UNIVERSITY OF WOLLONGONG AUSTRALIA

Thesis writing

Sample methods sections

BIOLOGY EXAMPLE

Example: methods section in a thesis

2 2 METHODS

This study was conducted at Waratah Creek (37°01'S, 149°23'E), in the Coolangabra State Forest, approximately 20km southeast of Bombala, New South Wales (see Fig 2-1). The study area contained six species of eucalypt (Eucalyptus radiata, E viminalis, E fastigata, E obliqua, E ovata, E cypellocarpa). See Chapters 6 and 7 and Kavanagh (1984) for further details.

locates study site

describes site

Thirteen field trips were conducted at the following times: ... Gliders were trapped in the study area and ear-tagged with coloured reflective tape to enable assessment of the number of individuals observed during each field trip (see Chapter 6). ...

when the study was carried out

Yellow-bellied gliders were located with a 12V 100W spotlight. Initial location was greatly facilitated by their extraordinary vocal behaviour (Kavanagh & Rohan-Jones 1982). After locating a glider, it was followed for as long as possible (up to 3 hr in 1984 but often for an entire night in 1985 and 1986; see Chapter 4) and observed with a 55W 'red' spotlight and a pair of binoculars. All feeding activities were timed to the nearest 1/2 min and recorded on tape. Observations commenced at dusk (when the gliders left their dens) and continued until approximately 0300h unless followed for an entire night. During each field trip except December 1984, at least one observation period was conducted throughout the night.

general comments about how study was conducted

2.2.1. Feeding Behaviour

A total of 122.4 hr was spent observing feeding by yellow-bellied gliders. The following feeding behaviours were identified on the basis of the spotlighting observations. Daytime observations of the substrate at which gliders were observed foraging were made in order to confirm the identity of the food types being ingested.

first of two sections detailing how study was carried out

Eucalypt sap feeding:- gliders were observed clinging to the trunks of eucalypts and licking at the 'V'-shaped incisions they had made into the bark. Licking was interspersed with relatively short bouts of bark gouging to extend the incisions or create new ones.

paragraphs detailing specific observations

Honeydew feeding:- gliders were presumed to be harvesting honeydew when engaged in branch and leaf-licking activities (Smith 1982a). Honeydew is .... Scale insects were clearly seen with binoculars and were present on the leaves occasionally discarded by gliders when leaf-licking. Trees containing psyllids were uncommon and could be distinguished ...

observation methods / criteria

Methods section continues with specific methods for each foodtype eg how indices of food availability would be established, references to a previous study and detailed procedures for the types of assessment to be used.

ENGINEERING EXAMPLE

Example: methods section in a thesis (excerpts)

3.0 Experimental Procedure

a 'preview' would make the text easier to read – ie before presenting details of each technique, first indicate categories covered (development of microwave method, conventional sintering, materials and sample preparation, design of key experiments & measurements)

3.1 Development of the Microwave Sintering Method

3.1.1 Microwave Equipment

All the initial experimental sintering work was performed in a commercial Sharp microwave oven, model R 2370. This is a 1300 watt, 2.45 GHz multimode chamber with a mode stirrer.

The true power level could not be altered, but a change in the level of power input over a period of time could be achieved by choosing one of the so called 66 "power levels" from the control panels. These cause the magnetron to operate intermittently, so that a 70% power level, for example, actually means that the samples were exposed to brief periods of full power, interspersed with periods when the magnetron was off. These on-off cycles for the various power level settings are listed in Table 1.

details development of simple, reproducible method for microwave sintering

Table 1: Power Cycles for Sharp 1.3 kW Microwave Oven

Power	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Time	6	8	12	16	18	22	24	26	30	32
Time	26	24	20	16	14	10	8	6	2	0

Although it was found to be possible to achieve high density using this oven, the cyclic operation of its magnetron caused a number of problems. Firstly, it meant that the samples were subjected to intermittent heating and cooling cycles over which there was little control, rather than a steady, controlled heating rate. Secondly, it made temperature measurement and control impossible, as the sample temperature fluctuated rapidly through a broad range in response to the changing field. It was also found that there was a plateau in the temperature as a function of time. The maximum temperature attainable was a function of material type, load size, and sample insulation, as well as the power level being used.

Attempts were made to measure the temperature of the samples during sintering using an infra-red pyrometer. A sight hole was made in one wall of the oven, and through the insulation. Problems were encountered with this technique. Firstly, the emissivity of the samples changed as a function of temperature, introducing significant uncertainty as to the reliability of the measurements. Radiation from the susceptors may also have affected the measurements. Secondly, there was considerable heat loss through the sight hole, causing non-uniform sintering of the samples.

3.2 Conventional Sintering

details method used in conventional sintering

Five samples were sintered in each run, in the arrangement shown in Figure 22. The furnace was resistance heated using Crusilite SiC elements located in the roof of a small alumina fibre board lined chamber. A calibrated type R thermocouple connected to a programmable controller was used to control temperature. The thermocouple tip was in contact with the surface of one of the samples. Measured temperature was controlled to within ±5^{o}C of the set point. To increase the uniformity of sintering, and to avoid contamination of the samples, the samples were raised slightly above the alumina fibre insulation by resting them on zirconia supports.

