, run at the Polytechnic of North London for several years and taken up by Queen Mary College London in 1988, was to encourage girls to consider seriously a career in science or engineering. The target group consisted of third year girls (14 year olds) in Inner London schools, since they represented a largely untapped source of recruits to physical science courses at all levels from GCSE to degree.

The project at Queen Mary College involved the girls participating in laboratory sessions in Material Science, Aeronautical Engineering, Astrophysics and Earth Science run by College lecturers, assisted by technicians and postgraduates.

Pindar (1988) presented an evaluation of the first SPISE scheme to be run at Queen Mary College. The most popular sessions were generally found to be those with the most practical involvement and the most easily understood or well explained concepts. She concluded that "while the girls and their teachers have made valid criticisms of the project and the lecturers did experience some difficulties in designing and running the sessions, it does seem that overall the experience was a valuable one for all concerned...".

It seems likely that the extension of the SPISE project to more institutions and a widening of the target group, perhaps to include fifth year girls, may have a positive effect on the number of students choosing to study 'A' level physics.

12.2.5  Peer Tutoring

Peer tutoring, whereby university students spend one afternoon each week as classroom helpers in local schools, is described in detail in Chapter 11. The presence of positive role models and the increased enjoyment of lessons indicated by the results of the evaluation exercise of the Loughborough scheme, indicate that some pupils may be encouraged towards studying physics as a result of participation in such a scheme. Larger scale, longer term studies are required in order to provide sufficient data to justify (or refute) the previous statement.
According to Smithers and Robinson (1989) there are basically two main arguments in favour of widening access into higher education. Firstly, there is the economic argument which can be expressed as "expanding education is important to provide a professional and highly skilled workforce". Secondly, the equity argument states that "higher education is so intrinsically worthwhile and personally useful that it should be fairly available to everyone who is able to benefit". Whatever the motivation is, wider access should lead to increased student numbers, resulting in a larger pool from which to draw potential teachers.

This section describes ways in which access to higher education may be widened.

12.3.1 The Vocational Route to Higher Education

The main vocational route into higher education is via the BTEC (Business and Technician Education Council) national qualification. However, "under 6 percent of candidates for 1988 university entry under 20 years of age were taking BTEC qualifications and they made up only 5 percent of acceptances" (Segal 1989). University, Polytechnic and College of Higher Education admissions tutors have the problem of matching BTEC and other vocational qualifications with the well tried and tested 'A' level qualifications.

In 1986 the Government set up the NCVQ (National Council for Vocational Qualifications) to devise a system of vocational qualifications with identifiable levels of attainment to match the academic examination structure. It has devised a framework with five levels into which it is hoped to fit all vocational qualifications. Most of these levels have a direct match with an academic level of achievement (Times Educational Supplement 1990b). When this scheme is implemented it will serve the dual purpose of enabling students to see a clear route into higher education and giving admissions tutors a direct comparison of levels of academic achievement.
12.3.2 Equality of Opportunity

Fulton and Elwood (1989) reported on admissions policies to higher education. They highlighted the fact that many groups such as women, ethnic minorities and those from the lower socio-economic groups were under represented in higher education. Whilst admitting that some targetting of such groups was being undertaken they stated that "It may appease an institution's or department's conscience, but it does not, and is not currently intended to provoke them into detailed consideration of new mechanisms to change their student balance, far less formalise this in admissions criteria". Their belief was that "active equal opportunities policies are needed throughout the system, not only for social justice, but in order to maximise the development of the nation's scarce supply of talent".

Despite the expansion of both the system of Comprehensive schooling and of Higher Education the proportion of University places taken up by Working Class students has fallen by 22.4% over the last 20 years. This fall is greater than the reduction in the Working Class population (Times Educational Supplement 1990c). O'Hear (1989) felt that the best way to help children from all social backgrounds to have access to higher education was for schools "to nuture talent from the start and to extend the talented from all social groups throughout their schooling. In a word .......... reintroduce Grammar School education".

Figure 3 illustrates the mismatch between social groups in the general population and that of University students for all subjects combined. It indicates the changes which have occurred in these groupings over the last 20 years.
University and general populations compared

Early 1960s

Early 1980s

KEY:

Students

Men aged 35-59

12.3.3 Links Between FE and HE

Contact between further and higher education establishments is increasing. Salford University initiated a four-year degree in Technological Physics in 1989. It is targeted at non-standard entrants who may not be adequately qualified for a traditional three-year degree. The first year of the course is undertaken in an FE College which is affiliated to the University. Students who complete the first year successfully will then enter the University components of the degree programme.

More commonly, FE Colleges may provide Access Courses validated by a local University. Upon successful completion of such a course, students qualify for automatic entry to a degree course at the University. The Physics Department at Loughborough University has forged links with some local FE Colleges and Colleges of Technology and discussions are being held with other Colleges.

As an extension of these initial links, Fulton and Elwood (1989) recommended that "All Higher Education Institutions should (be encouraged to) form or join regional access consortia including FE as well as HE providers, with opportunities not only for credit transfer on a case-by-case basis, but also for collaborative course provision".

12.3.4 Mature Entrants

The major thrust made by Higher Education Institutions towards widening access has been in the provision, or validation, of Access Courses and direct-entry schemes for mature candidates. Such students tend to be highly motivated and their degree results are generally as good as, if not slightly better than, those of 'A' level entrants (Smithers and Robinson 1989). Unfortunately, because of the hierarchical nature of mathematics and physics and the amount of assumed knowledge in these subjects for commencement of first year degree studies, the success rate for such students in science and engineering courses is 104
considerably less than that of students of social science for example.

Figure 4 illustrates the fact that there has been an overall increase of 74% since 1970/71 in the proportion of new university students aged over 21 (Universities Information Unit 1990). Currently 1 in 7 new university students is over 21.

12.3.5 Course Development

Since the mid 1980s there has been considerable interest amongst Higher Education Institutions in the development of modular course structures. Modular courses can be built around students' interests and backgrounds to provide individual packages best suited to the students' needs. The effect of the availability of such courses is to widen access to higher education and to make available different modes of attendance (full-time, part-time, day release, etc.) and different levels of award, for example Diploma, Certificate, or Degree, depending on the number of modules successfully completed.

The researcher has been a member of a team investigating the viability of the introduction of a Foundation Year or a set of Foundation modules for non-standard entrants to degrees in science and engineering at Loughborough University. She has also been a member of a Course Specification Working Group, based at the Open University. This group, consisting of members of staff from the physics departments of several universities and polytechnics, has designed a flexible learning package to bring students embarking on a physics or engineering degree to a common point during their first year regardless of their widely differing educational backgrounds. The package covers all the essential mathematics and physics in a self-study format with maximum flexibility (Chapter 14).

Taken together, these developments should make higher education available to much greater numbers of people with wider ranging backgrounds than ever before.
MATURE STUDENTS

Source: USR

Undergraduates 21 and over & Postgraduates 25 and over
The introduction of the National Curriculum, which includes compulsory science for all pupils up to the age of 16, may lead to an increased number of pupils staying on at school to study physics at 'A' level.

The presence of a 'scientist in residence' may encourage pupils to consider studying physics to 'A' or degree level.

Proposed changes in the 'A' level physics syllabuses may result in courses which are attractive to a wider range of students than at present.

Projects such as the SPISE scheme, in which school girls are introduced to practical physics in a Higher Education Institution, may have a positive effect on the number of girls choosing to study 'A' level physics.

The presence of university students acting as peer tutors in schools may encourage some pupils to continue with their study of physics up to 'A' level or beyond.

Access into higher education may be widened by increasing the number of students entering by the vocational route, providing equal opportunities for all sections of society, making stronger links between further and higher education and developing courses of varying levels and modular structure.
CHAPTER 13

GENDER ISSUES

13.1 INTRODUCTION

The low proportion of females to males studying or teaching physics has been well documented (APU 1986, Royal Society and IOP 1982, Stewart and Perrin 1989). Many studies have been undertaken to determine why the study of physics is a dominantly male activity. The APU occasional paper (1986) concludes that "the root of the problem most probably lies........... in differences in early socialisation experiences". Other studies also point out that "the most powerful forces undoubtedly originate outside school........... Nevertheless, there are strong indications that the content of the science curriculum, and the ways in which the...........subjects are taught............could do much to influence the girls' choice..." (HMI 1980).

Section 13.2 gives details of theories which have been proposed to explain the under-representation of girls in physics. A summary of recommendations which have been made is presented in Section 13.3 and an outline of the current situation is given in Section 13.4.

13.2 REASONS FOR SEX DIFFERENCES IN SCIENCE ACHIEVEMENT

The various reasons which have been proposed to account for sex differences in science (particularly physics) achievement fall into four, not entirely unrelated, categories. There may be fundamental biological differences, different social expectations, differences in attitudes and effects due to course content and teaching style.

13.2.1 Biological Differences

There is well-documented evidence that males generally outperform females in tests of 'spatial' ability (Gray 1981), and it is also true that physical scientists have been shown to score higher on such tests than arts, social science, or biological science.
specialists (Child and Smithers 1971). However, there is conflicting evidence as to whether these differences have a genetic origin, or not. Gray describes possible models such as the X-linked hypothesis, which suggests that there is a recessive gene for superior spatial ability carried on the X-chromosome, or the proposal that there are sex-differences in the degree of lateralisation of function (specialisation of left and right sides) of the brain.

According to Gray there is no conclusive evidence which would lead to support or rejection of the genetic basis for differences in spatial ability.

The APU Occasional Paper and Solomon (1988) both suggest that it may be a lack of technical experience, such as the early use of tools which inhibits the growth of girls' spatial ability. Solomon also states that tests have shown no differences between boys and girls in intelligence, mathematical or logical skills.

13.2.2 The Influence of Society

When considering the differences in the achievement in and the uptake of physics between boys and girls, it is important to take into account the influence of early childhood (pre-school) experiences. "School is only one contributory factor, other influences such as the youngsters' home environment, the community in which they live and their exposure to advertising and the media, all play important roles in shaping the self-image which they develop" (Secondary Science Curriculum Review 1987).

According to Kelly (1981) this theory of early socialisation, which she calls 'the cultural hypothesis' suggests that 'girls are socialised away from science at an early age by virtue of the toys they are given to play with, the hobbies they are encouraged in, the household jobs they are asked to help with and the masculine image of science and scientists in books, films and television".
13.2.3 Pupils Attitudes

It has been suggested that girls perform less well than boys in physics because in general girls have a less favourable attitude towards the subject. "By the age of eleven, many youngsters demonstrate sex-stereotyped behaviour and attitudes" (Secondary Science Curriculum Review 1987). "Girls as a group tend to favour what might be termed 'homemaking' activities - principally sewing and cooking. Boys, on the other hand, engage rather more in 'tinkering' activities such as building models" (APU 1986).

Small et al (1982) found, during their work on the Girls Into Science and Technology (GIST) project that sex differences in interests (as indicated by the results of attitude tests) among 11 - 12 year olds were much stronger than sex differences in knowledge. "Boys were much more interested than girls in learning about physical science and girls were much more interested than boys in learning about animals and plants".

Kelly (1981) found that "there was a connection between attitudes and achievement: good attitudes were associated with high achievement".

Nevertheless, there still remains the question of whether the differences in attitude between boys and girls "arise from innate causes, or do they result from different socialisation patterns for the two sexes?" (APU 1986).

13.2.4 The Influence of School

Girls and boys enter school with "different past experiences, different knowledge, different interests, different attitudes and different expectations" (Kelly 1981). If these differences are taken into account, it is clear that "To provide girls and boys with equal opportunities does not necessarily mean providing them with identical educational experiences" (Secondary Science Curriculum Review 1987).
Physics is widely regarded as a difficult subject and HMI (1980) stated that "present courses are unnecessarily theoretical and factually overloaded". Girls' subject preferences are more strongly related to their perception of subject difficulty than are those of boys (Royal Society and IOP 1982). This fact, together with the strong awareness of sex-stereotyping amongst adolescents, makes it less likely that a girl will choose to study physics.

It has been shown from a survey of schools in Clwyd (Clwyd County Council/Equal Opportunities Commission 1983) that girls achieve higher results in physics in single-sex schools. The survey also showed that in mixed schools physics is considered to be a boys' subject and the boys tend to dominate the practical work in particular. Boys also tend to take a disproportionate amount of the teachers' time and attention (ASE 1988). It is therefore not surprising to find that more girls choose to study physical science if they attend single-sex schools (Smail 1984). In surveys of PGCE students (Stewart 1989b) and physics teachers (Stewart 1990a), it was found that a much higher proportion of the females in the sample had attended single-sex schools for their own education than had the males.

Galton (1981) reported the results of a study of the effectiveness of different teaching styles on the attitudes and achievements of pupils. He found that the style of teaching best suited to boys was very different from that producing the best results in physics for girls. In boys' and mixed classes, the teaching style best suited to boys was more likely to be observed, whereas in an all girls class (with a higher possibility of having a female teacher) the pupil-centred style best suited to girls was more likely to be found. Thus "girls in single-sex schools have a greater chance of exposure to the more successful teaching styles" (Galton 1981).
13.3 RECOMMENDATIONS

There is wide agreement amongst the proliferation of reports about the action required to encourage more girls to study physics. Harding (1982) produced an impressive list of recommendations which encompassed (or was the basis of) those in many other reports. Changes in curriculum content, teaching style, printed material, examinations, the option system and class groupings were recommended, together with the introduction of a compensatory programme for girls and an investigation of ways of improving physics teacher supply. These recommendations are described in more detail in the following subsections.

13.3.1 Changes in the Classroom

There should be an increase in scientific activity for all pupils from entry to primary until the end of compulsory schooling. Teachers should adopt a more girl-friendly, pupil-centred approach to teaching and allow single-sex grouping for practical work. They should try to relate physics to social issues and use practical examples involving people as well as things, thus utilizing the greater concern that girls express for social issues and their greater 'person-orientation'. This should be undertaken as an addition to, not as a replacement for relating to topics of more interest to boys.

13.3.2 Changes to the Curriculum and Examinations

The level of difficulty of physics courses and examinations should be reviewed and adjusted. The option system should be examined "to determine if it conveys stereotyped expectations of boys and girls" (Harding 1982). All printed material, including text books and examination papers should be scrutinized in an attempt to remove the male image from physics. The physics syllabus should include social implications and practical applications and thus become less abstract. All pupils should study a balanced science course throughout their period of compulsory schooling.
13.3.3 Teacher Supply

The proposed increases in the number of pupils studying physics (as part of a balanced science course) implies that more physics teachers will be needed. This may be a severe problem in the short term, but should lead to an increase in the pool from which potential physics teachers may be drawn.

13.4 THE CURRENT SITUATION

Since the introduction of the GCSE examination in 1988 many of the above recommendations have in fact been implemented. Courses have in general become more practically based, more pupil-centred and less abstract. There has been a reduction in content and in difficulty.

From 1989 the National Curriculum is being phased in. All pupils in State schools will study science throughout their period of compulsory schooling. This science will be of a broad and balanced nature, and will include social, moral, spiritual and cultural aspects.

All these features should greatly improve the attitude of girls towards science and open up the opportunity for many more girls to study science, including physics, to 'A' level and beyond. This could have a substantial effect on the future supply of physics teachers, since female physics undergraduates have been found to have a more positive attitude than males towards teaching (Stewart and Perrin 1989).
CHAPTER 14

COLLABORATION IN HIGHER EDUCATION

14.1 INTRODUCTION

In May 1989 a meeting, aimed at encouraging collaboration between members of Physics Departments in Higher Education Institutions, was held at the Institute of Physics. Professor Stannard from the Open University gave a talk entitled "Forms of Collaboration" in which he described four possible models of collaboration. These models were the basis of later discussion, and led to several collaborative ventures.

Section 14.2 describes the models of collaboration proposed by Professor Stannard. The immediate action taken by the researcher and the results of such action are described in Section 14.3. The progress made as a result of the researcher's attendance at eight meetings of a working group based at the Open University is reported in Section 14.4. The reactions of Heads of Physics in Higher Education Institutions to the proposals put to them by the working group are reported in Section 14.5 and Section 14.6 summarizes the current situation and describes future plans.

