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The effect of assigning specific roles in science groups on the gender behaviour of primary school children

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The effect of assigning specific roles in science groups on the gender behaviour of primary school children.

by

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

This thesis reports on an investigation into the effects on gender behaviour of assigning specific roles (Manager, Tracker, Recorder, Communicator) to primary aged members of a cooperative learning group in science. The study was carried out in a Year 4 and a Year 5 classroom in a Perth primary school. Both classes used a six lesson programme on a physical science topic prepared by the researcher and taught by the classroom teacher. The target subjects were randomly chosen from students meeting certain criteria defined by the researcher. All other subjects were allocated to either single- or mixed-gender groups of four. The target group was observed and their behaviour and verbal interactions coded before and after the assignment of the specified roles. Data were collected during the third school term, 1992. Data collected prior to, and subsequent to, the treatment were compared and correlated with data collected through pre- and post-programme whole class questionnaires, field notes and post-programme interviews of the target group and the participating teachers. Implications for small group teaching are discussed and suggestions for future research conclude this thesis.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date 13th June 1993

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CHAPTER ONE

Introduction

Background

Poor retention rates of girls in upper secondary school physical science and a resulting lack of female scientists in the work force have been matters of concern for some years (Kelly, 1987).

Many researchers have attempted to isolate the factors involved in girls' negative attitudes to science. Recent research has focussed on the apparent emergence of differential behaviour by boys and girls in science at about Year 4/Year 5 level in primary school. Until about nine years of age, girls and boys show similar levels of curiosity and interest in science, but during the succeeding years girls appear to fall behind boys in both motivation and achievement (Erickson & Erickson, 1984). It appears that girls and boys exhibit most examples of differences in behaviour when working in mixed-gender groups, and therefore this is the type of group chosen for investigation in this study (Rennie, Parker & Hutchinson, 1984).

This study uses cooperative learning groups developed by Johnson and Johnson (1975) and refined by Burns (1981). Johnson and Johnson recommend four elements of a cooperative learning group:

1. Positive interdependence - all group members are required to interact to achieve the goals.

2. Face-to-face interaction between students - physical proximity aids cooperation.

3. Individual accountability for mastering assigned material.

4. Instruction in appropriate interpersonal and small group skills - by the teacher initially, and later peer tutoring for reinforcement.

The Groups of Four model of small group cooperative learning (Burns, 1981) is based on three rules for students to follow. These rules are:

1. Each member of the group is responsible for his or her own work and behaviour.

2. Each member of the group must be willing to help any other group member who asks for help.

3. You may only ask the teacher for help if all four group members have the same question.

During Groups of Four sessions the teacher is a facilitator who circulates around the groups, observing the interactions and helping if the entire group has a question. The teacher also summarizes the results for the whole class when the groups have finished exploring the problem (Burns, 1981).

This model is used in the Science for Life and Living curriculum (Biological Sciences Curriculum Studies, 1989).

Significance

No previous published studies were found to have focussed on role designation and gender behaviour. This thesis seeks to make a potential contribution to educational theory and practice in this field. It is postulated that using cooperative learning groups in which students are assigned specific roles (Manager, Tracker, Recorder, Communicator), behaviours more relevant to societal, personal and family attitudes and interactions may replace the differential behaviours attributed to gender. This may provide the teacher with a strategy to enhance gender equity in science lessons.

Purpose

The purpose of this study is to investigate the effects of assigning specific roles in cooperative learning groups in science on the gender behaviour of primary school students.

Problem

How does the assigning of specific roles to boys and girls in cooperative learning groups of four affect their gender behaviour in science lessons?

Research Questions

1."Can any observed differences in the gender behaviour of girls and boys in science be modified by the assignment of specific roles in mixed-gender groups?"

2."Are there any differences in gender behaviour between Year 4 and Year 5 students?"

3."Do students in mixed-gender groups show greater changes in attitude to science than those in single-gender groups?"

Definition of Terms

For the purposes of this study the following terms will be defined thus:-

Cooperative Learning Group: A group of students working on a common activity towards a common goal.

Roles: Assigned in accordance with those from the experimental edition of Science for Life and Living (Biological Sciences Curriculum Studies, 1989). (see Appendix 1).

Gender behaviour: stated behaviours associated with science activity which are more common in one gender than the other.

Mixed-gender group: A group comprising two boys and two girls.

Single-gender group: A group comprising four boys or four girls.

Target group: The mixed-gender group randomly chosen for in depth observation and coding of the stated gender behaviours.

Organization of the Thesis

This thesis reviews the literature in the two areas of gender issues in science and cooperative group learning then discusses the method of investigation for the study. Following the description of the data collection are the results and discussion. Conclusions are drawn from these results and implications for teachers and areas of further research are suggested. References and appendices complete this proposal.

CHAPTER TWO

Literature Review

The purpose of this chapter is to review literature in the two areas of gender issues in science and cooperative group learning. The review will identify behaviours in science attributed to gender and the elements of cooperative group learning which can impact on these behaviours.

This chapter initially discusses the general gender issues identified in science, then describes specific behaviour exhibited by girls, boys and teachers which has been observed and reported by researchers as impacting on science learning.
Literature on cooperative learning groups is reviewed in the light of cognitive and affective advantages over traditional teaching methods, and some of the methods of grouping are discussed.

General Gender Issues in Science

The differential involvement of girls and boys in science has been attributed to various causes. Genetic and biological differences have been found by Gray (1981) and Waber (1976), while Harding (1986), Kelly (1987) and Whyte (1986) attribute observed and measured differences to sociological and cultural influences of a

western patriarchal society. Other researchers (Fennema & Peterson, 1987; Good & Brophy, 1991; Tobin & Garnett, 1987) consider the differences reflective of teacher strategies and behaviour. Erickson and Erickson (1984) describe differences in the understanding of science knowledge and the application of that knowledge to the physical sciences. However, Parker and Offer, in their 1986 analysis of Western Australian results for Achievement Certificate Science over a fourteen year period, found differences vanished when the number and the nature of science courses taken previously were controlled for; boys and girls showed equal achievement levels when background experience was equal.

Kelly (1982, 1987) and Kahle (1987) have extensively documented the masculine image of science and find that the abstract, analytical, objective attitudes traditionally valued by scientists discourage the participation of girls. Curricula are largely based on boys' interests and textbook illustrations depict mainly men. The notion that science is about things and not people rejects female socialization attitudes of nurturing and concern for others and increases the "apparent remoteness of science from girls' everyday concerns" (Kelly, 1982, p.497).

Kahle (1987) reports that of 185 Year 10 students from four Perth secondary schools asked to "Draw-A-Scientist", only two depicted women. This

stereotypic male image matches results found in other countries (Chambers, 1983 - Canada; Kahle, 1986 - United States of America; Rennie, 1986 - Australia; Weinrich-Haste, 1981 - United Kingdom).

Projects such as the action research Girls In Science and Technology initiated in mixed comprehensive schools in the north of England, have focussed on providing female role models for girls in an attempt to improve attitudes to science (Whyte, 1984).

Behaviour of Girls

Rennie et al, (1984) report that in mixed-gender groups during a Year 5 physical science activity, girls spent nearly 25% less time manipulating equipment than boys. Girls also spent up to four times as long watching and listening as boys. In many group situations, girls had a peripheral role as note takers and onlookers, recording the results and watching as boys manipulated the equipment and did the experiment.

When off-task in science lessons, girls were generally more likely to passively tune out, withdraw or engage in social activities, while male students who had finished the assigned tasks were more disruptive and their off-task behaviour often involved misuse of the equipment (Tobin & Garnett, 1987).

Cognitive Learning Styles of Girls

Recent research points to girls and boys using different learning patterns and styles (Harding, 1986; Ormerod & Duckworth, 1975; Tobin & Garnett, 1987).

Harding (1986), speaking to Curriculum Consultants in Melbourne, said "Research indicates that girls in general tackle a new problem by putting themselves in the centre of the problem to examine all facets of it, and how the facets interact. Boys are more likely to look at a problem from the outside." Whyte (1986) found that boys approached laboratory tasks with "trial and error" methods, while girls tended to discuss the task, follow rules and set up the apparatus accurately the first time.

Ormerod and Duckworth (1975) believe that girls usually process information by memorizing or rote learning difficult material while boys prefer to understand the underlying principles. Tobin and Garnett (1987) believe these cognitive differences are primarily due to educational deficiencies which in turn lead to attitudinal changes. Researchers have found that "competition does not facilitate girls' learning" (Fennema, 1987, p.121), and the more competitive the classroom, the less girls learn (Good & Brophy, 1991; Johnson, Johnson & Holubec, 1990).

Range of Experiences for Girls

Girls lack background knowledge of many science concepts, and have had less experience engaging in "tinkering activities" such as using a saw, mending toys and playing with Meccano (Whyte, 1984). This lack of experience may contribute to the differences in visuo-spatial competence sometimes cited as a reason for girls' poorer performance on some physical science activities.

Kahle and Lakes (1983, p.134) analysed 1976-77 National Assessment of Educational Progress (NAEP) responses to attitude to science items drawn from 9, 13 and 17 year old students and found that

> Females reported far fewer "hands-on" activities with magnets, mirrors, electricity, heat, solar energy and erosion. Girls reported having significantly more experiences than males with only three materials: living plants, sound and human behavior.

They also reported less female involvement in all extra-curricula science activities such as watching science shows on television, working with science projects or hobbies, reading science books, magazines or newspaper articles. This may add to an overall deficiency of science experiences for girls, which in turn may contribute to negative attitudes toward

science. The resulting unfamiliarity with science equipment, and hesitancy and timidity in using it, may mean that girls avoid experiments and may "...end up having fewer opportunities to develop practical and technical skills, increasing their disadvantage in this respect compared with boys" (Whyte, 1984, p.84).

Behaviour of Boys

Boys "hog resources", allowing girls less opportunity to manipulate the equipment and resulting in the science experience being somewhat vicarious for them (Tobin, Kahle & Fraser, 1990). Other researchers have reported similar behaviour (Kahle & Lakes, 1983; Kelly, 1982, 1987; Whyte, 1984, 1986).

A gender difference has been reported in "calling out" behaviour. Sadker and Sadker (1985) described the results of a three year study of fourth-, sixth- and eighth-grade American classrooms, and noted that boys were almost eight times as likely as girls to call out. Whyte (1984, p.85) also found "The boys were falling over themselves to give the answer...". Tobin and Garnett (1987) characterise these behaviours as consistent with the interpretation that boys are more inclined than girls to take risks in science tasks.

Cognitive Learning Styles of Boys

Kelly (1982) postulates that boys believe science is a male domain, and this affects their classroom behaviour, increasing their dominance. Their physical dominance of the classroom environment also appears to add to the perception "that boys were more able in science and their higher ability allowed the work to be completed and for all in the group to learn." (Tobin & Garnett, 1987, p.99).

Boys preferred to learn through discovery methods and by spatial and quantitative means (Ormerod & Duckworth, 1975).

Teacher Behaviour

Teacher behaviour can also impact on girls' learning in science lessons. Many researchers have focussed on teacher-student interaction (Galton, Simon & Croll, 1980; Good & Brophy, 1991; Tobin et al, 1990), finding differential expectations for science achievement which often reflect the societal view that girls cannot do well in science or mathematics.

There is disagreement between researchers over the amount of teacher attention received by boys and girls. Galton, Simon and Croll (1980), Kelly (1987) and Whyte (1984) show significant differences, with teachers giving boys more attention, directing more questions to

them, accepting more responses, and giving more elaborative feedback. Clarke and Dart (1987) and Dillon (1982) found teacher attention and interaction fairly evenly distributed between the sexes. Tobin and Garnett (1987), analysing observations of 200 science lessons in a Private and a Public coeducational high school in Perth, found that even when girls outnumbered boys in the class, the boys answered 70% of the questions. In later works, Tobin identifies what he calls "target students" who are responsible for most of the teacher-student interaction. In science classes these students are generally high-achieving males (Tobin et al, 1990).

Tobin and Garnett (1987, p.96) also noted that teachers often ask higher cognitive level questions of boys, and consequently boys were involved in responding to questions "intended to stimulate thinking or to elicit responses that would provide a bridge to a new area of content". Student initiated questions tend to come from males, and if girls ask questions, they tend to be procedural or social. In addition, teachers more often provide boys with instructions to help complete a project, but show girls how to do it, or do it for them.