Example: methods section in a thesis (excerpts)

Figure 22: Sample arrangement in the electric furnace

[*graphic*]

3.3 Materials and Sample Preparation

3.3.1 Zirconia Powders

details materials and methods used

High quality spray dried zirconia powders supplied by Tosoh were used. These had nominal dopant contents of 3 mol% and 8 mol% Y203. Details of the chemical composition and particle size, as provided on the manufacturer's data sheets, are given in Table 2. These powders contained small amounts of organic binders to aid in consolidation.

Table 2: Composition and Grain Size of Tosoh Zirconia Powders

[*table*]

3.4 Design of Key Experiments

details methods used in comparative study

Initial work in the commercial microwave oven served to show that it was possible to sinter zirconia to high density while maintaining a small grain size. The "power cycles" which were successfully used to densify the powders are listed in Table 3. The design of the power cycles was an iterative process, with the results of previously used cycles forming the basis for modifications. Early work, which is not included in Table 3, showed that problems with thermal runaway were encountered whenever the 100% power level (magnetron on all the time) was used. The provision of brief periods without the electromagnetic field, such as occurred when using the 70 - 90% power levels, was found to be beneficial in avoiding thermal runaway and sample deformation. Some extended cycles were included to allow grain growth to occur.

However, there was not sufficient control over these experiments to allow any reliable assessment of the effects of various parameters on the process, nor to permit comparison of microwave sintering with conventional sintering methods. The custom-built unit, once commissioned, was able to study these relationships. A statistical design was used to permit efficient investigation of relationships between a number of parameters. Repeat runs were used to provide additional information, and to check reproducibility.

...

3.5 Property Measurement

3.5.1 Physical Properties

Green densities were determined by direct measurement. Densities of sintered samples were determined by the Archimedes method using distilled water with 1 % soap solution as the immersion fluid.

3.5.2 Mechanical Properties

Flexural strength was determined by performing four point bend tests on sintered bars approximately 4 x 5 x 45mm in size. An Instron model 4302 was used to perform the tests, with a loading rate of 0.3 nun/min. Toughness of fully densified samples was measured by Vickers indentation using a 30kg load. Samples were polished to a Igm finish, and gold coated prior to indentation. The gold coating increased the reflectivity of the surface, facilitating identification of crack tips. Toughness was calculated using the following equation: ...

Example: methods section in a thesis (excerpts)

3.6 Characterisation and Comparison of Microstructural Development

3.6.1 Scanning Electron Microscopy and Grain Size Measurement Samples were prepared for electron microscopy using standard ceramographic techniques to polish the surfaces to a l pLm finish. Samples were then thermally etched at 1500^{0}C for 3 minutes in a preheated electric furnace. Either a very thin gold or carbon coating was deposited onto the surface. Cross sections of some samples were cut using a Struer's Accutom-5, so that microstructural uniformity could be assessed. Samples were sectioned in either the longitudinal or transverse direction, and grain size measured in a number of locations along the sections. Fracture surfaces were also studied. Grain sizes were determined using ...

details comparison of microstructural development of both samples

EDUCATION EXAMPLE

Example: methods section in a thesis (excerpts - part of general introduction)

The ethnographic work of Scraton and, to a certain extent, the classroom interaction studies of Giffin et al (1981: 1983) have the closest immediate links with the present study. Although Hargreaves (1986), Scraton and others have to some extent investigated physical education and sport as sites of regulation and (re)production, none of these studies has systematically addressed the part played by the linguistic choices of students and teachers in this process. This study fills that gap and in doing so provides a more substantial model of classroom interaction by which teachers may come to analyse and change their practices.

final paragraph of section introducing the research and identifying the gap to be filled

logically leads to a Methods section, showing how research was carried out

1.3 Methodology

Methodology as section within general introduction to thesis, between identification of the topic and outline of following chapters

The study originated from a need to explain the differences in participation rates between boys and girls in physical activity. It was conceived as an ethnographic study working towards a 'grounded theory' that would emerge out of several cases studies of secondary schools. These were to be selected to cover the various combinations of female and male teachers, single-sex and mixed classes. It was intended that using the fieldwork tools of observation, open-ended interviewing and the analysis of curriculum and other relevant documents, certain trends would emerge to answer the original questions and to explain the differences in the experiences of boys and girls in relation to physical education and sport. As is the way with an ethnographic approach, a broad theoretical base may inform the focusing of the original investigation but it is through this investigation that further theoretical insights should emerge (Lincoln and Guber, 1985).

It soon became clear, however, that firstly, such a general study of the school ethos was not going to break any new ground, particularly as the Report from the Commonwealth funded project Girls, Physical Activity and Self-esteem (1986) had been published and secondly, that what was more revealing and yet unexplored was what was happening in the language students and teachers used with one another. Observations of lessons by male and female teachers suggested profound differences between the two that were difficult to explain using the tools of interaction a ...

Systemic functional linguistics requires a detailed and systematic analysis of text ...

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