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THE EFFECTS OF TEACHER'S WRITTEN COMMENTS ON PUPIL PERFORMANCE AND ATTITUDES

A thesis submitted in fulfilment of the requirements for the degree of Master of Philosophy of the Open University.

Psychology of Education

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ABSTRACT

The development of reinforcement theory and attitudes are examined, with particular reference to the influence feedback and knowledge of results (in the form of grades and comments) have on achievement and attitude change in science. Relevant previous research is discussed critically.
Hypotheses are formed regarding the effect of Teacher Written Comments on science attitudes and achievement.
Thirteen year old pupils were asked to grade comments either 'A','B','C','D' or 'E' depending on which grade they thought should go with the comments.
159 thirteen year old boys and girls were divided randomly into four treatment groups:- 1) Grades only, 2) Grades and matching comment, 3) Grade and above average comment, and 4) Control - existing marking and grading procedure.
The Science Attitude Questionnaire (Skurnik & Jeffs 1971) and a Science Achievement Test was administered before and after a topic (The Earth) was taught in science lessons. The pupil's work was marked, commented upon according to the four treatments above, and returned.
No treatment effects on science achievement were found for boys or girls. Treatment 3 was found to have produced significantly greater gain than the other treatments in the Science Interest, Social Implications of Science, Science Teacher and School factors of the Science Attitude Questionnaire.
Boys were found to have a significantly more favourable interest in science and it's social implications than girls.
Girls had a significantly more favourable attitude to school than boys.
Attenuation had reduced the sample to 147 (74 boys and 73 girls).
Two years later another application of treatments was given in

another middle school using 31 boys and 39 girls.

A significant treatment effect was found for the achievement gain for girls ($F = 4.71452$, $p > 0.1\%$). Follow up t tests showed girls in Treatment 3 to have made significantly greater gains than Treatments 1,2 or 4.

Again, some significant differences were found in favour of Treatment 3 in various attitude factor scores.

The findings are discussed comparing them with results from other researchers in this field.

The original findings of Page(1958) are not fully supported.

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"If flawless educational research
and efficient communication of its
results were usual, then perhaps
little harm would come of accept-
ing at face value the conclusions
drawn by those who engage in it".

Williams (1965) p.26

INTRODUCTION

Teachers within all types of schools differ in their beliefs, personalities, their approach to teaching, their organisational abilities and in many other ways. They also have many similarities e.g trying to take note of a child's social needs and background, his academic ability, personality and potential in attempting to maximise the pupil's learning.

One such shared belief leads to teachers spending many hours every week marking children's work, for it is a long standing educational custom that work needs to be corrected, checked and commented upon if the pupil is to realise his or her potential and make the most of their time in the educational system.

Often an individual school has a policy that corrected work must be assigned a mark (e.g. 9/10) or a grade (e.g. B+) which signifies something to the pupil and teacher (though not necessarily the same thing). One reason given for this is that the pupil will be motivated to maintain standards or achieve more (Stephens 1965) through their responses being reinforced and themselves feeling rewarded. Some teachers also spend hours writing comments alongside, at the bottom of, or at the top of children's work. These comments may contain detailed suggestions or criticisms, or may not and be restricted to one word, e.g. "good". The justification in writing comments is that they will produce some change in motivation, behaviour or attitude and eventually lead to a positive increase in attitude to the work, and/or attainment performance.

It seems appropriate therefore to examine how best may teachers spend their time to maximise the learning and motivating experiences for their pupils. The aims of this study therefore are:-

1. To examine the nature of reinforcement, its effects on learning and how school uses of marks, grades and comments may or may not be justified,

2. To examine how attitudes affect learning, and how they may be changed,

3. To look critically at the research concerning the effects of written comments on pupil's achievement and attitudes,

4. To formulate hypotheses based on the above concerning any relationship between comments, achievement and attitude and to test for any relationships experimentally.

CHAPTER I

REINFORCEMENTS, FEEDBACK AND KNOWLEDGE OF RESULTS

> "The essence of using written comments.....to motivate students to do better, is to involve them in an appraisal of their own work so they appreciate its errors and limitations but also see new possibilities".
>
> Beard and Senior 1980 p.73

> "A primary function of a teacher is to provide motivation through incentives and rewards to establish behaviour.... incentives may be provided by....reinforcers".
>
> ibid p.4

It may be argued that giving pupils grades or marks, and comments relating to those grades is supplying a pupil with knowledge of their results (K of R) which according to Allen (1972) is a method of supplying feedback. Allen also states that feedback could reinforce learning so that pupils who have received feedback learn more and score higher on tests than pupils who have had no feedback.

The above quotes and Allen's study contain several words (e.g. reinforcement) which need clarification if their method of operation in pupil learning is to be understood.

REINFORCEMENT

(i) Thorndike and satisfaction

E. L. Thorndike in formulating his "Law of Effect" early this century said that humans do not do something in order to achieve some future satisfaction but because satisfaction has been experienced; i.e. we make those responses which in the past have produced pleasure. He said that previous satisfaction has "reinforced" (strengthened) those responses which may lead to future satisfaction (Bolles 1979).

(ii) Tolman's purposive behaviour

Tolman as discussed in Bolles argued that behaviour is 'purposive'. That is, from animal observation studies it appeared that the animal's behaviour was guided by the outcome. He proposed that there is a 'need' for a particular goal. This 'need' was produced by either deprivation or incentive. When the animal acts in a certain way to satisfy this 'need' it may well act in the same way again because it has another 'need' for that goal and because it expects its behaviour will enable it to achieve that goal.

(iiia)
Hull's Need Satisfaction

According to Atkinson (1964), Clark Hull early in his career identified the paradigm which produced (in Thorndikean terms) the satisfaction, as a "reinforcing state of affairs". Later (Hull 1943) he said that a reinforcing state of affairs was the reduction of a biological need (e.g. hunger, thirst, sex etc.) cf. Tolman's need deprivation. One or more of these needs spurred the animal into action. This arousal was termed 'drive', e.g. if the animal was thirsty, the inner 'drive' aroused it into behaviour which ended in the animal drinking and satisfying its need. This drive activated the animal to behave, although in no particular way. (In this respect, the general activation theory ties in with the ethological use of 'drive' to explain spontaneous behaviour (Manning 1972)).

Hull maintained that when the need was satisfied and the drive reduced then the behaviour which produced the drive was reinforced, i.e.

> "there will be an increment in the tendency for that stimulus on subsequent occasions to evoke that behaviour"
> Atkinson 1964 p.64

This reinforcement cemented the bond (the connection) between the stimulus and the response (the need and the drinking).

Hull's "Drive-reduction" hypothesis was viewed by many as relevant to human reinforcement and learning. Peel (I956) said:-

> "When children are very young they demand 'need reduction' in a vehement way...... the smart pupil who brings up his exercise book for marking and anticipating the immediate praise (need-reduction)".
>
> p.26

Child (I973) discusses how the drive reduction theory may help the teacher in providing suitable reinforcement situations. Children, he states, show curiosity and questioning behaviour. The teacher should design the layout of the classroom to take account of these needs. As a result reinforcement occurs and the children maintain their inquisitive nature as their previous need was satisfied.

Hull's theory was based on experimentation using animals. Mowrer (I950) used it attempting to explain the needs of humans (other than homeostatic ones) e.g. need of security, of status, of approval, of success. He postulated that the anticipation of an action which previously threatened one or more of these needs and produced anxiety should lead to behaviour which avoided anxiety in the future. Anxiety he claimed was produced when, for example, through lack of money a person's need of security is put at risk. Behaviour would be produced which hopefully would reduce that anxiety. Anxiety was an "acquired drive" and differed from individual to individual. For some children the approval of parents may be a need, for others the need to achieve; for others, both.

(iiib)

Criticism of Hull's theory - incentive motivation

However, less than 10 years after his book "Principles of Behaviour" (1943) was published, Hull was reappraising his hypothesis to take account of the following evidence:-

Sheffield et al (1951 and 1954) found situations which were not 'drive reducing' but 'drive inducing'. Male rats learnt mazes to reach female rats on heat when they were allowed intromission but not coitus which would produce drive-reducing ejaculation. They said that reinforcement comes not from the reduction of a drive but either from doing the task itself or from the cues which led to the act. This reinforcement provided the incentive for subsequent tasks.

Davis and Buchwald (1957) discovered that showing pictures of nude women to men increased their excitement as measured by palmar conductance and did not decrease their excitement.

Hull adapted his theory to take this into account by postulating the idea of 'incentive motivation'. This is the anticipation of a goal (which may be a reward) and is based on past rewards; i.e. if a reward is obtained (gold star, completion of task, teacher approval etc.) and is valued by the pupil, then incentive motivation would be produced which would result in the reward happening. (If I go in every day to work, I will get paid on Friday because that happened last week). The reward acts as a reinforcer.

Atkinson (1964) links incentive motivation with drive induction stating there appears to be no fundamental disagreement between the two.

Reinforcement therefore

> "provides incentives for subsequent performance rather than by satisfying a need or drive".
>
> Atkinson p.201

Thus there can now be seen a link between this anticipation of reinforcement (incentive motivation) and Tolman's 'incentive' which enabled an animal to act in a certain way.

The learning which builds up as a result of reinforcement is not the strengthening of the stimulus-response bond but the increasing of incentives (motivators) to behave in a certain way, which will provide further reinforcement (Bolles 1979), i.e. the promise of future reward supplies the learner with energy to do certain tasks.

Despite the difficulty with the original drive-reduction hypothesis, Starkey (1970) still puts it forward as a theoretical basis for his work. For some (Child 1973) it may still have relevance. However, this is not a criticism of Hull's original reason for writing his book for in it he stated:-

> "to make an incorrect guess whose error is easily detected should be no disgrace; scientific discovery is part of a trial and error process and....cannot occur without erroneous as well as successful trials".
>
> Hull 1943 p.398

(iv) Skinner and behaviour

Another person who has influenced the way in which reinforcement is viewed is B. F. Skinner. He does not consider what is happening inside the organism but concentrates on the observable consequences of behaviour which enables a prediction to be made of what will happen next.

For Skinner a reinforcer is an event or stimulus which increases the probability of an action occuring. There are a) Positive reinforcers. These increase the rate of responding (e.g. provision of money at a one-armed bandit increases a person's involvement).

b) Negative reinforcers. These, when removed, increase the rate of responding (e.g. electric shock, when removed from a lever, increases the touching of that lever.) Skinner believes that by withholding reinforcement from a previously reinforced response then the response will eventually become "extinct". He does not try to explain this theoretically but focuses solely on the behavioural effect of a reinforcer.

Both Skinner's and Hull/Sheffield's theories regard reinforcement as an external source of motivation. That is, what motivates the animal or human to behave in a certain way is some variable external to the task itself. If something viewed as a positive reinforcer (encouraging comments) is given to pupils then, the pupils may develop incentive motivation and carry out the behaviour (e.g. learning) which enabled them to receive the reinforcement. Therefore it may be argued they will do better on an end of topic test than pupils who did not receive the reinforcement.

Forness (1973) has postulated a 'Reinforcement Hierarchy' in which he classes seven types of reinforcement which may be received:-

1. Competence (learning for learning sake)
2. Being correct (receiving knowledge of the correctness of the task done)
3. Social approval (praise from peer group, parents or teacher)

4. Contingent approval (completing one task in order to do another more enjoyable task)
5. Tokens (these are exchanged for other reinforcers e.g. sweets, freetime, housepoints)
6. Tangibles (e.g. toys)
7. Edibles (food)

Whithead (1976) says that teachers should "pull" the child toward the higher level of learning competence by utilising the correct complexity of material and the correct reinforcement (decided by trial and error) in the hierarchy. However it should be noted that once competence is achieved and a person becomes proficient at something, then he may strive after lower levels of reinforcement e.g. social approval (I'm better than you at.....) or monetary gain to buy edibles.

Hunt (1969) maintains that item I in the hierarchy is termed intrinsic (coming from the learning itself) and distinguished from the others (2-7), which can be controlled by a person outside and called extrinsic. However if it is accepted that behaviour (which includes learning) is carried out with a reinforcement in mind (the goal), then whether the reinforcement is intrinsic or extrinsic is an academic question.

TEACHER APPLICATION OF REINFORCEMENT

Bearing in mind the above hierarchy, what potential sources of reinforcement are at the teachers' disposal in school.

Gilchrist (1916) administered an English test to a sample of fifty students. On returning the test he praised some students and reproved others. When the test was repeated, those who had been praised improved their scores by 79% whereas the reproved group had lower scores.

Hurlock (1925) in a classic study of the effects of verbal praise found that the praised group performed better than the reproved group. These in turn performed better than ignored pupils, (who received no praise or reproof) and the control group. The control group were given no special instruction and kept apart from the other groups. He used an addition test as a measurement of performance.

Insko (1965) and Scott (1969) have found that the attitude of a person to a subject was affected by the amount of praise the person received concerning the particular subject. Keys and Ormerod (1976) advocate the employment of teaching strategies which include adequate praise and encouragement in order to develop pupils' liking for the subject and so with it their attainment.

Hughes (1973) using 12 year old pupils during science lessons found that pupils who received 'teacher support' in terms of praising correct answers and supporting them when they made a statement, gained more in terms of science knowledge than the control group who received no praise, although their answers were acknowledged as correct.

Although this indicates that teacher verbal behaviour, employing praise as a reinforcer, <u>may</u> influence a pupil's attitude and attainment, material rewards are held in high esteem by some pupils. Benowitz & Busse (1970, 1976) using, in their terms, lower class negro boys and girls, found they tended to respond to material rewards (receiving crayons) for doing well in spelling, by performing better in spelling the next week. This effect lasted as long as four weeks. In an attempt to determine the social extent of effective material rewards Benowitz and Rosenf eld (1973) found that for 9 year olds from all socio-economic groups, material incentives were more effective than praise.

Morrison and McIntyre (1969), Gordon and Durea (1948) and Brophy and Good (1974) say that the warmth of a teacher's voice; the teacher's posture; physical gestures; teacher-pupil eye contact and facial expression can act as reinforcers, increase incentive motivation and affect subsequent learning and test results.

There appears to be little doubt that reinforcement can influence learning. Lysakowski and Walberg (1981) in a large study of the literature used meta-analysis to estimate the effect of reinforcement in 39 studies of types of reinforcement which spanned 20 years and went from pre-school children to university age subjects. They found that the experimentally reinforced groups scored on average at the 88th percentile compared to the 50th percentile for the controls.

One direct consequence of Skinner's theory of behaviour concerns the effect that feedback, a type of reinforcement, has on learning and achievement, and this will be considered next.

FEEDBACK

When working with animals Skinner increased the likelihood of a behaviour happening (e.g. bar pressing), by providing food when the bar was pressed. This food reinforced the behaviour by providing feedback (knowledge of the consequences of a behaviour). According to Ilgen et al (1979) feedback is a process in which a message comprises of information perceived by the recipient to be about himself and may be written, verbal or non-verbal (e.g. facial expression, gold stars, presents, marks and grades, results).

They say later that feedback can derive from several sources:-

a) from persons who have observed certain behaviours and report back to the individual(s) who showed the behaviours,

b) from the environment (e.g. in orienteering when a mistake is made, the individual gets lost as a result. Feedback from the surroundings tell him he has made a mistake),

c) from the individuals themselves (e.g. if a person drinks when he is thirsty, then satisfaction of that thirst provides feedback).

However from whatever source the feedback comes, it must be perceived as being credible and trustworthy otherwise it would not be reinforced or shaping in its effect.

Allen (1972) commented that feedback besides being able to reinforce learning also acts as a 'shaping' tool, to provide information about a student's misunderstandings. Therefore it can be expected that providing feedback, in its reinforcing and shaping roles, leads to increased learning.

Feedback and Performance

Sassenrath and Garverick (1965) and Draper (1980) have shown that when feedback is provided, pupil retention and transfer is increased. This is when they were compared with groups who had no experimentally manipulated feedback. Hanna (I975) in a large scale study using I,400 IO and II year old pupils found that the treatment groups who received no feedback following a test, scored significantly lower on a subsequent test than the treatment groups who received feedback. This effect was more marked for boys than girls.

Lysaught and Williams (I963) believe feedback acts as a reinforcer and therefore, in order to get the behaviour established, should occur as soon as possible after the response has been made.

Weitzman and McNamara (I949) concur and state that immediate feedback is essential in school for three main reasons.

a) the pupils want to know how they performed and appreciate immediate feedback,

b) a delay causes a loss in interest

c) without immediate knowledge, especially of test results, the teacher lacks the information needed in remedial work

It can also be said that the greater the time delay between the behaviour and feedback then the more likelihood there is of intervening variables affecting the memory.

However in schools, a delay of a few days in marking and returning work is commonplace, as is marking a quantity of test results in order for the teacher to obtain information for future planning. If this is the rule rather than the exception then children realising that the feedback occurs next time may well ignore the intervening time and variables.

Programmed learning was designed to provide immediate feedback once a response was made. Fry (I963) provided evidence that immediate feedback,as opposed to a delay of hours or days,aids retention. Warm et al (I972) said that because of this immediacy of effect, feedback acts as a reinforcer. *

However, other research shows that this relationship is not so straightforward.

Sassenrath and Yonge (I968) found that a delay in feedback of five days produced better retention than immediate or longer feedback.