The type of praise the teacher gives can lead to the phenomenon of "learned helplessness" in girls by altering their locus of control (Kelly, 1982; Sadker & Sadker, 1985). According to Kelly (1987), girls are generally praised for behaviour, obeying rules and

compliance and criticised for intellectual inadequacy. Boys receive praise for academic excellence and intellectual qualities and criticism for poor behaviour or disruptiveness. Boys are more often told their lack of success is due to lack of effort, while girls are told they lack the skill (Tobin, 1987).

Cooperative Learning Groups in Science

Cooperative learning groups are small groups in which all members are working together to attain a joint goal. They have been recommended as an alternative to the traditional competitive classroom for some years (Johnson et al, 1990, p.31). The authors feel that cooperative learning is indicated:

> Whenever the learning goals are highly important, mastery and retention is important, the task is complex or conceptual, problem solving is desired, divergent thinking or creativity is desired, quality of performance is expected, and higher level reasoning strategies and critical thinking are needed.

In a meta-analysis by Good and Brophy (1991), 26 of 41 studies conducted in regular classrooms showed significantly greater learning in classes using cooperative methods, and only one found greater learning

in a control group.

As the use of cooperative learning has increased, different models (for example, Jigsaw I & II; Teams, Games, Tournament; Student Team Learning; Student Teams Achievement Divisions) have been trialled. All focus on the process of reaching a result. They promote more positive attitudes towards the subject area in which they are used (Johnson et al, 1990). This has important implications for teaching, for example, in influencing choice of secondary science subjects which may lead to science and mathematics oriented careers.

The value of cooperative learning is that it models attitudes and interactions which are important in society, and teaches skills which are relevant to students' lives, family and personal relationships (Biological Sciences Curriculum Studies, 1989).

Cognitive Advantages

Small groups allow students to interact with each other and learn from their peers. "Compared with interactions with adults, interactions with peers tend to be more frequent, intense and varied throughout childhood and adolescence" (Johnson et al, 1990, p.21). By using group members as the first level of help, students come to rely less on the teacher as the only source of knowledge and the validator of their thinking, and begin to become actively involved and take

responsibility for their own learning. Individuals are involved in "the exploration part of the learning process", and the teacher's role is to help them to understand the results of that exploration (Burns, 1981, p.51).

Good and Brophy (1991), Johnson et al (1990) and Lewis (1988), found that students often use higher order thinking skills in cooperative learning groups. Concept development, problem solving and synthesis are enhanced. Pupils in Grade 5 classes produced superior answers to questions requiring original contributions (Sharan, 1988). Davidson (1990, p.5) says that "Students in groups can often handle challenging situations that are well beyond the capabilities of individuals at that developmental stage".

Transfer of skills is facilitated, as are discussion and creativity. Others' ideas are more acceptable because of exposure to other perspectives which may be different from their own.

Pace of instruction is considered important for achievement. In cooperative learning groups children are able to set their own pace and are free to control their own cognitive strategies to a greater extent than in traditional whole class activities. (Barnes & Todd, 1981).

Affective Advantages

Piaget saw social interaction as one of the essential ingredients for learning (Woolfolk, 1987). Cooperative learning groups maximise interaction among students and therefore have major advantages over traditional whole class methods in this area (Good & Brophy, 1991; Johnson & Johnson, 1975). Galton et al, (1980) conclude from their studies of students in the United Kingdom that participation in cooperative learning experiences lead to significant increases in self-esteem and self-confidence. Johnson et al (1990) measured lower levels of anxiety in cooperative learning group members in American schools and support Galton's findings.

If the teacher structures the goals of learning so that students are concerned with the performance of other group members as well as their own performance, positive interdependence among group members may result (Johnson et al, 1990).

As all members of the group must have the same request for information (Burns, 1981), teacher management problems may be alleviated by teacher interaction with seven or eight groups instead of thirty two individuals.

Motivation may be enhanced because children are allowed to talk and move around. Consequently they spend more time on task (Good & Brophy, 1991).

Students need to understand the rules associated with small group cooperative learning and learn to interact constructively with other members of their group. They need to be taught how to work, cooperate and communicate effectively and develop interpersonal and small group skills (Johnson et al, 1990).

Methods of Grouping

There is controversy regarding the optimal method of grouping students for cooperative learning. Lockheed and Harris (1984) examined 84 data sets, 45 of which showed greater male activity, influence or leadership in mixed-gender groups. They postulate the sex segregation which occurs during elementary years may not be the harmless developmental stage previously thought, but may be communicating a "normative acceptance of sex segregation and its consequences" (p.278). Galton et al, (1980) measured the interactions of 489 primary students and found those of the same gender interacted more than twice as often as with the opposite gender in mixed-gender groups.

Webb (1984) investigated 77 Year 7 and Year 8 students in two mathematics classes taught by the same teacher and found higher male achievement in mixed-gender groups of equal ability where numbers of girls and boys were the same. She speculated that these differences were a consequence of the students being

able to obtain explanations and information when they requested it. Girls were less successful than boys in obtaining help when they needed it, and this impeded their learning. She also noted that in groups where the number of boys was greater than the number of girls, the girl was ignored and the boys achieved higher results, while in groups where the number of boys was less than the number of girls, most interactions were directed to the boy and he again evidenced higher achievement.

According to Rennie et al (1984) the pattern of time spent by boys on each activity is the same in either single- or mixed-gender groups, and is in turn, matched by single-gender girls' groups. However, in mixed-gender groups the girls are far more passive, spending more than four times as long watching and listening as the boys. These studies point to the widest degree of differences in the behaviour of boys and girls in mixed-gender grouping. This was therefore chosen as the target grouping in this study.

Good and Brophy (1991) report groups using all high or all low ability students are likewise unsuccessful. In mixed ability groups the high ability students tend to control a majority of the interactions. This study attempted to lessen the effect of high- and low-ability students by excluding them from the target group (see Figure 2).

Little published research was found on the effects of role allocation on group dynamics. Biological Sciences Curriculum Studies (1989) recommended specific roles in cooperative learning groups to enhance affective growth. Good and others (1990) focussed on cognitive rather than affective advantages of the strategy, and saw the value of assigning roles as artificial with highly questionable benefits. This study attempted to further investigate these diametrically opposed views.

Summary of the Chapter

The preceding review of the literature shows some of the differences in science behaviour attributed to gender. Such behaviours as reading, notetaking and recording, manipulating the equipment, watching and listening, off task behaviour, "calling out" behaviour, responding to questions and peer/teacher interactions have been reported as showing different patterns in boys and girls.

The literature reviewed in this chapter also shows some cognitive and affective advantages of cooperative learning groups over more traditional methods. The type of grouping chosen for this study is described with reference to the literature reviewed.

CHAPTER THREE

Methodology

As the review of the literature indicated, the dynamics of small groups was considered a significant aspect of cooperative learning. Accordingly, this study focussed on one feature of group dynamics, namely role allocation, and investigated its influence on some of the differences in the behaviour of boys and girls which have been attributed in the literature to gender.

Research Design

A case study of a target group during science lessons was conducted. Cohen and Manion (1980, p.99) define a case study as an observation of:

> the characteristics of an individual unit - a child, a clique, a class, a school or a community [to] analyse intensively the multifarious phenomena that constitute the life cycle of the unit with a view to establishing generalizations about the wider population to which the unit belongs.

Six lessons were taught by the classroom teachers of a Year 4 and a Year 5 class from a gender-neutral programme prepared by the researcher. The programme was

designed to use cooperative learning groups of four students, including role allocation, as outlined in the Science for Life and Living curriculum (Biological Sciences Curriculum Studies, 1989). The investigations focussed on a physical science topic, Wheels and Cogs.

Figure 1. Design of the study

Lesson 1	---	Lesson 3	---	Lesson 6
O1		X		O2 Year 4 target group
O3		X		O4 Year 5 target group

In Figure 1, O1 and O3 represent baseline observational data collected in Lesson 1. Roles were then allocated in Lesson 3 (X). O2 and O4 are observational data collected in Lesson 6 after the role allocation. The data were then processed to determine any differences in behaviour of the students in the target group before and after the role allocation (X).

Erickson and Erickson (1984) asserted that gender differences began to emerge at about nine years of age. A Year 4 (mean age 8 years 7 months) and a Year 5 (mean age 9 years 8 months) class were chosen to test this assertion. The design of the research study allowed inter- as well as intra-class comparisons.

Sample

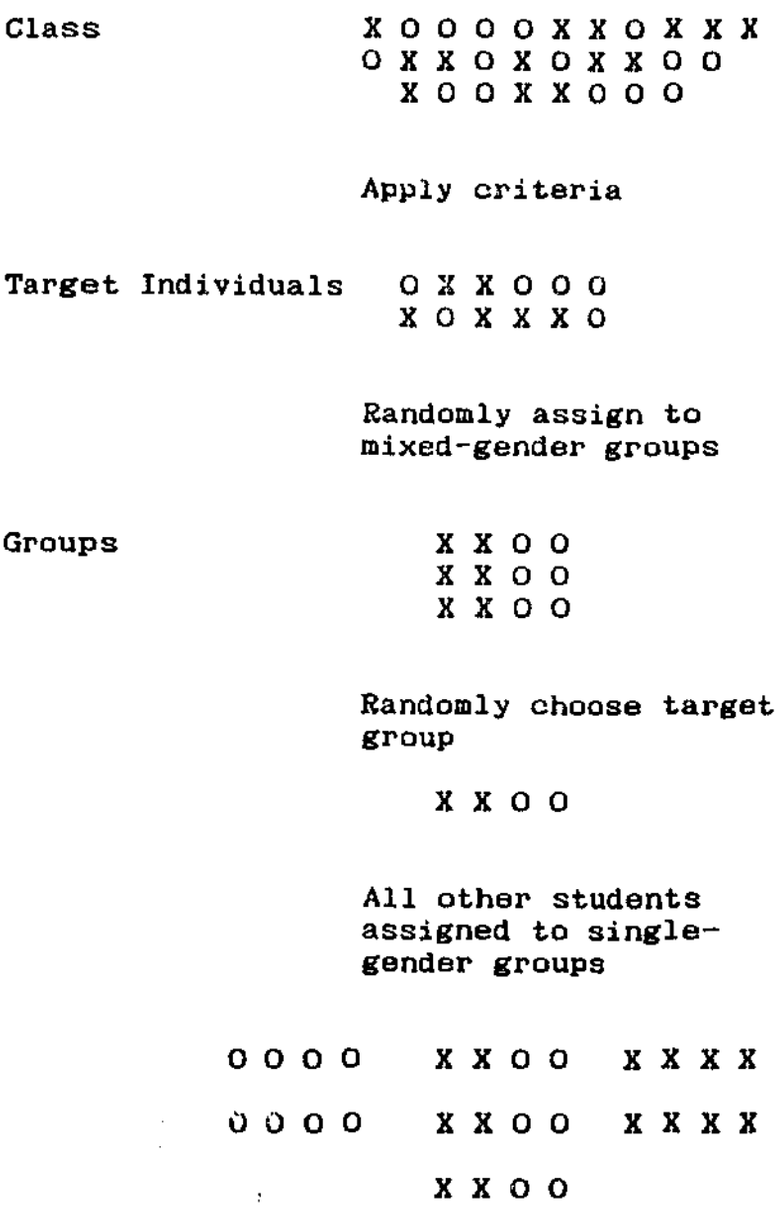
The subjects for this study were drawn from two middle primary classes at the same school in Perth. The Year 4 class comprised 26 students, the Year 5 class, 28. The students were assigned to a single- or mixed-gender group of four by the researcher and the teacher.

The mixed-gender groups comprised two boys and two girls who met criteria designed to minimise confounding variables. The target group therefore did not contain newly arrived migrant children because of the possible language difficulties and cultural influences; very high or very low achieving students who may be deferred to, or isolated (Tobin et al, 1990); or children with extreme personal attributes such as shyness or assertiveness. (Tayler, personal communication, 24th June, 1992). These criteria were applied to minimise the differences between students, grouping together "typical" students whose behaviour would be indicative of the treatment and not unduly confounded by extraneous factors.

All children who met the criteria were randomly assigned to one of three mixed-gender groups, and from these three groups one group was randomly chosen to be the target group (see Figure 2). All other children were assigned to a single-gender group of four, based partly on their choice of partners compiled by the

researcher into a class sociogram (see Data Collection Procedures, p.31 for further details of this grouping, and see also Appendix 2 for the Class Sociograms).

Figure 2. Choosing the target group in each class



KEY : O and X denote girls and boys.

The presence of both single- and mixed-gender groups in each class enabled a comparison of changes in attitude to science as a function of group composition (see Research Question 3). This method of grouping necessarily placed all students with the idiosyncratic qualities outlined above in the single-gender groups. The groups remained constant over the six lessons.

