Learning Development | Student Services

Research and Thesis writing

3. Thesis structure guidelines

3c. Sample Methods section from Biology, Engineering & Education

1. Research models and methods

2. Developing a research proposal

3. Thesis Structure guidelines

3a. Sample Abstract from Engineering & Biology

3b. Sample Introduction from Engineering, Biology & Education

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4. Thesis writing and persuasion

Methods section from Biology

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.

where the study was carried out

characteristics of study area

Thirteen field trips were conducted at the following times:- 9-18 January, 2-12 April, 13- 18 May, 22 June- 1 July, 30 August- 3 September, 28 October November, 3-9 December 1984; 2-8 February, 15-24 April, 8-14 July, 2-8 September 1985; 5-17 January and 23 June- 5 July 1986. During each field trip, gliders were trapped and ear-tagged with coloured reflective tape (see Chapter 6) to ascertain the number of yellow-bellied gliders in the study area.

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 3hr 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 details about **how** the study was carried out

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.

This is the first of two sections that provide specific details about **how** the study was carried out. Notice that the foodtypes referred to in this section relate to the foodtypes identified in the introduction section of the thesis.

Eucalypt sap feeding:- gliders were observed clinging to the trunks of eucalypts and licking at the 'V'-shaped incisions they had made into the

This and the following paragraphs provide details about the specific methodology used to observe gliders feeding from each foodtype: sap, honeydew, manna, nectar & arthropods.

Learning objectives

This module will help you to:

- learn about various research models.
- prepare a research proposal.
- structure your thesis and its chapters.
- write convincingly of your research outcomes and implications

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bark. Licking was interspersed with relatively short bouts of bark gouging to extend the incisions or create new ones.

sap

Honeydew feeding:- gliders were presumed to be harvesting honeydew when engaged in branch and leaf-licking activities (Smith 1982a). Honeydew is the substance excreted by sap-sucking insects and, as found in the study by Smith (1982a), was produced at Bombala by coverless psyllids concealed under the bark of eucalypts and by scale insects present on the smaller branches and leaves of eucalypts. 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 by the blackening of the branches (owing to a mould growing on the bark) under which the psyllids were living. One blackened branch collected from a E. cypcllocarpa regularly used for branch-licking showed that these insects were common under the bark.

honeydew

(methods section continues with specific methods for each foodtype)

Methods chapter from Engineering

2.8 Summary

The aims of this project were to develop **a simple, reproducible method for the microwave sintering** of two different yttria-zirconia ceramics, and to then **undertake a systematic comparison of the microstructural development of these ceramics during microwave and conventional heating** using identical thermal profiles. The two materials selected for study, 3 and 8 mol% yttria zirconia, were chosen because although chemically similar, they differ greatly in vacancy concentration, and in densification and grain growth behaviour. In the light of the proposed mechanisms for the conversion of microwave energy to heat, and the reported benefits of microwave sintering, it was considered that these two materials would provide a good indicator of the validity of some of these claims. The **effects of heating rate and yttria content were studied during constant rate heating**. Isothermal **ageing experiments** were also performed.

This final section of chapter two (the lit review) provides an overview of the study/experiment undertaken in this research. This is a necessary prerequisite to the presentation of a methods section. Notice the clear reference to these research aims (terms in bold) in the methods section.

Chapter 3:

This chapter could begin with an introduction. Introducing the following sections on 'development of the microwave method', 'conventional sintering,', 'materials and sample preparation' 'design of key experiments' and 'property measurement' would have made this chapter easier to read.

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

This section (3.1) details the development of a simple, reproducible method for microwave sintering.

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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 the table below (Table 1).

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.

…

This section (3.2) details the method used in conventional sintering.

3.2 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°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.

Figure 22: Sample arrangement in the electric furnace.

This section details the **materials** that were used and the methods used to prepare the yttria-zirconia ceramic materials used in the comparison between microwave and conventional sintering.

3.3 Materials and Sample Preparation

3.3.1 Zirconia Powders

Side View

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

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3.3.2 *Powder Consolidation*

Samples were prepared by pressing in a hydraulic press with an electric motor drive. Peak applied pressure was 200 Wa, with a hold time of 30 seconds. This pressure is similar to that used for commercial forming operations, and was found to give high density compacts with no remnant agglomerate structure.[152]

This section details the **methods** used in the comparative study, the study of the effects of heating rate, and the study of isothermal ageing.

3.4 Design of Key Experiments

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.

+ ageing experiments

3.4.2 *Ageing Experiments*

A small number of runs were conducted which included prolonged dwell periods (5, 10 and 15hrs) at 1500°C in both furnace types in order to indicate if there were any differences in grain growth rates once densification had ceased. A heating rate of 2°C/Min was used.

3.5 Property Measurement

This section details **how** the different samples, after heating, were measured for physical and mechanical properties.

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

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of the surface, facilitating identification of crack tips. Toughness was calculated using the following equation:

fracture toughness $K_{1c} = \$ \left[\frac{E}{H} \right]^{1/2} \left[\frac{P}{C_0^{3/2}} \right]$

where :

$ = material independent constant for Vickers produced radial cracks ($ = 0.016)

E = Young's Modulus (approx. 200 x 10^9 N for PSZ)

P = indentation load

a = length of one side of indentation

H= hardness (10. 12 x 10^9 typical for PSZ) H = P

C_0 = one crack length + half diagonal of impression or length from one crack tip to opposite crack tip divided by 2.