14.2 MODELS OF COLLABORATION

The four models described by Professor Stannard involved increased use of O.U. materials, exchange of students, production of a Bridging Package and other aspects of collaboration. They were entitled Models A, B, C and D respectively.

14.2.1 Model A: Use of Existing Undergraduate Material

During the production of an O.U. course academics put in an average of 50 hours of preparation for every one hour of student study. In addition to this there is the time spent by editors, BBC producers and graphic designers. It is thus possible to produce high quality packages consisting of printed material,
audiotapes and TV/video programmes.

Flexible use of all or parts of an O.U. course would give University and Polytechnic lecturers the opportunity to use up-to-date methods and be involved in mixed media teaching. The advantage to the students would be that each of them could work at his own pace. Small departments may be able to reduce the large amount of contact time required of their lecturers by using some O.U. courses in their entirety. The use of O.U. material may also facilitate an increase in the number of part-time mature students by enabling them to study mainly in the evenings and at weekends.

14.2.2 Model B: Student Transfer

A credit transfer system between the O.U. and 24 Universities and the Council for National Academic Awards is in existence. Under this scheme two-way traffic of students between the O.U. and other Higher Education Institutions is possible. One year of full-time study at a Higher Education Institution is deemed to be equivalent to two credits towards the eight required for an O.U. honours degree. It may be possible to extend the scheme to more Institutions.

14.2.3 Model C: Creation of a Bridging Package

There appear to be two distinct problems that could be tackled by a pre-degree study package in Physics. Firstly, students, even from the traditional route straight from school, are entering University with an ever-increasing diversity of qualifications. Course content is shrinking and the number of optional topics is increasing. The combination of these factors makes it impossible for university lecturers to assume that their new students have a common background knowledge upon which to build. Secondly, Universities are becoming increasingly aware of the need to facilitate access for mature students and entrants with non-standard qualifications. If it was possible to produce a sufficiently flexible package both of these problems could be addressed.
14.3 FOLLOW-UP ACTION

Of the four models described above both Model A and Model C appeared to be relevant to the problem of physics teacher supply, and thus worthy of further investigation and involvement by the researcher. The possibility of using O.U. material to facilitate entry into the part-time mature student market (Model A), and the availability of a Bridging Course to assist non-standard entrants into physics degree courses (Model C) could both result in an increase in the number of physics undergraduates. This, in turn, would mean that the pool from which to draw trainee physics teachers would be larger.

Sample O.U. physics texts and their associated videos were acquired by the researcher. There was some interest shown by the host department, but there was no immediate prospect of adapting first degree courses to accommodate part-time students. Thus involvement in Model A collaboration proved to be impossible.

However, involvement in Model C collaboration appeared to be a more viable prospect and further information was sought concerning the commitment that would be required of a member of a Model C working group. It transpired that each member, out of a total of 15-20 members, would be expected to devote up to 30 working days over a period of about 10 months to the project. The vast majority of this time would be spent in the member's own Institution, with the whole group meeting about eight times at the O.U. in Milton Keynes.

In a letter written in June 1989, addressed to those Institutions that had expressed an interest in Model C, Professor Stannard described what, in his view, would be the task of the working group.

"(i) examining existing O.U. courses and identifying those elements that should be incorporated into the package;

"(ii) identifying those topics and skills that also ought to be included in the package;

"(iii) circulating the outline proposals to Physics and Engineering Departments in Universities and Polytechnics with a view to inviting
Given this information, and being of the opinion that the availability of a package such as that proposed would open up the possibility of widening access to Higher Education, the researcher decided to join the working group.

14.4 THE WORKING GROUP IN OPERATION

There were 19 members of the team charged with the task of specifying the detailed contents of the package. The group met eight times between September 1989 and the end of April 1990. Summaries of the major features of each meeting are given below.

14.4.1 Meeting 1

At the first meeting Dr Jeff Thomas, Chairman of the O.U. 'Physics for Science Teachers' course team gave a talk about the practical issues affecting the re-use of O.U. materials. He described three possible strategies which were a) to use existing texts as they stand and write parallel texts as commentaries; b) to cut and paste existing texts or c) to rewrite the texts. He suggested that a 'mock-up' of the intended package should be produced as early as possible, in order to have something to show potential funding agencies and he recommended the use of professional marketing.

Later discussion centred on when such a package should be studied and the level at which it should begin and end. The importance of flexibility of use and a multi-media approach, involving audiotapes, videos and computer assisted learning was agreed. Each member of the group was asked to produce a list of required topics and skills to be covered by the package, and to examine O.U. courses such as S271, 'Discovering Physics', and MS283, 'An Introduction to Calculus' to determine which material was appropriate for inclusion in the proposed package. These tasks

117
were to be undertaken at the group members' own Institutions prior to the next meeting.

14.4.2 Meeting 2

At the second meeting several members of the group gave very brief talks on topics relevant to the package. The researcher described similar self-study schemes which had been undertaken at various Higher Education Institutions. The chairman, Dr R. Lambourne, undertook to distil the individual lists of required skills and topics to be covered by the package into one document and each group member was asked to consider what the ideal structure of the package should be before the next meeting.

14.4.3 Meeting 3

Ms K. Pindar from the O.U. Science Education Department gave a talk on the marketing of the package at the third meeting of the working group. She defined 'the four P's' of marketing as 1. The product (package) 2. The place (means of distribution) 3. The price (fixed to sell the product) 4. The promotion (method of promoting the product)

The group was introduced to the idea of SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis as a means of evaluating the proposed package. Figure 5 illustrates how this evaluation may be begun and Figure 6 illustrates how this type of analysis may be incorporated in an overall marketing strategy. Both of these figures are adapted from hand-outs received from Ms Pindar.
### SWOT Analysis of Proposed Bridging Package

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulfils known need for raising level of university entry students</td>
<td>Expected to be taken in full timetable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>To sell to all University Physics departments in UK</td>
<td>Students will not take on board</td>
</tr>
</tbody>
</table>
FIGURE 6

MARKETING STRATEGY

1. Quality Screen
Answer the following questions about the proposed package
A. Does it meet our overall aims?
B. Is its production compatible with our resources?
C. Is it likely to benefit the customers we are aiming at?
D. Will it benefit our own institutions?

If the answers to the above seem reasonably satisfactory

2. Concept test
Seek out a dozen people who might be expected to be customers for the package, and give details of it by letter. Telephone them for their reactions and for modifications they would like.

If the proposal as formulated seems satisfactory to them

3. Economic analysis
The production team is here recommended to examine the economics of producing the package under different assumptions of costs incurred and revenues achieved.

4. Comparative test
Take any comparative packages already being produced elsewhere, and subject them to a SWOT analysis comparable to that already undertaken by the team for their own proposed package. Amend the home proposal accordingly.

5. The product test
A large representative sample of the proposed customers should be contacted and sent a trial portion of the package and description of the rest to test their reactions to it and how they would view it. Proposed usage, means of distribution, price etc. should all be described in detail.

When the package has thus been market-tested, production should commence.
The members of the group decided against undertaking a formal SWOT analysis, but their overall marketing plan was based on that illustrated in Figure 6. However, the concept test was unnecessary since the members of the group were themselves potential customers. Thus, the first contact with the Physics Departments of Higher Education Institutions which were not represented in the working group would be at the product test stage (see Figure 6).

The remaining time available at the meeting was taken up with the distribution and discussion of the Skills and Content document (see Appendix H, 'Desired Course Content').

14.4.4 Meeting 4

Ms B. Parker from the Education Group of the Institute of Physics gave a talk about the Institute's '16-19 Working Group' at the fourth meeting. She described the group's task as having been to examine the mismatch between GCSE and 'A' level physics courses and consequently to make proposals concerning possible changes to the 'A' level physics syllabus. One of the conclusions in the draft document which had been prepared was that it was too restrictive to have a set core at 'A' level. This met with considerable opposition from members of the collaborative group and as a result Ms Parker stated that this conclusion would be reconsidered.

The collaborative group went on to discuss the possible structure of the package. Several basically similar structures were proposed. The researcher's proposal is illustrated in Figure 8. In this proposal the Main Block would give instructions about how to use the package and contain lists of appropriate text books, videos, audiotapes and CAL packages. The separate units would be preceded by Starter Units giving the Maths and Physics prerequisites and preliminary tests in Maths and Physics to determine if the student's knowledge was adequate for commencement of the unit itself. It would be possible to direct the student towards revision/remedial material if necessary.
Subsequent discussion led to agreement on a draft structure incorporating most of the ideas in Figure 8. However, it was decided that the Starter Units should become preliminary sections within each physics unit and that the maths units should be independent from the physics units provided that a considerable amount of cross-referencing was supplied.

14.4.5 Meeting 5

At the start of the fifth meeting the chairman, Dr Lambourne, informed the group that, partly in response to the comments of the members of the group at the previous meeting, the Institute of Physics' report on 'A' level physics had been revised. It now spoke of a core specifying fundamental themes and skills.

Discussions at the meeting led to agreement that the package must be text-led and that it may be produced in the form of copyright-free photocopy masters to be reproduced at the buyer's own institution as and when required. Each member of the group was set the task of producing a draft course unit according to the specification given in Appendix H. This was to be undertaken in the succeeding six weeks.

14.4.6 Meeting 6

It was the task of each group member at the sixth meeting to give a brief description of the draft course unit which had been his responsibility to specify. The researcher introduced the idea of producing a Tutor's Pack to accompany each unit. This was accepted in principle.

In order to facilitate the task of producing the consultative document, which was to be sent out to Heads of Physics in British Universities and Polytechnics, three sub-groups were formed. The first group, of which the researcher was the co-ordinator, was required to produce a brief discussion document concerning the form and content of the package. The documents to be produced by the second and third groups were to be entitled 'Articulation' and 'Audio, Video and CAL'. The discussion document for which the researcher had responsibility is reproduced in Appendix H.
14.4.7 Meeting 7

At the seventh meeting the 'Form and Content' document was discussed. Various modifications were suggested and accepted. It was agreed that the term 'package' should be used rather than 'course' because of its implication of greater flexibility of use. Presentation of the package in ring-binder form appeared to be the preferred mode, although it was agreed that the possibility of distributing the material on computer disc should be investigated further. Possible titles for the package were suggested and 'FLAP' (Flexible learning approach to Physics) was the one to be adopted by majority vote.

14.4.8 Meeting 8

Discussion of the sub-group reports continued at the eighth meeting. It was agreed that the Tutor Packs should provide a brief statement of the content and pre-requisites of each section, suggest routes through the package, and contain suggestions for tutorial topics. The group members examined the relational glossary for the O.U. course 'Understanding Space and Time'. In this glossary a term is defined, and a list of related concepts is given, enabling references and cross-references to be made. It was agreed that such a glossary should be an integral part of the proposed package.

To retain maximum flexibility, it was decided that the audio, video and CAL components should be regarded as optional extras.

After discussion of the aims of the package the chairman, Dr Lambourne agreed to produce a consultative document, based on the documents produced by the sub-groups, to be sent to other Higher Education Institutions. A questionnaire eliciting the views of the Heads of Physics at these Institutions was to be included. This consultative document is reproduced in Appendix H.
14.5 REACTIONS TO THE FLAP PROPOSALS

The completed questionnaires, the final design of which was the responsibility of Dr Lambourne, were returned to the researcher for analysis. Replies were received from 22 Universities, 10 Polytechnics and 2 F.E. Colleges. This represented an overall response rate of approximately 22%. Despite this low response rate reminders were not sent out because of the delay which would have ensued whilst awaiting responses to the reminder. It was necessary to complete the analysis of the completed questionnaires in time for a funding bid to be prepared. A partial analysis of the responses to the questionnaire is given below. The full results are given in Appendix H.

14.5.1 Potential Users of the Package

Over 70% of the questionnaire respondents stated that they were 'highly likely' to use the package if it were available in 1993. Inevitably, cost would be a factor in that decision. The respondents were asked what they felt was the maximum amount their departments would pay for the textual material, including the right to photocopy. Almost half (48%) of the respondents gave a maximum less than £500 (the lowest being £100), but more than one third of them were prepared to pay up to a maximum of between £500 and £1000.

14.5.2 The Importance of Audio, Video and CAL Components

There was a considerable difference between the opinions of University and Polytechnic respondents about the importance of the audio, video and CAL components. In the analysis percentages were used for ease of comparison, but the figures for the Polytechnics were unreliable because of the low base (10) from which they were calculated.

Only 10% of the University respondents compared with 30% of the Polytechnic respondents considered that the audio component was vital, and 65% of the University respondents and 40% of the Polytechnic respondents considered that it was not very important. The video component was considered to be vital by 35% of the
University respondents and 60% of the Polytechnic respondents. It was considered to be not very important by 55% of the University respondents and 30% of the Polytechnic respondents.

The CAL component was considered vital by 20% of the University respondents and 33% of the Polytechnic respondents, but it was considered to be not very important by 70% of the University respondents and 33% of the Polytechnic respondents.

Thus the video component appeared to be the most important, although the audio and the CAL components had a considerable amount of support, particularly from the Polytechnics.

14.5.3 Possible Uses

The most commonly stated possible uses of the 'FLAP' package were as a back-up to the first year of a degree course (15 respondents), in remedial work (8 respondents) and as a 'bridging' course for students with AS Physics (equivalent to half an 'A' level) or for mature students (6 respondents).

14.5.4 General Reactions

The overall reaction was very positive. The proposal was considered to be 'welcome', 'good' or 'excellent' by 25 (74%) of the respondents. Four respondents appreciated the flexibility of the package, four stated that the package was required as soon as possible, but four thought that there may be a problem of choosing an appropriate level. The only other negative comments came from two respondents who were unsure about the package finding a niche in the market and two who were concerned about the form of presentation (ring binders and photocopied sheets) of the package.

14.6 CONCLUSIONS

In the light of changing 'A' level syllabuses and widening access to higher education it appears that the 'FLAP' package is a timely proposal, the production of which would be welcomed by Higher
Education Institutions as the basis of introductory, remedial or bridging courses.
CHAPTER 15

SUPPORTED SELF-STUDY

15.1 INTRODUCTION

In preceding chapters there have been descriptions of measures which, on implementation, may lead to an eventual increase in the supply of physics teachers. Chapters 12 and 13 are concerned with ways in which students in general and girls in particular may be encouraged to study physics at 'A' level and beyond. However, any resultant increase in the supply of physics teachers would not come about for several years. Similarly, with the exception of the licensed and articled teacher schemes, the measures for increasing recruitment to teacher training in physics described in Chapter 8 would only be effective in the long-term.

There is an urgent requirement for measures which may be implemented immediately to alleviate the problems caused by the current shortage of physics teachers. If a school has insufficient or inadequately qualified physics teachers, there has to be a choice between allocating less curriculum time to physics, or making better use of the teachers who are available. If a move is made towards a school environment where there is an increasing amount of independent learning taking place i.e. pupils taking a greater responsibility for their own learning, it may be possible to avoid a reduction in the amount of curriculum time allocated to physics.

There are a confusing number of terms used to describe various similar types of educational provision, all of which require the pupil to be more responsible for his own learning. In section 15.2, definitions of the most common terms used in this context are given. A brief history of the development of supported self-study, whereby pupils take responsibility, to a large extent, for their own learning, but emphasis is placed on a good system of support, is given in section 15.3. The operation of supported self-study is described in more detail in section 15.4. A brief description of some of the schemes
15.2 TERMINOLOGY

Lewis (1986) describes open learning as "educational provision that seeks to meet the varied requirements of individuals ...... strongly student-centred and in particular concentrates on helping students to become more independent ......". Most of the other terms in use in similar context may be thought of as types of open learning with emphasis being given to particular features of the open learning. Lewis's definitions are given below.

"Pupil-centred, or student-centred learning" provision is focused on the needs and wants of the individual learner

"Individualised learning" the tasks, objectives and methods are tailored to the capacities of individual learners

"Independent learning" the responsibility for decision-making has passed, in varying degrees, from teacher to learner

"Resource-based learning" the learner uses sources of information directly, rather than through the mediation of a teacher

"Enquiry or active or experimental learning" methods which stress the importance of active engagement by the learner and the value of first-hand experience

"Group or co-operative or collaborative learning" methods which stress the value of group interaction and group processes
"Supported self-study 'self' stresses the individual nature of learning; the teacher's 'support' is personal, as well as administrative and intellectual"

Since this chapter is concerned with the learning of school-aged pupils not adults, it is most important that any individualised learning scheme is accompanied by a great deal of support. The Council for Educational Technology (CET 1988) lists the three types of support essential in any scheme of Supported Self Study. These are:

"Resources specially chosen to support the independent learner

"Tutoring provided regularly and usually organized in small groups

"Management designed to provide a disciplined framework"

Thus the most appropriate term to use for the type of individualised learning which is most suitable in the context of this research is that of 'supported self-study'.