The teachers who taught the two classes were similar in a number of ways. While Galton et al (1980) found some evidence that the sex of the teacher might be a factor in determining the attitudes of girl pupils to science, Hacker (1986, p.69) disputed these results and found the "presence of a male teacher had no adverse effects on either the frequencies or the quality of girls' interactions in science classrooms." Therefore the teachers chosen for this study were male, but were closely matched on other parameters to counteract any possible effects. Both teachers were four-year trained with a degree of Bachelor of Education with a science background, and comparable teaching experience. They have both used group work in other subjects (reading and mathematics), but not in science with the classes they currently teach. Both claimed to use gender neutral teaching strategies as outlined in the Ministry of Education Social Justice policy.

Teaching Programme

Kahle (1987) and Kelly (1987) found highest levels of female disinterest in physical science. It could therefore be expected that in a physical science topic, girls would exhibit high levels of watching behaviour, one of the traits attributed to gender in the literature (see page 20). This field was therefore chosen as the basis for the programme. It was expected that any modification of behaviour due to role allocation would be maximised.

The researcher met with the classroom teachers prior to the commencement of the study in order to determine a suitable physical science topic. Wheels and Cogs was mutually acceptable because:

i. it formed part of the Year 5 science syllabus,

ii. it had not been taught during the current year,

iii. suitable equipment was available on loan from Edith Cowan University, and

iv. lack of appropriate resources at the school and district level would minimise the chance of succeeding teachers of these classes exploring this topic in depth.

The researcher examined syllabus content for the concept areas to be taught, and consulted other science curricula to design materials-centred, inquiry-based activities in line with W.A. Ministry of Education

perspectives. Gender-neutral strategies were identified from the literature and incorporated wherever possible.

Data Collection Instruments

Behaviour identified in the literature as attributable to gender was reviewed in Chapter Two. Of the listed behaviours, several were deemed to be measurable in small group situations. The following instruments were chosen as most appropriate.

1. Behaviour Instrument

A behaviour instrument was developed to code the behaviour of the target group. This Behaviour Instrument used an adaptation of the categories of the Group Work Activity Schedule (Rennie et al, 1984). The categories were:

Reading/Writing - unchanged

Watching/Listening - unchanged

Manipulating Equipment - unchanged

Planning/Discussing - changed to Verbal Interactions

Other On Task - deleted.

Off Task - unchanged

Out of Role - this added category was developed to code a student exhibiting non role-appropriate behaviours in Lessons 3 and 6. Role appropriate behaviour was expected to be independent of gender. (See Appendix 1 for the Specific Roles and their designated appropriate

behaviour, and see also Appendix 3 for the Behaviour Instrument).

Trials were conducted by the researcher using the original instrument to code Year 4 mathematics group work lessons. During the first trial it became obvious that some of the categories on the original instrument needed to be changed for this study. Accordingly, the Planning/Discussing category was broadened to include all talk regardless of purpose, and renamed the Verbal Interactions category. The Other On-task category was deleted. A new Out of Role category was developed to code non role-appropriate behaviour.

The original instrument used a time interval of 90 seconds, at which time the class was observed and behaviours in all groups coded. Trials conducted by the researcher using this instrument indicated 30 second intervals were more appropriate when study was focussed on only one target group in each classroom. Additional data were obtained by script taping verbal interactions to supplement the audio recordings during the interval. The amended Behaviour Instrument was successfully trialled in a further Year 4 mathematics lesson.

The Rennie et al (1984) instrument was chosen because it measures both the nature and the extent of each target student's participation.

Elements of the Rennie et al (1984) instrument being used in this study have both internal and external

validity and reliability. It was developed for a 1984 field study of 18 Perth Year 5 classrooms, and was extensively trialled before use. For this study it was used in similar year levels in the same geographic area.

2. Verbal Instrument

The verbal exchanges between the members of the target group were tape recorded, transcribed and coded using the MAKITAB Small Group Learning Interaction Analysis developed in 1991 at Edith Cowan University, Perth, by King, Barry, Maloney and Tayler (see Appendix 4). Teacher interaction with the target group was coded, but teacher/whole class interactions omitted from the transcripts since they were not relevant to the study.

For the purposes of recording, each student in each group was assigned an identification number. Numbers were clustered to delineate between girls (numbers 1 and 2) and boys (numbers 5 and 6) as outlined in the draft manual for the MAKITAB system.

The coded verbal interactions were then analysed using the computer programme, SAS Statistics, to identify frequencies in interactions and significant patterns. MAKITAB has been trialled in Perth and at Missouri in the United States of America, and is currently being prepared for publication.

3. Questionnaires

Initial and Final Questionnaires were given before and after the programme to all students. The Questionnaires used a modified Likert-type response format (see Appendix 5). To visually enhance understanding, the response categories were matched with a series of circles of increasing diameter, as used successfully by Rennie et al (1984). The content of the items in this scale related to attitudes to science, attitudes to group work, and gender behaviour. The Final Questionnaire also probed previous knowledge of the topic. The nine questions of the Initial Questionnaire were matched with the twelve questions of the Final Questionnaire in each category of interest.

The Questionnaires were subjected to face validity by expert review by several teachers at the participating school, and a draft version was administered to a composite class of Year 4/Year 5 children not directly involved in the study. No difficulties were found with the content or the response format, but one question was amended slightly to enhance clarity. The language was judged to be appropriate for the age of the children involved.

4. Interviews

Post-programme Interviews were held with the teachers involved in the study to determine their perceptions of any differences in the stated gender behaviours before and after the assignment of roles. Following analysis of the Initial and Final Questionnaires of the target students and overall patterns identified from the Behaviour Instrument and field notes, the target students were individually interviewed using a semi-structured format outlined by Murphy (1980) (see Appendix 6). Discrepancies between the Initial and Final Questionnaires were probed, and further insights sought. The students' responses were tape recorded and transcribed. The Interviews served to triangulate data by clarifying and enhancing observations by the researcher (Jick, 1979).

Data Collection Procedures

Pre Study Organisation

A Programme was developed by the researcher on the physical science topic of Wheels and Cogs. It was shown to the teachers and their comments invited. The Programme included full lesson plans with detailed steps for the teacher to follow, background information on the concepts to be taught in each lesson, student worksheets

with answer sheets for the teacher, teaching aids, charts and equipment. Both teachers agreed the lesson formats appeared to be amenable to group work; gender neutral; and appropriate to the year levels concerned. The teachers used the same programme to maintain consistency in both content and method and to reduce the number of operational variables in the study.

The teachers were also provided with information on the Burns' (1981) Groups of Four model of cooperative learning and the Biological Science Curriculum Studies (1989) role behaviours expected (Appendix 1). Through these strategies, context variables relating to subject matter, instructional objectives and teaching methods, as well as general variables related to the level of teacher background information and experience with the topic, were incorporated into the research design.

The Behaviour Instrument was trialled, as noted previously, by the researcher during Year 4 mathematics group work lessons, and subsequently adapted. The trials were conducted with the dual purpose of familiarising the students with the presence of an observer, and allowing the researcher to practise with the Behaviour Instrument in order to identify strengths and weaknesses inherent in its use.

Later analysis of the tape recordings of these lessons showed very little interaction with the researcher, and minimal curiosity about the equipment

(tape recorder, microphone, etc.).

Before the programme began, the students in each class were invited to indicate the names of three classmates they would like to work with during the term's science lessons. On the basis of these lists, Class Sociograms were constructed (Barry & King, 1988). These Sociograms are included (see Appendix 2).

After the target groups were chosen (see Figure 2) the rest of the students were assigned to a single-gender group of four based partly on their choices for the Sociogram. Over half the class, 15 of 28 children, were placed in a group with one or more of their choices at the Year 5 level, and 13 of 26 at the Year 4 level.

Data Collection during the Study

The Initial Questionnaire was administered to the whole class at the commencement of the programme. The students were then grouped for science lessons as previously described (Figure 2).

At this point, due to circumstances beyond the researcher's control, the timelines of data collection were altered. The Year 5 class undertook the six week programme in a three week time frame, with two lessons per week on successive days. The Year 4 class delayed the onset of the programme by one week, but followed the programme format of one lesson per week for six lessons.

Lesson 1 was coded using the Behaviour Instrument

to categorise each target student's behaviour, and tape recorded for later coding and analysis using MAKITAB as planned. This provided the baseline data for the research. Field notes were also recorded at the conclusion of the lesson to triangulate and further clarify data collected.

At the beginning of Lesson 3 students were assigned roles in each group. Traditional gender behaviour as identified in the literature would lead to expectations that the boys would manipulate the equipment and do the experiment while the girls recorded the information and communicated the results. Roles were assigned across these gender expectations, so that the girls were allocated the non-traditional roles of Manager and Tracker; the boys, Recorder and Communicator.

The verbal and behavioural interactions were then tape recorded and coded with the Behaviour Instrument as before. Again, field notes were recorded at the completion of the lesson.

Lesson 6 was coded in the same manner, and again, field notes were recorded.

In addition to the extensive observational data collected during Lessons 1, 3 and 6, Lessons 2, 4 and 5 were partially coded using the Behaviour Instrument, and intermittently tape recorded. While these data were incomplete and therefore not included in the results, they were also examined and compared with the detailed data.

Figure 3. Plan of the Research Programme

	Stage	Measuring Instrument
July	Trial of Questionnaire	Questionnaire
	Trial of Behaviour Instrument	Behaviour Instrument
	Measurement of children's attitudes	Initial Questionnaire
	Selection of research sample	Sociogram
August-Sept	Instruction phase using Wheels and Cogs programme	Behaviour Instrument Verbal Instrument Classroom observation
Sept	Measurement of children's attitudes	Final Questionnaire Interview
	Measurement of teacher's perceptions	Interview
	Measurement of cognitive outcomes	Assessment test

At the request of one of the participating teachers, an Assessment Test was devised to conclude the unit. Both classes subsequently completed the Assessment Test, which was administered to the whole class during Lesson 7. The Final Questionnaire was also held over until this time.

Research Consistency

Research consistency was sought by:

1. Modified random selection of target students.

2. Trialling of the Behaviour Instrument and the Questionnaire with a group of students at the same age as the target population prior to its use in the field.

3. The researcher coding all behaviours exhibited in the lessons.

4. The researcher conducting all interviews.

5. Audio taping all lessons and interviews.

6. Joint coding of the lesson transcripts by the authors of the MAKITAB Verbal Instrument in collaboration with the researcher, ensuring context accuracy.

7. Teachers using matching behaviours and strategies in their teaching, and their treatment of the programme being approximately equivalent.

Assumptions of the Study

The following assumptions applied to the research:

1. The researcher assumed the students in Year 4 and Year 5 had similar educational and social backgrounds, cognisant of the one year age difference.

2. The range of academic abilities in each class was similar.

3. The concepts chosen were new to the students and neither class had previous background experience, other

than normal everyday experience, of the topic "Wheels and Cogs".

4. The participating teachers followed the programme closely to ensure consistency between classes.

5. Within the parameters of the study, the students were assigned randomly to their groups.

6. The Questionnaire and Interview environments were non-threatening to the students.

Limitations of the Study

The following limitations applied to the research:

1. The literature and previous research showed that the teachers required familiarity with group processes for effective small group cooperative learning. The two teachers who were chosen to participate in this study both had experience in using small group work. Their experience in using the particular approach outlined in the Science for Life and Living programme (Biological Sciences Curriculum Studies, 1989) was, however, limited.

2. While the observational data is extensive, the small size of the sample hampers generalizability when applying the findings of the study to a wider population. This problem is escalated by the fact that the sample was not determined in a random manner.

3. The "Hawthorn Effect" may have had some bearing on the results of this study. The Hawthorn Effect describes any situation "in which subjects' behaviour is affected not by the treatment per se, but by their knowledge of participation in a study" (Gay, 1987, p.275). The students in this study were not told the reason for the research, but believed the researcher was evaluating a new programme. This explanation was considered necessary to explain the group work, the roles allocated and the presence of the researcher.

Ethical Considerations

The following methods were undertaken to maintain the confidentiality of all participants in the study:

1. The school involved was identified by code letters and numbers in all written data.

2. The teachers involved were identified only as "the teacher of Year 4" or "the teacher of Year 5".

3. Although students' first names were used during the Interview, and appear in the transcripts of the audio tapes, a code was used to designate students in all written work. The target students were identified as Student 1, Student 2, Student 5 or Student 6 (abbreviated to S1, S2, S5 and S6), or by their role designation (Manager, Tracker, Recorder or

Communicator). The clustering of the code identifies their gender.