This was noted also by Kulhavy and Anderson (I972) who mentioned that their delayed feedback groups performed better than their immediate feedback group when the task involved meaningful verbal material. Surber and Anderson (I975); Sassenrath (I975); Peeck and Tillema (I978) and Kippel (I974) in a study of II year old science pupils, concur with these findings.

For explanation, they state that with immediate feedback, 'wrong' responses are not forgotten readily and proactive interference or response competition occurs when faced with the feedback containing the correct responses. However with delayed feedback 'wrong' responses are forgotten more readily and less proactive interference occurs. Anderson and his co-workers say that feedback appears to provide knowledge of results which helps a subject to correct his mistakes. They found this during multiple-choice tests when the correct response was given as feedback.

* Footnote

Programmed learning has not fulfilled the expectations originally made for it however, as children found long programmes boring.

Ilgen et al (1979) view feedback as an incentive, by acting as a promise of future rewards; i.e. it increases motivation to act or behave in a certain way and increase the likelihood of obtaining a reward. Therefore feedback may be seen as having the same characteristic as reinforcement described earlier, that is, in providing incentive motivation.

If feedback and current reinforcement act as a promise of future reinforcement then, according to Skinner, removal of the reinforcing agents will eventually lead to extinction of the previously established responses.

Feedback however may not just increase performance. Clair and Snyder (1979) found a gain in self-esteem when feedback viewed as positive (by the teachers) was given consistently. They found that the students in this group performed better on an achievement test than those students who had received negative feedback. They said that this was due to a gain in self esteem of the students who had positive feedback. They also found that a change in feedback from negative to positive produced the next highest scores, followed by positive to negative and uniformly negative. This also affected the student's view of the instructor with positive feedback students viewing their instructor the best, followed by negative to positive feedback students; positive to negative feedback students and uniformly negative.

Brophy and Good (1974) in their comprehensive discussion of teacher effects on pupil performance mention that verbal feedback and encouragement by the teacher can produce higher gain scores than if no verbal feedback or encouragement is employed.

Freeman (1973) found that his subjects said they could accept positive feedback about themselves rather than negative feedback, which elicited derogatory remarks concerning the teacher. Draper (1980) in a study of 10 and 11 year old boys, discovered that they persisted longer at a task when positive or negative feedback was given after they had succeeded at a task. When positive or negative feedback was given after failure then the boys did not persist. The positive or negative feedback was chosen by the teacher and therefore may not necessarily have been viewed as such by the pupils. In his discussion of the relevant literature, Draper states that comments such as "Right" are relatively ineffective as positive feedback and reinforcement due to them being used frequently and pupils not really valuing them.

Gagné et al (1979) in a study designed to investigate whether a discrepancy between feedback statements and teacher expectency in 9 year old high achievers, had any effect on performance, found that when pupils were told they should do well and then were informed after a task that they did not do well, their subsequent performance increased. This was significantly better ($p < 5\%$) to the performance of pupils who had expectency and feedback statements which coincided.

Knowledge of results and performance

It has been mentioned that giving pupils information as to what they have done correctly and incorrectly, influences later performance. This particular type of feedback is often called Knowledge of Results (K of R).

K of R has its roots in educational research which dates back to the turn of the century (at least), e.g. Judd (1906). Plowman and Stroud (1942) found that subjects who received K of R following a test scored higher on a subsequent test than those who did not receive K of R. De Weerdt (1927) in her study of 45 ten year old pupils found that knowing how they performed on practice tests helped them to learn material better.

However it is since Skinner's work on reinforcement and behaviour that most attention has been paid to K of R. Skinner maintained that feedback in the form of K of R at each step provided enough motivation to maintain interest and facilitate high achievement. To this end, linear programmes were developed, although in a discussion on K of R and programming Morris et al (I970) found little evidence to support this conjecture. However Sime and Boyce (I969) found that children who were given overt K of R after answering programmed questions made significantly greater progress than those who had no overt K of R. Child (I973) in a discussion of K of R concluded that in order to

> ".....be a really effective reinforcer in educational achievement, K of R must follow quickly upon completion of a task for it to have maximum influence on school performance".
> p.I09

Boonruangrutana (I980) using a sample of I80, I3 - I4 year old pupils, found that K of R with corrective group discussion increased the achievement of that group when compared to a "no discussion and no K of R" group. O'Neill et al (I976) gave students a multiple choice test. In one treatment, students were given K of R immediately on completion of each item of the test. In another, K of R on completion of the test and another treatment was given no K of R. They found that 'no K of R' students had significantly worse scores on subsequent tests than either of the other treatment groups.

Mukherjee (I972) examining the effects of K of R and personality factors found that K of R in the training stage of learning mathematics helped problem-solving techniques. Mukherjee also found that giving K of R I00% of the time during the learning of concepts produced children better able to solve problems than if K of R was given only 50% of the time.

Judging from the available literature, it appears that feedback in the form of K of R tends to have an advantageous effect on learning and achievement.

K of R may produce this effect in two ways:-

a) It may 'cue' the pupil as to the type, extent and direction of the errors made. Therefore the errors should not be made again (Sawin I969). This ties in with Anderson and his co-workers who view feedback as having this characteristic.

b) It may motivate the pupil to work harder or to persist at the task longer.

Annett (I972) in his wide-ranging discussion on K of R believes that both of these are possible insofar as K of R increases a learner's understanding both of the information required for responses of given kinds and of standards appropriate in given situations.

Locke et al (I968) in agreeing that K of R is motivating stated that results in experiments using K of R must be viewed with individual differences in mind.

> "One must know the perceived significance the information has for a man in a given situation. A man's knowledge and evaluations are reflected in the goals he sets on a particular task. For example, if a person appraises his performance as unsatisfactory in relation to some particular standard, he will ordinarily set himself a goal to improve his subsequence performance. If he is satisfied with his performance, he may attempt only to maintain his level. Or, if he is indifferent to a piece of knowledge, he may take no action at all.
>
> The crucial question is then.....what does he do with it (K of R)?"
>
> p.484

The teacher can manipulate K of R in order to produce incentive motivation. The external manipulation is termed <u>extrinsic K of R</u> by Annett (I972) and is the type most frequently used in schools.

(e.g. returning marked work, going over tests, saying if a pupil's answer is correct or incorrect). There is however, Intrinsic K of R which is normally present in tasks undertaken and not usually subject to manipulation by a teacher or experimentor. (e.g. In putting up wallpaper, if there is not enough paste the wallpaper will not stick, therefore more paste is necessary).

It is extrinsic K of R which is at the teachers disposal and most commonly used in the classroom. Two forms of extrinsic K of R are discussed in the next section viz. Marks/grades and comments on work.

SUMMARY

The concept of reinforcement can be seen as a development of Tolman's idea of an 'incentive', spurring animals on to action. It is a source of motivation which is external to the recipient providing an incentive to behave in a certain way which will provide further reinforcement in the way of a reward.

Reinforcement influences learning and attainment, its presence increasing performance. The lack of adequate reinforcement produces extinction of the responses which led to the original reinforcement.

Feedback and knowledge of results can be seen as instruments producing the same effect as reinforcement in providing incentive motivation, as well as 'cueing' the individual to make a correct response next time to gain reinforcement.

CHAPTER 2

MARKS AND GRADES

One method of giving pupils extrinsic K of R in the classroom is marking and grading the pupils' tests and written work. These are returned to the pupil with (or without) any written and/or verbal comments which can also provide feedback.

Marks and grades are inextricably linked, in many education systems, to assessment.

> "Mention of assessment in the classroom conjures up a picture of pupils labouring over tests and written exercises, and of teachers spending long hours in compiling questions, in marking and in producing sets of marks and individual reports".
>
> Morrison & McIntyre 1969 p.169

This is a very narrow view of assessment as Morrison & McIntyre later point out. However at this point, suffice it to say that assessment occurs whenever one person in some kind of interaction with another, obtains and interprets, using some standard, information about the other. This information may concern knowledge, understanding, abilities, attitudes or personality of that person (Rowntree 1977) and may be obtained from oneself (which constitutes "self-assessment").

This definition of assessment encompasses value judgements made by an individual. In American literature the term 'evaluation' is used instead, with 'assessment',

> "A process of observation or measurement.... not involving value judgements. It refers to collecting and analysing evidence before making judgements".
>
> Sawin 1969 p.3

In the U.K. according to Rowntree (1977) evaluation is used more in terms of identifying and explaining the effects and effectiveness of teaching.

Therefore the literature had to be read with this in mind.

Purposes of Assessment

In its widest sense as mentioned by Rowntree (1977), assessment serves several functions.

1. It motivates the pupils to work harder,

a) by using examinations, homework assignments, quizzes as encouragements (incentives). (Child (1973) mentions that the motivational quality of exams is easily noticed at around Eastertime in colleges).

b) by using grades, marks to compare one individual with another. The fact that one person may know they have a higher grade than another motivates them to stay ahead and motivates the other person to try harder (Rowntree (1977)). This feedback could therefore be seen as providing incentive motivation by providing a reward of a high grade, positive comment etc.

> "There can be no doubt that assessment is motivating in some ways".
>
> Beard & Senior 1980 p.65

2. It provides feedback to the pupils about their performance. This may be by verbal or written comments, by marks or grades or by facial expressions by the teacher. Effective feedback enables the pupil to identify strengths and weaknesses enabling him to build or alter them so that he might do his best. This is the "cueing" property of feedback - alerting the pupil to his mistakes.

3. a) It helps teachers, schools or employers select people on the basis of whether they have reached

an appropriate standard.

b) Having reached that standard, assessment provides a means of maintaining that standard, e.g. the firm who requires a standard equivalent to 'A' level grade 'B' economics one year does not employ a person with a lower standard the next year.

4. It helps the teachers match the learning situation to the pupil (Riley 1977). Assessment provides feedback to the teacher about how well or otherwise the pupil has done at a particular learning experience. Therefore it contributes towards course evaluation, and serves as a diagnostic appraisal of pupils' strengths and weaknesses.

One distinction must be kept in mind. Marks, grades, comments are not to be seen as a form of assessment but rather as one of the end products of the assessment process. The quality and nature of a pupil's work must be determined (assessed) before any mark, grade or comment is put on. The pupil and often the teacher are not able to distinguish between the two separate acts however.

It is the feedback and motivational qualities of assessment which particularly concerns this researcher.

Footnote

It should be noted that there are two types of assessment which are used in school:-

a) Norm-referenced assessment, where a pupil attainment is compared with others and examines a pupil's relative status.

b) Criterion-referenced assessment, where a pupil's attainment is compared with a criterion.

> "It identifies what a pupil knows or has attained, or is competent in. How that pupil stands with respect to others is irrelevant, it is the pupil's absolute status in relation to knowledge of the subject or performance of skills that is of concern".
>
> HMSO (I98I) p.2

Schools according to Brown in HMSO (I98I), often use the former to see how a child is performing under the guise of the latter.

The four purposes of assessment mentioned although concerned with diagnostic evaluation as in criterion-referencing, may be carried out by using norm-referenced tests.

MARKS AND GRADES

In the British system of education, assigning marks, grades and comments to pupil's work, after the process of assessment, is prevalent. It is necessary to determine how marks and grades (and in a later chapter, comments) affect motivation, learning and attitudes and to discuss the various problems in the assessment of work and the ensuing award of marks and grades.

Marks (e.g. 7/10, 7 out of 10, 49/50 etc.) awarded on the basis of the amount of correct work is a common form of K of R. For this study grades, as explained below, will be concentrated upon, as they are the system used in the experimental schools.

According to Geisinger (1982) the most important function of grades is to communicate information concisely about the pupil's academic achievement in certain learning situations. However, as Sawin (1969) points out, teachers have awarded grades for a variety of reasons other than the one above, e.g. amount of effort, achievement in relation to ability, extent of pupil co-operation, neatness. Assuming that grades are given for academic achievement, one of the other functions of grades is to provide the pupil with feedback.

Grades are usually given a letter symbol (A B C D E or F) with + or - attached to them to increase the spread of the scale (A, A-, B+, B, B- etc), so a pupil receiving a C grade will know that he has not performed as well as someone with an A or B grade but better than pupils with D or E grades. Rowntree (1975) and Geisinger (1980) consider that a grade, when it is the only source of feedback, is useless. Stewart and White (1976) tested the effect of grades, grades + specified comment, no grades + specified comment, positive comment (no grades) and control (grades + any comment) on achievement. They found no significant treatment effects. It appeared that neither grades nor comments, as feedback, had any effect on achievement.

However, apart from the research mentioned previously concerning the effect of feedback on subsequent performance, there does not appear to be much research which tests the 'grades' vs. 'no grades' effect as applied to feedback. This may be due to the problem in separating a feedback effect from a 'motivating' effect, separating the knowledge you are to be graded with the effect of the grade. It may also be due to a problem inherent in some research when the usual routine is upset, i.e. the Hawthorne effect. If a school was used whose pupils were used to being graded then some <u>not</u> being graded would be alerted to the fact that an experiment was in progress. However, one study has been published which has analysed these differences.

Yarborough and Johnson (1980) compared pupils in grade 6 (11 years old) of elementary schools. They measured achievement and attitude to school of pupils who were in a school which did not use grades. They found no difference in attainment between schools. Brighter pupils from the graded school possessed a more positive attitude to school than brighter pupils from a non-graded school. Slower pupils from a non-graded school possessed a more positive attitude to school than slower pupils from the graded school.

<u>The motivating function</u>

This was studied by Cullen et al (1975). Using college students they found that grades used as either a positive or negative incentive had a greater effect on the completion of an assignment than when grades were not used. They also found that the negative incentive value (i.e. avoiding a low grade) had a greater effect than the positive incentive value (to earn a high grade). They qualify this by saying that more research is needed into the incentive motivation effect of grades at different ages. They mention that their results would only be applicable at that age of student who have to get a certain grade to achieve a goal (i.e. passing). Then, giving lower than required grades, would be an incentive.

Pickup and Anthony (1968) say that the returning of graded work is not just informational, it may affect the later motivation of the pupil. However, some researchers cast doubt on the end product of this motivation.

Deci (1971); Lepper and Green (1973); McMillan (1977); Salili et al (1976) and Sarafino and DiMattia (1978) all conclude that grades and other rewards given by the teacher (gold stars etc.) motivate the pupil towards getting another reward (gold star, high grade). The pupil values the reward not the knowledge that led to its award (McMillan 1977). Geisinger (1980) points out

> "if studying is done purely to obtain the reinforcement of high grades, this behaviour will extinguish....after education is completed".
>
> p.1141

The worry is that if education prepares the children for life, and stresses the importance of lifelong habits, then using the motivational power of grades may inhibit the achievement of this aim. Despite this Sarafino and DiMattia (1978) found from their research with college students that grading only undermined the task motivation in 16% of their sample (interested students) but augmented the motivation of those whose task motivation was low at the outset. They mention that for the large majority, grades do motivate students to study more. It may also be argued that human behaviour is not dominated by a single source of reinforcement - it is multi-reinforced. Study habits may be set in motion by the motivating power of grades. Any study habits pursued in later life are motivated by other goals (financial rewards, job satisfaction, an extra 'O' level, an O.U. Degree etc.)

McKenzie et al (1968) by presenting grades with money as a back up reinforcer to those who reached a certain grade level, found that academic behaviour was enhanced. Their sample consisted of children with learning disabilities. They conclude that for these children grades with back up reinforcers should be presented often.

There seems to be little empirical support for the theories that grades by themselves act as an incentive motivator. Grades may be seen as an end in themselves. Teachers often remark that pupils look for the grade then close their books or get on with the next piece of work. It can be argued that in order to achieve the next reward (the next grade) the pupil has to work hard, do the work and probably learn some as well. Over the course of several years of education, certain things will be learnt, therefore aiming for the 'good' grade may not be an entirely bad thing.

Problems with grading

Perhaps marks and grades perform the other two functions listed at the beginning of this chapter, i.e. selection and providing feed-back to the teacher. Unfortunately it seems many ways of assessing and grading lay themselves open to strong criticism which casts doubt on the reliability or validity of the grading procedure.

These criticisms can be summarised as follows:-

a) The 'Halo' effect: An early impression relating to one aspect of a student's work will be over-generalised and make the assessor (grader) respond in the same sort of way (either positive or negative) to later work, so that the initial impression is maintained.

Carter (1952) found that girls are more likely to get higher marks than boys of equal ability. Wood and Napthali (1975) discovered that women teachers are more likely to be lenient to an attractive boy than to an unattractive boy or attractive girl. Primavera et al (1974) argue that throughout school life girls get better grades than boys of equal ability.

Hadley (1954) discovered that a pupil well liked by a teacher tended to be awarded higher grades than a pupil of equal ability who was not liked as much.