15.3 THE EVOLUTION OF SUPPORTED SELF-STUDY

The changes brought about by Comprehensive reorganization in England and Wales in the 1960's and early 1970's, often involving the management of mixed-ability classes, necessitated investigation of more appropriate teaching styles than the conventional whole-class didactic style. Resource packs and worksheets were developed mainly by the class teachers themselves. However, this resource-based learning "demanded a degree of commitment and energy that relatively few teachers could sustain" (Rainbow 1987) and it also required teachers to adapt from being an instructor to being "another important (and vital) resource for the pupil to use" (Rainbow 1987). Thus, developments in individualised learning in schools were minimal during the succeeding decade.

However, developments continued in the field of higher and further education. The Open University has been most successful in promoting open learning and more recently the Open College has adopted a similar
The NEC (National Extension College) has been active in the further education sector. Its FlexiStudy scheme is in operation over 220 F.E. Colleges. This scheme "enables students to take courses using open learning materials produced by NEC with the advantage of receiving local guidance and tuition from their F.E. College" (NEC Catalogue 1988-9). These students also have the use of their F.E. College's library, laboratories and other facilities. In order to implement such schemes it has been necessary to develop a new style of text writing. Textual resources now typically offer the student guidance about the allocation of time needed for study, the necessary study skills, the prerequisite knowledge required and the location of additional resources. The texts contain facts interspersed with self-assessment questions, reviews and tests which are all designed so that the student can work on his own with occasional tutorial assistance.

Recent educational innovations in schools, such as the introduction of GCSE exams with compulsory coursework components, alongside rapid technological changes have led to a change in emphasis from rote learning towards transferable skills such as information retrieval and problem solving. Pupils are also being encouraged to be more independent and self-motivated. Thus, from the mid 1980's onwards there have been a number of initiatives aimed at promoting flexible self-study arrangements in schools. Harding (1985), reporting on a project to investigate the use of flexible learning (based on NEC FlexiStudy) in small fifth and sixth forms, stated that "support appears to be a keyword in the development of flexible learning". Bradshaw and Stacey (1987) reported on the 'Flexitrist Project' which was in operation from 1986-7. They described this as a "staff development project to promote the use of flexible learning materials and through these to encourage autonomous learning". It seemed to them that to ensure success it was necessary for the teachers themselves to be involved in the development of resources rather than them simply adopting a published package. However, "this problem of lack of 'free' time in the teacher's day must be solved", if they are to carry out design and production tasks in addition to their teaching duties. Since their proposed learning strategies are to be carried
out in a classroom situation the concept of 'supported self-study' appears to be implicit in Bradshaw and Stacey's report despite the fact that it is not mentioned by name.

From 1981-88 the CET was involved in a Supported Self-Study Project. This coincided with a number of government initiatives on the curriculum and assessment, which stressed "the need to develop young people's personal capabilities and sense of responsibility" (Waterhouse 1988). Waterhouse emphasises the distinction between the concept of Supported Self-Study and the many previous initiatives in independent learning. "This is the supreme importance given to the work of tutoring in small groups". Currently, Supported Self-Study is being increasingly used throughout the secondary age range to encourage active learning, to assist in the teaching of mixed-ability groups, to enable small groups to be viable and to alleviate some of the problems caused by a shortage of teachers in some subjects.

15.4 SUPPORTED SELF-STUDY IN OPERATION

A course based on Supported Self-Study generally has learning materials consisting of many illustrated units written in a style conducive to individualised learning (see 15.3). Each topic may be treated at graded levels of difficulty within an overall curricular framework. Included within the course package there will be guides for the teacher and a supply of student record sheets (DES 1988). Non-print resources such as videos and computer programs may also be available. The preparation of the print and non-print resources requires skills, facilities, time and money. There are some commercially produced schemes available, but a teacher may devise a suitable scheme based on text books and locally produced study guides, or several teachers within an LEA may collaborate on the production of an entirely locally produced scheme.

The three vital supports in this type of learning are 'resources', 'management' and 'tutoring'. The amount of support required by an individual will depend on many factors such as age, intelligence and motivation. The 'self' in Supported Self-Study (SSS) is also important. Waterhouse (1988) states that "...helping young people to discover personal meaning for themselves is the guiding principle in
Generally, a student works within a class environment, at his own pace, using learning materials chosen — usually by the teacher — according to his ability and performance. The Self-Study Packs used in a pilot project at the Holyrood School in Somerset were devised at three levels: — Remedial, to provide individual help for a student to catch up; Enrichment, to add to and complement the basic course and Extension, to provide for more able students (Rainbow 1987).

The cycle of learning involves the student being given personal tutoring followed by a period of self-study, which is, in turn, followed by more tutoring and so on. Figure 8 b) illustrates this process. Rainbow (1987) emphasises the key role of tutoring in any system of supported self-study. "It is the tutorial session which enables the student and teacher together to structure the course of study; abandon unnecessary sections; reinforce important points; straighten out difficulties and negotiate a programme of work."

According to Waterhouse (1988) "there are no hard and fast rules about supervision and support during self-study". Time for self-study may be allowed during normal class lessons or, for older students in particular, self-study time may be organized in libraries and private study areas with varying amounts of supervision and general counselling support, which may not be provided by a subject specialist. The DES (1988) mentions other forms of tutorial support for older students. This may be undertaken by post (letter or audio-cassette), by telephone, or by periodic travel by the students to another educational establishment.

Wherever possible training and continuing support should be given to teachers who adopt Supported Self-Study schemes. The change of role from instructor to resource manager is a major one requiring a considerable amount of adjustment on the part of the teacher.

Rainbow (1987) found from his research that most children benefit from self-study methods of learning, but that the younger the child the shorter the 'dose' of study should be. He feels that it is feasible
The concept of Supported Self-Study

How does Supported Self-Study work?

SSS is a two-stroke operation.

Source Waterhouse 1988
to introduce a system of supported self-study into any secondary school with or without a flexible school day (e.g. 8.30 a.m. to 2.55 p.m. followed by flexi-time courses), "provided that there is some initial funding for books and equipment ....... and there is a small team of committed teachers".

15.5 RESOURCES AVAILABLE FOR SUPPORTED SELF-STUDY IN PHYSICS

In 1986 the OU submitted a proposal to the DES for the production of a mixed-media package of resources for the use of pupils studying physics to GCSE level. There were to be videos, overhead transparencies, slides, film-strips, graded worksheets, assessment sheets, instructions in experimental work, computer programs and audio tapes. The possibility of whole class, small group, or individual work would have been incorporated in the design of the materials. There was to be a teacher's manual giving guidance to the use of the package and in addition there were to be add-on components in which inexperienced or under-qualified teachers would be given additional help. It was most unfortunate that funding was not made available for the implementation of this ambitious project.

Wolsey Hall produces courses in physics at GCSE level which are matched to the examinations of the Southern Examining Group and the London and East Anglia Group. Its 'A' level course is matched to the examinations of the London Board, the Cambridge Board and the Associated Examining Board. The main target population for these courses consists of adults following distance learning (correspondence) courses and intending to sit the examinations as external candidates. However, the style of such packages, with activities, self-assessment tests, lists of aims and summary sections, is such that they could be used as a basis for a scheme of supported self-study for school pupils. Practical work and tutorial guidance would have to be added.

The NEC produces GCSE physics packs in an open learning format. In common with other similar schemes the format is flexible, there are clear statements of purpose, student activities and questions and frequent summaries. However, the packs are geared to adults studying the external physics syllabus set by the Southern Examining Group.
Thus, the packs would require additions and modification if they were to be used as a basis of a scheme of Supported Self-Study in a school. There are also NEC physics courses at sub-GCSE level, but there is currently no physics 'A' level pack available.

There are many packs of resources available from which a scheme of Supported Self-Study could be constructed. Scltech produces self-study packages entitled 'Physics 1' and 'Physics 2', but these are designed to introduce fundamental physics concepts and practical skills to BTEC (Business and Technician Education Council) students and thus would require considerable modification. The Inner London Education Authority produced a collection of resource materials entitled 'Modular Secondary Science Resources' for 13 - 16 year old pupils studying science. These materials consist of pupil activity sheets, references to printed material, videos and computer software, topics for discussion, teacher demonstrations and extension work. It seems that these resources could be used, with minor additions and modifications, as the basis for a scheme of Supported Self-Study for GCSE physics. The NERIS (National Educational Resources Information Service) database provides information on teaching and learning materials and has the ability to deliver some types of learning materials electronically direct to schools. Schools which subscribe to this system have access to large quantities of copyright free material from which it may be possible to construct a pupil self-study package covering a substantial proportion of the physics syllabus.

The only physics scheme of independent learning available nationally and capable of being used in schools, without the necessity of adding to the text or modifying it, is the APPIL (Advanced Physics Project for Independent Learning) scheme. As its title suggests, APPIL is a programme of individualised learning for 'A' level physics. According to Gilbert and Van Haeften (1988) this scheme was introduced "because of the realisation that there would be a limited number of teachers trained to teach physics to 'A' level. They state that the minimum amount of teacher contact time required may be as little as 25% of the course time, and the teachers should be educated to at least first year undergraduate level physics.

The complete APPIL package consists of eight student's units, one
student's resource book and one teacher's resource book. The materials are primarily print based, with computer software, audiotapes, slides and videotapes. However, the non-print materials are not essential to the course. The format of the student's units is typical of texts produced for independent learning. There are a clear set of objectives for each unit and within the text are study questions, discussion questions, development questions, self-assessment questions and guides to practical work. Text books are essential additional resources as they are constantly referred to. The teacher's main responsibility is to tutor and manage the resources.

The APPIL scheme was first published in 1979, but the content has now been extensively modified to bring it in line with the requirements of all 'A' level syllabuses.

15.6 THE ROLE OF PRINT AND NON-PRINT RESOURCES

In every scheme of Supported Self-Study known to the researcher, textual resources are the mainstay of the course. They may be in the form of worksheets, textbooks, booklets, or information sheets, all of which may be printed, typed, or handwritten and almost certainly contain pictures, diagrams, or other graphics. Gilbert and Van Haeften (1988) believe that "printed resources should continue to constitute the core" of media for supported self-study. They give many reasons for this belief. For example, time and cost factors would be important considerations and textual resources are easy to use and to organize. They state that "students can learn effectively from textual resources that have been expertly designed for self-study, under the guidance and support of teachers who need not themselves be subject experts".

Resources in non-print media may facilitate or enhance learning. The main use of computers in any scheme of Supported Self-Study would be in the field of computer-assisted learning (CAL). Deeson (1987) lists some potential applications of the computer. These include revision drills and objective tests; graphic introductions to certain areas of physics, simple physics-based games and teaching machine programs. However, Deeson estimates that over ten thousand computer packages
would be required to cover the whole physics syllabus for pupils from age 5 to 16 and in addition "many of the CAL programs that have been produced are rubbish - rubbish academically, pedagogically and information-technologically".

A more recent innovation involving the use of computers is that of interactive video (IV). In this system, film, pictures, sound, data and text are placed on a video disc and a computer program is used to control the presentation of this material. "As a result, students can select the depth, pace and direction at which they learn" (Cole 1988).

In March, 1987 the Interactive Video in schools project, funded by the Department of Trade and Industry, launched eight videodiscs for use in schools, but none of these was applicable to physics. However, if the problem of high cost can be overcome, (approximately £3,500 to set up a system), the educational potential of Interactive Video is great. Mashiter (1988) states that "The use of interactive video ..... is surely in accord with the philosophy of science education which GCSE makes explicit; of pupils enjoying their discovery, concept-driven learning; using facilities that are up-to-date and material which pertains to relevant, real-world contexts". Gilbert and Van Haeften (1988) are of the opinion that interactive video "is likely to be able to make a valuable contribution to the teaching of the shortage subjects".

Other more basic, but more widely available, non-print resources such as sound recordings, slides and videos have functions such as illustration, stimulation and reinforcement. Sound recordings may also have the additional function of providing an alternative to text for pupils with reading difficulties.

The Department of Education and Science (DES 1988) summarized the main findings of an investigation into Supported Self-Study undertaken by the Council for Educational Technology. Those conclusions which are relevant to the role of print and non-print resources are reproduced below.

"While the new technologies are important supplements to the work of the teacher, their successful use is largely dependent upon careful
and appropriate use by the teacher. At least in the immediate future, cost and other practical considerations must in any case limit the benefits that the technologies can bring to the teaching of the shortage subjects.

"Interactive video is the most promising exception. The full CET report recommends allocation of resources for further evaluation. But the need for further such evaluation and high current cost of equipment involved precludes widespread use for the time being.

"On the other hand, an inadequately qualified teacher can successfully organise and support the learner's self-study of a subject through the use of printed materials, provided that:

- the materials have been expertly designed to guide learning and to stimulate interaction;

- the teacher is trained in the tutorial skills involved."

Thus, at least in the near future, it seems that textual materials will remain the major resources for Supported Self-Study. "There is insufficient evidence that the systematic teaching of the shortage subjects can be based upon the new technologies" (Gilbert and Van Haeften 1988).

15.7 THE USE OF SUPPORTED SELF-STUDY TO COMPENSATE FOR TEACHER SHORTAGES

If pupils learn physics with the aid of a scheme of Supported Self-Study, the teacher's professional skills as a tutor and classroom organizer may be more important than his level of qualification in the subject. Provided that suitable materials were available, a teacher with an 'A' level or equivalent in physics should be able to teach the subject at sub 'A' level standard with some specialist support (Gilbert and Van Haeften 1988). These authors also suggested that it may not be essential for a teacher running an 'A' level physics course using supported self-study methods to have a degree in physics. Such a teacher could have a degree in another science subject and be given an intensive conversion course in physics.
The DES (1988) also points out that "Supported Self-Study makes it feasible for a class to have more than one teacher of the subject, as long as one person co-ordinates the work". Thus two or more teachers with a partial knowledge of physics may share the tutoring of a class. Retired teachers, or those with family commitments could be employed as part-time tutors, sharing classes with full time staff. If a school cannot provide its own tutoring, older students may be able to work independently with periodic tuition by telephone, post, or occasional visit from an external tutor based in another educational institution.

Thus, it may be possible to compensate for physics teacher shortages by adopting schemes of Supported Self-Study staffed by part-time teachers, and those thought to be inadequately qualified for teaching physics by traditional methods, provided that they are given training in the necessary tutorial skills and they have access to some specialist support.
16.1 INTRODUCTION

The research undertaken was, of necessity, very wide ranging and numerous conclusions could be drawn from its results. However, in this chapter the major conclusions are listed in Section 16.2. Further minor conclusions may be found at the end of each preceding chapter. In Section 16.3 the researcher lists twelve recommendations, the implementation of which would result in short-term assistance during the current physics teacher shortage and would lead in the long-term to an increase in the supply of physics teachers. Finally in Section 16.4, two of these recommendations are given special emphasis because they have the potential to be particularly effective low-cost methods of increasing the supply of physics teachers.

16.2 CONCLUSIONS

The following conclusions are implied from the results of the research described in preceding chapters. In some cases the sample sizes are small, which implies that it may not be valid in all cases to generalize the conclusions to the whole population.

Physics teachers in 11 - 16 schools tended to be inadequately qualified.

Only 69% of teachers of 'A' level physics had a degree in physics.

Sixth Form Colleges had the most appropriately qualified physics teachers.

Physics undergraduates in general had a negative attitude towards teaching. Females had a more positive attitude than males, particularly in their response to the prospect of working with young people.
Females are poorly represented at all levels of physics education. The percentages of GCSE pupils, 'A' level pupils, undergraduates, PGCE students and teachers who were female were 27%, 24%, 14%, 20% and 19% respectively.

Only half of the PGCE students stated that they had a definite desire to teach.