Summary of the Chapter

This chapter described the methods used to collect data for this study. A description of the method of choosing the sample is followed by an outline of the teaching programme devised. Measurement instruments are described, and their use is explained in sequential time plans of the data collection. Assumptions, limitations and ethical considerations of the study conclude this chapter.

CHAPTER FOUR

Results and Discussion

Overview

The results and discussion for this study have been combined to give a clearer picture of the patterns and trends of gender behaviour exhibited by the students.

The results from both the Behaviour Instrument and the Verbal Instrument have been combined with supporting data from the Questionnaires, Interviews and Field Notes, and examples from the transcripts of the audio tape of the lessons. Convergence of results from this multi-method approach gives confidence in the results.

For this study the students in the target groups were allocated code numbers to preserve anonymity. The numbers were clustered to delineate between boys and girls. In both target groups S1 and S2 are girls and S5 and S6 are boys.

Research Question 1

"Can any observed differences in gender behaviour by boys and girls in science be modified by the assignment of specific roles in mixed-gender groups?"

This question invited three subsidiary questions, each of which supplied part of the answer to the

research question as a whole. These questions are:

1:1 "What were the observed differences between boys and girls in Lesson 1?"

1:2 "Were any changes in behaviour observed after the allocation of roles in Lesson 3?"

1:3 "Were any changes in behaviour observed in Lesson 6?"

Data are reported for each category of behaviour nominated in the Behaviour Instrument; Reading/Writing, Watching/Listening, Manipulating Equipment, Verbal Interactions, Off Task. Data are discussed at each year level, firstly by gender and then by individual student if warranted.

Results from the data collected in each lesson will be interpreted in the light of the preceding questions, in order ultimately to answer Research Question 1.

1:1 "What were the observed differences between boys and girls in Lesson 1?"

Table 1 shows the girls in each target group did all the required reading and writing, while the boys manipulated the equipment more. The baseline results from observation of the target groups in this study are similar to general patterns found by other researchers investigating girls' behaviour in science lessons (Kelly, 1982; Rennie, 1985).

Table 1

Lesson 1 Behaviour by Gender

	Year 4 (N = 4)	Year 5 (N = 4)
Reading/Writing	g= 2.1%	3.7%
	b= 0%	0%
Watching/Listening	g=26.9%	25.8%
	b=11.8%	23.1%
Manipulating Equipment	g=14.5%	11.0%
	b=22.0%	16.7%
Verbal Interactions	g= 5.9%	7.0%
	b=10.8%	8.7%
Off task	g= 2.2%	1.3%
	b= 3.8%	2.7%
	100%	100%

Observed Differences in Reading/Writing Behaviour in Lesson 1

The Year 4 girls did all the reading/writing behaviour for Lesson 1: g = 2.1%, b = 0% (see Table 1).

S1 took possession of the worksheet and began reading aloud. S2 read over her shoulder. The boys in this group made no attempt to read the worksheet for instructions, relying on the brief directions given verbally by the teacher.

S1 remarked to S5 "I've got to do the writing", to which he replied, "You don't have to".

The Year 5 girls did all the reading/writing behaviour for Lesson 1: g = 3.7%, b = 0% (see Table 1).

They shared the worksheet equally and read in an undertone, raising their voices to read an instruction to the boys who were manipulating the equipment to make the model. For example S2 "Roll around a pencil..." S1 to Group "We'll see what's next".

The boys asked for clarification rather than reading the worksheet themselves. S6 to S1 "You're meant to tell me what colour it is".

Observed Differences in Watching/Listening Behaviour in Lesson 1

The girls in the Year 4 target group did more than twice as much watching and listening as the boys in Lesson 1: g = 28.9% , b = 11.8% (see Table 1).

When analysed on an individual basis, S2 appeared responsible for most of this behaviour, with 32 out of a total of 47 personal behaviour codings being in this category. She was a very passive group member, who said little, and participated minimally.

In the Year 5 target group the watching/listening codes were approximately equal: g = 25.8%, b = 23.1% (see Table 1).

Observed Differences in Manipulating Equipment Behaviour in Lesson 1

The Year 4 boys generally manipulated the equipment much more than the girls: g = 14.5%, b = 22.0% (see Table 1) but the passivity of S2 again skewed the codings in this category.

The boys physically took possession of the materials and began with a variety of trial and error methods. This behaviour was expected from the literature reviewed in Chapter Two. Only after three trials did S1 ask "Can I [have a turn]?" The lesson was marked by repeated conflicts between S1, S5 and S6 about whose turn it was. In the final analysis, S1, S5 and S6 had approximately equal codes in this category. S2, as previously mentioned, was extremely passive, and had a low number of codes in this category.

The Year 5 percentages for the manipulation of equipment were more equal: g = 11.0%, b = 18.7% (see Table 1).

The lesson transcript has a telling example of the gender stereotypes already existing.
S5 to S2 "Girls don't have enough power. Let us do it!" The activity in question was rolling a soft drink can.

Observed Differences in Verbal Interactions in Lesson 1

From the Behaviour Instrument it appears the boys

in the Year 4 target group did more of the talking than the girls: g = 5.9%, b = 10.8% (see Table 1). Codings of the lesson transcript using the Verbal Instrument provide measures which agree with the ratio of the Behaviour Instrument codings: g = 26% of all initiated speech, b = 46% (see Table 2). Further analysis on an individual basis using the Verbal Instrument codings of the lesson transcripts showed that the amount of time spent talking seemed more a function of the child's dominant or passive behaviour, than of their gender. S2 was a very passive student who initiated only 5.3% of the verbal interactions of the lesson, and was addressed only 1.8% of the time. S1, on the other hand, approximately equalled the verbal interactions of S6 : S1 = 20.7%, S6 = 19.5%, while S5 dominated the frequency of talk with 26.7% of the interactions (see Table 2).

Although S6 talked to the other students, he was not addressed by other group members very much (see Table 2). Most of the verbal interaction in this lesson was between S1 and S5.

The Year 5 target students had approximately equal verbal interactions, with the exception of S6, who had only 14% of the interactions, although the other team members appeared to defer to him and he was the recipient of much of the total talk (see Table 3).

The bulk of the conversation was directed to the group in general, and took the form of statements.

Table 2

Lesson 2 Verbal Interaction, Year 4

	S1	S2	S5	S6	Group
Frequency of speaker	20.7%	5.3%	28.6%	19.5%	
Frequency of listener	14.8%	1.8%	16.6%	7.1%	30.2%

Table 3

Lesson 1 Verbal Interactions, Year 3

	S1	S2	S5	S6	Group
Frequency of speaker	24.3%	26.7%	25.4%	14.1%	
Frequency of listener	10.2%	9.6%	11.2%	14.1%	37.2%

When the Listener by gender was compared to the Speaker by gender (see Table 4), a Year 4 girl talked to the other girl only 3% of the time and to a boy 13.6% of the time. A boy spoke to a girl 13.6% of the time, and to the other boy 7.7% of the time. The rest of the talk was directed to the group in general or to the teacher.

Table 4

Lesson 1 Speaker by Listener, Year 4

		Listener	
		Girl	Boy
Speaker	Girl	3%	13.6%
	Boy	13.6%	7.7%

In a group with two boys and two girls the expected frequency of cross-sex verbal interaction is twice that of same-sex verbal interaction (Webb, 1984). These proportions are shown in only three of the cells in Table 4. The fourth cell shows a significant difference in the frequency of same-sex verbal interactions due to the passivity of S2.

In the Year 5 group, a girl spoke to the other girl 7.5% of the time, and to the boys 17.1% of the time. The boys spoke to a girl 11.8% of the time, and to each other 7.5%. Again the rest of the conversation was directed to the group in general or the teacher.

Table 5

Lesson 1 Speaker by Listener, Year 5

	Listener	
	Girl	Boy
Speaker Girl	7.5%	17.1%
Speaker Boy	11.8%	7.5%

Table 5 shows girls speak to the boys more than boys speak to the girls. This may be a pattern of girls deferring to gender stereotypical male competence in science, as discussed by Webb, 1984.

The percentage of intra-group conversation is higher than that of the Year 4 group: Year 4 = 37.9%, Year 5 = 43.9%. This may be due to the lower levels of teacher interaction in the Year 5 group.

Observed Differences in Off Task Behaviour in Lesson 1

Off task behaviour was minor in this lesson, but showed patterns attributed in the literature to gender.

The Year 4 boys showed the highest amount of this category of behaviour : b = 3.8% of total codes (see Table 1). Most of the off task behaviour involved fiddling with the equipment, an off-task behaviour

associated in the literature with boys.

The Year 5 boys exhibited twice as much off task behaviour as the girls in the target group : g = 1.3%, b = 2.7% (see Table 1). Much of this behaviour was related to a discussion about the advertising on the soft drink can they were using in the activity.

Other General Observed Differences in Behaviour in Lesson 1

S1 was the only student in the Year 4 target group who assigned jobs to other group members in this lesson. Such statements as "Stand that there", "Move it up here so you get more space", "Let go", and "Let [S2] check it" were directed to the whole group or to S5 who often had the equipment in his possession.

The Year 5 target students seemed to work more cooperatively. Some examples in the transcript for this lesson were: S2 to S5 "I'll show you" ; S6 to S1 "Can I hold that?" S5 to S6 "You just gave me an idea".

S2 however did some allocating of jobs to the boys from her reading of the worksheet. For example: "Straighten that out" (to S6); "Start cutting out, youse" (to S5 and S6).

Summary

To summarise, the differences in behaviour between girls and boys observed in Lesson 1 were:

* girls did all the reading and writing required,

* girls watched and listened more than boys at Year 4 level,

* boys manipulated the equipment more than girls,

* frequency of talk seemed more dependent on the dominant/passive attributes of the child, rather than their gender,

* off task behaviour was minimal in this lesson,

* the Year 5 group worked more cooperatively than the Year 4 group, and

* girls allocated jobs to other team members.

1:2 "Were any changes of behaviour observed after the allocation of roles in Lesson 3?"

After the students in the target groups were assigned non-traditional roles (S1 = Manager, S2 = Tracker, S5 = Recorder and S6 = Communicator), their patterns of behaviour showed measurable changes (see Table 8).

Before the allocation of roles, the girls did all the required reading and writing. In this lesson, at both year levels, boys did approximately equal amounts

of reading and writing as the girls (see Table 6). Other observed differences were in manipulating equipment, and levels of off-task behaviour.

Table 6

Lesson 3 Behaviour by Gender

	Year 4 (N = 4)	Year 5 (N = 4)
Reading/Writing	g = 4.3%	3.9%
	b = 5.4%	3.4%
Watching/Listening	g =28.7%	13.1%
	b =21.3%	14.6%
Manipulating Equipment	g = 7.4%	20.4%
	b = 8.6%	14.6%
Verbal Interactions	g = 8.5%	5.8%
	b = 3.1%	10.7%
Off task	g = 5.3%	2.4%
	b = 4.3%	9.2%
	100%	100%

Observed Differences in Reading/Writing Behaviour in Lesson 3

Table 6 shows the Year 4 students participating equally in reading and writing: g = 4.3%, b = 5.4%

However when the data were analysed on an individual basis, it became obvious that only S1 and S5 were doing

any reading or writing, and S2 and S6 were doing none. This compares with Lesson 1 when only the girls did the reading and writing.

The teacher had explained the appropriate role behaviours at the time of allocating the roles at the commencement of this lesson. He emphasised that all group members should do the reading, but that the writing of the results could be initially left to the Recorder who would record the group concensus for each result required. At a later time, each individual would copy these group results onto their own worksheet as their personal copy.

S5, the Recorder, took his role seriously, changing his previous behaviours to accommodate the requirements of his new role. Towards the end of the lesson, he expressed a wish to manipulate the equipment, and handed the data sheet to S1, the Manager.

The Year 5 students had approximately equal instances of reading and writing behaviour: g = 3.9%, b = 3.4% (see Table 6).

Further analysis showed that each student participated in reading, although the Recorder, who was off-task a great deal, was constantly reminded by S2, the Tracker, and the teacher, to record the results. S2 to S5 "[S5], read your sheet. Read the parts in brackets".

Conflict arose later when it was discovered S5 had

recorded his answer, rather than the group concensus.

T to group "Have you got a result?"

S1 to teacher "Anti-clockwise"

S6 to teacher "Anti-clockwise"

S5 to teacher "Yeh, clockwise"

Group to S5 "ANTI-CLOCKWISE!"

Comparison of the results of observations made in Lesson 3 and Lesson 1 show a change of Reading/Writing behaviour after the role allocation.