Bull and Stevens (1979) and Briggs (1970 and 1980) have focussed attention on the effect of handwriting on grades. Briggs (1980) found that poor handwriting penalises a pupil of 16+ when taking examinations. The difference between grades awarded to poorly written scripts and neatly written scripts were significant at the 5% level. In addition, Bull and Stevens found that when the essay authors were female, the ratings given to their essays were influenced by the attractiveness of the writer. (Photographs of the authors were used). No such effect was found for boys. Unattractive girls generally received the highest grades.

b) Grades tend to smooth out irregularities in performance between pupils. Rowntree (1977), Ebel (1969) and Brown (1981) argue that letter grades do not tell the pupil or anyone else about the various strengths and weaknesses in the piece of work. For example a pupil may receive a grade 'C' when the work contains superb qualities and abysmal qualities. Another pupil may have a 'C' when the work is consistently 'C' all the way through. According to Sawin (1969) this could be seen as an argument for giving different grades to different sections of the work for different criteria (e.g. effort or progress). He points out however that several grades may make it too complicated, especially for parents!

c) Grades vary when work is marked by different people. Hartog and Rhodes (1935 and 1936) gave 15 examiners School Certificate scripts to remark (all the previous marks had been removed). They found great variation in the classifications of "pass, fail, credit" put onto the scripts, so much so that between markers many examination candidates passed, failed and gained a credit! Starch & Elliott (1913) took one geometry paper to be marked by 116 senior grade teachers. Percentage marks awarded ranged from 28% to 92%.

Murphy (1982) took G.C.E. scripts from 20 candidates, removed the marks and asked the Chief Examiners to remark them. He found the mark-remark reliability was around 0.90 for all scripts with the notable exceptions of

Biology essays = 0.61
English essays = 0.73
English language=0.75 - 0.76

The figures for these papers may partly be produced by the 'handwriting' effect mentioned earlier. The Schools Council has warned the users of G.C.E., that results on a six or seven point grading scale are accurate to about one grade either side of that awarded (Schools Council 1980). Farrell and Gilbert (1960) discovered that the more scripts an examiner marks the more likely he is to award 'extreme' grades. They suggest this is because he grows more confident and the number of answers available for comparison grows. It may also be that the probability of getting an extreme script increases with the more scripts that are marked.

Grades, especially grades awarded after subjective marking (e.g. essays) must be treated and interpreted with care. Obviously objective testing goes a long way to relieve this lack of high reliability. Rowntree (1977) summarises his views on grading with

> "...fairness might be best achieved by calling for the assessor to spell out just what he sees in the students work and how he justifies his response to it....The greatest unfairness is to... average out the assessor's interpretations of a student's work in order to label him with that educational enigma- the 'all-talking, all-singing, all-dancing' uni-dimensional grade".
>
> p.198

Improving grading

Therefore, judging from the available literature, it can be summarised that grades, by themselves, appear to offer little feedback and motivation and can, even when they are considered extremely important (i.e. in G.C.E.examinations) lack the reliability that they should have.

What are the alternatives and how may grades be improved? Holtz (1976) encourages the scrapping of grades and adopting a skill classification instead. Stansbury (1977) believes that a "curriculum activator" which gives a pupil a sense of direction and purpose is required. Geisinger (1980) however states that most people in the education process see the giving of marks and grades as inevitable and the system is not likely to change in the immediate future. He sees written comments on work as providing a source of reinforcing and motivation producing feedback. Beard and Senior (1980) in a review of how pupils may be motivated view written comments with grades as a source of motivation. They say that assignation of grades without comments leaves the student uninformed as to what he might do differently.

Feedback in the form of comments which contain praise, according to Kennedy and Willcutt (1964) are considered as positive reinforcement and therefore, according to the arguments put forward previously, be seen as giving incentive motivation. This is supported in a thesis by McAlpine (1982) who concludes that written comments are viewed by teachers as a motivational rather than an instructional aid to learning. If a pupil's behaviour is given an encouraging or praising comment, then incentive motivation may be provided, increasing the likelihood of the behaviour reoccuring. If the behaviour is getting answers correct, learning work or applying knowledge, then this will be strengthened and achievement on a test will improve.

If however, comments are withheld, this may lead to extinction of those behaviours with a resultant poorer performance on a test than from pupils who had continued to receive the comments.

CHAPTER 3

ATTITUDES

The Concept of Attitude

According to Voltaire "If you would converse with me, you must first define your terms". A laudable statement which could be used to excellent effect in a lot of discussions about psychological topics. It is doubtful if Voltaire had intended his statement to be applied to the concept of attitude especially as one eminent researcher in the field (Evans 1965) has not formally defined "attitude". It could therefore be suggested that a definition may not be straightforward. The literature brings to light various definitions with similarities and differences.

The Dictionary of Psychology says an attitude is

> "A more or less stable set or disposition of opinion, interest or purpose, involving expectancy of a certain kind of experience and readiness with an appropriate response; sometimes used in a wider sense but rather less definitely, as in aesthetic attitude, in the sense of a tendency to appreciate or produce artistic results, or social attitude, in the sense of being sensitive to social relations, social duties or social opinions".
>
> Drever 1952 p.33

Drever's definition leans heavily upon those of Warren (1934) and Allport (1935). According to Warren an attitude is

> "A specific mental disposition towards an incoming (or arising) experience, whereby that experience is modified; or, a condition of readiness for a certain type of activity".
>
> Warren (1934)

Allport in mentioning that the concept of attitude was in dispute, being surrounded at that time by a considerable degree of confusion, produced a definition which said that an attitude:-

a) is a mental and neural state of readiness which enables an individual to perceive objects and people in certain ways.

The individual is alerted to deal more readily with things and events.

b) is organised through experience. The individual's attitudes are learned and are not innate. They are malleable and subject to change.

c) can exert a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. Attitudes, therefore, can cause a person to seek, or avoid, various objects.

If attitudes follow these basic principles, then it follows that an attitude cannot be observed directly but can only be inferred from the resultant verbal or non-verbal behaviour patterns. They also lead the individual to chose between two or more courses of action - they help set up an individual's priorities.

Campbell (1963) points out that Allport's definition may have an inherent weakness in that it can be applied to a number of social science concepts including attitude, belief, opinion, habit and value disposition.

Despite this possible source of confusion and after reviewing various work in this field, Shaw and Wright (1967) conclude with their own definition

> "An attitude is a relatively enduring system of evaluative affective reactions, based upon and reflecting evaluative concepts or beliefs which have been learned about the characteristics of a social object or a class of social objects".

Selmes (1971) points out that sociologists view attitudes in the context of their social value (e.g. Krech et al 1962), whereas psychologists tend to stress the relationships between an individuals' attitudes and other characteristics possessed by him, e.g. Triandis (1971) who simply calls an attitude "an idea charged with emotion" and Eggleston (1976) who states that an attitude is a relatively enduring tendency to perceive, feel or believe towards certain people or events in a particular manner.

By studying the various definitions and by researching the literature, it was noticeable that some researchers (e.g. Evans 1965, Campbell 1962) do not define the term but have a "general feel" for the word. The researcher will not adopt one particular definition, but will look at similarities between them, to find factors which may assist the formulation of hypotheses.

From the available information several reasonable assumptions may be made about the concept of attitude.

a) Attitudes are not innate and can be learned (Sherif and Sherif 1956; Evans 1965; Shaw and Wright 1967; Vernon 1969; Gupta 1972; Newton 1975; Nash 1976). Therefore it would seem logical to suggest that attitudes can be influenced and changed if attitude acquisition follows the general principles of learning theory.

b) Accepting that attitudes can be learned, they are also relatively stable and longlasting (Allport 1935; Drever 1952; Sherif and Sherif 1956; Krech et al 1962; Shaw and Wright 1967). A transient "attitude" need be no more than a passing thought and therefore would present no observable tendency to act or behave in a certain way.

c) Attitudes possess varying degrees of inter-relatedness to each other (Shaw and Wright 1967; Allport 1935) e.g. For some people their attitude to immigration may be influenced by their attitude to coloured people.

d) Attitudes are generally described as varying in intensity from strongly positive through neutral to strongly negative. This contrasts 'attitude' with the term 'interest' for according to Mangion (1950) these two terms are not interchangable, interests always being positive; although they are related when the attitude is positive and being expressed, e.g. a general positive attitude towards science may mean the person having a specific interest in, for example, practical work. Evans (1965) does state that an attitude is a general orientation of the individual whereas interest is more specific and selective directed towards a particular object or activity.

These four characteristics of attitudes are important in the later development of arguments and hypotheses in this research.

ATTITUDE CHANGE

> "The problem of attitude change is the problem of the degree of discrepency between one's own position and the position advocated in a message; and the felt necessity of coping with that discrepancy".
>
> Halloran (1967) p.58

He states that the 'advocated message' may arise from several sources:-

1. Direct experience with an object and/or situation,
2. Explicit and implicit learning from others,
3. Personality development (This supports the theory of Krech et al (1962) that attitude and personality are related, attitude being an acquired part of personality tendencies which can be innate as well. However as has been said attitudes are not innate and are not as permanent as personality traits).

Attitude change therefore may arise from any or all of the above. Evans (1965) in a thorough discussion of attitude development identified the home as one major source of children's attitudes. A parent's attitudes were seen as important in aiding the child to work out his approaches to the environment. Shoben (1949) tested the attitudes of 100 mothers, 50 of whom had "problem" children (those who had been in court at least twice) and 50 of whom did not have problem children. He found a significant positive relationship between the behaviour of the mothers and the attitudes of the children.

Glassey (1945) found the following correlations (Pearson) between children's attitude to education and their parents:-

	Daughters	Sons
Mother	+ 0.57	+ 0.28
Father	+ 0.07	+ 0.35

Meyer and Penfold (1961) state that the child's approval of their parents' attitudes rather than the actual attitudes of the parents were significant in the development of the child's attitude to science.

However any attitudes obtained during childhood are not immutable. If they were then the education system would not be able to influence them or even try to influence them. Evans (1965) mentions as evidence of this a thesis by Evans (1962). His pupils increased their attitude scores to poetry as a result of being involved in verse writing themselves.

How else are attitudes changed at school?

(i) Attitude change in school

When a pupil starts school, he/she will possibly try to form a friendship with one or two or more peers. Generally, when groups are formed, they have something in common which unites the members of the group (a liking for football or living in close proximity to each other). The attitudes of other members of the group towards an object may influence an individual's attitude towards that object if he/she wishes to remain in that group.

Meyer and Penfold (1961) have found a significant relationship between a pupil's partner's interest and the pupil's own interest towards science. Nash (1973) states that a pupil's friendship choices can act to strengthen the pupil's attitude to school.

Barker Lunn (1969), as part of her work to develop a scale to measure children's attitudes, found that a pupil's preference for a certain group of pupils was significantly related (5% level) to "Attitude to School" and "Interest in Schoolwork", in that pupils who liked being in their class also had a favourable attitude to school and interest in schoolwork.

Any change in attitude as a result of being a group member may last after the group influence has disappeared. Miller and Biggs (1958) found the change lasted at least two weeks after the group disbanded although it could be argued that this was not an "attitude" change in the strictest sense of the term that they were testing, as an attitude tends to be more stable and less ephemeral.

Gupta (1972) believes that the greater the association with peers then the greater their influence on the formation of attitudes.

Several researchers have found that attitude to school changes as pupils progress through the educational system. Thompson (1976) concluded that the attitude to school of 15 year olds is significantly less positive than the attitude of 11 year olds.

Fitt (1956) in a large study of 1,244 pupils between 7 and 18 years of age found significant differences in the critical ratio results for secondary school and primary school pupil attitude to school, secondary school pupils possessing least favourable attitudes to school. Wisenthal (1965) using 2,249 grammar school pupils found that the deterioration in attitude to school between classes (and four of the junior school classes) was highly significant ($p < 0.1\%$).

Haladyna and Thomas (1979) using a large sample (n=2845) of pupils grades 1 to 8 (5 to 13 year olds) found that the attitude to school deteriorated as pupils progressed through the school, this deterioration being significantly greater for boys than for girls. Allen (1960) discovered that boys possessed a significantly more favourable attitude to school than girls at age 11 which had disappeared after 1 year and was significantly worse by the age of 14. ($p < 5\%$). One might expect from the present research that in a middle school at the age of 13 there is a difference (possibly significant) in the attitude to school of boys and girls.

Flanders et al (1968) found that the deterioration of pupils' attitudes occurs during a school year and may be due to the novelty of a new class (and/or teacher), wearing off.

> "Children compelled to learn a subject at school frequently find that they enjoy it and so develop a favourable attitude. What they enjoy may be .... the subject matter, a method of working, something about a particular teacher or the conditions under which a subject is studied".
>
> Evans (1965)p.17

(ii) Attitude change and the teacher

The influence of the teacher is considered important by many researchers. Nash (1976) views their influence as either overt or unintentional (the tone of voice, facial expression or other gestures may alert the pupil to a teacher's attitude). This dovetails with the idea proposed by Lambert and Lambert (1964) that attitudes can be learned by transfer, especially the thought, belief or cognitive component of the attitude. They argue that when a close relationship exists between teacher and pupil, feelings are transferred by the teacher, which suggest how the pupil should recognise and integrate certain basic ideas held, with those of the teacher.

Evans (1965) is certain that the attitudes held by the teacher influence the pupil's attitudes and the pupil's attitude to the teacher affects the pupil's attitude to work. She mentions Lippitt and White's studies (1943, 1947) as examples of the effect teachers have. When the teacher was "dominating" the children were likely to be aggressive or over-submissive; when the teacher was "democratic" the children were relaxed and friendly and interested in what they were doing. Phillips (1973) has found that elementary school pupils who have a favourable attitude to mathematics are likely to have had a teacher with a favourable attitude to mathematics within the previous two years. Aiken (1972) in a study of 85 girls and 97 boys, found that their attitude to mathematics was possibly related to their perceptions of their parents' and teachers' attitudes.

However, this relationship is by no means clear cut with regard to science. Kelly (1961); Meyer and Penfold (1961); Rowlands (1961); Meyer (1960); Lovell and White (1958); Barker (1976) have all found that there is a negligible effect of of teacher attitude on pupil attitudes to science.

Pidgeon (1970); Burstall (1970) and various American researchers (Bixler 1958; Greenblatt 1962; Ramsey and Howe 1969; Christiansen 1974) <u>have</u> found that teacher attitude towards science does affect the attitude of the pupil.

Ormerod (1971) concluded that within fairly wide limits, science teachers do not seem to have a great influence over the attitudes of their pupils to science, due possibly he says to the early foundation of the attitude outside school.

Musgrove and Batcock (1969) in a study of why students dropped science concluded that the influence of teachers is probably indirect, through the presentation of the subject. Therefore it can be seen that any relationship between Teachers' attitudes and pupils' attitudes to science is tenuous, there being no one factor which might explain the difference between the various research results.

Levin and Fowler (1984) found from their sample of 988 15 - 17 year olds subjects that both boys and girls recalled that their teachers rather than parents were the ones who influenced their interests and abilities in science. If this is not due to teacher attitude then as Hamachek (I97I) and Ormerod & Duckworth (I976) conclude, there may be other characteristics of science teachers which may affect pupil attitude namely,

i) Pupil perception of teacher competence. Pheasant (I96I) and Sawin (I969) point out that if a teacher is not familiar with the subject, materials or lesson, this is noticed by the pupils who may change their attitude towards the subject as a result. Harvey (I977) in his research with 8 - I0 year olds found no noticeable difference in performance of pupils when taught by science trained and non-science trained teachers. This is attributed to the specially prepared teaching materials which were designed to overcome any deficiencies in specialist subject knowledge. This also presupposed a link between performance (achievement) and attitudes. There may however be more of an effect when the child is I3 or I4 and preparing for external examinations. Even with supportive material the quantity of knowledge necessary to gain total competence is large and any deficiencies may well be noticed by the pupil.

ii) Teacher 'personality'. Evans (I965) suggests that pupils respond to certain aspects of a teacher's personality e.g. sincerity, interest in children, never bearing a grudge. Hart (I934), Witty (I947), Cogan (I958) and Burns (I976) all realise the influence personality may have.

iii) Davidson and Lang (I960) have shown that a pupil perceives a teacher's <u>feeling</u> of approval as positive appraisal. This may be construed as a reward for certain behaviour or attitude and as Scott (I959) and Lambert and Lambert

(1964) point out, reward may lead to a favourable attitude to the subject or person, whereas punishment, disappointment or failure leads to an unfavourable one. Woolfolk and Woolfolk (1974) discovered that 4th grade pupils who received positive evaluations from the teacher viewed the teacher as more positive and attractive than did the pupils who received negative evaluations.

This last point (iii) indicates a direction which Halloran (1967) has taken, namely to link attitude change with motivation. Halloran adopts a Hullian view of attitude change in that he views a child initiating and adopting the attitudes of significant others * in order to satisfy a need which reduces a drive. The attitude towards the object(s) or situation which have provided this satisfaction is intensified (Lambert & Lambert 1964). This intensified attitude may further motivate the child to receive more need satisfaction (Dinkmeyer and Dreckura 1963; Shaw and Wright 1967; Lunzer 1968).

If this satisfaction comes from secondary reinforcement as Secord and Backman (1964) point out, then feedback in the form of written comments (especially favourable or praising comments) may be said to constitute positive reinforcement and satisfy a need of the child for reward. This may polarize further the attitude of the child towards the situation/subject/person which was perceived as being responsible for the reward.

*

Footnote "Significant others" could be parents, friends, teachers, relations, peers, indeed anyone who is held in esteem by an individual, whose ideas and views are respected and whom he tries to please.

Doob (I947) believes that an attitude is partly derived from the reinforcement of overt behaviour and reward constitutes the reinforcement.

However in Chapter I it was argued that need satisfaction is no longer considered a viable theory but that incentive motivation is viewed as increasing the likelihood of behaviour when reinforced. Therefore a written comment (especially perceived as favourable or praising) may intensify a child's attitude towards the object which is seen as giving the reward by providing an incentive to obtain further rewards.