The percentage of PGCE students who had a degree in physics or joint physics and another science was 61%.

The females in the sample of PGCE students were more likely to have attended single-sex schools than were the males.

Physics teachers, and physics PGCE students after their teaching practice, felt that time management was a much more serious problem than was class management.

Without the payment of the Bursary one in three of the PGCE students would not have undertaken the course.

Almost as many of the PGCE students would prefer Maths as a second teaching subject as would prefer Science.

One in five of the male and none of the female PGCE students would prefer to teach students aged 16 plus.

Approximately one in three of the physics teachers wanted to leave the profession. Their main reasons were 'poor rewards', 'low status', and 'pressure of work'.

Peer tutoring, whereby physics undergraduates acted as classroom helpers, appeared to have benefits for the students, the pupils and the teachers alike and also seemed to have a positive effect on the undergraduates' attitudes towards teaching as a career.

It is difficult to separate the effects of innate differences and socialization effects on the attitudes of males and females towards physics. However, current changes in the science curriculum may
encourage more girls to study physics to a high level.

There was some indication that government initiatives such as the shortened B.Ed, the licensed and articulated teacher schemes, the bursary, retraining schemes and sponsorship of peer tutoring schemes were having some effect on the supply of physics teachers.

Schemes of Supported Self-Study may be partial short-term solutions to the problems caused by physics teacher shortages.

16.3 RECOMMENDATIONS

1. Further research should be undertaken to determine the percentages of female physics students and teachers who attended single-sex schools.

2. Further investigations should be undertaken to determine whether mixed Comprehensive Schools provide a suitable environment in which to encourage more females to study Physical Sciences.

3. Peer tutoring schemes should be initiated at all H.E. Institutions where physics is taught and wherever possible assessed Science Education courses should become an integral part of all physics degree courses.

4. The Bursary Scheme should be retained, and the sum paid to trainee physics teachers should be increased.

5. New physics teachers should be given a considerably reduced timetable throughout their first year of teaching.

6. Teachers' pay should be increased and their class contact time reduced.

7. There should be an investment in new equipment for school physics laboratories.

8. Access to higher education should be widened, and a Foundation Year introduced into H.E. Institutions to enable non-standard
entrants to be admitted to physics degree courses.

9. Consideration should be given to the fact that large numbers of physics teachers are not qualified to teach Balanced Science to GCSE level and would prefer and are better qualified to teach Maths as a second subject.

10. There should be a reconsideration of moves towards an increase in the number of 11 - 16 schools and Sixth Form Colleges with the resulting concentration of inadequately qualified teachers in the 11 - 16 schools.

11. The production and dissemination of schemes of Supported Self-Study in physics should be encouraged.

12. Physics syllabus writers and course planners should consider the greater person-orientation of females than males, and aim to produce courses that are girl-friendly.

16.4 **FINAL COMMENTS**

There are considerable cost implications to several of the above recommendations. However, two potentially highly effective proposals, peer-tutoring and girl-friendly science courses, could be put into effect at very little cost. Peer-tutoring has been shown to encourage undergraduates towards a career in teaching, and females have been shown to be more likely than males to choose teaching as a career.

Therefore, if girl-friendly science courses were to become widely used in schools, the result should be an increased uptake of physics degree courses by girls, and a corresponding increase in the number of students undertaking physics PGCE courses. This number should be further boosted if peer-tutoring schemes, with their consequent positive effect on the attitudes of physics undergraduates towards teaching, were made more widely available.
APPENDIX A

SCHOOL SURVEY

Fifth Year Boys

Total number
Number studying G.C.S.E. Physics
Number studying 'double cert.' science
Number studying other G.C.S.E.s with high Physics content

Fifth Year Girls

Total number
Number studying G.C.S.E. Physics
Number studying 'double cert.' science
Number studying other G.C.S.E.s with high Physics content

Sixth Form Boys

Total number
Number studying 'A' level Physics

Sixth Form Girls

Total number
Number studying 'A' level Physics

145
### Staff

**Number teaching G.C.S.E. Physics related courses**

<p>| | |</p>
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Number of above</td>
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<tr>
<td>with a degree in</td>
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<tr>
<td>b) Chemistry</td>
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<tr>
<td>c) Maths</td>
<td></td>
</tr>
<tr>
<td>d) Engineering</td>
<td></td>
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<tr>
<td>e) Other</td>
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**Number teaching 'A' level Physics**

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<tr>
<td>with a degree in</td>
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<td>a) Physics</td>
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<tr>
<td>b) Chemistry</td>
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<tr>
<td>c) Maths</td>
<td></td>
</tr>
<tr>
<td>d) Engineering</td>
<td></td>
</tr>
<tr>
<td>e) Other</td>
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</table>

**Number of female staff teaching G.C.S.E. Physics related courses**

<p>| | |</p>
<table>
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**Number of female staff teaching 'A' level Physics**

<p>| | |</p>
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<th></th>
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APPENDIX B

UNDERGRADUATE QUESTIONNAIRE

B1 Text of Questionnaire

B2 Comparison Between Two Universities

B3 Full results of question 3
1. What is your attitude to a career in teaching? (Tick one box)
   - Actively considering it
   - It is a possibility
   - Only as a last resort
   - Would not consider it at all

2. Listed below are some possible attractions of a career. Please tick the ones which you think would be applicable (and attractive) to teaching.
   - Job satisfaction
   - Good pay
   - Long holidays
   - Work with young people
   - Good promotion prospects
   - Pleasant working environment

3. Below is a list of problems which may be faced by physics teachers who are new to the profession. Please indicate whether you would expect each one to be a major problem or otherwise. (Tick one box)
   - Insufficient free periods
   - Unfamiliarity with laboratory equipment
   - Marking/preparation to do in evenings
   - Indiscipline
   - Working together with other teachers
   - Dealing with pupils' personal problems
   - Large class size
   - Inadequately equipped laboratories

   Major problem ← ← No problem
It would be appreciated if you would give some personal details, to help in the classification of your answers.

4. Sex  
   (Tick one box)
   M
   F

5. 'Handedness' (Tick one box)
   Dominantly left-handed
   Dominantly right-handed
   Ambidextrous

6. What was your 'A' level physics grade?  
   (Tick one box)
   A
   B
   C
   D
   E
   None

7. Please state briefly why you chose to study physics.

Thank you for your cooperation. Please check for missing answers before returning this questionnaire.
Comparison Between Two Universities

Figures 9 to 16 illustrate comparisons between the questionnaire results at the two universities used in the physics undergraduate survey. It must be noted that Figures 11 and 12 are on different vertical scales, as are figures 13 and 14. In each case the results appear to be very similar. However, to determine if there were any statistically significant differences in the responses of the undergraduates from the two universities chi-squared tests were undertaken for the responses to questions 1, 2, 3 and 4.

Question 1 Attitudes to a Teaching Career

The value of $\chi^2$ was found to be 0.977 with 3 degrees of freedom. This value shows that there was no statistically significant difference at the 1% level between the responses of the physics undergraduates at the two universities.

Question 2 Pluses of Teaching

The value of $\chi^2$ for the category 'job satisfaction' was 0.541; for 'good pay' 0.004; for 'long holidays' 0.109; for 'work with young people' 0.904; for 'good promotion prospects' 0.078 and for 'pleasant working environment' it was 0.679. All the values were calculated using the Yates' correction for 2 x 2 tables, all had 1 degree of freedom and all showed no statistically significant difference at the 1% level between the responses of the physics undergraduates at the two universities.

Question 3 Anticipated Problems

Table 59 shows the results of a chi-squared test, incorporating the Yates' correction for 2 x 2 tables, for each category in this question.
Table 59  \( x^2 \) Values for Anticipated Problems of a New Physics Teacher (Physics Undergraduates Opinions)

<table>
<thead>
<tr>
<th>Category</th>
<th>( x^2 )</th>
<th>Degrees of Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient free</td>
<td>0.414</td>
<td>1</td>
</tr>
<tr>
<td>Unfamiliar equipment</td>
<td>2.279</td>
<td>1</td>
</tr>
<tr>
<td>Marking/preparation in evenings</td>
<td>0.660</td>
<td>1</td>
</tr>
<tr>
<td>Indisclipline</td>
<td>1.122</td>
<td>1</td>
</tr>
<tr>
<td>Work with others</td>
<td>0.438</td>
<td>1</td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td>1.630</td>
<td>1</td>
</tr>
<tr>
<td>Large class size</td>
<td>0.492</td>
<td>1</td>
</tr>
<tr>
<td>Inadequate equipment</td>
<td>0.308</td>
<td>1</td>
</tr>
</tbody>
</table>

In none of these categories was a statistically significant difference at the 1\% level found between responses of the physics undergraduates at the two universities.

Question 4  Sex of Students

The chi-squared value, incorporating the Yates' correction for 2 x 2 tables, was found to be 0.006 with 1 degree of freedom. Thus there was no statistically significant difference at the 1\% level between the number of males and females at the two universities.

Conclusion

There seems to be a broad agreement between the responses of the physics undergraduates at the two universities.
attitudes to a career in teaching

UNIVERSITY 1

- last resort: 47.1%
- actively considering: 2.9%
- wouldn't consider: 23.5%
- possibility: 26.5%
attitudes to a career in teaching

UNIVERSITY 2
FIGURE 11

pluses of teaching

UNIVERSITY 1

1 - job satisfaction
2 - good pay
3 - long holidays
4 - young people
5 - promotion prospects
6 - pleasant environment

pluses

percentage frequency
FIGURE 12

pluses of teaching

UNIVERSITY 2

1 - job satisfaction
2 - good pay
3 - long holidays
4 - work with young people
5 - good promotion prospects
6 - pleasant environment

percentage frequency

pluses

1 2 3 4 5 6
anticipated problems of new physics teachers

FIGURE 13

UNIVERSITY 1

1=insufficient trees
2=unfamiliar equipment
3=work in evenings
4=indiscipline
5=work with other teachers
6=pupils' personal problems
7=class size
8=inadequately equipped labs
Anticipated problems of new physics teachers

UNIVERSITY 2

1 - insufficient trees
2 - unfamiliar equipment
3 - work in evenings
4 - indiscipline
5 - work with others
6 - pupils' personal problems
7 - class size
8 - inadequate equipment
FIGURE 15

gender of physics students

UNIVERSITY 1

males 87.3%

females 12.8%
sex of physics students

UNIVERSITY 2

FIGURE 16

male 86.0%

female 14.0%
Tables 63 to 78 show the full results of the question about the problems that a new physics teacher may face. The physics undergraduates were asked to rate each anticipated problem on a five point Likert-type scale with 1 corresponding to a major problem and 5 corresponding to no problem. In each case the results on the left-hand side of the page refer to the responses of the physics undergraduates at university 1. The responses from physics undergraduates at University 2 are shown on the right-hand side of the page.

It has been shown in section B2 that there were found to be no statistically significant differences between these two results.
Table 63 University 1 Undergraduates

<table>
<thead>
<tr>
<th>ROWS: sex</th>
<th>COLUMNS: Shortage of free periods</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<tr>
<td>Female</td>
<td></td>
<td>15.38</td>
<td>38.56</td>
<td>30.77</td>
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<tr>
<td>Male</td>
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<td>3.12</td>
<td>16.85</td>
<td>37.08</td>
<td>31.46</td>
<td>13.48</td>
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</tr>
<tr>
<td>ALL</td>
<td></td>
<td>9.98</td>
<td>16.67</td>
<td>37.25</td>
<td>31.37</td>
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CELL CONTENTS: -- % OF ROW

Table 65 University 1 Undergraduates

<table>
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<th>ROWS: sex</th>
<th>COLUMNS: unfamiliar equipment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Female</td>
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<td>15.38</td>
<td>23.08</td>
<td>46.15</td>
<td>15.38</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>7.87</td>
<td>12.36</td>
<td>19.10</td>
<td>33.71</td>
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<tr>
<td>ALL</td>
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<td>6.86</td>
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<td>35.29</td>
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CELL CONTENTS: -- % OF ROW

Table 67 University 1 Undergraduates

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<thead>
<tr>
<th>ROWS: sex</th>
<th>COLUMNS: work in evenings</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<td>7.09</td>
<td>69.73</td>
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<td>--</td>
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CELL CONTENTS: -- % OF ROW

Table 69 University 1 Undergraduates

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<tbody>
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<td>15.38</td>
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CELL CONTENTS: -- % OF ROW
### Table 71 University 1 Undergraduates

<table>
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<th>ROWS: sex</th>
<th>COLUMNS: Working with other teachers</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>ALL</th>
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<tbody>
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<td>23.08</td>
<td>46.15</td>
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**CELL CONTENTS:** Z OF ROW

### Table 72 University 2 Undergraduates

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**CELL CONTENTS:** Z OF ROW

### Table 75 University 1 Undergraduates

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**CELL CONTENTS:** Z OF ROW

### Table 76 University 2 Undergraduates

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**CELL CONTENTS:** Z OF ROW

### Table 77 University 1 Undergraduates

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<th>ROWS: sex</th>
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<th>3</th>
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<tbody>
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**CELL CONTENTS:** Z OF ROW

### Table 78 University 2 Undergraduates

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<th>COLUMNS: inadequately equipped lab.</th>
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**CELL CONTENTS:** Z OF ROW
APPENDIX C

PGCE QUESTIONNAIRE

C1 Text of Questionnaire

C2 Full Results of Question 3

C3 Full Results of Sex and Qualifications Comparisons
1. What is your main reason for doing the P.G.C.E. course? (Tick one box)

Definite desire to teach

To try out teaching as a possible career

A desire for a career change

Lack of success in job applications

Other (specify below)

2. Listed below are some possible attractions of a teaching career. Please put them in order of importance to you. (1 most important ----- 6 least)

Job satisfaction

Good pay

Long holidays

Work with young people

Good promotion prospects

Pleasant working environment

If you consider other factors to be important please specify below.
3a) Below is a list of problems which may be faced by physics teachers who are new to the profession. Please indicate whether you would expect each one to be a major problem or otherwise. (Tick one box for each)

<table>
<thead>
<tr>
<th>Major problem</th>
<th>No problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient free periods</td>
<td></td>
</tr>
<tr>
<td>Unfamiliarity with laboratory equipment</td>
<td></td>
</tr>
<tr>
<td>Marking/preparation to do in evenings</td>
<td></td>
</tr>
<tr>
<td>Indiscipline</td>
<td></td>
</tr>
<tr>
<td>Working together with other teachers</td>
<td></td>
</tr>
<tr>
<td>Dealing with pupils' personal problems</td>
<td></td>
</tr>
<tr>
<td>Large class size</td>
<td></td>
</tr>
<tr>
<td>Inadequately equipped laboratories</td>
<td></td>
</tr>
</tbody>
</table>

b) Please specify other major problems you consider may be faced by new physics teachers.

4. Answer this question if you were given careers guidance at school.

a) How helpful was the careers guidance you were given at school? (Tick one box)

Very helpful
Quite helpful
Not helpful

b) Was teaching suggested to you as a possible career? (Tick one box)

Not suggested
Suggested amongst other options
Strongly suggested
5. Answer this question if you were given careers guidance during your period of higher education.

a) How helpful was the careers guidance given during your period of higher education?
   (Tick one box)
   - Very helpful
   - Quite helpful
   - Not helpful

b) Was teaching suggested to you as a possible career?
   (Tick one box)
   - Not suggested
   - Suggested amongst other options
   - Strongly suggested

6. At what stage did you choose teaching as a career?
   (Tick one box)
   - Prior to secondary education
   - During secondary education
   - During higher education
   - After another career
   - Still undecided
   - Other (specify below)
7. How many close relatives do you have who are/were teachers? (Consider grandparents, parents, brothers/sisters, cousins, aunts and uncles) (Tick one box)

None
One
Two
Three
More than three

8. How many close friends do you have who are teachers? (Tick one box)

None
One
Two
Three
More than three

It would be appreciated if you would give some personal details, to help in the classification of your answers, and to make some statistical comparisons.