Observed Differences in Watching/Listening Behaviour in Lesson 3

In the Year 4 group during Lesson 1, girls had twice as many Watching/Listening codings as boys : g = 11.8%, b = 23.1% (see Table 1), but in Lesson 3 these percentages were far more equal: g = 28.7%, b = 21.3% (see Table 6).

Each of the students, with the exception of S2, showed increased levels of watching and listening, probably because of the high levels of teacher monitoring and intervention in this lesson. S2 was assigned the role of Tracker. She showed a decrease in passive watching and listening from 17.2% in Lesson 1 to 14.9% in Lesson 3, indicating more involvement and participation in Lesson 3. The field notes recorded at the conclusion of this lesson indicate bursts of role appropriate activity exhibited by S2, with lapses to

normal "non-involvement".

In the Year 5 class, Watching/Listening behaviours were very similar to Lesson 1, with both boys and girls having approximately equal percentages of the total coding in this category.

Lesson 1 : g = 25.8%, b = 23.1% (see Table 1).

Lesson 3 : g = 13.1%, b = 14.6% (see Table 6).

Comparison of the results of observations made in Lesson 3 and Lesson 1 show a change in watching and listening behaviour for S2 (Year 4) after role allocation.

Observed Differences in Manipulating Equipment Behaviour in Lesson 3

The Year 4 girls made large gains in the manipulation of equipment category codings. In Lesson 1 the ratio of boys using equipment to girls using equipment was approximately 3:2 (g = 14.5%, b = 22.0% see Table 1). In this lesson the ratio was far more equal : g = 7.5%, b = 8.5% (see Table 6).

Individual analysis shows that the bulk of the equipment manipulation was done by S1 and S6. S2 only handled the equipment once or twice during the lesson. S5 complained during the post programme Interview that he didn't like working in groups because "...I couldn't get my shot because [S6] took it, or [S1] and if I did get a shot, [S6] would just take the Lego off me".

S1 also felt she did not do enough manipulation of

equipment. She complained in the Interview that she didn't actually build the models, "...just ... fiddle around with it a little bit afterwards".

S6 complained that his role as Communicator hampered him and "I didn't get to do much..."

In fact, these three students had approximately equal codings in this category. The only group member who considered she got equal turns was S2, the student with by far the least codings.

The Year 5 group showed an inversion of the ratio of manipulating the equipment from Lessons 1 to 3. In Lesson 1 : g = 11.0%, b = 16.7% (see Table 1) a ratio of approximately 2:3. In Lesson 3 : g = 20.4%, b =14.6% (see Table 6) a ratio of approximately 3:2.

The largest gain was made by S2, the Tracker (Lesson 1 = 5.0%, Lesson 3 = 14.1%). A large decrease was made by S6, the Communicator (Lesson 1 = 8.0%, Lesson 3 = 3.9%).

S2 used the role of Tracker to take charge of the task after being challenged for not doing her job.
S6 to S2 "You're the Tracker, man. You're meant to know what to do, where we're up to." She then embraced the role and became very directive.
S2 to Group "Next we have to turn the handle wheel clockwise."

... to S6 "It has to be much longer."

... to S5 "You can fill in this part."

She was also the student who physically removed the Lego from the box and began making the model.

S5, the Recorder, was off-task a good deal during this lesson (see Observed Differences in Off-Task Behaviour in Lesson 3, p.58). He was manipulating the equipment to construct a personal model of an army tank.

S6 did less manipulation also. As the Communicator, he used the opportunity to investigate the work of the other groups, leaving his own group on several occasions during the lesson.

Comparison of the results of observations made in Lesson 3 and Lesson 1 show a change of levels of manipulation of equipment codings of all students, some in a positive way, others in a negative way.

Observed Differences in Verbal Interactions in Lesson 3

The Behaviour Instrument showed the Year 4 girls increased their proportion of talk : g = 8.5%, b = 3.1% (see Table 6) compared with the Lesson 1 codings : g = 5.9%, b = 10.8% (see Table 1). The Verbal Instrument supported these patterns, although the percentages were much closer : g = 30.6%, b = 32.8% (see Table 7).

On an individual basis S2, the Tracker, increased her verbal interactions from Lesson 1, but still had fewer interactions than other group members (S2 as speaker = 6.7%, as listener = 2.3%). An apparent anomaly

in the Behaviour Instrument readings for this student show an increase in the Verbal Interaction category from Lesson 1 = 1.0% to Lesson 3 = 5.3% of all codes in this lesson. As previously stated, S2 had bursts of Tracker appropriate role behaviour which necessitated verbally directing other group members, and it is postulated by the researcher that several of these incidents may have coincided with Behaviour Instrument coding intervals.

The Behaviour Instrument also showed a marked decrease in verbal interactions for S6, the Communicator: Lesson 1 = 5.9%, Lesson 3 = 1.0%; but the more sensitive Verbal Instrument does not show this large difference :

Lesson 1 S6 as speaker =19.5%, as listener = 7.1%

Lesson 3 S6 as speaker =16.0%, as listener = 9.1%

Table 7

Lesson 3 Verbal Interactions, Year 4

	S1	S2	S5	S6	Group
Frequency of speaker	23.7%	6.9%	16.8%	16.0%	
Frequency of listener	16.0%	2.3%	10.7%	9.1%	28.2%

Both instruments agreed that the boys in the Year 5 target group increased their verbal interactions to approximately twice the level of the girls in this lesson: g = 5.8%, b = 10.7% on the Behaviour Instrument (see Table 6); g = 28.2%, b = 66% on the Verbal Instrument (see Table 7). This was significantly different to Lesson 1, with its more equal codings.

Table 8

Lesson 3 Verbal Interactions, Year 5

	S1	S2	S5	S6	Group
Frequency of speaker	12.7%	15.5%	38.5%	27.4%	
Frequency of listener	8.5%	14.0%	22.3%	22.5%	22.1%

This difference may have been due to the fact that the two girls in the group did not speak to one another during this lesson. The girls spoke to the boys, the boys spoke to the girls, and to one another, but the girls did not speak to one another (see Table 9). The researcher can only speculate an argument or tiff as the reason for this result, as it was unique to this lesson. The two girls usually interacted well.

Table 8

Lesson 3 Speaker by Listener, Year 5

	Listener	
	Girl	Boy
Speaker Girl	0%	20.6%
Boy	22.1%	23.2%

The rest of the talk was directed to the group in general or the teacher.

Comparison of the results of observations made in Lesson 3 and Lesson 1 shows a change in the verbal interactions of some students.

Observed Differences in Off-Task Behaviour in Lesson 3

The Year 4 levels of off-task behaviour were slightly higher than in Lesson 1:
Lesson 1 g = 2.2%, b = 3.8% (see Table 1)
Lesson 3 g = 5.3%, b = 4.3% (see Table 6).

In the Year 5 class, S5 was off-task significantly more than any other student : S1 = 1.4%, S2 = 1.4%, S5 = 6.8%, S6 = 2.4%. This behaviour explains the high readings in Table 8 : g = 2.4%, b = 9.2%.

S5 was constructing a model of his own from the

Lego. The other group members spent some time attempting to get him on-task. The lesson transcripts illustrates one of these attempts:

S2 to S5 "What are you doing?"

S5 to S2 "Just making a little tank."

S6 to S5 "Take it apart or you'll get into trouble."

S5 to Group "Oh well, the army tank explodes."

Comparison of the results of observations made in Lesson 3 and Lesson 1 show more off task behaviour generally, and especially by S5 in the Year 5 group.

Other General Observed Differences in Behaviour in Lesson 3

The Behaviour Instrument was used to code non role-appropriate behaviour exhibited in this lesson. This category was coded using 30 second intervals. This method was not successful at indicating non role-appropriate behaviour. Ideally this behaviour should have been incident recorded to give a true indication of its prevalence. Therefore the observations of this behaviour are anecdotal from the field notes rather than empirical.

In the Year 4 group, S1, S2 and S5 showed some incidences of non role-appropriate behaviour. S5, as previously mentioned, took the role of Recorder very seriously, only relinquishing the worksheet to S1 when he felt he was missing out on manipulating the

equipment. At this stage, fairly late in the lesson, he reverted to the type of behaviour recorded during Lesson 1.

S1 took the role of Recorder from S5 in addition to her role of Manager for the last part of the lesson.

S2, as previously mentioned, exhibited bursts of Tracker role appropriate behaviour, and in between, lapsed back to non-involvement.

In the Year 5 group, S2, the Tracker, and S5, the Recorder, showed some examples of non role-appropriate behaviour. S2 did some recording after constant reminders to S5, whose role it was. The transcripts of the lesson show several references to role behaviour :

S6 to Group "Who's the Tracker?"
S1 to S6 "Ask [the teacher]. YOU have to ask.

Summary

To summarise, the differences between boys and girls observed in Lesson 3 were:

* girls and boys shared the reading and writing,
* girls and boys watched and listened at equal rates,
* girls manipulated the equipment at least as much as boys,
* the frequency with which a student spoke may have been modified by the role allocated to the student,
* a Year 5 boy was very off-task during this lesson, and
* some students showed examples of non role-appropriate behaviour, but generally role behaviour as identified in Appendix 1 was dominant over behaviour attributed to gender.

1.3 "Were any changes in behaviour observed in Lesson 6?"

The Communicator of the Year 4 target group, a boy, was absent for Lesson 6. This meant the data could not be directly compared with the previous lessons' data, nor with the Year 5 data, as research in the field of small group work indicates that the size and composition of the group has marked effects on the group dynamics (Good & Brophy, 1991; Webb, 1984).
The Year 4 results will be discussed after the Year 5 results have been compared as in the previous lessons.

Lesson 6 showed a pattern of reversion to gender behaviour at the expense of role appropriate behaviour for some of the Year 5 students.

Table 10

Lesson 6 Behaviour by Gender, Year 5

	(N = 4)
Reading/Writing	g = 9.5% b = 8.1%
Watching/Listening	g = 12.2% b = 6.8%
Manipulating Equipment	g = 13.6% b = 19.0%
Verbal Interactions	g = 7.3% b = 7.3%
Off-task	g = 3.1% b =13.1%
	100%

Observed Differences in Reading/Writing Behaviour in Lesson 6

This lesson required more reading and writing than previous lessons. The Year 5 students showed almost equal levels of reading and writing behaviour : g = 9.5%, b = 8.1% (see Table 10), compared with Lesson 3 : g = 3.9%, b = 3.4% (see Table 6).

The Recorder, S5, was again constantly directed by S2, the Tracker. Some examples of these directions were:
"[S5] put there - They're fast, they're slow."
" You can write down SOMETHING."

S1, the Manager, showed the most significant change in behaviour, reverting to doing most of the reading and writing in this lesson as she had in Lesson 1. Although she was still exhibiting Manager-role behaviours, she reverted to the Recorder role.

Comparison of the results of observations made in the three lessons show some of the group members maintaining a more equitable share of the reading and writing behaviours. S1, however, reverted to Lesson 1 levels of this behaviour by doing more reading and writing than any of the other group members.

Observed Differences in Watching/Listening Behaviour in Lesson 6

Table 10 shows the Year 5 girls did almost twice as

much watching and listening as the boys. When analysed individually, S1 was responsible for the largest proportion of these codings : S1 = 9.5%, S2 = 2.7%, S5 = 1.4%, S6 = 5.4%. The field notes record that the Manager spent most of her time "looking at others". She joined in off-task conversations, for example :

S1 to S6 "Mark him up in the classroom."

S6 to S1 "Yeh, that's my nickname, Marky."

S1 to S6 "Marky, oh, Marky."

Comparison of the results of observations made in the three lessons show a reversion by one of the Year 5 girls to the baseline levels of behaviour in the watching and listening category.

Observed Differences in Manipulating Equipment in Lesson6

Although the percentages for this category appear close : g = 13.6%, b = 19.0% (see Table 10), individual analysis showed S2 and S5 working with the equipment three times as much as S1 and S6.

S6, the Communicator, gradually increased his manipulation of the equipment towards his Lesson 1 percentages after having exhibited a large percentage drop in this behaviour during Lesson 3.

Lesson 1 = 8.0%, Lesson 3 = 3.9%, Lesson 6 = 5.9%

S1 did very little manipulation in this lesson. She had to reach diagonally across two joined tables to touch the equipment which was mostly in front of S5.

The other girl in the target group, S2, the Tracker, maintained her increased levels of manipulating the equipment and decreased levels of watching and listening throughout this lesson.
Lesson 1 = 5.0%, Lesson 3 =14.1%, Lesson 3 = 10.4%

S5, the Recorder, increased his levels over the three coded lessons:
Lesson 1 = 8.7%, Lesson 3 = 10.7%, Lesson 6 = 13.1%
He had physical control of the equipment for most of the lesson.