This section details how the microstructural development of both samples were compared.

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 1500^0C 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 image analysis techniques. This involved taking raicrographs from various regions of the samples …

Methods section from Education

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.

This methods section is presented as part of the thesis introduction.

This is the final paragraph of a section introducing present research. Notice how it identifies the gap that will be filled by this research. The methods section is the logical 'next step' that shows how the research will be carried out.

1.3 Methodology

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.

This methodology section follows a section that details what the research is about and precedes a short section that outlines the following chapters in the thesis.

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These schools were to be selected to cover the various combinations of female and male teachers, taking 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 ...

Most of the studies into class room interactions have drawn on the work of Good and Brophy (1973) and Cinclair and Coulthard (1975) to develop a checklist which could be used by an observer to identify and quantify the number and duration of different types of teachers and pupil behaviour. ...

In the present study, systemic functional linguistics and semiotic theory and methodology have provided the means to go beyond the earlier approach – that is, to take into account the complexity of meanings generated in lessons, including meanings, that operate at the unconscious as well as the conscious level of awareness. ....

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

Three schools were finally settled upon as the most appropriate sources for the variety of lesson situations required. This selection took into account the combinations of teachers and students most likely to be found in New South Wales secondary schools. One school situated in a semi-rural area had universal mixed physical education except for the odd special exception; one other school was an independent religious school that had recently amalgamated and had all single-sex classes but with some of the girls classes being taught by male teachers; and the third school was an urban government school having most of its classes segregated but with some mixed classes in Years 7 and 10 and mixed classes for social dance. From these schools, six male teachers and three female teachers consented to have their lessons recorded on video and audio tape (through lapel microphones). These teachers, together

These three paragraphs provide the details of how the researcher gathered data for that part of the research that looked at classroom interactions.

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with at least one other member of staff from each school, were also interviewed at length …

In all, eighteen lessons were recorded, some lasting for one 'period' of 40 minutes duration and others for a 'double period' of 80 minutes. As some lessons yielded 40 pages of transcript, the usual detailed analysis of every clause followed by systemicists was obviously impracticable for this amount of a data. A taxonomy was developed to provide the initial framework (grid) by which the lessons could be analysed in terms of the research questions described below. As a starting point, two lessons were selected for analysis …

A very detailed analysis of each lesson revealed that while the field components would be important and a limited mode analysis would be required for an understanding of the physical education lesson as genre, the most striking difference was in the way teachers chose language to create interpersonal relations of power, intimacy and solidarity. …

At this stage of the study, several broad questions could be said to inform the interpretation of the lesson texts:

- Were there differences in the language resources that teachers drew on to make meaning?
- Was there a difference that could be attributed to the sex of the teachers and/or the sex of the students?
- If differences existed, what were the consequences of such differences for students in terms of their understandings of themselves as male and female and in terms of their attitude and behaviours in relation to physical activity?

This last question took the study beyond a comparison of differences to the issue of the very production of gendered subjectivities. Although a broad theory of social and cultural reproduction that argued for the reproduction of society through its institutions (Connell, 1977; Hargreaves, 1986) had provided some explanatory power for the study to this point, it was no longer adequate to provide the link between what teachers did and said, and students' consciousness of themselves in terms of masculinity and femininity. To a certain extent Michael Halliday's (1978; 1982) (following Sapir and Whorf) understanding of language as a social semiotic makes the connection between cryptotypical patterns of grammar and ways of thinking that are located in particular cultures and are thus incorporated into the consciousness of member of that culture as they learn the language. However, more recent work from Foucault (1972; 1984) and feminist writers like Weedon (1987) and Silverman (1983) under the umbrella of what has come to be known generally as poststructuralist theory, as well as feminist linguists such as Poynton (1985), have more clearly articulated the close relationship between linguistic but also non-linguistic practices in producing individual consciousness or subjectivities.

- rationale for the broadening of the study

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Foucault (1972; 1984) in particular describes the historical and cultural production of systems of knowledge and beliefs (discourse) that regulate the behaviour of individuals in a culture at any one time. These discourses include discourses of sexuality. At any one instance of action, according to Foucault, individuals' thinking, feeling and acting, are determined by their positioning in specific historical and cultural discourses. Although there are some problems (as well be discussed in Chapter 2) with the degree to which individuals and their actions are wholly determined by discourses and discursive formations, Foucault's 'Genealogical' approach, which maps the operation of discourses and their production and influence at any one time, was important to the development of the study at this stage.

This section provides a rationale for using history and culture as interpretive tools that add meaning to the data gathered in the classroom.

It became clear that in order to understand what was happening in physical education classrooms I would need to understand how the very structure of physical education lessons in general (the genre of the physical education lesson) and the experiences of the teachers and students, that is, their previous experience of discourses and discursive practices, determined their behaviour in the instance that was being analysed. That is, to what historically and culturally constituted discourses associated with physical education, sport and sexuality had the participants in the lessons been exposed and how were these enacted in their practices? Further, a 'genealogical' approach provided the means to argue that the interactions of teachers and students were in themselves productive and reproductive of discourses and, most importantly for this study, discourses of masculinity and femininity.

In practice then, this led to the decision to trace the production of those discourses that most affected the field of physical education – that is, to examine the historical production of the genre of the traditional physical education lesson and the discourses that it realises. An understanding of student and teacher subjectivities also meant investigating the cultural resources outside of the school genre and discourses on which they drew to make meaning in the lesson – for instance the discourses that informed the media representations of women and men in sport.

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