9. Sex

M
F

Age (years)
10. Type of school attended for majority of education between the ages of 11 and 16.
(Tick one box)

a) 
- Comprehensive
- Grammar
- Secondary Modern
- Independent
- Other

b) 
- Mixed
- Single-sex

11. Type of school attended for 'A' level (or other further education) studies.
(Tick one box)

a) 
- Comprehensive
- Grammar
- Independent
- F.E. College
- VIth Form College
- Other

b) 
- Mixed
- Single-sex
12. What was your 'A' level physics grade?
   (Tick one box)
   
   A
   B
   C
   D
   E

13. What was your degree subject?
   
   Physics
   Joint Physics/other science
   Maths
   Chemistry
   Engineering
   Other (please specify below)
   None

14. What was the class of your degree?
   
   First
   Upper Second
   Lower Second
   Third
   Pass
   None
15. Do you have any other relevant qualifications? (e.g. H.N.C./H.N.D.). If so please specify below.

Thank you for your co-operation. Please check for missing answers, and return your completed questionnaire as soon as possible in the envelope provided.
Tables 76 to 83 show the full results of the question about the problems that a new physics teacher may face. The PGCE students were asked to rate each problem on a five point Likert-type scale with 1 corresponding to a major problem and 5 corresponding to no problem. The results are shown broken down by sex.

**Table 76** PGCE Students' Opinions

**Sex v. Insufficient Free Periods**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>16.67</td>
<td>41.67</td>
<td>20.83</td>
<td>16.67</td>
<td>4.17</td>
</tr>
<tr>
<td>Male</td>
<td>13.27</td>
<td>37.76</td>
<td>30.61</td>
<td>11.22</td>
<td>7.14</td>
</tr>
<tr>
<td>Total</td>
<td>13.93</td>
<td>38.52</td>
<td>28.69</td>
<td>12.30</td>
<td>6.56</td>
</tr>
</tbody>
</table>

**Table 77** PGCE Students' Opinions

**Sex v. Unfamiliar Equipment**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>8.33</td>
<td>41.67</td>
<td>29.17</td>
<td>8.33</td>
<td>12.50</td>
</tr>
<tr>
<td>Male</td>
<td>5.10</td>
<td>23.47</td>
<td>31.63</td>
<td>27.55</td>
<td>12.24</td>
</tr>
<tr>
<td>Total</td>
<td>5.74</td>
<td>27.05</td>
<td>31.15</td>
<td>23.77</td>
<td>12.30</td>
</tr>
</tbody>
</table>
Table 78  PGCE Students' Opinions

Sex v. Work in Evenings

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>8.33</td>
<td>25.00</td>
<td>37.50</td>
<td>25.00</td>
<td>4.17</td>
</tr>
<tr>
<td>Male</td>
<td>7.22</td>
<td>32.99</td>
<td>36.08</td>
<td>15.46</td>
<td>8.25</td>
</tr>
<tr>
<td>Total</td>
<td>7.44</td>
<td>31.40</td>
<td>36.36</td>
<td>17.36</td>
<td>7.44</td>
</tr>
</tbody>
</table>

Table 79  PGCE Students' Opinions

Sex v. Indisclipline

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>12.50</td>
<td>58.33</td>
<td>25.00</td>
<td>4.17</td>
<td>----</td>
</tr>
<tr>
<td>Male</td>
<td>16.49</td>
<td>36.08</td>
<td>29.90</td>
<td>11.34</td>
<td>6.19</td>
</tr>
<tr>
<td>Total</td>
<td>15.70</td>
<td>40.50</td>
<td>28.93</td>
<td>9.92</td>
<td>4.96</td>
</tr>
</tbody>
</table>

Table 80  PGCE Students' Opinions

Sex v. Work With Others

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>----</td>
<td>4.17</td>
<td>8.33</td>
<td>37.50</td>
<td>50.00</td>
</tr>
<tr>
<td>Male</td>
<td>3.06</td>
<td>7.14</td>
<td>17.35</td>
<td>43.88</td>
<td>28.57</td>
</tr>
<tr>
<td>Total</td>
<td>2.46</td>
<td>6.56</td>
<td>15.57</td>
<td>42.62</td>
<td>32.79</td>
</tr>
</tbody>
</table>
### Table 81  PGCE Students' Opinions

Sex. v. Pupils' Personal Problems

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-----</td>
<td>8.33</td>
<td>37.50</td>
<td>20.83</td>
<td>33.33</td>
</tr>
<tr>
<td>Male</td>
<td>5.15</td>
<td>20.62</td>
<td>26.80</td>
<td>31.96</td>
<td>15.46</td>
</tr>
<tr>
<td>Total</td>
<td>4.13</td>
<td>18.18</td>
<td>28.93</td>
<td>29.75</td>
<td>19.01</td>
</tr>
</tbody>
</table>

### Table 82  PGCE Students' Opinions

Sex v. Class Size

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>25.00</td>
<td>58.33</td>
<td>12.50</td>
<td>4.17</td>
<td>----</td>
</tr>
<tr>
<td>Male</td>
<td>21.43</td>
<td>40.82</td>
<td>24.49</td>
<td>11.22</td>
<td>2.04</td>
</tr>
<tr>
<td>Total</td>
<td>22.13</td>
<td>44.26</td>
<td>22.13</td>
<td>9.84</td>
<td>1.64</td>
</tr>
</tbody>
</table>

### Table 83  PGCE Students' Opinions

Sex v. Inadequate Equipment

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>45.83</td>
<td>25.00</td>
<td>20.83</td>
<td>8.33</td>
<td>----</td>
</tr>
<tr>
<td>Male</td>
<td>28.57</td>
<td>44.90</td>
<td>20.41</td>
<td>2.04</td>
<td>4.08</td>
</tr>
<tr>
<td>Total</td>
<td>31.97</td>
<td>40.98</td>
<td>20.49</td>
<td>3.28</td>
<td>3.28</td>
</tr>
</tbody>
</table>
C3 Full Results of Sex and Qualifications Comparisons

Table 84 shows the 'A' level physics grades of the PGCE Students in the sample broken down by sex.

Table 84 | PCCE Students 'A' Level Grades Broken Down By Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Grade A</th>
<th>Grade B</th>
<th>Grade C</th>
<th>Grade D</th>
<th>Grade E</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>31.5</td>
<td>23.9</td>
<td>18.5</td>
<td>10.9</td>
<td>12.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Female</td>
<td>17.4</td>
<td>30.4</td>
<td>26.1</td>
<td>8.7</td>
<td>17.4</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Percentages may total 100 ±0.1 due to rounding errors

Table 85 shows the degree subjects of the PGCE students in the sample broken down by sex.

Table 85 | PCCE Students' Degree Subjects Broken Down by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Physics</th>
<th>Physics/Other Science</th>
<th>Engineering</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>38.1</td>
<td>21.7</td>
<td>24.7</td>
<td>15.5</td>
</tr>
<tr>
<td>Female</td>
<td>40.0</td>
<td>24.0</td>
<td>4.0</td>
<td>32.0</td>
</tr>
</tbody>
</table>

The range of other degrees for females included Chemistry (2 students), Materials Science (2 students), Economics (1 student), Psychology (1 student) and Health Physics (1 student).

The range of other degrees for males included Maths (1 student), Chemistry (2 students), Geology (3 students), Marine Biology (1 student), Philosophy (1 student), Biological Science (2 students), Materials Science (3 students), Geophysics (1 student) and
Table 86 shows the class of degree held by the PGCE students in the survey broken down by sex.

**Table 86**

<table>
<thead>
<tr>
<th>Sex</th>
<th>First</th>
<th>Upper Second</th>
<th>Lower Second</th>
<th>Third</th>
<th>Pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4.2</td>
<td>24.2</td>
<td>33.7</td>
<td>23.2</td>
<td>14.7</td>
</tr>
<tr>
<td>Female</td>
<td>12.5</td>
<td>25.0</td>
<td>37.5</td>
<td>16.7</td>
<td>8.3</td>
</tr>
</tbody>
</table>
APPENDIX D

TEXT OF FOLLOW-UP QUESTIONNAIRE

1. Listed below are some possible attractions of a teaching career. Please tick the ones which you think would be applicable (and attractive) to teaching.

   Job satisfaction
   Good pay
   Long holidays
   Work with young people
   Good promotion prospects
   Pleasant working environment

2. Below is a list of problems which may be faced by physics teachers who are new to the profession. Please indicate whether you would expect each one to be a major problem or otherwise. (Tick one box for each)

   Insufficient free periods
   Unfamiliarity with laboratory equipment
   Marking/preparation to do in the evening
   Indiscipline
   Working together with other teachers
   Dealing with pupils' personal problems
   Large class size
   Inadequately equipped laboratories
3. Now that you have spent some time on teaching practice, what do you feel about a career in teaching? (Tick one box)

<table>
<thead>
<tr>
<th>Keen to teach</th>
<th>Definitely do not wish to teach</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. If you have decided to teach, in what type of school would you prefer to begin your teaching career?

- Comprehensive
- Grammar
- Secondary Modern
- Independent
- F.E. College
- Sixth Form College
- Other (specify below)

5. Sex

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
</tr>
</tbody>
</table>

6. Age

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
</table>

7. Would you have undertaken a P.G.C.E. course if there was no Bursary? (Tick one box)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Would you have undertaken a Physics P.G.C.E. course if there was no Bursary? (Tick one box)

   Yes  |  No
   _____|_____

9. Which subject in addition to Physics would you prefer to teach? (Tick one box)

   Balanced Science
   Chemistry
   Biology
   Maths
   Computer Studies
   Other (specify below)

Thank you for your co-operation. Please check for missing answers before returning the questionnaire.
APPENDIX E

FIRST DESTINATION OF PHYSICS PGCE STUDENTS

At the end of the academic year 1988-89 the physics PGCE tutors at the institutions involved in the initial survey were asked to supply information about the pass rate and the first destination of the physics PGCE students who had just completed their course.

Information was received about 93 of the students from the original sample of 123 (approximately 76%).

The pass rate of the students in this subsample was approximately 85%.

The percentage of those who passed the course whose first destination was a post in teaching was 92%. This represented approximately 79% of the subsample. This seems rather better than Smithers and Robinson's (1988) figure of 65%.

The proportions of these students accepting teaching posts in the state sector and the independent sector were 92% and 8% respectively.
1 Listed below are some possible attraction of a career. Please tick the ones which you think would be applicable (and attractive) to teaching.

Job satisfaction
Good pay
Long holidays
Work with young people
Good promotion prospects
Pleasant working environment

2 a) Below is a list of items which may cause physics teachers stress and/or dissatisfaction. Please indicate whether you consider each one to be a major problem or otherwise. (Tick one box for each item).

<table>
<thead>
<tr>
<th>Item</th>
<th>Major problem</th>
<th>No problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insufficient free periods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marking/preparation in evenings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indiscipline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils' personal problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large class size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequately equipped laboratories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate pay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed-ability classes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching outside one's own specialism</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) Please list below other major causes of stress to physics teachers.

3 In which type of school would you prefer to teach? (Tick one box)

<table>
<thead>
<tr>
<th>Type of School</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11-14 Comprehensive</td>
<td></td>
</tr>
<tr>
<td>11-16 Comprehensive</td>
<td></td>
</tr>
<tr>
<td>11-18 Comprehensive</td>
<td></td>
</tr>
<tr>
<td>14-18 Comprehensive</td>
<td></td>
</tr>
<tr>
<td>Sixth form College</td>
<td></td>
</tr>
<tr>
<td>FE College</td>
<td></td>
</tr>
<tr>
<td>Independent</td>
<td></td>
</tr>
<tr>
<td>Other (specify below)</td>
<td></td>
</tr>
</tbody>
</table>

.............................
4 Which subject in addition to physics would you prefer to teach? (Tick one box)

Science
Chemistry
Biology
Computer Studies
Other (specify below)


5 For how many years have you been teaching physics? (Tick one box)

0-2 years
2-4 years
4-6 years
6-8 years
over 8 years

6 Do you intend to stay in teaching for at least 5 more years (or until retirement, if this is sooner)? (Tick one box)

Yes
No

7 a) Are you actively looking for employment other than teaching? (Tick one box)

Yes
No

b) If you answered 'Yes' in a), please state briefly why you wish to leave teaching.

It would be appreciated if you would give some personal details to help in the classification of your answers.

8 Sex (Tick one box)

Male
Female
9 Age

10 Which type of school did you attend for the majority of your education between the ages of 11 and 18? (Tick one box)

- Mixed
- Single-sex

Thank you for your cooperation. Please check for missing answers, and return your completed questionnaire.
APPENDIX G

STUDENT-TUTOR SCHEME QUESTIONNAIRES

C1 Tutor Questionnaire

C2 Teacher Questionnaire

C3 Pupil Questionnaire
1. Do you think that you benefitted from the student-tutor scheme in any of the following ways? (Tick one box for each)

<table>
<thead>
<tr>
<th></th>
<th>Greatly</th>
<th>Somewhat</th>
<th>Not at all</th>
<th>Not sure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) By reinforcing your knowledge of some aspect of your subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) By getting practice in the simple communication of scientific ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) By gaining insight into how other people perceive your subject</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) By increasing your self-confidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) By getting to know people from a wide range of social backgrounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) By feeling you were doing something useful with what you had already learned</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Are there any other ways in which you feel that you benefitted greatly or somewhat?

3. Answer this question if you had previously considered going into teaching:

   a) Are you now:

   - [ ] Keener to teach
   - [ ] Less keen to teach
   - [ ] About the same

184
b) Was the student - tutor experience useful in helping you to make up your mind? (Tick one box)

- Greatly
- Somewhat
- Not at all
- Not sure

4 Answer this question if you had never seriously considered teaching as a career.

Did the school experience encourage you towards teaching? (Tick one box)

- Greatly
- Somewhat
- Not at all
- Not sure

5 Did the school experience interfere with your academic studies? (Tick one box)

- Greatly
- Somewhat
- Not at all
- Not sure

6 What did you like best about the school experience?

7 What did you like least about the school experience?

8 Please suggest any ways in which you think the student - tutor scheme could be improved.
9 Do you have any further comments about your own experiences, or the scheme in general.

Thank you for completing this questionnaire. Please check for missing answers before returning it to Mrs Stewart in the Physics Department.
We would very much like to know what you thought about having student - tutors in your lessons this term. Please would you write some comments under the headings below.

1 Advantages of having student - tutors

2 Disadvantages of having student - tutors

3 Suggestions for improvement of the scheme

4 Other comments

5 With student - tutors lessons were: (Tick one box)

- easier to hand
- more difficult to handle
- about the same as usual

6 With student - tutors teaching was: (Tick one box)

- more enjoyable
- less enjoyable
- about the same as usual
7 With student-tutors I felt that pupils learned: (Tick one box)

- more than usual
- less than usual
- about the same as usual

8 Would you be interested in having student-tutors in your lessons next term?

- Yes
- No

9 What do you think is the ideal number of student-tutors per class?

- one
- two
- More than two

Thank you for completing this questionnaire. Please check for missing answers before returning it to Mrs. Stewart, Department of Physics, Loughborough University.
Loughborough University of Technology

Student - Tutor Scheme

Pupil Questionnaire

We would like to know what you thought about the visits of Loughborough University students. Please answer this brief questionnaire.

1 Please complete the following sentences:-

a) What I liked best about having student - tutors was

b) What I liked least about having student - tutors was

c) I think they would have been more help if

2 Please tick one box in answer to each part of this question.

a) With student - tutors lessons were:

- more interesting
- less interesting
- about the same as usual

b) With student - tutors lessons were:

- easier to follow
- harder to follow
- about the same as usual
c) With student - tutors lessons were:

- more enjoyable
- less enjoyable
- about the same as usual

d) With student - tutors I feel that I:

- learned more than usual
- learned less than usual
- learned about the same as usual

Thank you for filling in this questionnaire. Please check for missing answers before returning it to your teacher.
APPENDIX H

THE 'FLAP' PACKAGE

H1 Desired Course Content
H2 The Specification Process
H3 Form and Content
H4 FLAP, Flexible Learning Approach to Physics
H5 Full Results of 'FLAP' Questionnaire
DESIRED COURSE CONTENT

SKILLS

(A) Problem Solving Skills

(1) Ability to understand verbal questions and to reformulate them in mathematical terms by using previous knowledge.

(2) Ability to apply physical principles to unfamiliar situations.

(3) Ability to use basic physical principles to devise a strategy for problem solving.

(4) Ability to manipulate simple mathematical expressions and solve simple mathematical problems.