Comparison of the results of observations made in the three lessons show that S1 and S6 reverted towards baseline levels of manipulating the equipment, while S2 maintained an increased level.

Observed Differences in Verbal Interaction in Lesson 6

Verbal interactions were coded as identical for boys and girls in this lesson : g = 7.3%, b = 7.3% (see Table 10). The more sensitive Verbal Instrument showed g = 40.8%, b = 56%.

For the first time, S6, the Communicator, seemed to become a dominant member of the group. He initiated conversation 31.2% of the time (see Table 11). In fact, he more than doubled his verbal interactions from Lesson 1 to Lesson 6 : Lesson 1 = 14.2%, Lesson 6 = 31.2%.

S1, the Manager, appeared to fade out, participating less and seemingly less interested. She

initiated less conversation and was addressed less often by the others.

S2, the Tracker, maintained a high profile in the group. Her task oriented verbal interactions were maligned by S5, the Recorder, as the following conversation illustrates:

S5 to S2 "[S2] stop bossing us around."

S2 to S5 "I'm just telling you what you have to do."

S5 to S2 "OK, OK, that's still bossing."

S6 to S5 "We don't have to do it."

S5 to S6 "Why doesn't she be better?"

S2 to S5 "Do you want me to say ANYTHING? You guys say anything you want."

S1 to S5 "Stop hassling us OK?"

S5 to S1 "NO"

Table 11

Lesson 6 Verbal Interaction, Year 5

	S1	S2	S5	S6	Group
Frequency of Speaker	13.9%	26.7%	24.8%	31.2%	
Frequency of Listener	7.3%	19.0%	17.1%	14.5%	32.7%

The levels of conflict in this lesson were high. Conversations which began innocuously became increasingly acrimonious. S5 and S6, the boys in the group, were involved respectively in 16 and 26 of the total of 62 conflict codes for this lesson. Lesson 1 had only two codes recorded, and Lesson 3, fourteen.

Comparison of the results observed in the three lessons show an increasing level of discord within the group after the allocation of roles.

Observed Differences in Off Task Behaviour in Lesson 6

The Tracker, S2, was the only Year 5 group member to record no codes of off task behaviour. Both boys had 6.5% each of the total codes for the lesson recorded on the Behaviour Instrument as Off Task. Most of this behaviour for S5, the Recorder, involved making his own models with the equipment, while S6, the Communicator was involved in a lot of verbal bickering with the others, as well as fiddling with the equipment. He was not constructing anything, merely turning a Lego piece such as a wheel, over and over in his hand.

Comparison of the results of observations in the three lessons show increasing levels of Off Task behaviour from Lesson 1 to Lesson 6.

Other General Observed Differences in Behaviour in Lesson 6

As previously mentioned, the levels of conflict were high in this lesson (see Observed Differences in Verbal Interactions in Lesson 6, p.65).

The girls dismantled the models and packed away the equipment. This did not happen in any other lesson. Usually all the group members helped with this task.

Summary

To summarise, the differences between Year 5 girls and boys observed in Lesson 6 were:

* a girl did most of the reading and writing,
* a girl did most of the watching and listening,
* a girl and a boy worked with the equipment almost three times as much as the other pair,
* one girl was verbally very passive,
* the lesson was marked by high levels of verbal conflict,
* the boys were off task more than the girls,
* both girls packed the equipment away.

Year 4 Behaviour in Lesson 6

As previously explained, the absence of a group member could be expected to change the dynamics of the group, and therefore the results from this lesson are not compared with the Year 5 results, nor with the previous Year 4 results. The statistical results from the Behaviour and Verbal Instruments have been tabulated individually and not segregated by gender in this section (see Table 12).

Table 12

Lesson 6 Behaviour, Year 4

	S1	S2	S5
Reading/Writing	1.6%	5.2%	9.4%
Watching/Listening	6.3%	16.2%	8.9%
Manipulating Equipment	19.8%	5.2%	6.8%
Verbal Interactions	7.3%	3.2%	7.3%
Off task	0.6%	0%	2.2%
		100%	

For this lesson, S5, the Recorder, also took on the role of the absent Communicator, S6.

S1, the Manager, did most of the manipulation of materials (see Table 12).

S2, the Tracker, played a more participatory role in this lesson. In the four person group she was very passive, but in this three person group she exhibited less watching and listening behaviour, more reading and writing behaviour, and increased verbal interactions. The Verbal Instrument shows her frequency of speaking as almost equal to the other two students (see Table 13).

Table 13

Lesson 6 Verbal Interactions, Year 4

	S1	S2	S5	Group
Frequency of Speaker	25.8%	24.3%	28.8%	
Frequency of Listener	15.0%	8.7%	16.1%	41.6%

The high frequency of the group as a listener, that is, the conversation was addressed to all rather than one individual (see Table 13); suggests a more cohesive group. The transcripts of the lesson reinforce this in the type of language used. There was less bickering and more sharing. Little off task behaviour was shown.

Research Question 1:

"Can any observed differences in the gender behaviour of girls and boys in science be modified by the assignment of specific roles in mixed-gender groups?"

From the research data presented it can be concluded that the assignment of roles corresponded with changes in gender behaviour of students in the target groups at both year levels in several categories of behaviour in this study.

Allocation of roles equalized the reading/writing activities of the students. Prior to role allocation the girls had followed a path identified as "typically female" by researchers (Kahle, 1987; Kelly, 1982; Rennie et al, 1984), by doing all the reading and writing activities for the group. Assigning non-traditional roles with concomitant expectations of appropriate role behaviour seemed to encourage target students to change their gender stereotypical behaviour in this category. The boys did more reading and writing, the girls less, after role allocation, changing their behaviour in this category.

Allocating roles seemed to aid some more passive students to participate more in the group and exhibit less watching and listening behaviours. Before role allocation the Year 4 girls watched and listened more than the boys; after role allocation the rates were more

equal.

The Year 5 girls and boys watched and listened at equal rates throughout the programme, and role allocation had no detrimental effect on these rates. It seems possible these behaviours might be age/maturity related.

Allocating the non-traditional role of Tracker to a girl seemed to encourage more participation in the lesson than might otherwise have occurred. The data do not suggest the other roles were affected to the same extent as this role.

Allocating roles changed the behaviour of both boys and girls in the manipulation of equipment category. Before role allocation the baseline data suggested the type of scenario reported in the literature, with the girls recording, and the boys almost exclusively doing the activity (Kelly, 1987; Whyte, 1984). After role allocation the girls and boys manipulated the equipment to do the activity at more equal rates. In the Year 5 group, the girls handled the materials even more than the boys.

Some students seemed to use the opportunity to replace gender behaviour with role behaviours and maintained increased levels of non-traditional gender behaviour required by the role allocation. Further research might indicate the personality traits of the students who would benefit most from this opportunity.

Patterns in the data from this study could not be

used to substantiate claims made in the literature that boys had more verbal interactions than girls in small group work (Webb, 1984). The only pattern appearing in the data appears to support frequency of talk being a function of the passivity/dominance of the individual, regardless of gender (Good, Reys, Grouws & Mulryan, 1989).

Following role allocation it appeared that the roles of Tracker and Communicator encouraged more student verbal interactions, but the trend of passivity/dominance of the individual was still paramount.

The increased verbal interactions of the Year 4 Tracker, S2, would have been extremely interesting to chart through Lesson 6. As previously discussed, the absence of one of the group members could be expected to change the group dynamics, so the apparent pattern could not be interpreted as a continuing one. The results recorded by the Year 4 three person group may indicate more involvement of passive individuals in smaller groups.

Role allocation could not be said conclusively to modify verbal interaction in the short term.

The levels of off task behaviour were higher in the lessons where students had been allocated roles. In the short period of time involved in this study, it is difficult to conclude that roles increase off task behaviour. Other factors such as the students' interest

in the programme; the group dynamics; personal student characteristics and the loss of novelty and motivation of group work in science may have caused this result.

The "calling out" and disruptive off-task behaviour attributed to boys and reported in Chapter 2 was not evident in this study. Off task behaviour was mainly exhibited within the group. It did include the withdrawal and tuning out of the girls as reported, but not the misuse of equipment by boys.

Summary

Overall, it appears that role allocation corresponded with changes in gender behaviour in the areas of reading and writing and manipulation of equipment, but the data were not conclusive that role allocation changed gender behaviour in the other categories.

Research Question 2:

"Are there any differences in gender behaviour between Year 4 and Year 5 students?"

The baseline data indicated that girls and boys at both year levels exhibited behaviour attributed to gender in the literature (Rennie et al, 1984).

The girls did the reading and writing for the group and the boys manipulated the equipment (see Table 1).

At the Year 4 level the differences in Watching/Listening behaviour between girls and boys was large, but as previously reported, mainly attributable to one passive student (see Table 1). The Year 5 levels in this category were approximately equal on a gender basis (see Table 6). Rennie et al (1984) reported large differences in this behaviour when Year 5 physical science lessons were coded with the Group Work Schedule, which was adapted slightly for this study. With the small sample used in this study it is difficult to draw accurate conclusions, other than noting the possibility of an age/maturity differential.

This sample also leads the researcher to conclude that verbal interaction is a function of dominance/passivity rather than gender. Both target groups could be considered to have one dominant boy and one dominant girl. In the Year 4 group, three of the students

struggled for leadership of the group with concomitant power plays being a feature of the verbal interactions. The Year 5 target group worked more cooperatively. After role allocation they shared the reading/writing and manipulating of equipment more equally, and "helping" behaviour was a feature of several verbal interactions (see discussion Other General Observed Differences in Behaviour, Lesson 1, p.49).

Analysis of the verbal interactions showed the Year 5 group asked more higher level cognitive questions (average 4.9% of all questions asked) than the Year 4 students (average 3.2%). This increase would be expected with added maturity.

Summary

The researcher found any differences in gender behaviour between Year 4 and Year 5 students to be minor. The added maturity of the Year 5 students may have allowed them to work together more cooperatively.

Research Question 3:

"Do students in mixed-gender groups show greater changes in attitude to science than those in single-gender groups?"

On the gross data, 't' tests revealed no statistically significant levels of change. No conclusion can be drawn regarding the changes in attitude to science as a function of mixed- or single-gender grouping. The largest changes in attitude were evidenced by single-gender groups in Year 4 and mixed-gender groups in Year 5 (see Table 14).

Table 14

Attitudes to Science by Group

	Average Questionnaire Rating (High attitude to science = 6, Low attitude to science = 1)		
	Initial	Final	Change
Year 4 (N = 26)			
single-gender	5.5	4.6	-0.9
mixed-gender	5.7	5.3	-0.4
Year 5 (N = 28)			
single-gender	5.0	4.5	-0.5
mixed-gender	4.5	3.6	-0.9

When the data were analysed along gender parameters, the boys, regardless of grouping, showed very little change in attitude to science over the programme, while the girls seemed to lose their positive attitudes (see Table 15). Results from 't' tests show the changes are significant at the 5% level for the Year 4 single-gender girls' group. Changes for other groups are not statistically significant. Since further analysis showed attitude to group work did not change, it seems that the programme was responsible for the measured change of attitude to science. This dislike of, or disinterest in, physical science topics is well documented in the literature (Kahle, 1987; Kelly, 1987), and even though gender neutral strategies were included in the programme to interest the girls as well as the boys, the topic was not a popular one with them (see Table 16).

Further probing during the Interviews elicited the information that the topic was "pretty boring" (Year 5 girl) and " I didn't really like it that much".

Although analysis of response in the group interactions category questions on the Initial and Final Questionnaires did not show any changes in attitude to group work, the Interviews with the target students highlighted group management problems which may nevertheless have had an influence on individual attitudes to science.

Table 15

Gender Attitude to Science by Group

	Average Questionnaire Rating (High attitude to science = 6, Low attitude to science = 1)		
	Initial	Final	Change
Year 4			
single-gender	g = 5.7	3.7	-2.0
(n = 14)	b = 5.4	5.0	-0.4
mixed-gender	g = 5.7	5.0	-0.7
(n = 12)	b = 5.7	5.7	0
Year 5			
single-gender	g = 4.4	4.3	-0.1
(n = 16)	b = 5.5	5.3	-0.2
mixed-gender	g = 4.3	2.7	-1.6
(n = 12)	b = 4.7	4.5	-0.2

Table 16

Gender Attitude to Science

	Average Questionnaire Rating (High attitude to science = 6, Low attitude to science = 1)		
	Initial	Final	Change
Year 4	g = 5.7	4.6	-1.1
(N = 26)	b = 5.5	5.3	-0.2
Year 5	g = 4.6	3.7	-0.9
(N = 26)	b = 5.0	4.8	-0.2

Summary

It seems the composition of groups had less effect on attitude to science than the gender of the students. The pattern of changes in attitude as measured by the Initial and Final Questionnaires was delineated on a gender basis with girls evidencing more change than boys regardless of mixed- or single-gender groupings.