> "It is important therefore that schools seek to promote positive attitudes through the attention they give to content method".
>
> (HMSO I985 p.4I)

(iii) <u>Need for change</u>

a) <u>Attitudes and Achievement</u>

However the discussion so far on attitude change omits one important question, namely "Why do attitudes need to be changed?"

As Evans (I965) makes clear, it was originally thought that an alteration in racial attitudes was desirable in order to avoid bias and prejudice towards some racial or ethnic groups or social classes. Later it was considered that a positive attitude towards a task or subject facilitated success in that task and led to a stronger positive attitude. (Halloran I967). The link between achievement and attitude, having great relevance for schools and for this research. deserves closer examination.

Ormerod and Duckworth (I975) discussed work by Lewis (I96I, I964, I967) who suggested that a high proportion of variance in exam results of I4 year old pupils loaded on a "general factor" of attainment. However later they considered research which showed that amongst I6 year old girls this "general factor" is loaded with non-cognitive variables, such as interest, attitude.

As early as the I930's Shakespeare (I936), analysing the various interests of 9,I27 pupils found that at about the age of II, pupils who were progressing well in a subject at school tended to show a preference for that subject. Pritchard (I935) discovered that if pupils were doing well in a school subject they showed a liking for it, with failure a reason for dislike. Jordan (I937 and I94I) found with boys, small correlation coefficients between attitude and achievement of +0.2I English and 0.33 for Mathematics , but Arvidson (I956) said that this relationship may be due to effective teaching, favourable background or high ability which act together to foster high attainment and positive attitudes towards school activities.

Khan (I948) in a study of attitudes to mathematics found a positive correlation of +0.33 between attitude and attainment.

Barker Lunn (I969) found that attitude to school, interest in school work, relationship with teacher attitude to class, importance of doing well and self-image correlated significantly (at I% level) with achievement in tests of English, arithmetic, verbal and non-verbal reasoning.

Wisenthal (I965) in a study of II64 boys and I085 girls in junior schools found differences in mean scores between low IQ pupils and high IQ pupils who possessed a more favourable attitude. This difference was significant for girls.

Aiken and Aiken (I969) in a review of literature on this subject conclude that there is a positive relationship between ability and attitude. Later Aiken (I972) using I82 thirteen year old pupils found that their attitude to mathematics was positively correlated to the grades they obtained in arithmetic and mathematics ($p < 5\%$).

Marjoribanks (I976) in his study of 450 twelve year old children has put forward evidence that for high and low ability pupils, increases in attitude scores were associated with small to moderate increases in academic performance.

b) Science Attitudes and Attainments

Considering science, Billeh and Zakharides (I975) during the construction of a science attitude scale say that they found a low but positive relationship between the students' attitude to science and the grades they received. There is however no statistical information to show on what evidence this conclusion was reached nor any detail about how the grades were given or the work assessed.

In a study of science education in nineteen countries, Comber and Keeves (I973) found, for I4 year old children, a 0.2 to 0.3 positive correlation between attitude to science and achievement in science.

Meyer and Penfold (I96I) developed an attitude test called "Interest in Science" which was divided into 3 sections - Leisure Interest, Interest in School Science topics and Interest in Scientific Method. The split-half reliabilities were 0.94, 0.93 and 0.90 respectively. They found no significant difference between pupils' interest in science and their attainment as measured by a standardised test.

Croucher and Reid (1981), in a study of 9 - 10 year old pupils (N = 1000), found no significant relationship between attitudes to school subject and attainment in mathematics and verbal reasoning.

Brown and Davis (1973), using 323 11 - 14 year old children, and Wynn and Bledsoe (1967), using 325 14 year olds, have found no significant correlation between science interest and attainment.

These are rather contradictory results and the optmism of Mager (1968), in that a pupil will learn more, remember longer and use more of what is learned, is fostered by a positive attitude to the subject, is not fully justified.

Ormerod and Duckworth (1975) close a brief discussion with

> "Research findings as well as commonsense suggests that the attitudes and interests of pupils are likely to play an important part in any satisfactory explanation of the variable levels of performance shown by pupils in their school science subjects".
>
> p.2

With these findings and statements it is difficult to determine anything conclusively. It may be that there are one or more intervening variables which allow attitude and attainment to be correlated. If so, then a hypothesis may be formed that there will be an increase in achievement scores for pupils whose attitude scores increase.

c) Development of Science Attitudes

Shakespeare (1936) noted that a pupil's scientific interest seemed to develop at an early age. In trying to narrow down 'early age', Kelly (1961) found that the majority of pupils who specialised in science had a long standing stable attitude which was expressed in their concept of high social prestige for scientists. This was formed he postulated, at around the age of II for the grammar school boys he studied. Ormerod (198Ib) found that pupils' attitude towards the social implications of science (as opposed to the subject of science itself) had developed by the age of I4. This backed up his previous finding (Ormerod 1973). Butcher (1969b) found that by the age of I3, children exhibited "patterns of interest" in science subjects before they showed a preference for <u>any</u> particular science subject.

Perrodin (1966) in a study of 4th, 6th and 8th grade U.S. pupils (9, II and I3 year olds) concluded that a positive attitude to science was shown as early as nine years old.

Brown (1976) in a monograph states that pupil's attitudes to the social implications of science (whether science performs a relevant or irrelevant role in society) had peaked by the age of I2.

Moore (1962) concluded that interest in science peaks at I2 with further peaks at I3 and I4. Tyler (1964) found that interest in science is formed between the ages of I0 and I4. This is supported by Bottomley and Ormerod (198I) who concluded that between the ages of I2 to I4 attitude to science is still labile and subject to change. Baker (1985) with 4I male and 57 female thirteen year olds, concluded that attitudes to science can be identified by the age of thirteen.

"In the U.K. and the U.S. at least, the critical ages at which pupils' attitude to science can be influenced extends from about 8 years of age to about I3 or I4".

Ormerod and Duckworth (I975) p.42

Therefore, it would appear that a middle school of age range 9 - I3 could have a crucial role to play in the development of attitudes towards science. It should also be noted at this time the child is becoming more aware of other sources of scientific knowledge, e.g. that coming from the television ("Great Egg Race", "Eureka"). According to Newton (I975) these may also influence the pupils' attitude to science.

d) Attitude to Science and Sex Differences

The Dainton Committee in their report of I968 was concerned at the decline in numbers of sixth formers choosing science (the so-called "swing from science"). They envisaged encouraging more pupils to take science subjects and teachers to encourage the science choice.

Several previously mentioned researchers have used as an important manifestation of a favourable attitude to science, whether pupils opt for and follow science courses leading to science specialism at C.S.E. 'O' and 'A' level. Whitfield (I979) quotes figures for C.S.E./'O'level entries for the three sciences in I974:

	Boys	Girls
Physics	I788I2	47378
Chemistry	I08956	50989
Biology	I08733	204829

It has been suggested therefore that subject choice is influenced by a pupil's attitude towards those chosen subjects. (Lovell & White I958; Butcher I969a). It would seem desirable to identify those areas which influence most strongly a pupil's attitude to science at middle school age, for it may be possible to help develop a favourable scientific attitude by the time he/she leaves middle school at age I3 and begins to make subject choices at the High School.

One variable identified as influencing attitude and choice of subjects is whether the pupil is a boy or girl.

Barker Lunn (I969) found that girls tended to have more positive attitudes to school, school work and "importance of doing well". Sharples (I966 and I969); Cohen and Cohen (I974) and Croucher and Reid (I98I) have shown that between the ages of 9 and II girls hold more favourable attitudes towards school subjects than boys. These researchers made no specific mention of science.

When the literature concerning sex differences and attitudes to science is examined, the differences are there but in the opposite direction.

Meyer and Penfold (I96I) found that at the ages of II and I3, boys hold a significantly more favourable attitude to science than girls. This finding is supported by Meyer (I959 & I960); Muthulijah (I963); Newton (I975); Fraser (I978); Haladyna and Thomas (I979) and Ormerod (I97I, I98Ib).

Using II year old pupils, Livesey (I98I) found several significant sex differences when using the Science Attitude Questionnaires (Skurnik and Jeffs I97I).

For Science Interest boys held a significantly more favourable attitude ($p < 1\%$) than girls.
For attitude to Science Teachers, girls held a significantly more favourable ($p < 0.5\%$) attitude than boys.

For attitude to school, girls held a significantly more favourable attitude ($p < 0.1\%$) than boys.
There were no significant differences between the sexes for attitude towards the social implications of science and attitude towards the learning activities used in science.

Levin and Fowler (1984), with 988 15 - 17 year old pupils, found that boys had a significantly more positive attitude towards success in science than girls ($p < 1\%$).

Only in Lowery (1966) can this researcher find evidence of girls holding a more positive attitude to science than boys (this being at ages 10 - 11). Hoffman (1977) has found no significant differences between the sexes in their attitude to science at age 8.

With the evidence that boys hold a more positive attitude to science than girls at ages 11 - 13, there are several possibilities which might explain these differences.

a) Kamm (1965) and Walford (1983) emphasised the influence of parental and grand-parental attitudes on the sex stereotypes of boys and girls in believing that the physical sciences especially are not the domains of girls. This leads at the age of 14 to boys believing that women spend the day tied to the kitchen sink and girls to be envying the position of men (Duxbury 1984). Kelly et al mentioned in Wood (1983) in a study of 2,000 eleven year olds found that boys agreed with statements such as "learning science is more important for boys than girls". Victor (1961) and Selmes (1969) have found that girls tend to think of scientists as usually men.

Ormerod (1975 and 1981a) points out that at puberty in mixed-sexed schools, pupils appear to use subject preference and subject choice to assert their sex roles. This does not appear to occur to such an extent in single-sex schools (DES 1975).

b) There may be differences in the cognitive abilities of boys and girls. In a study of 1,152 pupils in Durham, Cornelius and Cockburn (1978) found that girls perform better than boys in English and languages but worse than boys in science and maths. Lewis (1964) found that spatial ability is needed for the physical sciences but verbal ability for the biological sciences. Boys tended to progress more at the former whereas girls were better at the latter (Moore 1967). There is tentative evidence (Ormerod and Duckworth 1975; Bagnara et al 1981) that the differences in spatial and verbal ability is caused by differences in the brains of the sexes. Bagnara et al (1981) also found that girls tend to employ a verbal strategy when working out problems which may well interfere with the spatial processing in the brain's right hemisphere which is required in spatial problems.

Lord (1985) found that superior spatial ability is found in students of physics, chemistry, biology, geology and astronomy. These differences could, according to Lewis (1964), be sex linked. If spatial ability is sex-linked then it may automatically lower the number of girls who had the sex-linked spatial ability gene.

c) There may be differences in the perceived difficulty of the subject. Kamm (1965) notes that girls were ascribed with a lack of stamina (possibly due to a) above) and held the belief that work needed to acquire scientific knowledge was enough to cause mental damage!!

However there is a growing body of evidence that girls choose subjects perceived as 'easier', and the physical sciences are seen as 'hard'. Ormerod and Duckworth (1975), Keys and Ormerod (1976) and Ormerod (1981a) mention that as the subject is perceived as 'difficult' then the pupils' attitude to that subject changes negatively, especially it seems in girls. James et al (1984) in a review of 'A' level choices of boys and girls following 'O' levels back up this statement. They found that there was a significant difference between boys and girls in the way 'A' level chemistry was perceived, girls thinking it would be hard.

d) Brophy (1985) argues that the 80% of primary school teachers who are women, have negative attitudes towards science because they perceive it as more masculine. Therefore, he says, little primary science is taught well, with a "rub off" effect on the girls who are taught.

There may well be a combination of any or all of these reasons in the explanation of the difference in attitude to science between boys and girls.

SUMMARY

The available literature concerning attitudes is considerable and probably reflects the upturn in research into the affective domain since the early I960's.

Various characteristics of attitudes have been discussed and ways of effecting attitude change examined.

Shoben (I949) and Glassey (I945) have shown that parental attitudes and the perception of them by children, play an important role in the formation and development of the children's attitudes. The attitudes of significant others, peers and teachers to an extent, also play their part.

As regards school/subject progress and choice of subject, it appears that a child's attitude to a subject may influence attainment although this relationship is tentative.

It appears that the extent of a favourable attitude to science at most ages in girls is less than that of boys. This appears to affect their choice of science subjects and involvement in anything scientific. (So much so that I984 was designated WISE Year [Women into Science and Engineering]. This was hoped to encourage more females to opt for and enter science and science related courses and jobs).

The way in which girls' attitudes became stereotyped and their perception of science as 'difficult',when antagonised by innate physiological differences, may lead in mixed schools to them not wanting to appear a failure at science when compared to boys, (Ormerod I975 and I98I). When the quantity of women scientists and engineers in the Soviet Union is noted,a study of their methods of a) rearing children in creches and b) exposing them at an early age to situations designed to develop their spatial abilities,may prove useful in this country in encouraging more females to take up science in school and after.

It is possible to list some hypotheses concerning attitudes and the way they may affect this research:-

1) On an "Attitude to School" scale, girls may have a more positive attitude than boys.

2) On "Attitude/Interest in Science" and "Social Implications of Science" boys may have a more positive attitude than girls.

3) Improved achievement in science may be reflected by improved attitude scores in boys and girls.

4) Groups given 'reward', in terms of encouraging/praising comments, may have a positive change in their measured attitudes to science.

5) Groups given 'reward', in terms of encouraging/praising comments, may have a positive change in their measured attitudes to the science teacher if he is seen as a dispenser of these rewards.

CHAPTER 4

REVIEW OF PREVIOUS RESEARCH

The major study concerning the effects which teachers' written comments have on pupils' learning was carried out in the U.S.A. by Ellis Batten Page (Page 1958). Follow-up work by various researchers (which will be detailed later) has all taken place in the United States. To date, there seems to be no British research dealing directly with the effects of teachers' written comments on pupil learning, achievement, attitudes or personality. However, Page's research has been used by British researchers and writers to support theories about the effects teacher attitudes have on pupil learning (Barker 1976) and the importance of providing feedback from assessments (Rowntree 1971).

Pickup's research (1967, 1974) into the expected and actual marks received by pupils was, according to the author, strongly influenced by the experimental design of E. B. Page.

His appreciation of Page's study is not unique. Charters and Gage (1963), Starkey (1970) and Cross and Cross (1981) have all commented on the "rigorously controlled research" while Campbell and Stanley (1963) mention Page as having avoided pitfalls common to experimental workers such as sample representativeness, reactive arrangements and testing-experiment interactions. Indeed they propound Page's basic design as one to be imitated if normal classroom procedures are to be preserved during the course of an experiment.

Page's study has been replicated to a greater or lesser degree by numerous post graduate students and researchers (Allen 1972, Hake 1973, Sweet 1966, Lesner 1967, Dain 1969, Rhoads 1967, Moody 1970, Shrago 1970, Mapel 1970, Starkey 1971, Klinger 1971, Simons 1971, Hammer 1972, Stewart 1975, Stewart and White 1976, Cross and Cross 1981, and Elawar and Corno (1985).

Each worker was impressed by the contribution of Page's research to classroom procedures and wished to apply it to another particular area. The importance of Page's findings and their relevance to teaching can be found by reading textbooks and papers on educational psychology and assessment. Gage and Berliner (1975), Lindgren (1967), Craig, Mehrens and Clarisio (1975), Barker (1976) and Rowntree (1977) quote Page's findings as being very pertinent to the teacher in the classroom, e.g.:-

> "Research has confirmed.... that students who are given individualised verbal comments on their work, incorporating suggestions for improvement, do tend to 'improve' significantly more than students who are given standard comments (e.g. 'poor', 'average', 'good', 'Excellent') or grades".
>
> Rowntree 1977 p.26

Page's 1958 Study

As Page's work has had such an influence on research and thinking within the past twenty-five years and has led to his work being quoted and criticised, the present researcher believes that Page's experiment deserves closer examination.

The aims of his experiment were

1. To find out if teacher comments caused a significant improvement in student performance.
2. If there was an effect, would some comments have more effect than others.
3. To find out if there were any conditions in students or class conducive to such effects.

In outlining the experimental basis of his work Page noted several weaknesses in previous research which he hoped to overcome:

I. Treatments have been administered by persons who do not normally work in the classroom with that particular group of pupils who are the subjects of the research. If a pupil is taken out of the classroom situation, anxiety can be aroused in the individual with a resultant change in performance. (Sarason et al 1960).

2. Tests, he points out, have been contrived in order to keep subjects (unrealistically) ignorant of the true comparative quality of their work, although he states no examples.

3. Praise or blame have been administered on a random basis whereas in the normal classroom they are not at all randomly allocated.

4. He criticises the areas of training (i.e. subject matter taught) which has been so new that the subjects would have little or no experience of related success or failure, which is an assumption one cannot make in the classroom.

5. Page also pointed out some statistical errors when research workers have used significance tests, presupposing pupils were totally independent of each other, when in the classroom pupils were often interacting members of small groups.

After these points Page proposes the belief which has brought him most acclaim from his supporters, that is, he left

> "the total classroom procedures exactly what they would have been without the experiment, except for the written comments themselves"
>
> (Page 1958, p.174)

Page randomly selected 74 teachers from a variety of secondary school classes in a variety of subjects, to carry out the experiment. The 2,139 pupils in these classes ranged from 7th grade to 12th grade (12 year olds to 18/19 year olds).