(5) Ability to interpret mathematical results in physical terms (including the ability to extract information from straight line graphs).

(6) Ability to both comprehend and develop the combined verbal and mathematical arguments that are appropriate to A level.

(B) Practical Skills

(1) Ability to follow simple instructions to get equipment up and working.

(2) Ability to successfully wire and check a simple circuit from a circuit diagram.

(3) Ability to make accurate observations and measurements.

(4) Ability to keep a clear record of practical work.

(5) Basic keyboard skills.

(C) General Skills

(1) Basic skills in study technique and work organization.

(2) To be methodical in approach.
**MATHS CONTENT**

**Basic Algebra**  \( (B, La, Le, Lo, R) \)

Polynomials and operations upon them.
Solving quadratic equations (roots and coefficients).
Simultaneous equations (2 unknowns).
Partial fractions?

**Functions**  \( (B, La, Le, Lo, SB) \)

Simple real functions.
Rational functions.
Exponential and logarithmic functions.
Compositions and inverses.
Graphs of functions (sketching?)
Linear relations.
Reduction of given relation to linear form.

**Expansions**  \( (La) \)

Binomial theorem.
Taylor series.

**Trigonometric Functions**  \( (B, La, Le, Lo, R, SB) \)

Circular measure, arc length and sector area.
Trig functions and their graphs.
Inverse trig functions and their graphs.
Geometric interpretation, sine and cosine rules.
Approximations (\( \sin x \approx x \approx \tan x; \cos x \approx 1 - \frac{1}{2}x^2 \)).
Addition theorems and identities.

**Complex Numbers**  \( (R) \)

Algebraic and trig forms (not exponential).
Modulus, argument and conjugate.
Sums, products and quotients.
Equating real and imaginary parts.
Argand diagrams.

**Differential Calculus**  \( (B, La, Le, Lo, R, SB) \)

Derivative as a limit.
Derivative of : algebraic functions,
  trig functions, inverse trig functions,
  exponential and logarithmic functions.
Differentiation of sums, products and quotients.
Chain rule (function of a function).
Parametric functions and implicit functions?
Second derivatives.
Applications to gradients, velocity and acceleration.
Maxima, minima and points of inflection.
Calculus and graph sketching.
Connected rates of change and small increments with one independent variable.

**Integral Calculus** (B, La, Le, Lo, R, SB)

Integral as a limit of a sum and as inverse of derivative.
Evaluation by: standard forms, substitution,
integration by parts, partial fractions?

**Differential Equations** (R)

1st order d.e. with separable variables
Exponential decay laws.

**Vectors** (R, SA)

Vectors in 2 and 3-d.
Addition and subtraction.
Scalar multiplication.
Cartesian co-ords.
Position vectors.
Linear equations \( \vec{r} = \vec{a} + t \vec{b} \).
Skew lines?
Scalar products.

**Geometry** (Le)

Simple theorems about lines and triangles.

**Co-ordinate Geometry?**

Distances, angles and lines.
Circles and curves (inc. parametric forms).
Applications of calculus to tangents and normals.

**PHYSICS CONTENT**

**Mechanics** (B, La, Le, Lo, O, R, SA + SB (vectors only))

Statics: forces, moments, couples, centre of mass, equilibrium conditions.
Dynamics: displacement, speed, acceleration.
Uniform and non uniform acceleration (inc. projectiles)?
Momentum and Newton's laws.
Work, energy and power.
Conservation of energy and momentum.
Impulse?
Circular motion.
Simple harmonic motion (graphical and analytic).
Free and forced vibrations, and resonance (qualitative).

**Wave Motion** (B, La, Le, Lo, O, R, SA)

Amplitude, frequency, wavelength, speed, phase.
Progressive and standing waves.
Longitudinal and transverse waves.
Polarisation.
Significance of media for mechanical waves.
Application to electromagnetic waves and acoustic waves (here?)
Electromagnetic spectrum (here?)

**Vibrations and Sound**

Vibrations of strings?
Vibrations of air columns?
Speed of sound in air (method)?
Beats?

**Optics** (B (not instruments), La, Le, Lo, O (not instruments), R, SA (not instruments) + SB)

Reflection and images in plane mirrors.
Refraction, refractive index and Snell's law.
Total internal reflection.
Lenses and optical instruments.
Principal focus, focal length, power (= \( \frac{1}{f} \)).
Ray diagrams and image formation by lenses, lens formula.
Linear magnification.
Location of images by method of no parallax.
Measurement of focal lengths.
The eye, including defects of vision.
Variable focus single lens camera.
Angular magnification.
Microscope and telescope.

Interference and wave superposition.
Diffraction from a single slit (Fraunhofer).
Double slit system.
Diffraction grating.
Measuring wavelength of light with a spectrometer.

**Fields** (B, La, Le, Lo, O, R, SA + SB)

Concept of a field.
Newton's law of gravitation.
Gravitational field strength \( g \).
Kinetic and potential energy in a gravity field.
Gravitational potential \( (g = \frac{dV}{dx}, V = -\frac{GM}{r}) \).
Circular orbits.
Electricity \( (B, La, Le, Lo, O, R, SA + SB) \)

Current and potential difference \( (V = \frac{W}{Q}) \).
Kirchhoff's 1st and 2nd laws.
Use of ammeter and voltmeter.
Conductance, resistance, conductivity and resistivity.
Resistors in series and parallel.
Ohms law.
Shunts and series converters.
Energy and power in d.c. circuits.
Electromotive force.
Internal resistance.
Potential divider and Wheatstone bridge.

Capacitors and charge storage.
Energy of a charged capacitor.
Capacitors in series and parallel.
Charging and discharging of capacitors (decay law).

AC circuits Hall effect

Electromagnetism \( (B, Le, Lo, O, R, SA + SB) \)

Magnetic field concept.
Magnetic field strength \( B \) and flux \( \phi \).
Magnetic fields due to currents.
(Effect of iron cores).
Forces on current carry conductors.
Force on a moving charge.
Force between parallel currents.
Couple on a rectangular coil.
Moving coil meters.

Electromagnetic induction (Motional and Faraday).
Simple treatment of self inductance.
Simple treatment of mutual inductance.
Energy stored in a self inductor.
d.c. motor (including effects of load).

Cathode ray tube?
Oscilloscope?
X-ray tube?
Matter (E, La, Le, Lo, O, R, SA - SB)

Phases of matter.
Density p.
Pressure p (normal force per unit area).
Hydrostatic law.
Gas laws.
Equation of state of an ideal gas.
Avogadro's law, the Avogadro constant.

Temperature and thermal properties.
Absolute zero, Kelvin scale, Celsius scale.
Triple point.
Use of common types of thermometer (thermistor thermocouple, resistance and liquid in glass).
Measurement of internal energy, specific heat capacity and specific latent heat.
Thermal conduction and thermal conductivity.
Convection and radiation.
Calculation of heat lost through materials and structures.
First and second laws of thermodynamics?
Adiabatic and isothermal changes?

Elementary kinetic theory (La, R)

Temperature and molecular energy.
Pressure and molecular momentum.

Modern Physics (B, La, Le, Lo, O, R, SA + SB)

Atomic sizes, masses and constituents.
Atomic structure.
Optical spectra.
Continuous line emission spectra.
Absorption spectra and the solar spectrum.

Radioactivity.
Exponential decay.
Half life, isotopes.
Attenuation?
Waste disposal etc.?
Energy release in fission and fusion?
Rutherford scattering?
Photons, compton effect, photoelectric effect?
de Broglie waves?
**Recording Experimental Data** (Le, Lo, D, SA)

- Units and dimensions.
- Tabulating data.
- Significant figures.
- Human and instrumental errors.
- Accuracy and precision.
- Minimising errors.

**Analysing Experimental Data** (Le, Lo, O)

- Means and standard deviations.
- Absolute, fractional and percentage errors.
- Combining errors.
- Maximum and standard errors.
- Graphical analysis.
- Exponential, logarithmic and power curves.
- Histograms and probability distributions.
1.2. THE SPECIFICATION PROCESS

The general aim must be to specify the content of each component in sufficient detail for potential buyers (and funders!) to decide whether or not they are interested in the package. To provide ourselves with a sufficiently clear picture of the package we now need to specify each component in some detail. This requires the following items for each component.

(0) A cover page indicating the title of the component, its authors and the date.

(1) A contents page naming each section and subsection, and indicating the location of "special features" such as lists of achievements, summary sections and end-of-section tests. (An example is enclosed.)

(2) As far as possible the contents page should "tell the story" of the component and enable students to locate a topic easily even though they may not properly understand its context.

(3) Each section should begin with "inspirational" starter material followed by a brief subsection outlining the prerequisites for that section. (The latter may take the form of self-assessment quizzes plus revision guides and may be subdivided to correspond with the subsections that follow.) For more ideas about the nature of the section introduction and the prerequisite subsection consult CSWG/4/1 and 2 and CSWG/5/3 and 4.

(4) Where possible, a clear indication of the kind of treatment that you feel is appropriate for each subsection should be given. This might take the form of photocopied material from OU sources.

(5) Each subsection should end with a short test. If possible, please include a few examples of suitable questions. (These may well come from the same source as any material you include under item (4)). Answers, if available, should be included on a separate sheet.
Each section should end with a list of testable "Achievements" - these are objectives by another name - followed by an end-of-section quiz. The questions in the quiz should be related to the achievements (see enclosed examples).

Each component should include a clear list of topics from other components that have been used. This is particularly important with regard to mathematical concepts and techniques.

Each component should include appropriate references to supporting video/CAL/experiments etc.

Each component should conclude with a page indicating which of the topics specified for that component in the document 'Desired Course Content' have been covered, which have been omitted and which have been reassigned to another component (following appropriate negotiation). This concluding page should also indicate which of the skills listed on the front page of 'Desired Course Content' have been developed in the course of the component.

By using existing treatments of topics to show the precise level and extent of proposed discussions, it should be possible to estimate the length of each subsection. These length estimates should be included on the contents page. They should be expressed in terms of typescript pages under the assumption that one printed page in an OU units is equivalent to two typescript pages.

The following principle should be kept in mind throughout:

No topic is specified by its name alone. Some idea of the depth and breadth of treatment must always be given.
This new package is designed as a flexible entry course to bring students embarking on a physics degree to a common starting point regardless of their widely differing educational backgrounds. It aims to cover all the essential maths and physics in a self-study format with maximum flexibility.

COURSE CONTENT AND LEVEL
The course is divided into nine physics units together with five (?) maths units (table 1). There is a considerable amount of cross-referencing both between the individual physics units and between the maths and physics units. The range of the course is from GCSE level to the early stages of the first year of a physics degree.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Physics</th>
<th>Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mechanics</td>
<td>Algebra functions and equations</td>
</tr>
<tr>
<td>2</td>
<td>Waves</td>
<td>Differentiation</td>
</tr>
<tr>
<td>3</td>
<td>Optics</td>
<td>Integration</td>
</tr>
<tr>
<td>4</td>
<td>Fields</td>
<td>Vectors &amp; Complex Numbers</td>
</tr>
<tr>
<td>5</td>
<td>Electricity</td>
<td>Geometry</td>
</tr>
<tr>
<td>6</td>
<td>Electromagnetism</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Matter</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Modern Physics</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Recording &amp; analysing</td>
<td>experimental data</td>
</tr>
</tbody>
</table>
FORM OF MATERIAL

The material will be available in A4 ring-binder form. Each institution will be supplied with a Master set of material covered by a site-licence to photocopy. This should lead to great flexibility of use since, provided that due attention is paid to the stated pre-requisites, the material can be supplied and studied as and when required.

STRUCTURE OF EACH UNIT

Each unit begins with a 'starter' section which lists the recommended textbooks and the maths and physics pre-requisites. There is a pre-test with answers which include pointers to necessary revision depending on the student's test score. If the student has an excellent score on the pre-test he may be directed to the post-unit test to find out if it is necessary to study the whole or part of the unit.

The introduction to the main body of the unit contains inspirational material which stresses the practical applications of the subject matter of the unit, and perhaps poses a problem which can be solved by the end of the unit.

The unit is divided into sections each of which is interspersed with SAQs and ends with a brief self-marked test. Throughout the text essential passages are highlighted, statements or formulae requiring learning are boxed, there are liberal scatterings of references, cross-references and suggested experiments, and the more advanced material is marked by pages with a coloured border.
At the end of the whole unit there is an end-of-unit test followed by answers containing pointers to the sections which may require revision, depending on the marks obtained. Finally there will be a list of further reading.

OPTIONAL EXTRAS

1 Videos, audiotapes and CAL packages will be recommended but not essential components of the course.

2 A tutor's pack will be available for each unit. This will contain a summary of the content of the unit, notes on students' common misconceptions in the area covered by the unit, suggestions on how to use the material, additional tests and answers for more formal post-unit testing, a list of appropriate text books, tips on parallel experiments and cross-references to other units.

MODE OF USE

The course may be full-time, part-time, completely self-study or tutor-led. There will be a Guide to Study in the form of initial pages for the A4 folders. Each student can be issued with a folder or folders containing the Study Guide and then subsequently make up his own individual package from all the material available. The course may or may not be formally assessed using the tests supplied in the tutor's pack. It is possible to use this package as the backbone of an access package for non-standard entrants to higher education or as a 'bridge' between A or AS level and traditional first year degree courses. In fact its great flexibility opens up innumerable possibilities for use.
COLLABORATION IN HIGHER EDUCATION

FLAP

FLEXIBLE LEARNING APPROACH
TO PHYSICS

May 1990
FLEXIBLE LEARNING APPROACH TO PHYSICS

Introduction to FLAP

This document outlines a proposal for a new venture in undergraduate physics education: FLAP - the Flexible Learning Approach to Physics. In its final form, FLAP will contain a large number of compact, freestanding, text-based teaching modules dealing with basic topics in physics and applicable mathematics. Audio, video and CAL materials will also be available, as optional extras, to augment the basic package and further broaden its scope. The text modules will be suitable for student-centred self-paced study, and will range in level from GCSE to some point in the first year of existing degree courses. FLAP itself is not a course, but a package from which a variety of different courses can be assembled with ease and efficiency. Appropriately selected modules, supported by tutorials, can provide anything from highly specific support in one or two areas of weakness for an entrant with good A-levels, to a complete access course for students without any post-GCSE qualifications. No matter how it is used, FLAP will enable students to identify and remedy their own weaknesses while making use of their own individual strengths and achievements.

The highly detailed FLAP proposal that is briefly outlined in the following pages is the result of a series of meetings between physicists and physics educators from fourteen UK universities and polytechnics. The meetings followed a one-day conference held at the Institute of Physics in May 1989, at which it was proposed that a consortium of higher education institutions should collaboratively design a "bridging package", drawing upon existing Open University materials, that could be used to deal with problems that might arise at the school/HE interface. The project has undergone considerable evolution since those early days and the current proposal for the FLAP package is the result.

Now that the task of designing FLAP is essentially complete, the next step is to seek out the development funds that will be required to realise the proposal. However, before taking that step, the design team is keen to assess the level of support for the project amongst those institutions that were not directly involved, and to gather comments and criticisms that can be used to refine the proposal. To this end, the final pages of this document constitute a questionnaire that seeks your views on the project. The team would be most grateful if you would give the proposal your consideration and return the questionnaire by the middle of July.

The need for FLAP

There can be little doubt that the next six years will see radical changes in the style and content of physics degrees. The upheavals currently taking place in school science teaching, the demographic decline in the number of eighteen year olds, and the pressure to increase the proportion of the population benefiting from higher education, are all factors that seem certain to affect HE physics courses and particularly the introductory parts of those courses. No one can tell what the future will bring, but it is widely expected that, compared with their predecessors, those who embark on physics degrees in the 1990s will know less physics and will
have less experience of using mathematics in a physical context. In future, many physics departments will have to cope with a greater diversity of entrants drawn from a wider ability range than ever before. Even those departments that can expect to attract large numbers of well-qualified students with conventional A-levels are likely to find that the introduction of new 16+ syllabuses will lead to less homogeneous classes. Moreover, if the expected growth in the provision of AS-level courses materialises, it will further complicate an already confused and unpredictable scene.