Supplementary Results

Although this research project did not set out to address the issue of achievement as a function of group work, the teachers requested an assessment in the form of an End of Unit Test be included in the programme. This test was composed of structured questions. Research findings show this format is more gender-neutral than multiple choice or essay questions (Harding, 1980).

A pattern was noted by the researcher when examining the results of these Assessment Tests. These findings are additional to the original intention of the study, and therefore have no bearing on the Research Questions. However, they were deemed worthy of discussion and inclusion in the thesis.

The researcher marked the Year 4 tests, and recorded the results; the Year 5 tests were marked by the classroom teacher from a marking key provided by the researcher.

Analysis of results showed the groups which had worked best together (as subjectively noted by the class teacher and the researcher at the conclusion of each lesson and recorded in the field notes) attained the highest aggregate of results.

In the Year 4 class, the all girls group G1 and the Target Group had average scores well above the rest of the class : G1 = 87.5%, T = 83.8%. Class average = 64.2%

(see Table 17).

In the Year 5 class the nominated cooperatively working groups similarly attained the highest scores : G2 = 92.5%, T = 86.3%, Class average = 73.6% (see Table 17).

Table 17

Assessment Test Results

		Group Composition		Average Score
Year 4 (N = 26)	*	Mixed	Target	83.8%
		Mixed	M1	49.4%
		Mixed	M2	66.3%
		All boys	B1	50.9%
		All boys	B2	47.5%
	*	All girls	G1	87.5%
		CLASS AVERAGE		64.2%
Year 5 (N = 28)	*	Mixed	Target	86.3%
		Mixed	M1	77.5%
		Mixed	M2	85%
		All boys	B1	58.8%
		All girls	G1	70%
	*	All girls	G2	92.5%
		All girls	G3	45%
		CLASS AVERAGE		73.6%

* denotes cooperatively working groups

These results could not be considered valid or reliable because of the initial method of choosing the target groups. High and low achievers were excluded

from the mixed-gender groups by applying the criteria designed to include only "typical" students (see Figure 2), and therefore it is conceivable that the single-gender groups comprising the rest of the students may have inadvertantly included all high or all low achievers in one group, thereby skewing the results. Nevertheless, there seem to be indications of a correlation between cooperative ability or cohesiveness of a group and their subsequent achievement. This would align with results found by Johnson et al (1990).

Summary of the Chapter

This chapter reported the results from the data collected in this study, and discussed consistent interpretations in the context of the Research Questions posed in Chapter One.

CHAPTER FIVE

Conclusions and Implications of the Study

This study investigated the effects of role allocation on the gender behaviour of girls and boys in Year 4 and Year 5 cooperative learning groups of four in science. Both classes were taught the physical science topic "Wheels and Cogs" by the classroom teacher from the same six-lesson programme. Target groups in each class were observed and behaviours and verbal interactions of the students before and after the allocation of the specified roles were compared. Selected results from this study were used to address the research questions.

A Behaviour Instrument was used to record behaviours displayed by each of the target students at 30-second intervals throughout the lessons. Transcripts of audio tape recordings of the lessons were coded using the MAKITAB Small Group Learning Interaction Analysis System. Anecdotal field notes were compiled for each lesson. Pre- and post-programme Questionnaires and an End-of-Unit Assessment were completed by all students in each class. The target students and the teachers were interviewed at the conclusion of the programme.

Results and Findings

The size of the sample selected and the complexity of independent variables acting on this data set mitigates definitive conclusions being drawn.

Data collected in this study indicates that following role allocation, there were changes in the behaviour of boys and girls in mixed-gender groups in the reading/writing and manipulating equipment categories of gender behaviour. This change of behaviour was continued by some students for the duration of the role allocation.

There was little difference in the type and amounts of gender behaviour between the year levels; Year 4 and Year 5 target students both exhibited comparable codings in each category measured.

Changes in attitude to science were evidenced more by girls than boys regardless of grouping. The choice of a physical science topic may have influenced these changes of attitude to science (see discussion p.78).

Discussion Related to the Literature

No studies were identified on the interaction of role behaviours and gender behaviours, so this study adds to the knowledge in this area.

Kahle (1984), Kelly (1987) and Whyte (1984) suggested the girls in a mixed-gender group read the

instructions and recorded the results, while the boys manipulated the equipment and did the experiment. The baseline data from this study supported the literature in this respect. This study showed more equal interactions in some categories of gender behaviour between boys and girls in mixed-gender groups when non-traditional roles with specified behaviour expectations were allocated.

Other studies which investigated the effect of different strategies on gender behaviour also concluded that group dynamics and gender behaviour can be modified. Rennie et al (1984) used an inservice course on non-sexist teaching to attain more equal interactions in mixed-gender groups being taught a physical science topic. Lockheed and Harris (1984) found gender stereotypes were not reduced by cooperative grouping until they controlled for male leadership.

Patterns in the data from this study could not be used to support claims made by Spender (1980) that boys in a mixed-gender environment had more verbal interactions than girls. Nor could the data justify the findings of Webb (1984) that the total verbal activity for boys was equal to the total verbal activity for girls, allowing for differences in the type of interaction between the sexes. The only patterns identified in this study related the frequency of talk to the passivity or dominance of the individual, regardless of gender. Good

and Brophy (1991) suggest the composition of each group determines the verbal interactions, which necessarily vary from one group to another. The failure of the study conclusively to support the literature in this area may be as a consequence of the particular groupings and the small sample size in this study.

Kelly (1987, p.71) observed that boys used "ridicule to remind girls of their inferior status", and this trait was illustrated by several of the passages of conversation.

This study found only minor differences in gender behaviour between year levels, and did not support the findings of Erickson and Erickson (1984), who showed similar levels of curiosity and interest in science until about nine years of age and a significant decline thereafter.

Kelly (1987) found a strong correlation between female gender and negative attitude to the physical sciences and Johnson and Johnson (1975) found higher levels of male interest in science. This study supported these findings.

The research design used in this study allowed the collection of data to formulate answers to the research questions and to draw some conclusions. However the ambiguous nature of some of the findings highlight the complex nature of group work and student performances.

Impacting Variables

Five factors have been identified as contributors to the ambiguous nature of some of the results: the different teaching styles of the participating teachers; the preparation of the students; the content of the lessons; the differing time periods over which the programme was implemented; and the length of the study.

Different teaching styles of the participating teachers may have affected the results of the research. Although each taught from a prescriptive programme, the Year 4 teacher often recalled the class from small group to whole class format to further explain a concept. The Year 5 teacher explained concepts to each group when required, and did not use the whole class format. The Year 4 children therefore had less time in small group work due to the interruptions, but results show they spent more time on task. The Year 5 class had uninterrupted small group work, but showed more off-task incidents. Other results may also have been affected.

The students had no previous experience of role allocation in science lessons. This lack of experience and necessity for "on-the-job training" may have caused some confusion and affected measurements of some behaviours.

The physical science content of the lessons which could be expected from the literature to appeal more to

the boys than the girls in the class, may have influenced their behaviour during the study.

The Year 4 class completed the programme in six weeks, the Year 5 class in three weeks, and this difference in time period may have affected the results. Any novelty effect due to the specific roles may have been influenced in either a positive or a negative manner by the time period, although the data collected in the study did not address this variable. The spread of the lessons may have added a dimension of once-a-week novelty to the Year 4 lessons, or required more effort to remember the roles, or, alternatively, allowed the Year 5 students to remember the role behaviours more easily, or lose interest in the group format.

Had the study been continued over a longer period of time, for example a semester, the patterns emerging may have been clearer. The beginning trend of reversion to gender behaviour at the expense of role behaviour for some students may have been modified by other factors.

If this study were replicated, it would be advantageous to control more closely the teaching style, student preparation,and time period of the research. More detailed questionnaires may have clarified some of the ambivalent results. The overall structure of the research design appeared sound in terms of gathering the required data, and the instruments used functioned as planned.

Implications for Instruction

The research design appeared to assess appropriately the parameters being investigated even though the sample is small. The behaviours coded as baseline data agree well with those expected from the literature. Results gathered from this research study have implications for teachers, students and science education.

* Pre-treatment measures indicate that gender inequities do exist in small group work in science. The changes in gender behaviour following role allocation in the areas of reading/writing and manipulating equipment imply that this strategy may be useful in promoting gender equity.

* Implications for students are highlighted by the changes in gender behaviour in both girls and boys which followed role allocation. Some students, when offered the opportunity to use non-traditional role behaviour, did so and subsequently became more highly involved in the lessons. Having a role to play seemed to add a dimension of purpose to their behaviour.

* Working in small groups in science seemed to encourage pupil responsibility and some affective gains were made. A favourable attitude to group work persisted with most students in the class. The behaviour of some target students subjectively offered

an increase in levels of personal responsibility for learning and group interaction. Close monitoring of small groups by the teacher appears necessary to limit high levels of off-task behaviour.

* Curriculum developers may need to examine the approaches currently taken to physical science topics in the primary school. Even the gender-neutral strategies used in this study were not sufficiently motivating to the girls in the group, and an even more "girl-friendly" approach may be necessary for the maximum participation of girls.

Recommendations for Further Research

Analysis of the results discussed in Chapter 4 has highlighted several aspects of gender behaviour and cooperative learning in science which may be worthy of further investigation.

* Extension of the time period of the study, to a semester or a year, would allow deeper insights into the patterns which form over time.

* Investigations using teachers of different gender and experience levels would add to the generalizability of the study.

* Altering the numbers of students in a group, while still allocating roles to the group members, might

highlight strengths and weaknesses in varying group sizes.

* Studies of the effect of role allocation on gender behaviour in same-sex small groups would add to the data found on mixed-sex small groups in this study.

* Inter-group differences between lower and higher levels of primary-aged children, for example Year 3 and Year 6, could be investigated in order to pinpoint the age at which gender behaviour becomes a problem.

* The personality of the student most likely to benefit from role allocation may need to be further clarified. Data collected in this study shows that not every child benefits to the same degree, nor would we expect equal gains. Further research might tailor this method more closely to the cognitive and affective learning styles of individuals.

Summary of the Chapter

This chapter discussed the conclusions reached by this study and the implications for teachers, students and science education arising from the results. The data from this study imply that role allocation in small groups may be a useful strategy to promote gender equity in the science classroom. For some students cooperative learning in small groups may allow more participation

than other methods, and the allocation of non-traditional roles may allow the chance to experience non-stereotypical gender behaviour. Further investigation using larger samples would be necessary for conclusive proof of the efficacy of this strategy. Other areas for further research in this complex field have been listed.

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APPENDIX ONE

Specific Roles in Cooperative Learning Groups

The following role behaviours are considered appropriate for the specific roles allocated to the students in the cooperative learning groups in science.

Manager

The Manager is responsible for collecting and returning the equipment the team needs. The Manager also informs the teacher if something is damaged or broken. All team mates are responsible for cleaning up after an activity and getting the materials ready to return.

Tracker

The Tracker is responsible for tracking the team's progress through the steps of a team activity, and ensuring that every member of the team participates. The Tracker focusses the team's attention on the directions, or reminds team members to read the directions again if they are moving too quickly onto the next step. All team mates should help read and follow directions.

Recorder

The Recorder is responsible for completing the team record for the group activity. The entire team is responsible for assisting the Recorder in formulating the responses.

Communicator

The Communicator is responsible for asking the teacher or another team's communicator for help to resolve a question, or decide how to follow a procedure. The Communicator then shares the information with the other team members. All team members should be able to report on the team's results.

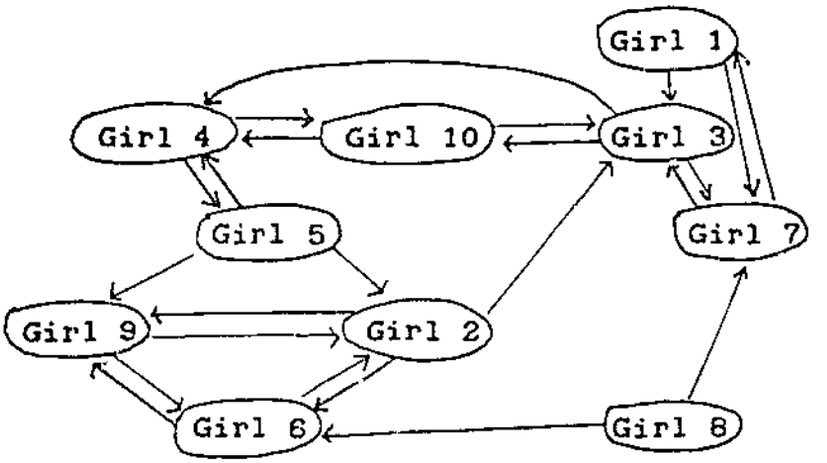
N.B. Although each student has a specific role to play in the team, all students manipulate the equipment and collect the data.