The teacher gave the next objective test in the subject he or she was teaching, collected, marked the tests and graded them A,B,C,D or F.

After placing them in rank order the top paper was allocated randomly to one of the following three groups, and the next two papers to the other two groups,

I. No comment group. The paper was returned to the pupil with the numerical score and grade only.

2. Free comment group. Besides the score and grade the group received a comment given freely by the teachers who were instructed to "write anything that occurs to you in the circumstances".

3. Specified comment group. This group received the score, grade and a comment thought appropriate to that grade by the experimenter, i.e.

A	received	"Excellent. Keep it up".
B	"	"Good work. Keep at it".
C	"	"Perhaps try to do still better?"
D	"	"Let's bring this up".
F	"	"Let's raise this grade!"

Test papers were then returned to the pupils with no discussion of the results. The next objective test, given in whatever subject was used as the criterion test with the pupils then being ranked before statistical analysis began. By using a variation on Friedman's analysis of variance Page discovered the following relationships:-

I. The free comment group achieved the highest scores. The difference between this group and the no-comment group was significant at the 0.I% level. The difference between the no comment and specified comment groups was significant at the 5% level. The free comment and specified comment difference was not significant.

2. There was no significant treatment effect between the schools used in the sample (for this test only 30 groups were selected).

3. There was no significant influence by school year on comment effect. (Age had no effect).

From these Page concluded:-

> "When the average secondary teacher takes the time and trouble to write comments (believed to be "encouraging") on student papers, these apparently have a measurable and potent effect upon student effort, or attention, or attitude, or whatever it is which causes learning to improve......Such a finding would seem very important for the studies of classroom learning and teaching method".
>
> Page 1958, p.180-181

Certainly since 1936, educational researchers and psychologists have been trying to reproduce strictly controlled laboratory conditions in the classroom. Forlano's (1936) opinion was that if the principles governing learning were to be considered worthwhile they should be proven effective under school conditions and not just scientifically true. This according to some is exactly what Page did (Starkey 1970, Shrago 1970 and Pickup 1967).

"Reactive" Classroom Arrangements

When educational research concerns itself with the investigation of practical techniques in a school setting, it would seem a condition of such research to reproduce as exactly as possible normal school conditions, involving the use of curricular materials in preference to "routine tasks"(which might indicate to some pupils that they were research subjects)and be supervised by the usual class teacher.

Campbell and Stanley (1963) regard Page as having avoided this particular "reactive arrangement". At the end of their discussion of experimental techniques they conclude that school research must be conducted by the teaching staff of that school, especially if the results are to be generalised. This has also been supported by Charters and Gage (1963). Since Page, some researchers do not appear to have considered this point fully, e.g. Rhoads (1967) tested and carried out the experiment with 147 slow learning pupils himself. The pupils were tested individually, immediately on entering the classroom. In finding no significant difference between "praise" comments, "reproof" comments and "no comments" on the achievement of the pupils, he says himself that the experiment was probably too far removed from normal conditions. The variable of anxiety may have affected results, with High Test Anxious Subjects (Sarason et al 1960) having their performance on the criterion test, used by Rhoads, affected to a greater degree than the performance of low test anxious subjects. Hake (1973), like Rhoads, was very concerned by the problem of teacher variability in his research.

In order to control this variable he taught the 93 pupils in his sample himself. Neither Rhoads nor Hake state whether or not they had previously taught those pupils and were therefore "known" or "unknown" to them.

Cross and Cross (1981) used four other teachers and their 196 11 - 15 year old pupils for a long term experiment. However, in order to keep a careful watch on the experimental procedure, G. M. Cross carried out the experiment with one of the classes, therefore according to the argument put forward previously rendering one of the classes subject to a "reactive arrangement" by not having their normal teacher. Out of the four classes remaining, three teachers were lax in putting comments on the pupils work after two weeks. One class remained which suffered absenteeism. The criterion tests used had reliabilities of +0.7 and +0.59. With such a small sample these relia bilties were very low, compared with a recommendation that a test should have a correlation coefficient of reliability as high as possible, preferably above +0.9. (Ebel 1965, Crocker 1974, Downie and Heath 1965). They found no significant difference between the group which received "marks and no comments" and the experimental group which received "marks and a positive statement", although the gain for the experimental group was significant at the 0.1% level.

If the groups were matched at the start of the experiment and there was no significant difference between the groups at the end, and bearing in mind the difficulties there were in applying comments consistently, Cross and Cross are not really justified in concluding

> "personalised supportive comments do have the potential for facilitating a greater sense of internal control".
>
> Cross and Cross 1981 p.71

One of the greatest problems affecting classroom research is this "reactive arrangement", often termed the "Hawthorne" effect whereby as soon as subjects realise they are taking part in research or some form of experiment they change (often temporarily) and thus produce changed effects. The presence of strange experimenters may produce this, as may the reshuffling of classes, the realisation that "something different" is taking place and trying to ascertain the experimenters strategy (Burroughs 1975). This other type of reactive effect obviously concerned Page and it must have been with considerable relief that he wrote:

> "It is interesting to note that the student subjects were totally naive. In other psychological experiments, while often not aware of precisely what is being tested, subjects are almost always sure that something unusual is underway......In none of the classes were students reported to seem aware or suspicious that they were experimental subjects".
>
> Page 1958 p.174-5

The pupils' detection of treatments is a considerable worry (Campbell and Stanley 1963) but if the experiment is a variant on usual classroom events which occur at plausible periods in the calendar then, as Shrago (1969) believes, this particular problem can be solved. Undoubtedly Page did achieve this requirement by using normal classroom practices, but did this mean total subject naivety, as Page and Starkey (1970) seem to imagine?

Klinger (1971) in his study of the effects of positive comments on the academic performance of 5th grade pupils casts doubt on Page's findings because of the 'likelihood' that some of the 2,139 pupils were aware something was happening. It is encouraging to think that Page was aware of this problem, especially when some researchers, for example Stewart (1972) and Stewart and White (1976) in their comprehensive review of this particular research field, do not mention the possibility that the Hawthorne effect could alter their findings. It does seem however, optimistic of them to think that there was no Hawthorne effect in some classrooms. Also, the fact that pupils did not seem to the teacher to be "aware", did not necessarily mean they were "naive".

Some researchers go to the other extreme. Simons (1971) studying the effects of written incentives on academic performance told all the pupils about the research and printed information concerning it in the local paper on the grounds that children and their parents have a right not to take part in experimental educational research if they wish. The results showed no significant difference between the subjects who were given written comments and those who were not.

<u>Pupil Perception of Comments and Stewart & White's 1976 Research</u>

All too often, teachers make assumptions about children; children's potential; their views; what they see as fair and unfair etc. Teachers can also make assumptions about the comments put on the bottom of children's work. A teacher may write what he considers an encouraging 'positive' comment which unfortunately is read by the pupil as the exact opposite of what is intended. Page is not the only researcher to encounter this problem. He lists the specified comments to be given to the specified comment group believing them to be encouraging (Page 1958 p. 180). Rhoads (1967), Cross and Cross (1981), Allen (1972), Shrago (1969), Simons (1971), Hammer (1972), Klinger (1971), Starkey (1970) also chose the specified comments themselves.

Klinger (1971), Stewart (1974) and Stewart and White (1976) have crticised Page and some of the other researchers on this point. Stewart and White asked 160 students (not part of the experimental sample) to judge 20 typical teacher written comments. They were asked to rate them positive (would make the student feel good about their work) or negative (would make them feel bad about their work). They were also asked to judge which letter grade, A, B, C, D, or F, most suited each comment. From this they obtained five comments (one for each letter grade) to put onto the children's work (tests, homework, written assignments etc.), although some comments were allocated to some grades by only 44% of the pupils, meaning that for a grade D 56% of the pupils did not regard the comment "You must do better next time" as a suitable comment for a 'D' grade.

The difference between a comment perceived by the teacher as encouraging and the same comment perceived by the pupil as negative can be seen by the 'F' comment in Page (1958) i.e. "Let's raise this grade!" Some pupils, depending on their attitude to the subject and to the teacher, may well see this comment as a command given by an impatient teacher, and not, as it was meant to be, encouraging. If it is seen as blaming the pupil for his or her poor work, then there may be an inhibiting effect upon the performance of the pupil (Kennedy and Willcutt 1964).

Despite Stewart and White's change in Page's experimental design in getting the pupils to allocate comments to grades, they opened themselves to criticism on other grounds. They did not ask the teachers in their study to comment just once on pupils' work as Page did, but to mark, grade and if necessary comment on <u>all</u> work marked during the experimental period of 6 weeks. This idea was not new, having been tried by Rhoads (1967), Cross & Cross (1981), Allen (1972), Shrago (1969), Mapel (1970), Hake (1973) and Klinger (1971) on the premise that Page's "single shot" (one comment) experiment precluded the evaluation of any transitory effects of the treatments, and also whether continuous treatments increased their effect. However, the comments chosen by Stewart and White did not vary within grades meaning that:-

i) Some pupils who received a grade more than once received the same comment by that grade. They did not mention if one comment given repeatedly was normal practice in the schools;

ii) As one of the treatment groups was "comments only" there was a very big danger of children knowing they were part of an experimental group especially as others within their same class were receiving grades or grades and comments, although they were not informed of this directly.

iii) In their experimental group called "Positive comments only", where, no matter which grade the pupil received they obtained one of series of nine pupil rated positive comments, some pupils who consistently obtained grades D or F could find themselves with a comment such as "You are improving" all the time as none of the others would seem to fit (e.g. "Excellent", "Good work", "Nice", "O.K.", "Really fine work", "Not bad", "Good", "Well done").

All these points mentioned may lead to the suggestion that the research results could have been influenced by the "reactive interference" effect mentioned previously.

Several researchers did attempt to investigate possible longer term relationships:-

Rhoads (1967) found no significant difference between no comment and comment groups ($F = 1.557$ $p > 5\%$), although his comment group received the same comment at each assessment before the criterion test.

Allen (1972) with a sample of 352 female college mathematics students, found no significant treatment effects after one application of treatments ($F = 0.8284$ $p = 4.7\%$) or after several applications ($F = 0.34$ $p > 5\%$).

Shrago (1970), with 327 8-9 year olds, found no significant difference between treatments after criticising Page's one comment study ($F = 1.582$ $p > 5\%$).

Mapel (1970), using a large number of college students ($N = 2640$) found no significant difference between no comment, free teacher comment, and specified comment after one or two applications of treatments ($p > 5\%$).

Hake (1973), in an experimental session lasting 20 weeks, found no significant difference in attainment between no comment and comment groups. ($F = 0.756$ $p > 5\%$ for algebra and $F = 0.323$ $p > 5\%$ for geometry). Hake also pointed out that the written teacher comments may lose their effectiveness over 20 weeks and may have vicariously reinforced the 'no comment' group. If this occurred then it would agree with the research of Auble and Mech (1953) who found that if one pupil or a group of children is praised by a teacher then any other group which overhears may identify with those who were praised and feel just as strongly rewarded, although this transfer effect does depend on the pupil's past history of success and failure.

Klinger (1971), in a study of 88 ten year old pupils, found no significant main treatment effects between numerical score; numerical score and teacher judged positive comment; and numerical score and pupil judged positive comment ($F = 0.094$ $p > 5\%$). He also quotes Dain (1969) who expanded Page's study to four weeks finding that the reinforcing effect of written comments diminished after one week.

In a recent study by Elawar and Corno (1985), their sample of 504 eleven year old Venezuelan children was taught mathematics by 18 teachers. One half of each class was given written comments as well as the number of correct answers on their homework. The other half (according to the authors, the 'normal' control treatment) was given the number of their correct answers only. The written feedback given served both cueing and rewarding functions.

The experimental treatment had significantly higher scores in achievement test than the control group ($p < 5\%$).

Stewart and White point the way towards another possible explanation of Page's results. One of their treatment groups is termed the "existing evaluative practice" (i.e. control) group where the teacher marks or grades and/or comments on work in exactly the same way as he/she has done in the past. After finding no significant difference between their treatments, Stewart and White discard this control group, hoping to find significance, on the grounds that this group

> "consisted of a hodgepodge of evaluative styles that were probably duplicated in the four basic treatment groups".
>
> Stewart & White 1976 p.464

They still found no significant difference between the remaining treatment groups but it could lead to Hammer's (1972) explanation of one of Page's findings, in that in Page's free comment group, some pupils probably received no comment or a specified comment while others received extensive informational as well as affective remarks. Therefore this would result in no significant difference between Page's free comment and specified comment groups.

However, one could argue that Stewart and White's findings of no significant difference when the "existing evaluative practice" group is left out, shows that Hammer's argument does not apply.

Hammer (1972) with 87 undergrads, found no significant difference between his no comment and specified comment group. His specified comments were restricted to one word only in order to take into account any 'length of comment' effect, but he did not test for differences between 'free' comments and specified comments. He did however find a significant difference ($p < 0.05\%$) between the "specified comment" group and the "specified comments which also accounted for student grade expectation".

Testing Interactions

> "If the experiment can use regular classroom examinations as tests, but probably also if the experimental tests are similar to those usually used, no undesirable interaction of testing and X (the experimental treatments) would be present".
>
> Campbell & Stanley in Gage (1963) p.188

This testing - treatment interaction is often a problem in experimental research, especially if any pretest used has an arousing effect on the pupils. Page obviously avoided this by having each of the 74 teachers give their own tests to their pupils. There being no other test imposed on them by the experimenter, there was no possibility of this interaction effect. A pretest is not absolutely necessary or desirable in some research and therefore no threat to external validity (Burroughs 1974). He points out that a pretest is often used to ensure that groups are equivalent. This equivalence is also assumed to be produced by random selection as an alternative technique for obtaining representativeness in the groups.

In Page's research a test was used to allocate pupils to experimental groups although one might have thought that by allocating treatments randomly in such a large sample he would have achieved representativeness (Burroughs 1974).

In only a few studies however, were any attempts made to use reliable tests of criterion. Rhoads (1967) used a criterion test of +0.75 reliability, Cross and Cross (1981) one of +0.59, Lesner (1967) because of the variation in the spelling tests used by the teachers in his sample, made use of frequency distribution techniques to analyse the data. Should a criterion test as used by these researchers be of good reliability? Cronbach et al (1963) says that it should, because one can then begin to generalise from the experiment in hand to a section of research or situations to which it belongs. There would be great difficulty in attempting to get all 74 teachers to use reliable tests without imposing a reactive effect on the pupils but if the results were to achieve good credibility then an attempt should be made to overcome this problem.

Page points out, that the tests used by the teachers were objective tests which, one hopes, eliminates any subjective assessment of pupils' work. For example Briggs (1970) and Bull & Stevens (1979) found that pupils' handwriting influenced the grades awarded by teachers when their work is marked. Briggs (1980) found that poor handwriting significantly penalised a student when taking examinations.

However, although Stewart and White used objective tests for their criterion tests, they allowed the teachers in their sample to mark <u>any</u> work done by the pupils whether the work was subjective (i.e. essay) or objective. Some pupils in some classes may have had grades and/or comments allotted to them they did not truly deserve (judged on the standard of their handwriting) and therefore this may partly explain Stewart & White's lack of significance in their results.

The marking of every assignment also meant that before the final criterion test after six weeks, some of Stewart & White's subjects had 2 evaluations whilst some had II. Some subjects may have therefore received the same comment on their work II times with the possible effect noted on p. 59.

Teacher-pupil interactions

> "Indirect teacher influence (on learning) is when the teacher accepts feelings, praises or encourages, accepts or uses pupil ideas or if he asks questions".
>
> (NFER I975 p.79)

Feedback from a teacher to a child does not just occur when a piece of work is graded, commented on (or not) and then handed back. It can occur everytime a pupil talks to the teacher or even looks at the teacher. Macleod (I972) mentions that in Page's study he did not make any reference to this classroom feedback. Perhaps Page may have thought that this aspect of his research was randomised and need not be taken into account.

Research in primary classrooms in the United Kingdom has shown that on average each child individually interacts with the teacher for 2.3% of the lesson time and for another I.5% as a member of a group. (Galton and Simon I980). During this time the pupil may receive verbal praise or blame. However, the same research also identified four types of pupils who receive varying amounts of the teachers time. Compare just 2:-

I. The Attention Seeker who is continually seeking out the teacher for constant feedback, and

2. Quiet Collaborators who have a very low verbal contact with the teacher and their classmates.

These two groups would be randomly spread amongst Page's sample but the Attention Seekers would get far more teacher time and therefore praise or blame. Insko (I965) found that a pupil's attitude to learning a particular subject was affected by verbal praise and, if as Aiken (I969) and others seem to suggest in the previous chapter, pupils' attitude affects their learning, then any praise given by the teacher would influence future performance.

Klinger (I97I) quotes research (Sikes I97I) which had determined that in classroom interactions there were more positive comments (e.g. praise) given to girl pupils than to boys. He makes the point that as this is related to their reinforcement value, the girls will be reinforced more. This was supported by Barker (1976) who also found that teachers have a more favourable attitude to girls than to boys. Galton and Simon (1980) found no significant relationship between the sex of pupils and the sex of teachers when measured in mathematics attainment. Girls tended to be more conforming and more amenable to discipline and order (Fitt 1956), place more importance on doing well than boys ($p < 0.1\%$) and have a better attitude to school and interest in their school work ($p < 0.1\%$) (Barker 1976). Do teachers, because of these points, give girls greater amounts of approval or do teachers generally prefer girl pupils with the result that girls develop these particular characteristics? Cause and effect are difficult to distinguish here.

