Tackling Biology Projects

*Dedicated to the memory
of my father
Alexander Mackay Craig*

Tackling Biology Projects

Marilyn Anne Wedgwood

BSc, MSc, PhD, CBiol, MIBiol

M
MACMILLAN

© Marilyn Anne Wedgwood 1987

All rights reserved. No reproduction, copy or transmission of this publication may be made without written permission.

No paragraph of this publication may be reproduced, copied or transmitted save with written permission or in accordance with the provisions of the Copyright, Designs and Patents Act 1988, or under the terms of any licence permitting limited copying issued by the Copyright Licensing Agency, 33–4 Alfred Place, London WC1E 7DP.

Any person who does any unauthorised act in relation to this publication may be liable to criminal prosecution and civil claims for damages.

First published 1987

Reprinted 1991

Published by
MACMILLAN EDUCATION LTD
Houndmills, Basingstoke, Hampshire RG21 2XS
and London
Companies and representatives
throughout the world

British Library Cataloguing in Publication Data
Wedgwood, Marilyn
Tackling biology projects. – (Tackling
projects)

I. Biology

I. Title II. Series

574 QH308.7

ISBN 978-0-333-42869-6 ISBN 978-1-349-09131-7 (eBook)

DOI 10.1007/978-1-349-09131-7

Contents

<i>Preface</i>	<i>vii</i>
<i>How to Use this Book</i>	<i>ix</i>
<i>Tackling the Project — A Summarised Step by Step Guide</i>	<i>x</i>
1 General Background to a Biology Project	1
1.1 General background	2
1.2 The development of a project	4
1.3 What is expected of the student?	6
1.4 The supervisor's role in the project	7
1.5 Choosing a project	9
2 The Investigation	13
2.1 The place of the investigation within a project	14
2.2 Basic characteristics of investigations	15
2.3 Categories of investigation in a project	17
2.4 Choosing an investigation	20
2.5 Formulating the aims of an investigation precisely	22
2.6 Expansion from the aim to increase results (with minimum effort)	25
2.7 Final preparation before contemplating the design	29
3 Designing an Investigation	31
3.1 General aspects	32
3.2 Identifying the steps in an investigation	32
3.3 Deciding on the techniques to be employed	35
3.4 A consideration of the analysis of results	37
3.5 Controls, samples and replication	42
3.6 The final design	50
4 The Practical Work	51
4.1 Some general considerations	52
4.2 Preliminary investigations	52
4.3 Planning and organisation	57
4.4 Doing the practical work	60
4.5 A strategy for overcoming difficulties	62

5 Results	65
5.1 Introduction	66
5.2 What is a result?	66
5.3 What kind of results can you expect from your project?	67
5.4 When are there enough results?	69
5.5 Increasing your chances of obtaining results	70
5.6 What you can do if you cannot get any results	71
5.7 The analysis and interpretation of results	73
5.8 Using the results for subsequent investigations	79
6 Using and Applying Statistics	81
6.1 A basic approach to using and applying statistics	82
6.2 Statistical techniques for summarising data	85
6.3 Significance tests for making comparisons between sets of data to test for significant differences	86
6.4 Parametric tests for comparing means and their non-parametric, rank order statistics, equivalent	92
6.5 Chi square tests for testing for significant differences with nominal data	96
6.6 Understanding how to use a significance test	98
6.7 Regression and correlation	101
6.8 A word of warning about applying statistics	103
7 Using the Literature	105
7.1 General points and advice	106
7.2 Sources of information	106
7.3 Finding the information from the literature	110
7.4 Some advice in using the literature	113
8 Writing the Project Report	117
8.1 The importance of writing a good project report	118
8.2 General practical points to be aware of before you start	119
8.3 Maintaining coherence in the project report	121
8.4 When and where to start	122
8.5 Writing the Methods section	125
8.6 Writing the Results section	127
8.7 Writing the Introduction and Discussion	129
8.8 Showing you know the literature in a project report	137
8.9 Demonstrating a critical awareness of your own and other researchers' work in the project report	138
8.10 Writing up the remaining sections	142
<i>Index</i>	<i>144</i>

Preface

I wrote this book in the hope that it would give direct help to students who have to complete a practical project in Biology – thus fulfilling an often expressed desire by students for more guidance. The idea evolved as I witnessed the difficulties and problems many students faced when embarking on a project, and as I recognised that such problems and difficulties were similar between different groups of students and recurred each new academic year. Furthermore it became clear to me from the comments made by supervisors and examiners that there existed many common mistakes by students in the approach to the project work across a range of different types of projects, and students too often commented that they would have appreciated some clear, straightforward, practical guidance to enhance the experience gained.