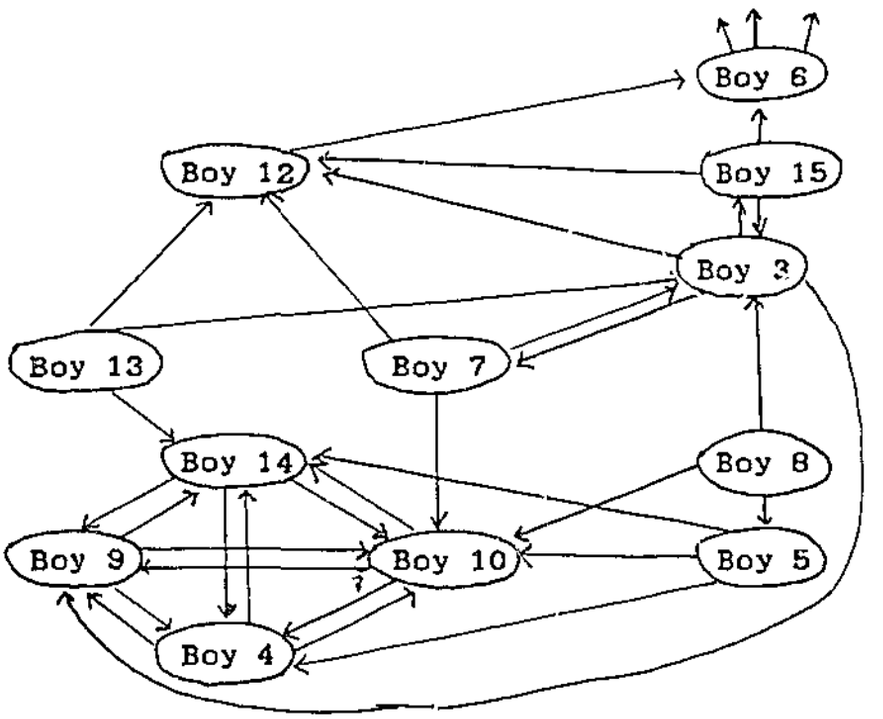
(Biological Sciences Curriculum Studies, 1989).

APPENDIX TWO

Class Sociogram

Year 4

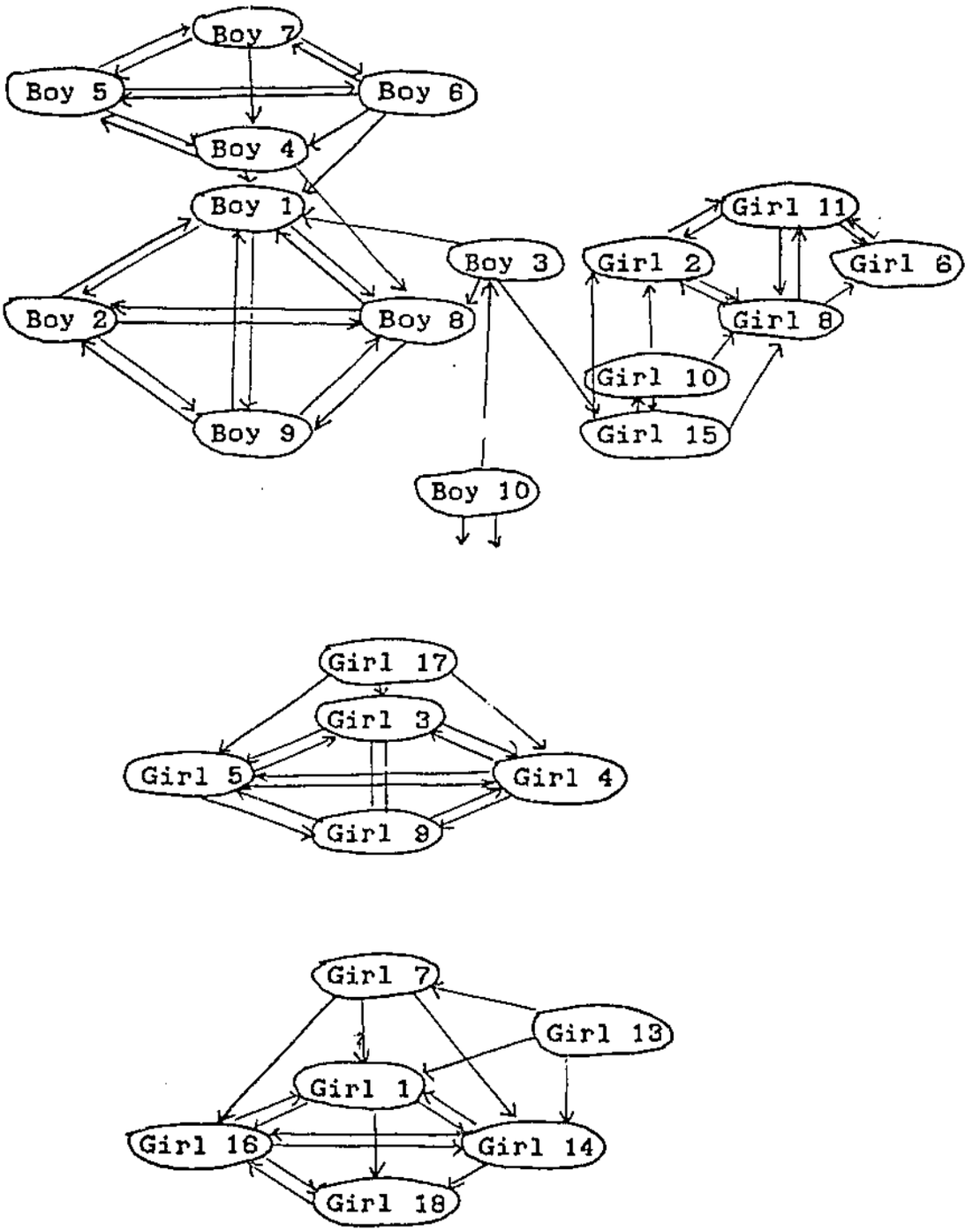




APPENDIX TWO

Class Sociogram

Year 5



APPENDIX THREE

Behaviour Instrument

	Student 1	Student 2	Student 5	Student 6
Reading/ Writing				
Watching/ Listening				
Manipulating Equipment				
Verbal Interactions				
Off Task				
Out of Role				

Faculty of Education
School of Education Studies
Pearson Street
CHURCHLANDS WA 6018

SMALL GROUP LEARNING INTERACTION ANALYSIS (MAKITAB)

August 1992

EDITH COWAN UNIVERSITY
PERTH WESTERN AUSTRALIA

WHOLE CLASS INTRODUCTION	GROUP TASK	GROUP DYNAMICS	MONITORING GROUP	WHOLE CLASS INTERVENTION	WHOLE CLASS WRAP-UP
IS01 Recapitulating from previous lessons	TS01 Management - materials / movement	DS01 Decision-making processes	MS01 Checking progress	NS01 Recapitulating previous activity	RS01 Recapitulating / summarizing lesson
IS02 Explaining task content / procedures / materials	TS02 Clarifying task directions / requirements	DS02 Assigning role(s)	MS02 Clarifying or eliciting task content / solution	NS02 Clarifying task content / procedures / materials	RS02 Marking / collating findings
IS03 Feedback - positive		DS03 Task feedback - positive	MS03 Feedback - positive	NS03 Feedback - positive	RS03 Feedback - positive
IS04 Feedback - negative		DS04 Task feedback - negative	MS04 Feedback - negative	NS04 Feedback - negative	RS04 Feedback - negative
IS05 Setting context	TS05 Determining work actions	DS05 Challenging group member(s) / asserting	MS05 Clarifying task procedures	NS05 Checking thinking process(s)	RS05 Reviewing thinking process(s)
IS06 Explicit teaching of content	TS06 Accepting work actions	DS06 Positive response to challenge / assertion	MS06 Giving answer / solution	NS06 Explicit teaching of new content	RS06 Looking ahead
IS07 Recapitulating task content / procedures	TS07 Rejecting work actions	DS07 Negative response to challenge / assertion	MS07 Giving explicit directions	NS07 Giving explicit directions	RS07 Giving directions
IS08 Control / discipline	TS08 Examining, comprehending, clarifying & routine responding	DS08 Seeking approval / feedback	MS08 Control / discipline	NS08 Control / discipline	RS08 Control / discipline
IS09 Student question / comment	TS09 Sudden ideas / insights	DS09 Self-evaluation - positive	MS09 Student initiated contact	NS09 Student question / comment	RS09 Student question / comment
	TS10 Proposing	DS10 Self evaluation - negative	MS10 Resolving problems (dynamics)	NS10 Checking progress / marking	
	TS11 Negotiating, arguing, reacting to ideas, insights or proposals	DS11 Monitoring behaviour in group			
	TS12 Final agreement	DS12 Group evaluation			
	TS13 Final rejection	DS13 Aggression / conflict			
	TS14 Representation	DS14 Seeking help			
	TS15 Reviewing	DS15 Offering help			
	TS16 Monitoring student / group progress				

SPEAKER - LISTENER

1-4	Female student
5-8	Male student
9	Group
U	Unknown student
C	Class
T	Teacher
H	Helper
P	Parent
O	Outsider
S	Self
X	Other /Coder

CODING NOTES

##99	Non-task related (IS, TS, MS, NS, RS)
0000	Cannot code
S	Statement - For coding questions substitute
?	for a cognitive question and
X	for all other forms of question

APPENDIX FIVE

SCIENCE QUESTIONNAIRE

Name: _____

Here are some questions about science.
First, here is a practice question. Colour in the circle which is right for your answer.

	Not at all	A little bit	A fair bit	A lot
How much would you like to meet a dinosaur?	○	○	○	○

(If you aren't sure how to answer, ask your teacher).
Now here are the questions for you.

	Not at all	A little bit	A fair bit	A lot
Do you think science is interesting?	○	○	○	○
Do you enjoy science?	○	○	○	○
How useful do you think science will be to you when you are an adult?	○	○	○	○
How much will you enjoy science if you work in groups?	○	○	○	○
Do you like working in groups with all girls / all boys?	○	○	○	○
How much do you like working in mixed groups with boys and girls together?	○	○	○	○

Do you get equal turns in groups with all boys or all girls?	YES	NO
Do you get equal turns in mixed groups?	YES	NO
Do you think boys and girls act the same in science lessons?	YES	NO

APPENDIX FIVE
SCIENCE QUESTIONNAIRE 2

Name:

Job:

Group:

	Not at all	A little bit	A fair bit	A lot
Did you find the Cogs and Gears lessons interesting?	o	O	◯	◯
Did you enjoy the Cogs and Gears lessons?	o	O	◯	◯
Did you learn anything about how Cogs and Gears work which you didn't know before?	o	O	◯	◯
How useful do you think knowing about Cogs and Gears will be to you when you are an adult?	o	O	◯	◯
Have you played with Lego Technics before?	o	O	◯	◯
Do you have Lego at home?	o	O	◯	◯
How much did you enjoy working in groups?	o	O	◯	◯
Did you like the job you had?	o	O	◯	◯

Did you have equal turns in your group? YES NO

Did one person take over your group and boss you around? YES NO

Do you think boys and girls act the same in science? YES NO

Do you have any brothers or sisters? YES NO

Could you please write their names and ages.

BROTHERS

SISTERS

APPENDIX SIX

Interview Questions for Semi-Structured Interview

Question 1. "Did you like the Wheels and Cogs programme? Why, why not?"

Question 2. "Did you enjoy using the Lego?"

Question 3. "Did you like working in groups?"

Question 4. "Did you like your group? Why, why not?"

Question 5. "Did you like your role? Why/why not?"

Question 6. "Did you think you had equal turns in your group? If not, who had the most turns and why?"

Question 7. "Do you think girls and boys act the same in science? If not, how are they different?"

Question 8. "Do you think having a job to do made any difference to how you worked? Did it make a difference to how anyone else in your team worked?"