Barker also discussed the research which has found that bright pupils tend to be more satisfying and therefore receive more praise than dull pupils. Her own study came to the conclusion that teachers have more favourable attitudes towards bright pupils.

Williams and Knecht (1962) discovered a high correlation ($p \leqslant 0.01\%$) between the teacher's liking of a particular pupil and measures of the pupil's ability and course grade.

Morrison and McIntyre (1969) discuss at some length the various types of non-verbal communication that takes place in a classroom. This generally stems from the teacher's posture; physical gestures; proximity to the pupil; eye contact; facial expression and non-liguistic aspects of speech. They say that even looking at a person can indicate either attitudes or emotion. Dropping of eye contact can be used to show rejection of the pupil. Although this can also be dependant upon the prestige of the teacher. If the pupil thinks highly of the teacher then he will be less likely to feel totally rejected and still retain a favourable attitude towards the teacher, than would a pupil who does not hold the teacher in such high esteem (Ewing 1942).

The discussion above concerning Teacher-Pupil verbal interaction is, this researcher feels, important for it raises the question as to whether Page, or anyone who did a follow-up to Page's work, instructed teachers to monitor carefully what was said to the pupils, to ensure, as far as is ethically and practically possible (without causing reactive interference) that no particular treatment group of pupils received more verbal feedback (positive or negative) than any other treatment group. Even further clarification as to where a particular pupil went wrong may constitute feedback in addition to that already received.

In general, looking at all the studies concerned with the effect of written comments on pupil learning, it can be seen that Page's conclusions are not supported by later research. In the eighteen studies written since 1958 only three have shown significant comment effects. Hammer (1972), Lesner (1967) and Elawar and Crono (1985). Only one of the studies (Mapel 1970) managed to match Page's for the number of pupils (2,640 college students) and here no significant effects were noted. Stewart (1974) and Stewart & White (1976) argue that Page found a statistical significance because of his large sample and that if a random selection of pupils was taken from Page's data, the new figures would fail to show a statistically significant comment effect. They say that partial support for this theory came from Page himself on page 178 Table 6 of his data where he restricted the sample of schools to 36 (compared with 74) to try to ascertain any interaction between the school and comment effectiveness. No significant main treatment effects were found. Even Lesner's (1967) sample, although less than half the size of Page's, was 965.

Burroughs (1974) questions the use of large samples by arguing that a well designed experiment which results in a significant result and

and uses small numbers carries more conviction than one which reaches significance only by using large numbers.

> "Large numbers are not convincing in themselves. It is far better to replicate the small well-designed experiment over many different conditions than to use the same total number of children in a single large scale experiment, inevitably under a single condition......One should look for replication rather than size".
>
> Burroughs 1974 p.239

He states that one may secure significance by reducing the standard error of mean, which is accomplished by increasing the sample size.

Mapel's results could possibly be explained by those of Hammer (1972). He found that undergraduates who received a personalised comment, which took into consideration the grade they had expected to achieve, performed better than those who did not. Mapel's study with undergraduates used comments, perhaps not viewed as so personalised, and standard comments which students were probably used to after many years of schooling.

Marble, Winne and Martin (1978) in finding no significant difference between grades and grades + comments treatments in 13 year old pupils, say that verbal feedback provided by the teacher is very important because of the immediacy of its application.

Comments and Attitudes

Five of the many 'replications' of Page's work have set out to discover if there is any influence of comments on attitudes of pupils.

Starkey (1970), using 875 11 - 18 year old high school mathematics, students found that comments had no effect on "attitude to mathematics" scores although the same comments were used for each evaluation.

Shrago (1969) tested 9 year old pupils' attitude to spelling and found no significant difference in attitude scores between "marks only" and "marks + experimenter specified comment" groups.

Hake (1973) found no significant difference in pupils' attitude to mathematics between groups who received no comments and groups who did.

Allen (1972) found no significant difference between comments and no comments groups in college students' (female) attitude to mathematics.

However Elawar and Corno (1985) using eleven year old Venezuelan schoolchildren found that the group who received written feedback in the form of comments on mathematics homework had significantly more favourable attitudes to mathematics ($p<0.05$) than those pupils who did not receive comments and just marks only.

Summary

Where does all this discussion lead? This researcher believes that although Page and subsequent researchers succeeded to some extent in "taking research into the classroom", there are still many variables which the studies either did not take into account or manage to control as well as they possibly could. Out of eighteen studies (including Page's) there have been significant main treatment effects in only three. From this literature, therefore, only tenuous conclusions can be made regarding the effect of comments on achievement.

Despite this, it is obvious how some authors apparently treat the findings of Page without question and also attribute to him, that which he did not find. For example Barker (1976) in her thesis says that a teacher who takes a personal interest in a pupil by writing encouraging comments on his work, improves the pupil's motivation and their work. As mentioned earlier, the "encouraging" comments need not be encouraging to some pupils.

Rowntree's quotation (p.56) is also misleading. Firstly the comments were not "verbal" but written and secondly there was no confirmation in the research literature that children have been given suggestions for improvement in the "free comment" groups. Undoubtedly some were given advice but as Hammer (1972) makes clear, this group probably received the least as well as the most information of all the treatments. This group did not differ significantly from the specified comment group which received far fewer words in the statements.

In the next chapter the researcher hopes to explain how the present research was set up, bearing in mind the previous discussions. Page has contributed greatly to the design of the experiments which can be carried out in the classroom, but at the same time his results must be viewed with caution considering the problems still to be overcome and the lack of support from later research.

From this chapter and the previous chapter on Reinforcement and Feedback some working hypotheses can be formulated:-

I. Those pupils who consistently receive comments, seen as a reward, will show increased achievement when compared with those groups who do not receive such comments, and with a control group.

2. Those children who receive "grades only" and no comments will show lower achievement scores than either those groups who receive comments or a control group.

CHAPTER 5

DESIGN OF THE EXPERIMENT

In this chapter the writer intends to detail:-

a) the reasons for the choice of the measuring instruments;

b) the design of the research;

c) the variables which may affect the experiment;

and d) how the work of Page and later workers was used and modified for this study, hopefully improving scientific objectivity and validity.

To place the experiment in context, it is necessary to point out the following. The writer when starting this research was head of science in a IO - I3 middle school in Worcestershire. The responsibilities included design of a suitable curriculum in science for this age, in conjunction with other middle schools in the area and bearing in mind the work a) done in first schools (5-IO years old) and b) to be done in High Schools (I3-I8 years old).

In the middle school it is necessary to give the children a good foundation in science skills and scientific concepts and understanding. To this end topics loosely based on Nuffield Combined Science and Science for the 70's were decided upon.

The writer considered that the topics taught in the I3+ age group could be used as part of the experiment in this research, i.e. "The Earth".

After one trial the writer obtained the post of Deputy Head and Head of Science in another Worcestershire Middle School, twenty miles away from the first. It was thought useful to try the experiment again using children from another area who covered the same topic in the I3+ age group.

Both schools drew children from towns, with their catchment area covering Council housing, private dwellings, and also from rural areas.

The time scale followed was therefore

Year I	Collation of Comments
Year 2	Selection of Comments. Design of Pre/Post Achievement Test
Year 3	TRIAL I with Pre and Post Achievement and Attitude Tests
Year 4	Changed schools Children getting used to my style of teaching
Year 5	TRIAL 2 with Pre and Post Achievement and Attitude Tests

I. COLLECTION AND SELECTION OF COMMENTS

One of the criticisms levelled at Page was that he chose the "encouraging" comments placed by teachers on the childrens' tests. Cross and Cross (I98I) and Shrago (I969) did the same. It can be suggested that comments chosen in this way may not be seen as "encouraging" by the children.

Collection The field researcher collected comments that he had placed on I2 - I3 year old childrens' science work over a two year period. These comments were duplicated and given to II6 mixed-ability, I2 - I3 year old pupils of both sexes the following year.

Selection These pupils were asked to place by each comment either an 'A', 'B', 'C', 'D', or 'E' grade, depending on which grade they thought would go with the comment. After doing this for each comment they handed the sheets in. The results were tallied.

The pupil chosen comments are in Appendix I.
Because of the low number of polarised comments selected in 'A', 'B', 'D' and 'E', and for the reason given on page 98 it was decided to group 'A' and 'B' comments together and 'D' and 'E' comments together to provide an 'above average' comment group; an 'average' comment group and a 'below average' comment group. A percentage score was obtained for each comment in the following manner:- The number of pupils who marked a comment 'A'/'B' or 'C' or 'D'/'E' was tallied and transformed to a percentage score. The highest percentage for each comment was examined to see if it was high enough (over 75 %) to be included in the list of comments.

The spread of responses was also noted. Comments that had a wide spread were rejected.

There were 48 comments in the 'A'/'B' groups; 30 in the 'C' group and 24 in the 'D'/'E' group. These comments chosen by pupils to accompany appropriate letter grades were used in the experimental treatments. (See Appendix II).

From the responses given, comments were chosen which showed up as being highly polarised. Stewart and White (1976) after allowing pupils to grade comments found that 'A' and 'B' comments produced highly polarised results. However, their 'C' and 'D' comments did not. Therefore they chose the comment selected by the highest percentage of pupils. The 'C' comment ("not as good as it could be") was chosen by 61.25% of 10 year olds and 72.5% of I2 year olds. The 'D' comment ("You must do better next time") was chosen by only 43.75% of the IO year olds. Therefore this comment was viewed as pertinent to another grade or grades by over half of the pupils.

2. PRE AND POST ACHIEVEMENT TEST

It was decided to formulate a multiple-choice test for the following reasons:-

I. The children were often given a multiple-choice test at the beginning and/or end of a topic, so this procedure would appear as nothing new.

2. An objective multiple-choice test destroys

a) the 'halo' effect.

b) the 'serial' effect. Vernon (1962) states that the position of the essay paper in the pile may influence the grade awarded with the examiners getting fatigued towards the end. According to Vernon this may produce more extreme marks.

c) the 'time of day' effect which may influence the grade a pupil obtains when an essay-type of question is marked (Tittle & Millar, 1976).

3. The field researcher had already built up a bank of multiple-choice questions on the topic "The Earth" which would be taught.

An 85 item multiple -choice test (see Appendix III), was designed according to the suggestions put forward by Macintosh (1974).

(i) The items were arranged randomly (with the exception of items 72 - 76 inclusive, which were included as one question).

Gaudry & Spielberger (1971) suggest that difficult questions should be avoided in the early part of a test to avoid undue arousal of anxiety in some pupils who may answer later, easier, items wrongly. Hambleton and Traub (1974) have found that the number of correct responses on a test containing items arranged from difficult to easy, was lower than if the items were arranged randomly or from easy to difficult.

(ii) Friel and Johnstone (1978) discussed the advantages and disadvantages of having 2, 3, 4 or 5 choices in each multiple choice item. They suggest that 3 or 4 choices seemed to give maximum discrimination without affecting the reliability of the test.

(iii) Taylor (1966) conducted an experiment into the effects of instructions given in multiple choice tests with 14 year old pupils. His 3 treatments were

a) Pupils were instructed to answer a question only when certain it was correct

b) Pupils were instructed to 'do the best you can'

c) Pupils were encouraged to guess

He found no significant treatment effects on the means or variances of the scores and concluded that treatment b) did not run the risk of giving rise to random error and did not leave a feeling of unfairness, as well as being congruent with the policy encouraged by teachers in schools.

The field researcher's multiple choice test therefore had instructions akin to Taylor's treatment b).

(iv) Head (1968) commented that multiple choice tests are poor tests because they are open to guessing. Guessing would appear to be spread across all levels of ability although there has been reported small correlations between ability and guessing, and sex and guessing - with girls guessing slightly more frequently than boys (Choppin 1975). Several researchers quoted by Friel & Johnstone (1978) do not advise applying a correction for guessing as it does not affect the rank order only the final scores, but often causes anxiety.

No guessing correction was used in this research.

Application of Test

After taking the above into consideration the multiple choice test was given to 152 thirteen year old mixed ability boys and girls as an end of topic test. The papers were scored and subjected to item facility and item discrimination analysis.

(i) Item discrimination

The top and bottom 27% of pupils were taken and items selected which had a discrimination between +0.3 and +0.77. According to Crocker (1981) and Shoesmith (1977) these questions would discriminate between the more and less able.

(ii) Item facility

Item facility indices were calculated and items selected which had a facility index between 40% and 60% as recommended by Crocker (1981), Tittle and Millar (1976) and Shoesmith (1977).

From these analyses 39 items remained which fulfilled the conditions of having a discrimination above +0.3 and a facility between 40% amd 60%.

(iii) Reliability

These 39 items were subjected to a statistical analysis (Kuder-Richardson 20) to determine reliability. This K-R 20 exercise according to Ebel (1965) can be used on multiple-choice tests.

The descriptive statistics were:-

a) Mean = 20.345

b) Standard Deviation = 7.82

c) Reliability = +0.87

d) Standard error of Measurement = 2.8

The Reliability is the ability of that test to produce the same answer on successive occasions when no change has occurred in the thing(s) being measured. According to Sumner (1970), it also gives the investigator the opportunity to generalise from the observation in hand to some group of observations to which it belongs.

By testing and retesting to ascertain reliability it may be difficult to ensure that the pupils do not change or learn between the testings. The technique of using the top and bottom 27% employed here (N.F.E.R. 1969) eliminates intervening variables although two shorter tests are quite often less reliable than a longer test.

Cross and Cross (1981) in their study of effects of teacher written comments used a pretest of 0.33 reliability. With a test of low reliability, the results of comparison of gain scores between treatments must be viewed sceptically. This could account for the lack of significance in their findings. (It also means that the test was less than 11% valid).

Reliability correlations should be as high as possible, the nearer to +0.9 the better (Crocker 1981). Page (1958) did not control the tests the 74 teachers used. Some undoubtedly used tests with a high reliability correlation but some (possibly a lot) used tests of unknown reliability.

As this 39 item test would be used for the pretest and immediate post-test, it could be argued that the pretest would alter the children's naivete about the experiment and affect the post-test performance (Coulson 1962, Burroughs 1975). However, Apter et al (1971) and Apter and Boorer (1971), have concluded that pretesting has no significant effect on post-test performance even when pupils' ability is taken into consideration.

The pupils in this present research were quite accustomed to taking a pre-test before a topic was taught so this should not have alerted them to the research.

(iv) Validity

It must be stated that there is no available figure for predictive validity. There being no other reputable test results available for these pupils, there is no figure for concurrent validity.

It is believed that the test has content validity in that it assesses a thirteen year old pupil's knowledge of the topic "The Earth" which has been taught in Science lessons. Downie and Heath (1965) regard the sampling procedure of the test constructor as sufficient to ensure that a test has content validity. Taken to the extreme this could mean that no matter what the constructor does it is bound to be correct! This test was used later by other science staff who thought it suitable for them.

A maximum validity figure however can be obtained from the reliability coefficient in that if all aspects of the testing and application of treatments are perfect, the validity coefficient can reach the square of the reliability coefficient (Crocker 1981). If this is applied to this researcher's test then

$$0.87^2 = \underline{0.76}$$

This is substantial and marked but is a maximum possible figure and should not be assumed to be the validity coefficient for this test.

3. SCIENCE ATTITUDE TEST

From the earlier discussion on attitudes, their formation and change, several assumptions can be made about attitudes to science and scientists:-

(i) the pupils taking part in the experiment will possess an attitude to science and an attitude to scientists.

(ii) these attitudes are based on the pupils previous experience and can be used in new situations

(iii) these attitudes are generally consistent yet are also subject to modification and change;

and (iv) these attitudes can be inferred by the pupils responses to objects, situations and statements. This stems from the fact that an attitude is not an immediately observable variable but rather a hypothetical one (Green in Lindzey 1959).

With (iv) in mind, one of the most frequently used measures of attitude is an attitude test in which the pupil has to agree or disagree with various written statements from which his attitude or attitudes towards a particular object, school subject or situation can be inferred.

This however, presents an over-simplistic view of the development and use of such a test. Many researchers have for years attempted to produce attitude tests which have been well founded on a theoretical construct and are reliable and valid. Yet Gardner (1975a) has shown that since 1960 tests have been produced which do not meet these criteria.

Choice of Attitude Test

In selecting an attitude scale for this research several points had to be borne in mind:-

a) Various methods for measuring attitudes have been produced (e.g. Thurstone and Chave; Guttman; Likert; Bogardus). From the literature it seemed that a Likert scale would be suitable, comparing as it does favourably with other more sophisticated procedures in terms of reliability and validity (Burroughs 1975). According to Fisher (1973) this technique also lends itself for control group vs experimental group comparisons. Moore and Sutman (1970) consider Likert type scales as giving a more reliable estimate of attitudes by using more than one item to measure each attitude and that

> ".... a respondent's attitude varies in strength, he should be permitted to indicate the extent of his acceptance or rejection of an attitude statement".
>
> Moore and Sutman, 1970 p.85

However Baker (1976) casts doubt on the Likert system preferring Guttman's method on the grounds that different children could have the same score on Likert but possess different attitudes. Bearing in mind the earlier discussion (p.35) that attitudes are considered to vary in intensity, then a Likert scale which partly allows for this variation is thought useful.

b) Many attitude scales for children (e.g. Moore and Sutman 1970; Billeh and Zakharides 1975) have been produced by the researchers using language which may not necessarily be used by the children, although Moore & Sutman attempted to make the test "readable" by pupils.