This book therefore aims to give straightforward, easily accessible and relevant help and guidance on how to approach and do a Biology practical project successfully. It is written primarily for undergraduate students on BSc, GIBiol (MIBiol), B/TEC HND and HNC courses, though postgraduates embarking on an MSc or PhD might also find it useful.

As I wrote the book I tried to ensure that the advice offered was consistent with the generally established view of sound scientific practice, took account of the common problems and mistakes made by students and kept sight of the fact that the project is an assessed part of a course. Obviously, in a book of this size and approach it is impossible to give a full examination of many of the issues but there are other more detailed and specialised texts which can be referred to. I would, however, be most happy to receive comments on the usefulness of the book and any suggestions for modifications and improvements.

A bibliography has not been prepared as it was felt to be generally inappropriate within the context of the aims of this book. There are many related areas which could be pursued through the subject index of a library under such headings as: experimental design; experimental methods; scientific methods; writing reports; practical investigation; projects in Biology; and philosophy of science.

I am grateful to the many students at Manchester Polytechnic who acted as 'guinea pigs' for testing out some of the ideas – often unwittingly, and for their comments and reactions to the work – particularly Carl Brown and Craig MacKerness for their constructive criticism. I

would particularly like to thank Mantz Yorke for his encouragement and patience in ploughing carefully through the early manuscripts and Vic Pentreath for his valuable criticism and advice which concentrated and focussed my thoughts. I am grateful to Roger Williams for reading, advising on, and correcting the chapter on statistics, to Michael Head, John Gaffney and Derek Gordon for comments on the early chapters, and to Jean Higginbottom and Tina Theis for their advice on chapter 7. I would like to convey my special thanks to my friend and colleague, Maureen Dawson, who offered support and advice throughout with good humour and good sense, and who generously read and made useful comments on the final manuscript, and to my husband Barry for his continual encouragement and reassurance which sustained me through the various crises of confidence, so enabling me to complete the work. I would like to thank Christine Foster who typed the final manuscript caringly and carefully, and Marion Sibbit for patiently typing some of the earlier drafts – each of whom worked from some untidy and almost illegible scripts. Last but not least, I would like to thank Gary Larvin for the good humoured drawings.

How to Use this Book

The flow diagram which follows gives you a summarised step by step guide to completing your Biology project. Use the flow diagram as an overall guide and main point of reference as you tackle your project.

Four stages to the project are identified in the flow diagram: Initial Preparation; Design the Investigation; Do the Practical Work; and Write the Project Report. For each stage there is a series of tasks which you will have to complete. References to sections in the book are given for each of these tasks, to help you. The outcomes resulting from completing the tasks are identified in the flow diagram.

Each chapter of the book is divided into sections and the sections have two main styles of text. There are checklists of direct practical advice for easy and quick reference. Other text in the section then discusses some of the issues in more detail.

At the beginning of the book (sections 1.1, 1.2, 2.1, 2.2 and 2.3) some more general aspects of the project are discussed. They are worthwhile reading for gaining a fuller understanding of the project and for using other parts of the book. However, they are short on the direct practical advice that the other sections concentrate on.

The book can be approached and used in various ways. The chapters are presented in an order which reflects as far as possible the way in which a project develops. You could, therefore, follow it through chapter by chapter with the flow diagram guiding you. However, it is possible to delve into the different chapters and sections as the need or your interest arises. (The sections are as self-contained as possible, with cross-referencing, and a full index is given at the end.) Alternatively, you could read the book through before you start, to give you an overview.

Whatever method you employ, keep sight of the flow diagram and use it to guide you through the different stages of tackling a project.

Tackling the project—a summarised step-by-step guide

(At all stages seek help and guidance from your supervisor as necessary)

PROJECT BEGINS

Task

Initial Preparation

Make sure you know what the project is about and what is expected of you and your supervisor

Choose a project

Familiarise yourself with the background to and the reasons for the particular project

Appreciate the place of investigations within a project

Break down the project into a set of possible investigations

Choose an investigation to work on

Check if another investigation can be carried out at the same time

Formulate the aim of the investigation precisely

Check whether the aim can be extended to increase the number of results with minimal effort

Plan to read the literature to help with the next stages if necessary

Refs (sections)

(mainly chapters 1 and 2)

1.1, 1.2, 1.3 and 1.4

1.5

1.3. 1.4. all of chapter 7

2.1. 2.2 and 2.3

2.4

2.4, 5.2, 5.3 and 5.5

2.1

2.5

2.6

All of chapter 7

Design the Investigation

Identify the steps necessary in an investigation

Decide what techniques will be used at each

(mainly chapters 3 and 6)

3.2

FINAL DESIGN OF INVESTIGATION

do another investigation

if time available

RESULTS OBTAINED
FROM PRACTICAL
WORK

PROJECT REPORT
WRITTEN UP

PROJECT FINISHED