Quite apart from the problems arising from increasingly diverse entrants, other factors are also likely to lead to changes in first year provision. The new emphasis on skills and the move to pupil-centred teaching methods in schools will raise educational expectations that are unlikely to be met by traditional lecture courses alone. Nor will such courses meet the call, noted in the recent report of the Institute of Physics Working Party on Higher Education, for students to play a more active part in the learning process.

The designers of FLAP - many of whom have substantial experience of teaching first year introductory classes - believe that a wide ranging package of skills-oriented, flexible-entry, high-quality, self-study material provides one of the best ways of responding to the rapidly changing educational environment of the 1990s. In addition, the fact that the package has been designed by physicists ensures that FLAP will address itself to those issues, such as mathematical manipulation, that are of greatest concern to physicists.

The aims of FLAP

The aims of FLAP are the following:

1. To provide a package of high quality, self-study material, in the form of small self-contained modules, covering a sufficient range of physics and applicable mathematics to constitute a bridge or ladder from any point above GCSE to some point in the first year of existing undergraduate courses in physics.

2. To be sufficiently flexible in style and coverage to accommodate substantial changes in the location and nature of the school/higher education boundary.

3. To provide institutions with a resource for the rapid production of high quality, tutor-supported, self-paced courses that can meet their own institutional needs. These needs may include one or more of the following:

   (a) A brief "top-up" course for well qualified students who are ill-prepared in a few limited areas.

   (b) A "conversion" course for students with HNC, AS-level or other non-A-level qualifications.

   (c) An "access" course or a substantial part of such a course, directed towards physics studies.
(d) A course that, when supported by tutorials, workshops and laboratory sessions, can form a substantial part of a wide ranging first year course in introductory physics.

(e) A source of reference material that can be used to support students throughout their undergraduate studies and even beyond.

4. To provide students with an enjoyable, challenging, flexible-entry approach to physics that will:

(a) Let them discover their own strengths.
(b) Help them to identify and remedy their own weaknesses.
(c) Stimulate their interest in physics and build their confidence in tackling physics problems.
(d) Enhance their modelling and problem solving skills while providing physical motivation for the introduction of the relevant mathematical methods.
(e) Provide a firm base of clearly defined knowledge for further studies in physics.
(f) Use tutor guided, self-paced teaching methods to help develop an active approach to learning rather than a passive reliance on lectures.

The form and content of FLAP

From the academic point of view, FLAP consists of two parallel strands covering physics and applicable mathematics. Each strand is divided into a number of "Blocks" dealing with familiar topics:

**Physics strand**
- Recording and analysing experimental data
- Forces and motion
- Fields
- Electricity
- Electromagnetism
- Wave motion, vibrations and sound
- Optics
- Heat and properties of matter
- Modern physics

**Mathematics strand**
- Algebra, functions and equations
- Vectors and geometry
- Differentiation
- Integration
- Introduction to differential equations
- Complex numbers

(The inclusion of an electronics block is under consideration.)
The two strands may be studied separately, so that mathematics, for example, may be treated as a stand-alone subject. However, the designers attach great importance to the facility that FLAP provides for using problems that arise naturally in the physics strand to motivate the introduction of topics from the mathematics strand. The possibility of using the package in this combined mode is seen as one of its greatest advantages.

Another crucially important feature of FLAP is the division of each Block into relatively small modules called "Sections". It is these Sections, most of which are expected to require 2 to 6 hours of study time, that are the academic units of FLAP - the Blocks are simply convenient groupings of Sections. As far as course design is concerned, the enormous flexibility offered by FLAP lies in the freedom to combine suitably selected Sections in a variety of ways.

Each Section of FLAP deals with a specific topic such as momentum, simple harmonic vibrations or Taylor series, and is subdivided into a number of Subsections. A typical Section starts with a brief introduction that summarises the content and explains its significance. This is followed by a self-assessment test designed to ensure that the student has the appropriate background to study the main body of the Section. (The answers to the test will contain information and references that will enable the student to correct any deficiencies that are detected.) Students who feel they are already familiar with the bulk of the material in the Section will be directed to an end-of-section test that will assess their mastery of the subject and indicate the action required to remedy any weaknesses.

The text of each Section will be written in the clear, student-friendly, interactive style that is the hallmark of Open University teaching material. Indeed, a substantial proportion of the physics strand will have been adapted from the earlier parts of the OU's own introductory physics course Discovering Physics, though much will also have been specifically written for FLAP. The text will contain all the customary features including the highlighting of important terms, the boxing of major equations and the provision of marginal flags and comments. Questions incorporated into the main body of the text will sometimes play a crucial role in developing important academic arguments while simultaneously enhancing problem solving skills. Great attention will be paid to the widely perceived need to provide plenty of practice with elementary mathematical manipulation.

Each Section will end with a summary and a detailed list of the skills and knowledge that the student should have acquired as a result of studying the Section. This will be accompanied by a self-assessment test, enabling the student to confirm that the expected attainments have indeed been achieved.

The detailed FLAP proposal specifies the content of 84 Sections, so the total package is very large, though only students without any post-GCSE qualifications would be expected to study it in its entirety. A list of the section titles is given in an Appendix towards the back of this document.
The flexible use of FLAP

It has already been stressed that the modular Sections of FLAP will give great flexibility to course designers, while the careful use of self-assessment questions will give even greater flexibility to students, enabling them to pin-point with considerable accuracy the particular items they need to study. Nonetheless, a number of additional features are required to ensure that FLAP really will be as flexible as its designers intend.

Ring binder presentation The substantial amount of material that comprises the full FLAP package will be made available to institutions in the form of single sided, monochrome, A4 pages distributed in ring binders. Although the exact position with respect to copyrights has yet to be resolved, it is expected that the bulk of the material will be free of the normal copyright restrictions, so that those presenting FLAP based courses will be able to distribute photocopies of the relevant parts of the package to students. It is presumed that most institutions will recover the costs of supplying such copies from their students. (The possibility of providing FLAP on computer disc or in an economy printed format is also under consideration.)

Relational Glossary There will inevitably be a certain amount of cross-referencing between the various Sections of FLAP, particularly between the maths and physics strands. In order to support the aim of maximum flexibility, many of the most important and commonly encountered equations and definitions from throughout the package will be gathered together in a reference work called the FLAP Relational Glossary. This will combine the functions of index, dictionary and thesaurus, not only listing definitions but also showing how they relate to one another across the full range of the package. This important component of FLAP will help to overcome the problems that might otherwise disadvantage students who do not have access to the complete package.

Tutor packs These will include content summaries, lists of prerequisites and suggestions for tutorial topics relating to each of the Sections. In addition, they will provide suggestions for ways in which the material can be selected and arranged in order to meet specific educational objectives.

Audio, video and CAL support for FLAP

The text of FLAP will be supported by audiocassette tapes, video tapes, and a limited amount of CAL (Computer Assisted Learning). In order to avoid unnecessarily restricting the use of FLAP by insisting that all students must have access to cassette players, VCR's and computers, each of these supporting media has been treated as a highly desirable addition to the basic FLAP package rather than an indispensable component. Each medium has its own role to play that makes the maximum use of the unique features and particular strengths of that medium.
**Audiocassettes** Audio is seen as the most supportive and least intimidating of the three media. The audio component of FLAP consists of four C90 cassette tapes, each of which contains a number of interactive tape tutorials devoted to some of the most difficult and/or important parts of the text. Subjects covered by the tapes include electric fields, wave/particle duality and integration by substitution. In each case, the tape provides line by line commentary on the relevant part of the text together with helpful advice and clear guidance. At certain points in the tape questions are posed that the student is required to answer before proceeding. Like the main text, it is expected that the tapes will be free of many of the usual copyright restrictions, so that purchasers will be able to make copies for the use of their students.

**Videocassettes** The proposed video component is the most ambitious of the three auxiliary components - it is also the most costly to produce. It is likely that its funding will be separated from that of the rest of the package, and its existence and ultimate nature will be entirely dependent on the funds secured for its production. As currently envisaged it will consist of ten 25 minute programs together with a small amount of supporting text. Each program will be devoted to one of the major subject areas covered by the package; mechanics, electromagnetism, waves, optics, matter, modern physics, vectors, functions, differentiation and integration. The programmes will be subdivided into a small number of essentially independent segments, though there will be a brief, purpose written commentary linking the segments. It is probable that some of the material will be taken from existing Open University programmes. Animations and experimental demonstrations will certainly play a prominent role in the video component, though it is the applications of physics, particularly the technological applications, that are expected to dominate. The printed material supporting the videos will consist of programme summaries and indices, together with lists of key words and guidance on appropriate pre- and post-programme work.

It should be noted that although each programme may be watched at a single sitting, maximum benefit will be obtained if each segment is viewed as it becomes relevant to the study of the text. Marginal references included in the text will provide students with clear guidance on this point.

**Computer Assisted Learning** The CAL component will emphasise simulations and computer experiments. (It will have little to do with the old fashioned teaching machine.) Though potentially the most powerful of the three media, it is also the one most prone to rapid obsolescence and problems arising from lack of hardware. For this reason the proposed CAL component is modest and makes restricted use of specific software, concentrating instead on giving users valuable, up-to-date information. According to current plans, the CAL component will consist of (i) a 3.5 inch floppy disc containing simulations and computer experiments relating to mechanics, electromagnetism and the properties of matter; (ii) an up-to-date catalogue of commercially available software that will be of direct relevance to users of the FLAP package.
The cost of **FLAP**

**FLAP** is a large, highly ambitious and potentially very important project that will require a great deal of money for its full development. However, the design team are well aware that the price charged to potential users for a copy of the basic package (i.e. excluding the audio, video and CAL components) must be kept reasonably low if the project is to succeed. It is not possible at the present time to put a figure on the cost of each copy of **FLAP** but it is certainly intended that the development costs will be fully funded before development commences. If this is achieved, the cost per copy will be mainly determined by the marginal unit cost of production together with a charge for distribution and overheads. Under these circumstances the package will be a relatively small, though not insignificant, once-off charge to the budget of a typical physics department.

The future development of **FLAP**

Owing to the policy of using Open University material for some parts of **FLAP** it is already possible to describe some of the contents in great detail, including much of the main text and many of the assessment questions. Of course, other parts are not so well developed, but even these have, almost without exception, been specified in considerable detail by the members of the design team. The complete specification occupies approximately 750 pages and is in many respects a first draft of the full package. Despite this excellent start, the preparation of effective teaching material is a time consuming business and the development of the package will probably require at least two years. It thus seems unlikely that the package will be available before 1993, at the earliest.

While the design team waits to learn your views on **FLAP**, the project is not standing still. Work continues on the specification with the aim of refining its structure and tidying-up loose ends. Furthermore, moves are underway to establish a team of engineers who will modify and extend the existing **FLAP** proposal so that it meets the needs of engineering departments. A preliminary meeting of this group, involving representatives from the Open University, Coventry Polytechnic and from the Universities of Exeter, Nottingham, Oxford and Southampton took place on 8th May. The existence of this group is now being publicised and engineers from a number of other institutions including Birmingham University, Queen’s University Belfast and the Polytechnic of North London have already expressed an interest in becoming involved. The engineering project will establish its own timetable and will ultimately produce its own specification. Although this process will not influence the nature of **FLAP** it is hoped that the engineers will soon be in a position to support **FLAP**’s bid for funding.

The rapid progress made by the **FLAP** design team has been possible only because of the collaborative nature of the project. The mix of university and polytechnic physicists pooling their experience and working together towards common goals has proved to be highly effective. The team now looks forward to receiving your views, so that they too can be taken into account in producing the final proposal.
The designers of \textit{FLAP}

The following team members have been responsible for the production and circulation of the documents that specify the detailed contents of the \textit{FLAP} package:

Dr. J.A. Evans (University of Sussex)  
Professor J. Dutton (University College Swansea)  
Dr. F. Foster (University of Lancaster)  
Dr. G.A. Gledhill (Royal Holloway and Bedford New College, London)  
Dr. A.A. Green (Oxford Polytechnic)  
Dr. D. Grimes (Leicester Polytechnic)  
Dr. K. Higgins (Birkbeck College, London)  
Dr. M.C. Holmes (Lancashire Polytechnic)  
Dr. R.J.A. Lambourne (Open University)  
Dr. C.A. Newport (Open University)  
Mrs. M.F. Stewart (Loughborough University)  
Dr. M.H. Tinker (Reading University)  
Mrs. S. Williams (Sheffield City Polytechnic)

In addition, other members of the team have contributed to the design through their general advice or by their expertise in specific areas; they include:

Mr. H. Jones (Wolverhampton Polytechnic)  
Miss. B. Parker (Institute of Physics)  
Ms. K. Pindar (Open University)  
Dr. T.B. Stowell (Liverpool Polytechnic)  
Dr. G.A. Toombs (Nottingham University)  
Ms. E. Whitelegg (Open University)
Appendix: The Sections of FLAP

The 'Section' is the flexible academic unit of FLAP. Titles of the Sections that have been specified by the design team are listed below. Although they have been arranged in 'Blocks' for ease of presentation, it should be remembered that the Blocks themselves have no particular significance in terms of the flexibility of the package.

Recording and analysing experimental data

- Measurement
- Recording experimental data
- Analysing experimental data

Forces and motion

- Motion along a straight path
- Motion in space
- Motion in a circle
- Forces
- Work and energy
- Momentum
- Rotational motion

Fields

- Gravitational fields
- Electrostatic fields

Electricity

- Current, circuits and resistance
- Sources of electric current

Electromagnetism

- Currents and magnetic fields
- The electromagnetic force
- Magnetic fields due to current carrying conductors
- The nature and laws of electromagnetic induction
- Examples of current induction
- Experiments with coils in circuits
- The effect of changing the current - self-inductance
- Energy and self-inductance
- The effect on an adjacent coil - mutual inductance
Wave motion, vibrations and sound

Introduction to vibrations
Simple harmonic vibrations
Combination of simple harmonic vibrations
Damped simple harmonic vibrations
Forcing and resonance
Wave properties
Sound waves
Electromagnetic waves

Optics

Reflection and refraction
Lenses and optical instruments
Diffraction and interference

Heat and properties of matter

Hydrostatics
Temperature and thermal properties
Kinetic theory
Mechanical properties

Modern physics I

Light as particles
Atoms - size and mass
Atomic structure - the nuclear model
Atoms and spectra
Bohr's quantum model of the hydrogen atom
Bohr's quantum model of heavy atoms
Shells, sub-shells and the second quantum number
Magnetic properties of electrons in atoms
Electric configurations of the elements
First ionization energies and the link to chemistry

Modern physics II

The atomic nucleus
Radioactive decays of nuclei
Nuclear fission and fusion

Modern physics III

The Compton effect and the de-Broglie formula
Quantum mechanics - a new approach to describing atomic matter
A quantum mechanical description of free and confined particles
Understanding atomic energy levels

214
Algebra, functions and equations

Algebra and equations
Functions and graphs
Solving equations
Functions for physicists
Expansions and approximations

Vectors and geometry

Geometrical ideas
Co-ordinate geometry and circles
Conic sections
Modelling scalars and vectors - the geometric approach
Scaling and adding vectors
Modelling vectors as ordered numbers
Scalar products and their significance

Differentiation

Why calculus?
Basic ideas of differential calculus
Differentiation of more difficult functions
Stationary points
Approximation of functions: Taylor series

Integration

Basic ideas of integral calculus
Techniques of integration: substitution
Techniques of integration: products and quotients
Averages, areas and volumes: applications of integration

Introduction to differential equations

Types of first order differential equation
The reverse of the chain rule: solution by substitution
Choosing a correct method

Complex numbers

Complex numbers and the Argand diagram
Polar representation of complex numbers
Powers and roots of complex numbers
De Moivre's theorem
Complex algebra
FLEXIBLE LEARNING APPROACH TO PHYSICS

QUESTIONNAIRE

Any responses you make to the following questions will not be in any way construed as a firm commitment to expenditure. If you want extra information about the package before answering the questions please contact Dr R J A Lambourne of the Physics Department, The Open University, Tel. 0908 653873.