Barker Lunn (1969) may have been the first British researcher to use statements in her attitude scale which had been made by the pupils for whom the scale was intended.

Skurnik and Jeffs (1971) extracted items for their Science Attitude Questionnaire from discussions they had with secondary school pupils.

c) Ormerod in 1971 and 1973 identified two factors in an "Attitude to Science", namely a 'school science' factor and a 'science in everyday life' factor. This followed the thinking of several researchers that there is no uni-dimensional structure that can be called an "Attitude to Science", but that it is a multi-dimensional entity consisting of a variety of attributes one of which may be a 'science in everyday life' factor, (Gupta 1972; Aiken and Aiken 1969, Moore and Sutman 1970).

Newton (1975) maintains that there is AN attitude to Science but is taken to task by Gardner (1975a) who likens some tests which produce a single score for an "attitude to science" to trying to list the attributes of a table (e.g. length, weight, reflectivity of surface etc.) He argues that there are some correlations between some attributes (longer tables are generally heavier tables) but a lot are completely distinct (reflectivity and weight). Therefore he says it is meaningless to try to add up the various attributes for factors in Science attitudes just as it is meaningless to add up the attributes of the table to produce a single figure for a "table".

Aiken and Aiken (1969) quote work by Diederich (1967) who identified 20 scientific attributes. Haney (1964) has proposed 8 attributes. Ormerod and Duckworth (1975) in their comprehensive discussion state that when factor analysis is used on some of these multi-dimensional attitude tests, the argument for proposing so many attributes is weakened considerably.

Skurnik and Jeffs (1971) produced their 58 item Science Attitude Questionnaire (S.A.Q.)using factor analytic methods. They identified 5 factors or attributes, which are not wholly independent but have low enough intercorrelations to suggest that they form psychologically distinct factors, i.e.

Factor I	Science interest
2	Social implications of Science
3	Learning activities
4	Science Teachers
5	School

The Intercorrelations were:- Table I

FACTOR	I	2	3	4
2	0.47			
3	0.44	0.29		
4	0.40	0.33	0.34	
5	0.45	0.17	0.30	0.36

Nuttall (1971)

It might be expected that there would be some shared variance, for attitudes do possess a degree of interrelatedness to each other. (Shaw and Wright 1967, Allport 1935). There does seem to be shared variance between all factors except Factors 2 and 5.

Fraser's (1978) comment that an intercorrelation of 0.59 is still

> "sufficiently low enough to indicate that the scales do not measure the same thing".
>
> p.382

is open to doubt for there will be approximately 35% shared variance between the factors. His results and this researcher's results from the attitude scales must be viewed with this in mind.

However, it does tie in with Ormerod (1971, 1973) and Evans and Baker (1975) who found that the 'social implication of science' attitude is related though not identical to 'interest in science' attitude.

If it is accepted that there are several factors which make up an "attitude to science" battery, albeit with the factors exhibiting shared variance, then these factors must be tested for separately in the results.

d) As stated previously, the reliability of a test is the extent to which it will produce consistent results given a similar experimental sample under similar experimental conditions.

With attitude tests it may not be easy to get an estimate of reliability. If attitudes are subject to modification and change there may well appear to be a low test - retest correlation. This may indicate either an unreliable test or that between the two applications of the test, attitudes have changed.

Kozlow and Nay (1976) say that their science attitude test has a KR - 20 of +0.39. However, many attitude tests have higher reliabilities:- Newton (1975) +0.80/0.82

Billeh and Zaharides (1975) have scales with reliabilities between +0.55 and 0.74

Welch and Pella's test (1967) has a reliability of +0.79. They consider this to be adequate.

Evans (1965) reviews several attitude tests which have reliabilities between +0.71 and +0.92. This is qualified by a comment by Vernon (1938) who considers a very high reliability to be detrimental to validity in that if the individual items are too homogeneous, as might occur with the split half technique, it is too easy for the pupil to put forward his own picture of himself rather than his true opinion.

Gardner (1975a) criticises a 50 item test with a split half reliability of +0.63 stating this to be extremely low.

It does however seem common for attitude scales to have lower reliabilities than one would expect from standardised achievement tests. This does not necessarily make them acceptable, and reliabilities should be as high as possible.

The SAQ reliabilities for each factor are given onthe next page in Table 2. They were calculated by computing the inter-item correlation (an estimate of unit reliability) and using the Spearman-Brown formula for the number of items in a scale to "step it up".

The 'Homogeneity' is the internal consistency of that scale. The 'stability' is the figure obtained from "test-retest" conditions.

Table 2

Factor	No. of items	Homogeneity	Stability
I. Science Interest	20	+ 0.94	+ 0.94
2. Social Implication	I3	+ 0.72	+ 0.80
3. Learning Activities	7	+ 0.65	+ 0.65
4. Science Teachers	8	+ 0.8I	+ 0.77
5. School	I0	+ 0.82	+ 0.83
		n = 462	n = 233

With reference to the previous studies these would appear to be satisfactory reliabilities with the exception of Factor 3. Results concerning this factor must be discussed with this in mind.

e) Validity

Nuttall (I97I) gives examples of content validity and concurrent validity of the SAQ.

He states that the content validity is assured because

> "of the method of construction of the scales - involving the interviewing of school children, extensive pre-testing allowing comments from other pupils, and statistical analysis at each stage".
>
> Nuttall p.I2

He also quotes correlations between the five factors of the SAQ; a scholastic aptitude test (CP I00), and examination grades in G.C.E. science subjects and mathematics. (See Table 3)

Table 3

	CP I00	SAQ FACTORS I	2	3	4	5
G.C.E. Biology	0.59	0.40	0.I6	0.05	0.02	0.03
Chemistry	0.46	0.40	0.I6	0.02	0.I4	0.I8
Physics	0.48	0.55	0.I9	0.08	0.24	0.I5
Maths	0.60	0.29	0.I4	0.07	0.II	0.04

The 'Science Interest' factor can be seen to be virtually as good a predictor of attainment in science as test CP I00. The lower correlation with mathematics may indicate that this factor is specific to science subjects and not a more general measure, say of achievement motivation.

The low correlations on the other factors may not be surprising if as shown in Chapter 3 there is little relationship between science attitudes and attainment.

With these five points in mind, it was decided that the SAQ fulfilled the needs of this research for a Science Attitude test. A copy of the SAQ is in Appendix V.

Normative data supplied by Nuttall is shown in Table 4.

Table 4

	SAQ FACTORS I	2	3	4	5
Mean (Boys) = 278	57.2	42.I	24.6	25.5	33.2
Standard deviation	I6.3	6.9	4.I	5.7	6.4
Mean (Girls) = 203	49.9	4I.6	24.3	26.2	34.4
Standard deviation	I4.2	5.4	4.I	4.5	6.2

He states that these norms should be used with caution until evidence based on larger samples becomes available.

Alexander (I974) used the SAQ in her study of the effects of Nuffield Secondary Science in the Inner London Education Authority.

She used I76 boys and I85 girls in her control group.

Table 5

SAQ FACTORS

	I	2	3	4	5
Mean (Boys) n=I76	62.6	45.7	28.5	27.9	35.6
Standard deviation	I2.5	8.4	4.0	5.7	7.9
Mean (Girls) n=I85	54.2	45.3	27.3	27.3	36.8
Standard deviation	II.3	7.I	3.8	5.3	6.I

A comparison of these two tables shows in every case higher mean scores here than in Nuttall's findings.

Alexander mentions that the population in her study ranged from I3+ to I4+ pupils, whereas Nuttall's data was from I4/I5+ pupils. As Wisenthal (I965), Thompson (I976) and Haladyna & Thomas (I979) have found, at a lower age pupils exhibit more favourable attitudes whereas in the higher age group there is often a

"deterioration in attitude"

Alexander I974 (p.20)

4. APPLICATION OF SAQ AND PRETEST

The 39 item pretest and the SAQ were given to a fresh sample of thirteen year old mixed ability pupils of both sexes, in their science lesson by the researcher. The pretest was marked and checked to ascertain if anyone had gained extremely high marks. (The highest was 24). If there had been, there was a possibility of the 'Ceiling' effect, i.e. pupils with a high mark would not have as much room for improvement as those with a lower mark.

5. ASSIGNMENT OF TREATMENTS

From studying previous research on this topic it became clear that several treatment groups were required. These would be as follows:-

Treatment I	Children's marked work would be handed back with only a letter grade on it (B, C or D).
Treatment 2	Marked work would be returned with a letter grade and a matching comment, i.e. if the work had a 'C' grade, a comment chosen from the 'C' comment section would be used, 'A/B' comments with 'B' grades, 'D/E' comments with 'D' grades.
Treatment 3	Marked work would be returned with a letter grade and, no matter which letter grade, a comment chosen from the 'A/B' selection of comments i.e. a comment previously perceived by children as belonging to the 'A/B' group that was

also professionally possible in the light of the quality of the work.

Treatment 4 (Control)

Marked work would be returned with a letter grade and any comment or comments thought appropriate anywhere on the work. This treatment was the control, this being no different to normal marking practice.

Assignment of Pupils to Treatments

As shown by many researchers (chapter 3 p. 48), boys and girls have different attitudes towards science. Therefore it was decided to treat boys and girls separately, unless any results suggested that they should be treated as one sample.

The I59, twelve to thirteen year old mixed ability pupils of both sexes in 5 science classes were allocated to treatment groups randomly.

Each boy's name was given a number by the field researcher. The numbers were put in a hat and drawn out one at a time. The first number drawn was put into treatment I, the next number into treatment 2 and so on. This procedure was repeated with the girls names.

This allocation to treatments should mean that variables such as intelligence, anxiety, extroversion etc., are spread randomly through the treatment groups.

The fact that only I2 -I3 year old pupils were used contrasts with the different aged pupils (I2-I8/I9 year olds) used by Page (I958) and several other previous researchers (Stewart & White I976; Lesner I967; Mapel I970; Starkey I97I; Simons I97I; Hake I973).

It was decided not to include a "comments only" treatment which contrasts with Stewart & White (I976). By having a "comments only" treatment, some pupils may have been alerted to the idea that something was not normal, especially as they had grades on their work in the past. This might raise the problem of the Hawthorne effect mentioned in chapter 4.

Stewart and White retained this "comments only" treatment stating that pupils were not informed that they were involved in an experimental study. If pupils used to obtaining a grade, received only comments whilst others in their class received grades as well as(or instead of) comments, then suspicions may well have been raised (especially after II evaluations over 6 weeks).

It was hoped in this research that the presence of Treatment 4 would help to ensure nothing different to normal routine was taking place.

6. DESIGN AND MARKING OF WORKSHEETS

The work the children undertook during the period of the experiment was the topic "The Earth". This looked at various aspects of the earth (e.g. worms, oil, metals) during one half term of the school year. To try to cut down on Teacher-Pupil Interaction, this researcher designed a series of worksheets covering this topic. This development took place over the previous four years. This time span enabled ambiguities and errors to be eliminated as far as possible and for the questions requiring pupil written answers to be as objective as possible.

There were twelve separate worksheets designed to take approximately I science lesson each to complete. However, sheets 2 and 3, 7 and 8, 9 and IO, could be completed in I science lesson and so were regarded and scored as I worksheet. There were therefore 9 worksheet sessions which were marked and returned.

To work from worksheets for a science topic was not new to the children.

During these trials to formulate effective worksheets it was considered important that information included in the worksheets should present a new challenge and possibly lead on to the next worksheet in the series. It was not considered essential for the worksheets to provide totally errorless learning for as Brophy and Evetson (1976) point out, the data for 100% success learning has come from gamelike situations or physical skill activities involving little or no cognitive work. The worksheets were as far as possible, self-explanatory. However if a pupil had a problem with experimental procedure, then he/she was helped in the interests of safety and professionalism.

The worksheets together with answers expected and marks given are in Appendix IV.

Every worksheet the pupils completed was marked, graded and depending on the treatment, given a comment or left without comment.

Page (1958) gave the criterion test after only one application of treatment. Dain (1969), Klinger (1971) and Hake (1973) used more application of treatments over a longer period of time. Hake performed his experiment over 20 weeks but concluded that written teacher comments may lose their effectiveness over this period of time. Dain (1969) agrees, arguing that the written comment effect diminishes after the first four weeks. This contrasts with the idea put forward by Carroll (1963) and Cronbach (1966) who stated that studies of instruction should be given over a long period of time so that the pupil becomes familiar with the instruction. Educational policy, they say, cannot be based upon what the pupil does in his first encounter.

Stewart and White (1976) found that in 12 of the 17 classes of pupils used in their research, only 1 application of treatments was carried out before the first post test (comments + grades, no comments, comments only etc.). However, prior to the second application of the post test, six weeks later the number of treatment applications ranged from 2 to 11. No allowance for, or discussion of this was made.

When one considers the possibility that some pupils may have received eleven "positively" perceived comments, (e.g. excellent) and some only two, the amount of reinforcement and incentive motivation would vary between individuals. The fact that one person may have received one comment, eleven times and therefore have alerted them to the experiment, goes undiscussed.

Some of the problems in the subjective marking of pupils' work have already been discussed in Chapter 2. The teachers in Stewart and White's (1976) study evaluated every piece of work whether objectively or subjectively written.

The majority of questions on my worksheets demanded one word or short answers enabling them to be marked as objectively as possible and reducing the subjective element in marking the pupils' writing.

Application of Comments

The pupils handed in the completed worksheet at the end of the lesson. They were collected, marked and the scores for that particular worksheet were tallied by me. These were then divided into three, equal in number, sections.

The pupils whose score came in the top $\frac{1}{3}$ of the marks were given a grade 'B'.

The pupils in the next $\frac{1}{3}$ were given a grade 'C'.

Those pupils in the bottom $\frac{1}{3}$ were given a grade 'D'.

It was found when devising these worksheets that no pupil gained full marks on any of the worksheets and so the highest grade was 'B' as a grade 'A' (according to the normal practice of the school) was given to a perfect score. During the experimental periods, no pupil obtained full marks on any worksheets and so no grade 'A's were awarded. During the worksheet trials no pupil scored a low enough mark to be justifiably awarded a grade 'E'. Therefore for the purpose of the experiment, only three grades ('B', 'C', 'D') were awarded.

In the second trial in another school the same method of applying grades was performed even though the school had no practice of awarding only perfect scores an 'A'. This may be one source of contamination in Trial 2. No pupil in Trial 2 could have been awarded, justifiably, an 'E' grade although several worksheets may well have been given an 'A' grade but were given 'B' according to the experimental design.

After the grades were written on the top of each worksheet they were sorted into one of the four treatment groups based on the random allocation described earlier. Comments were written (or not written) on the top of the worksheet according to the treatment.

Hammer (1972) discussed the possibility that differences in the length of comments put on childrens' work may have produced his finding of no significant difference between the no comment and specified comment groups. He suggested that the longer comments put on childrens' work by Page may have indicated to the pupil a greater concern about him by the instructor, although Hammer's own comments were lengthier than Page's, (e.g."O.K., but I really expect you can do much better than that".)

The comments chosen by the pupils in this research were all of varying length. As these were applied to the worksheets it may reasonably be assumed that pupils in treatments 2 and 3 received an assortment of comments - long and short, but nevertheless appropriate to the work they had produced.

The pupils retained their worksheets in their science folders, which were handed in containing their next worksheet to be marked. It was possible, therefore, to keep a careful check on the comments placed on a pupil's previously completed and marked worksheets in treatments 2 and 3 so that no comment was repeated which might alert pupils to the research.

During the marking of the worksheets, if a pupil had made an error then the correct word or formula was written alongside. Spelling mistakes were corrected by writing in the correct word. Correct answers were ticked, wrong ones marked with a cross. These procedures were normal practice in the school. These worksheets were then returned to the pupils at the beginning of the next science lesson.

As mentioned in chapter I, Paige (1966) favoured immediate K of R but Sassenrath and Yonge (1968); Surber and Anderson (1975) and Kulhavy and Anderson (1972) found that a short delay of two days had no effect on subsequent performance when the learning task involved verbal material.

Due to school timetabling, in both applications of the experiment, marked worksheets were handed back to the pupils <u>three</u> days after they were handed in. Again, this was the normal practice between the field researcher and the pupils.

7. POST TESTS

After each session the worksheets were marked and returned in this way. The lesson following the return of the final worksheet, the pupils answered the S.A.Q. and the post-test of science attainment (identical to the pre-test). This differed from Page (1958), Lesner (1967) and Stewart and White (1976), as they used the next objective test that the teacher produced as their criterion test. Thereafter they used a ranking procedure followed by a non-parametric Friedman analysis of variance.

8. REPLICATION STUDY

Two years after the experimental period, the experiment was repeated using another group of thirteen year old mixed ability boys and girls in 3 science classes in another middle school. *

9. ATTENUATION

Attenuation, as a result of a) some pupils being ill during the course of the experiment, b) others going on holiday, and c) some being excluded, as their work could not justifiably be given any of the pupil chosen comments, led to sample reduction as follows:-

	Original sample	Attenuated sample
1st experimental session	n = 159	n = 147 Boys=74 Girls=73
2nd experimental session	n = 79	n = 70 Boys=31 Girls=39

*Footnote

This was after the researcher changed jobs. The children in the replication sample were used to the researcher's methods.