Name (Mr/Mrs/Miss/Ms/Dr/Prof) _______________________________

Position ________________________________________________

Institution ________________________________________________

If the FLAP package were available in the first half of 1993 at reasonable cost, how likely is it that your department would use FLAP? Please ring one of the following:

certain    highly likely    possible    unlikely    inconceivable

Realistically, what is the most that you feel your department would be willing to pay for a single mastercopy of the basic package (i.e. excluding the audio, video and CAL materials, but including the right to photocopy the package for sale to your own students)  £______________.

If it were available in 1993, in what ways do you think the package could be used in your department.

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

What importance do you attach to the audio, video and CAL materials?

Audio:   Vital       Not very important        Unimportant

Video:   Vital       Not very important        Unimportant

CAL:     Vital       Not very important        Unimportant
Please list your general reactions to the *FLAP* proposal as outlined in this document.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

May we use the information you have provided, without attribution, in our attempt to obtain funding? Yes/No

May we quote your views in our funding bid? Yes/No

Please detach this sheet, complete the questionnaire and return it as soon as possible (no later than Monday 16th July) to:

Dr. R.J.A. Lambourne  
Physics Department  
The Open University  
Walton Hall  
Milton keynes  
MK7 6AA

Thank you for your help.

217
Full Results of FLAP Questionnaire

Table 87 shows the percentage of respondents from each category.

Table 87  Breakdown of Respondents by Institution

<table>
<thead>
<tr>
<th>Institution</th>
<th>Percentage of all Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>65</td>
</tr>
<tr>
<td>Polytechnic</td>
<td>29</td>
</tr>
<tr>
<td>F.E. College</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 88 shows the likelihood of each type of institution using the 'FLAP' package if it were available in 1993. It should be noted that in this and subsequent tables percentages are given for ease of comparison. However, the low base (10) used to calculate the percentages for the responses from the polytechnics leads to unreliability. Responses from F.E. Colleges are omitted because of low numbers (2).

Table 88  Potential Users of 'FLAP' Package

<table>
<thead>
<tr>
<th>Institution</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Certain</td>
</tr>
<tr>
<td>University</td>
<td>4.6</td>
</tr>
<tr>
<td>Polytechnic</td>
<td>20.0*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers

218
Table 89 shows the maximum amounts that the respondents would be willing to pay for the textual resources including rights to photocopy.

**Table 89. Maximum Acceptable Cost**

<table>
<thead>
<tr>
<th>Maximum Acceptable Cost</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than £500</td>
<td>48.2</td>
</tr>
<tr>
<td>Between £500 and £1000</td>
<td>37.0</td>
</tr>
<tr>
<td>Over £1000</td>
<td>14.8</td>
</tr>
</tbody>
</table>

Tables 90-92 show the results of the questions concerning the respondents' opinions of the importance of the audio, video and CAL components of the package.

**Table 90. Importance of audio component**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Percentage of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vital&lt;-------- Not very important---------&gt;Unimportant</td>
</tr>
<tr>
<td>University</td>
<td>10.0  5.0  65.0  0.0  20.0</td>
</tr>
<tr>
<td>Polytechnic</td>
<td>30.0* 10.0* 40.0* 0.0  20.0*</td>
</tr>
</tbody>
</table>

* Unreliable due to small numbers

Overall the audio component does not seem to have been considered very important.
Table 91: Importance of Video Component

<table>
<thead>
<tr>
<th>Institution</th>
<th>Percentage of Respondents</th>
<th>Vital &lt;---</th>
<th>Not very Important</th>
<th>---</th>
<th>Unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>35.0</td>
<td>5.0</td>
<td>55.0</td>
<td>0.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Polytechnic</td>
<td>60.0*</td>
<td>0.0*</td>
<td>30.0*</td>
<td>0.0</td>
<td>10.0*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers.

The video component was considered to be the most important of the three add-on components.

Table 92: Importance of CAL Component

<table>
<thead>
<tr>
<th>Institution</th>
<th>Percentage of Respondents</th>
<th>Vital &lt;---</th>
<th>Not very Important</th>
<th>---</th>
<th>Unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>20.0</td>
<td>5.0</td>
<td>70.0</td>
<td>0.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Polytechnic</td>
<td>33.0*</td>
<td>11.1*</td>
<td>33.3*</td>
<td>0.0</td>
<td>22.2*</td>
</tr>
</tbody>
</table>

*Unreliable due to small numbers. Percentages total 100 + 0.1 due to rounding errors.

Table 93 lists all the uses of the 'FLAP' package suggested by the respondents and the number of respondents citing each one. Each respondent was able to suggest several uses if they wished.
<table>
<thead>
<tr>
<th>Use</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back-up Material for First Years</td>
<td>15</td>
</tr>
<tr>
<td>Remedial Work</td>
<td>8</td>
</tr>
<tr>
<td>Bridging for AS/Mature Entrants</td>
<td>6</td>
</tr>
<tr>
<td>Access Course</td>
<td>4</td>
</tr>
<tr>
<td>Assessment</td>
<td>3</td>
</tr>
<tr>
<td>Development of Active Learning</td>
<td>3</td>
</tr>
<tr>
<td>Mixed Ability Teaching</td>
<td>2</td>
</tr>
<tr>
<td>Pre-term Study</td>
<td>2</td>
</tr>
<tr>
<td>Option Course for Non-Physics Students</td>
<td>2</td>
</tr>
<tr>
<td>Distance Learners</td>
<td>1</td>
</tr>
<tr>
<td>Resource for Academic Staff</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 94 shows the general reactions of respondents to the proposed package. It was possible for respondents to list more than one reaction.

Table 94  General Reactions to 'FLAP' Proposal

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Percentage of all Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good idea/Excellent/Welcome</td>
<td>25</td>
</tr>
<tr>
<td>Needed as Soon as Possible</td>
<td>4</td>
</tr>
<tr>
<td>Welcome Flexibility</td>
<td>4</td>
</tr>
<tr>
<td>Level may not be Appropriate</td>
<td>4</td>
</tr>
<tr>
<td>Timely Proposal</td>
<td>2</td>
</tr>
<tr>
<td>Comprehensive Package</td>
<td>2</td>
</tr>
<tr>
<td>Style of Presentation may be Inappropriate</td>
<td>2</td>
</tr>
<tr>
<td>May not be a Niche in the Market</td>
<td>2</td>
</tr>
<tr>
<td>May be unsuitable for Scottish Institutions</td>
<td>1</td>
</tr>
<tr>
<td>CAL Under-represented</td>
<td>1</td>
</tr>
<tr>
<td>Tutor-Packs Look Useful</td>
<td>1</td>
</tr>
</tbody>
</table>

222
APPENDIX I

Publications

11 List of Publications

12 Stewart and Perrin 1989

13 Stewart 1989a

14 Stewart 1989b

15 Stewart 1990a

16 Stewart 1990b
List of Publications

Stewart M.F. and Perrin R. 1989
"A Comparison of Physics Undergraduates and PGCE Students' Attitudes to a Career in Teaching"
Physics Education 24 252-53

Stewart M.F. 1989a
"The End is Nigh!
Attitudes of Physics PGCE Students at the End of their Course"
Physics Education 24 320-22

Stewart M.F. 1989b
"Statistics Relating to Physics PGCE Students"
School Science Review 71, 255, 154-55

Stewart M.F. 1990a
"Physics Teacher Morale"
Physics Education 25 70-71

Stewart M.F. 1990b
"Peer Tutoring: What's in It for You"
School Science Review 71, 257, 140-42
Assessment of Performance Unit (APU) 1986
Girls and Physics
Department of Education and Science

Association for Science and Education 1988
Gender Issues in Science Education
Draft Statement of Policy

Ball C. 1989
Aim Higher
Widening Access to Higher Education
Report to the Royal Society for the Arts

Bradshaw M. and Stacey M. 1987
The Flexitrist Project
A report on the Development of Open Learning in Schools
and Colleges
NEC Publications

Castle S. 1989
"Teachers Line Up to Quit Dead-end Job"
Sunday Telegraph July 23rd

CET 1988
Information Sheet 12

Chapman B. R. 1988
Letter to Guardian October 18th

Child D. and Smithers A. 1971
"Some Cognitive and Affective Factors in Subject Choice"
Research in Education 5,1
Clark M. 1957
Left Handedness
Laterality Characteristics and Their
Educational Implications
London: University of London Press

Clark M. and Vere-Jones D. 1987
Science Education in New Zealand:
Present Facts and Future Problems
The Royal Society of New Zealand
Miscellaneous Series 15

Clwyd County Council/Equal Opportunities Commission 1983
Equal Opportunities and the Secondary
School Curriculum
Final Report

Cohen L. and Manion L. 1980
Research Methods in Education
London: Groom Helm

Cole G. 1988
"Exploding onto the Scene"
Times Educational Supplement November 25th.

Deeson E. 1987
"Learning Physics With IT
To School or not to School"
Physics Education 22 212-18

Department of Education and Science 1986
Action on Teacher Supply in Mathematics,
Physics and Technology

Department of Education and Science 1988
University of Bath,
Action on Teacher Shortages:
A First Report on the Impact of Government Initiatives
238
DES
Action on Teacher Shortages
A guide to the Role of New Technology and
Other Approaches to Learning

Dunn R. 
Reported in "Science and Mathematics Teachers"
Hansard July 11th

Ebison M. and Davies B. 
"Crisis in the Physics Lab"
Guardian June 10th

Fulton O. and Ellwood S. 
Admissions to Higher Education
Policy and Practice
Report to the Training Agency

Galton M. 
"Differential Treatment of Boy and Girl
Pupils During Science Lessons"
The Missing Half: Girls and Science
Education
A. Kelly (Ed.)
Manchester University Press

Gilbert L. and Van Haefton K. 
Teacher Shortage Subjects
The Contribution of Supported Self-Study and Other
Alternative Approaches to the Teaching of Maths, Physics
and CDT
NCET

Goodlad S. and Hirst B. 
Peer Tutoring
A Guide to Learning by Teaching
London: Kogan Page
Gray J.A. 1981
"A Biological Basis for the Sex Differences in Achievement in Science?"
The Missing Half: Girls and Science Education
A. Kelly (Ed.)
Manchester University Press

Hadfield G. 1989
"Teachers: Crisis What Crisis?"
Sunday Times July 23rd

Harding J. 1982
Switched Off: The Science Education of Girls
Schools Council Programme 3

Harding J. 1985
Flexible Learning in Small Fifth and Sixth Forms
Final Report
NEC

Hirst B. et al 1989
"Send Undergraduates to School"
Physics World November, 27 - 8

HMI 1980
Girls and Science
H.M.S.O.

Howarth A. 1989
"Generating Future Physicists"
Physics World December 13-16

Institute of Physics 1986
Statistics Relating to Education and Physics
Institute of Physics
'News and Comment'
Physics Education 22 , 66

Institute of Physics
Physics in Higher Education

Institute of Physics
Report of the 16 - 19 Physics Course Working Party

James E.
"National Curriculum"
Times Educational Supplement September 23rd

Kelly A.
the Missing Half: Girls and Science Education
Manchester University Press

Lewis R.
Schools Guide to Open Learning
National Extension College

Lodge B.
"Bursary Fails to Tempt Physics Staff"
Times Educational Supplement December 15th

Lodge B.
"Licensed Staff to Get Extra £2,000"
Times Educational Supplement November 24th

Lodge B.
"Students Wooed with Vacation Classwork"
Times Educational Supplement March 23rd

Mashiter J.
"Interactive Video in Science"
School Science Review March 446-50
Nash I. 1988
"Something Begins to Stir in the Lab"
Times Educational Supplement November 18th

Nash I. 1990
"Entries for Language A-Levels Rise by a Fifth"
Times Educational Supplement March 16th

NEC Catalogue 1988-9
O'Connor M. 1989
"Dobson's Choice Pays Off"
Guardian February 28th

O'Hear A. 1989
"Access Can't Make Up for Failure"
Times Educational Supplement October 20th

Open University 1981
Research Methods in Education and the Social Sciences
Open University Press

Open University 1988
Physics for Science Teachers
Open University Press

Pindar S. C. 1988
Evaluation of SPISE 5
Queen Mary College Internal Document

Rainbow B. 1987
Making Supported Self-Study Work
Council for Educational Technology

Royal Society and the Institute of Physics 1982
Girls and Physics
Report by the Joint Physics Education Committee

242
Scalfe J. and Wellington J. 1989
"Preparing Teachers for the National Science Curriculum"
Physics Education 24 250 - 51

Secondary Science Curriculum Review 1987
Better Science for Both Boys and Girls Heinemann

Segal A. 1989
"Courses Increasingly Attract Mature Students Yet Continue to Fail the Working Class Young"
Guardian July 25th

Smail B. 1984
Girl Friendly Science: Avoiding Sex Bias in the Curriculum
Schools Council Programme 3 York: Longman

Smail B. et al 1982
"Girls into Science and Technology: the First Two Years"
School Science Review 63 620

Smithers A. 1988
"Heads Told of the Trainees that Get Away"
Times Educational Supplement September 23rd

Smithers A. 1989
"Where Have All the Teachers Gone"
Times Educational Supplement May 12th

Smithers A. and Hill S. 1987
"Science Teaching"
Education 170 375
Smithers A. and Hill S.  
"Recruitment to Physics and Mathematics Teaching: A Personality Problem"
Research Papers in Education 4(1) 3 - 21  

Smithers A. and Robinson P.  
The Shortage of Mathematics and Physics Teachers Report to Headmasters' Conference. Secondary Heads Association and the Engineering Council University of Manchester  

Smithers A. and Robinson P.  
Increasing Participation in Higher Education 1989 BP Educational Service  

Solomon J.  
"Teaching Approaches"  
Physics for Science Teachers Open University Press  

Sommers R.  
"Ban Physics from Schools"  
Physics Education 21 140-43  

Spencer D.  
"The Authorities not Known for Their Wit"  
Times Educational Supplement April 28th  

Springer S. and Deutsch G.  
Left Brain Right Brain  
Freeman  

Stewart M.F.  
"The End is Nigh! Attitudes of Physics PGCE Students at the End of Their Course"  
Physics Education 24 320 - 22
Stewart M.F.
"Statistics Relating to Physics PGCE Students"
School Science Review 71, 255, 154 - 55

Stewart M.F.
"Physics Teacher Morale"
Physics Education 25 70 - 71

Stewart M.F.
"Peer Tutoring: What's in it for You"
School Science Review 71, 257, 140 - 42

Stewart M.F. and Perrin R.
"A Comparison of Physics Undergraduates and
PGCE Students' Attitudes to a Career in Teaching"
Physics Education 24 252 - 53

Straw J.
"Low Morale Deters Entry"
Times Educational Supplement September 23rd

Sutcliffe J.
"Tory MPs Favour Big Pay Rise for Teachers"
Times Educational Supplement March 23rd

Swann Report
HMSO
London : HMSO

Teaching as a Career (TASC)
"Ten Tasters Across the Country"
Summer Bulletin

Teaching as a Career (TASC)
"The Year Ahead"
Winter Bulletin

245
Thiel D.  
"Scientist in Residence" 
Physics Education 25 106 - 8

Thompson P.  
Reported in "Science and Mathematics Teachers" 
Hansard July 11th

Times Educational Supplement  
"Broad Approach Boosts A-Levels" 
October 2nd

Times Educational Supplement  
"GCSE Examinations 1989 (provisional results)" 
September 1st

Times Educational Supplement  
"Another Crusade That Must Be Won" 
May 26th

Times Educational Supplement  
"A Mixture That Can Plug the Caps" 
January 27th

Times Educational Supplement  
"Entries for Some Science A-levels Fall" 
April 28th

Times Educational Supplement  
"Plucking Statistics from the Crystal Ball" 
May 4th

Times Educational Supplement  
"Level Headed in the World of Work" 
April 27th

Times Educational Supplement  
"A Ladder that Very Few Can Climb" 
May 11th
UNESCO
New Trends in Physics Teaching
Volume 3

Universities Information Unit
University Factsheet

Waterhouse P.
Supported Self-Study
An Introduction for Teachers
Council for Educational Technology

Wellington J. J.
"Recruiting Physics Teachers - 12 Years
After Swann"
Physics Education 15 134 - 35

Wellington J.J.
"Straight from the Horse's Mouth: Physics
Undergraduates Attitudes to Teaching"
Durham and Newcastle Research Review 10 21 - 22

Whitelegg et al
"The Physics for Science Teachers Project"
Education in Science, November