It was noted that at no time during the experimental periods did any pupil comment to the researcher on the grade they received or question why they obtained or did not obtain a certain comment. Only one member of staff in the first trial school and one in the second trial school, other than the researcher, knew that an experiment was underway. They both realised the importance of secrecy.

All pupils of age 13 in the school, not just those taking part in the experiment were invited at the end of the year to comment on their science course. The instructions given were:-

"On the paper in front of you, please comment on the following aspects of the science course you have followed in the past year.

a) Practical work

b) Workcards and worksheets

c) The topics covered

d) The grades and comments you obtained

We hope this will help future years".

The papers were read by the field researcher. No comments were made which indicated a pupil had noticed they had taken part in an experiment on marking and commenting on work.

Statements on grades and marking are included in Appendix VI.

10. OTHER POSSIBLE INFLUENCES

a) Hawthorne effect The major contribution Page (1958) made on later research was that he attempted to leave classroom conditions exactly as they would have been without an experiment.

Many classroom experiments have involved a strange adult entering, conferring with the teacher and then asking one or more pupils to go with him. Sarason et al (1960) see this as one of the major sources of anxiety arousal in pupils which may well affect future performance on tasks.

Campbell (1974) examining the effect that a change of teachers has on high and low ability pupils, concludes that low ability pupils suffer from the presence of a new teacher. Page (1958) and Shrago (1969) were concerned with the influence of an external experimenter. However, Hake (1973) taught all the experimental subjects himself and does not state whether he was their usual teacher. Cross and Cross (1981) used one experimenter and four normal class teachers.

Campbell and Stanley (1963) concluded that experimentation within schools must be conducted by the regular staff of the schools concerned especially when the findings were to be generalised.

With the above comments in mind this researcher concluded that the experiment must be carried out as part of the normal science course that was taken by the pupils. Classroom practices and procedures were left as normal. No other teacher, apart from the field researcher, was involved in the experimental work. This necessitated in both experimental sessions only, some science classes in one school year taking part in the experiment whilst the other classes were taught by another member of the science staff. This led to a reduction in numbers for each trial.

b) Ethical restrictions Campbell's (1974) research mentioned before does consider another potentially important variable, that of professional ethics.

> "Investigating human problems presents even added difficulty, because ethical restrictions limit experimental control over a number of variables related to human behaviour".
>
> Sarbin & Coe (1968) p.21

Some researchers in the first half of this century when studying the effect of praise or blame on pupil performance, administered them randomly (Gilchrist 1916). This entailed some pupils receiving blame when it was unjustified by their work. This is no longer regarded as ethically acceptable.

Bridgeman (1974) studying the effects of knowledge of test scores on an immediately subsequent test deliberately misled his students into believing a) some had done well when they had not, b) some had done poorly when they had not. Clair and Snyder (1979) say that some classroom manipulations have been weak in design because of ethical considerations. However, this researcher is convinced that classroom research must be ethically acceptable as well as methodologically sound.

With this in mind, the comments placed on the pupils' work in this research, were not misleading or untrue. They may have been harsh in some cases but were honest and accurate. As far as the researcher was able to be sure, there were no comments put on pupils' work which would interfere with the field researcher's professional competance as a teacher or the pupils' involvement in science. When in treatments 2 and 3 a pupil's work did not warrant any of the pupil-chosen comments, he/she was excluded from any of the experimental treatments and his/her work marked and commented on as normal. (Of course, these pupils - 3 in the first application of treatments and 3 in the second application - could not be included in the control group as they had already been subjected to another treatment).

c) Teacher-pupil interaction When a pupil asked a question in a science lesson during the experimental period, it was answered as fully as possible without giving, as far as the researcher was aware, any verbal praise or blame. Of course, a simple "Yes" given by the teacher acts as a K of R and may be seen positively by the pupil. Ebel (1969) discloses the possibility that if a teacher intentionally or unintentionally ignores a pupil's question or comment then the pupil may see this as either implied affirmation or implied incorrectness with this question. The direction of perception depending on the personality of the pupil, and the degree to which the pupil has been subjected to positive or negative reinforcement in the past. Wright and Nuthall (1970) found that statements such as "good" and "thank you" given by the teacher following pupil comments were positively related to pupil achievement in that subject.

Delamont (1976) discusses various research which indicates that teachers give clever pupils more time to answer questions, offer more clues to the answer (or rephrase the question) and accept a wider range of responses, when compared with less able pupils.

Woolfolk (1978) found a significant positive relationship between pupil achievement and teacher non-verbal behaviour (e.g. nod of the head, facial expression, looking towards or away etc.). Fraser (1981) discovered that pupils of a low socio-economic status showed significantly less enquiry skills than pupils of higher socio-economic status. He therefore wanted the teacher to spend a greater amount of time with these children developing these skills.

Noble and Nolan (1976) have discovered that a teacher asks more questions of a particular pupil if that pupil volunteers answers to questions. Shymansky (1976) in a study of 10 - 11 year old children reported that any prolonged 1 - 1 interaction between the teacher and a pupil in a practical science lesson may actually distract the pupil and result in reduced productivity and learning effectiveness.

The amount and variety of verbal and non-verbal communication between teacher and pupil(s) in a laboratory situation is large. Even when each pupil has the same directives and questions provided by worksheets there are certain to be questions concerning the experimental procedure during the lesson. Without secret video-taping of each lesson to record both verbal and non-verbal interactions, it was impossible to take note of this. *
Even some interaction analyses miss occasional non-verbal and verbal cues. As far as this field researcher is aware no extra praise or blame was issued to one or more pupils belonging to one of the treatment groups. In fact it was noticed that it was not until the fourth or fifth marking

*Footnote Videotaping and tape recording were impossible as either may have alerted the pupils to the experiments.

of the worksheets did the field researcher remember to which treatment group one or more pupils belonged.

It can be reasonably expected because of the selection procedure that low socio-economic children, teacher non-verbal and verbal behaviour and comments, and answers to pupils' questions during the lesson, would be randomised amongst the treatments. Group or individual variables should be randomised also, especially as there were pupils from more than one experimental treatment in any one working group within the class.

Verbal and/or non-verbal behaviour made by the teacher to the class or individuals and seen or heard by all may be shared by all who noticed. Both Nash (1976) and Auble and Mech (1953) found that there was a degree of shared perception amongst pupils in the classroom. However there still remains the danger noted by Johnson (1970) that no matter how aware a teacher may be of the above points, his feelings or expectations may be transmitted to the pupils without him being overtly conscious of them or the ways in which they are transmitted.

d) Group influences The pupils taking part in the experiment worked (as was the normal practice) in pairs whenever possible with some groups occasionally being composed of three pupils. The use of group work in science has provoked much discussion which has reflected the concern felt about why groups are used (Sands 1981; DES 1978). It appears, however, that little research has been carried out to determine if group work in science aids or hinders learning. Some work along these lines has been done with programmed instruction. Amaria, Biran and Leith (1969) found that co-operative learning seemed somewhat better for low ability pupils only, when compared to individual learning,although Hartley and Cooke (I967) and Hoogstraten (I977) have found no significant difference in achievement between pupils working in pupil selected pairs or working singly. Halloran (I967) points out that if the majority of a group (either large or small) is favourably inclined to a message or section of work, then the group will tend to reinforce the message or work and possibly facilitate a change in attitude to the mesage, work or person who provides the work. If however the majority are against the work in some way then it does not promote attitude change. Any group influences such as this might be expected to be randomly spread amongst the treatments.

The majority of influences on the treatments can be assumed to be controlled by the randomization process which allocated pupils to treatments. The communications between teacher and pupil(s), which may influence the way a pupil performs, and/or his attitude towards the teacher and subject, was cut to the minimum necessary to ensure

a) safety

b) proper professional ethics; and

c) that the pupils did not realise an experiment was in process.

SUMMARY

1. 116 thirteen year old mixed ability boys and girls were asked to grade comments placed on pupils' science work over a two year period.

2. From the results, comments were chosen which were highly polarised as either 'A' and 'B' comments; 'C' comments; or 'D' and 'E' comments.

3. A 39 item multiple choice science achievement pretest which tested the topic "The Earth" was given to 159 thirteen year old mixed ability boys and girls the following year. The Science Attitude Questionnaire was also administered.

4. The topic "The Earth" was taught in science lessons over a five week period. The work was arranged in a series of worksheets previously designed, tested and changed by the field researcher. Each worksheet was collected, marked and graded according to 5. below.

5. The pupils were randomly assigned to one of four treatment groups.

   Treatment 1-Marked and graded worksheets would be returned containing only a letter grade

   Treatment 2-Marked and graded worksheets would be handed back with a letter grade and a matching, relevant comment from the lists prepared in 2. above.

   Treatment 3-Marked and graded worksheets would be handed back with a letter grade and no matter which letter grade an appropriate comment chosen from the 'A/B' grade section selected from 2. above.

   Treatment 4-The work would receive a letter grade and any comment (Control) the teacher (the field researcher) thought appropriate. This being no different to normal practice.

6. Each pupil completed nine worksheets. After completing, marking and return of the ninth, the pupils sat a science achievement post-test (identical to pre-test) and the SAQ, in the following lesson.

7. No pupil received the same comment twice. For various reasons attenuation led to sample reduction from I59 to I47.

8. Stages 3 to 7 were repeated two years later with 79 pupils in another middle school. Attenuation led to sample reduction to 70.

STATEMENT OF HYPOTHESES

Tying together the hypotheses from the previous chapter, several hypotheses can be produced which will be tested by this research:-

I. Pupils receiving comments will perform better on an achievement test than will either those pupils receiving marks only or the control group.

2. Pupils who consistently receive above average "perceived" comments will perform better on an achievement test that either those pupils who do not or the control group.

3. Children who receive 'no comment' treatment should perform less well on the achievement test than those treatments who had received comments and the control group.

4. Boys will have a significantly less positive attitude to school than girls at age I3.

5. On an a) "attitude to science/interest in science" and
b) "social implications to science scale"
girls will have a less positive attitude than boys.

6. "Above average" perceived comments when received consistently will relate to more positive attitudes towards school, and/or science, and/or teacher when compared to those pupils who did not receive such comments or the control group.

7. There may be a positive correlation between attitude post test scores and achievement post test scores. Those pupils who show an increase in their attitude scores will show an increase in attainment scores.

CHAPTER 6

RESULTS

TRIAL I

Before making detailed analysis of the results it was decided to carry out checks on the pretest data to determine whether the pretest scores for the different experimental treatments were significantly the same. This would check that the random allocation of pupils had succeeded in terms of their science attitude and science achievement.. t - tests of significance were carried out.

There are however, several important prerequisites for the use of such a test:-

a) The samples are roughly the same size (The smallest being I7 and the largest I9, would seem to satisfy this requirement).

b) The samples are not too small; five usually being regarded as the minimum (Crocker I98I).

c) The samples to be compared do not have significantly different standard deviations.

d) The samples are drawn from a population which does not differ significantly from a normal curve of distribution.

To determine c), the significance between the standard deviations for the various treatments was calculated using the F distribution as explained by Lewis (I965). Calculated values of F are in Appendix VIII.

It can be seen that all standard deviations tested are significantly the same, with the exception of Girls Attitude Factor 4, Treatments 3 and Control. Therefore a t-test utilising unequal variance must be calculated between these two samples.

To ascertain d) it was originally proposed to use χ^2 analyses for goodness of fit. However, calculated f_e for some cells were very small (below 5) and after consulting textbooks it was not really possible to apply Yates correction (Garrett 1958; Lewis 1965; Dubois 1965). It was decided to apply the Kolmogorov-Smirnov goodness of fit one-sample test (Siegal 1956). Results are in Appendix VIII.

It can be seen that no value of D approached significance at the 5% level. Therefore the individual treatments pretest scores can be assumed to fit the normal curve of distribution.

χ^2 Goodness of fit tests were able to be performed on the boys' combined treatments and the girls' combined treatments, as f_e figures were above 5. (Appendix VIII). It can be seen from the results that the girls combined treatment pretest achievement scores differ significantly (at 5% level) from normality. Therefore t-test of significance using the combined scores for the girls cannot be used and a slightly less powerful non-parametric test (e.g. χ^2) should be used.

EQUIVALENCE OF SAMPLES

It may be stated that by random selection and allocation of pupils to treatments, equivalence between the treatments would be ensured. However, to check on this a series of t-tests was carried out for the pre-test achievement and attitude scores for both boys and girls. These are two tailed t-tests of samples with equal variances, except between Treatment 3 and Control in SAQ factor 4 for girls, when a t-test assuming unequal variance was performed.

The results are in Appendix IX, and summarised here.

Boys-Achievement Scores - Values of 't'

	Treatments			
	I	2	3	Control
I	-	0.642	0.463	0.266
2		-	0.0465	0.317
3			-	0.214
Control				-

Boys SAQ Pretest Scores - Values of 't'

FACTOR I Science Interest

	Treatments			
	I	2	3	Control
I	-	0.318	0.216	0.077
2		-	0.0586	0.255
3			-	0.155
Control				-

FACTOR 2 Social Implications of Science

	Treatments			
	I	2	3	Control
I	-	0.562	0.019	0.254
2		-	0.621	0.346
3			-	0.303
Control				-

FACTOR 3 Learning Activities

	Treatments			
	I	2	3	Control
I	-	1.467	0.158	0.654
2		-	1.358	0.805
3			-	0.524
Control				-

FACTOR 4 Science Teachers

	Treatments I	2	3	Control
I	-	0.43	0.239	0.24
2		-	0.177	0.245
3			-	0.035
Control				-

FACTOR 5 School

	Treatments I	2	3	Control
I	-	0.073	0.074	0.013
2		-	0.004	0.071
3			-	0.074
Control				-

GIRLS - Achievement

	Treatments I	2	3	Control
I	-	0.305	0.142	0.182
2		-	0.435	0.104
3			-	0.312
Control				-

ATTITUDE FACTOR I

	Treatment I	2	3	Control
I	-	0.416	0.609	0.196
2		-	0.952	0.538
3			-	0.03
Control				-

FACTOR 2

	Treatment I	2	3	Control
I	-	0.874	0.149	0.404
2		-	0.994	0.322
3			-	0.531
Control				-

FACTOR 3

	Treatment I	2	3	Control
I	-	0.459	0.336	0.344
2		-	0.136	0.103
3			-	0.026
Control				-

FACTOR 4

	Treatment I	2	3	Control
I	-	0.732	0.515	0.202
2		-	0.299	0.456
3			-	0.238
Control				-

FACTOR 5

	Treatment I	2	3	Control
I	-	0.0703	0.406	0.136
2		-	0.307	0.052
3			-	0.294
Control				-

All of these t distributions are not significant at the 5% level. Therefore it can be assumed that the treatments are equivalent and that the randomization process employed was successful.

SEX DIFFERENCES

a) Attitudes

It was hypothesised earlier that there should be various differences in the attitudes of boys and girls

viz : Hypothesis 4, "Boys will have a significantly less positive attitude to school than girls". (Factor 5 in the SAQ)

: Hypothesis 5a, "On an 'Interest in Science' scale, girls will have a significantly less positive attitude than boys" (Factor I in the SAQ)

: Hypothesis 5b, On a "Social implications to Science" scale, girls will have a significantly less positive attitude than boys (Factor 2 in the SAQ)

To test these hypotheses, one tailed t-tests of significance were carried out between the combined boys and combined girls pre-test scores for the five Science Attitude factors.

Results are in Appendix IX and summarised here.

	Significance	In favour of
Science Interest Factor I t = 5.4309	< 0.1%	Boys
Social Implications Factor 2 t = I.90363	< 2.5%	Boys
Learning Activities Factor 3 t = 0.428091	> 5%	n.s.
Science Teacher Factor 4 t = I.09231	> 5%	n.s.
School Factor 5 t = I.80457	< 5%	Girls

It appears therefore that Hypotheses 4, 5a and 5b are all upheld.

b) Achievement

A χ^2 test of significance with Yates' correction for continuity was carried out between the boys and girls achievement pretest scores.

$$\chi^2 = 13.558 \text{ with } 5 \text{ d.f.}$$

This is significant at the 2% level and indicates that boys have a significantly superior knowledge of the topic 'The Earth' than girls. Therefore the differences exhibited between boys and girls based on this result and the previous attitude pretest results indicate that they cannot be pooled for analysis of results after the experiment.

ANALYSIS OF EXPERIMENTAL DATA

I. Achievement post-test results

By subtracting the pretest score from the subject's post-test score a GAIN(LOSS) SCORE was obtained. However, the post-test score may well have been subject to the ceiling effect mentioned previously, especially for those pupils with higher pretest scores having a smaller possible improvement than those with lower pretest scores.

Therefore the gain score for each pupil was converted into a decimal fraction:-

viz $$\frac{\text{Gain Score}}{\text{maximum possible gain score}}$$

e.g. if a pupil had scored 19 on the pretest and 29 on the post test his gain would be 10.

His maximum possible gain score is:-

Maximum number of marks possible - pretest score

i.e. 39 - 19 = 20

The fraction would be $\frac{10}{20}$ expressed as a decimal = 0.5.

The gain scores from each treatment were subjected to Kolmogorov-Smirnov Goodness of Fit analysis and significance of variance analysis as described earlier. No significant differences were found.

A one-way analysis of variance was carried out to ascertain if there were any significant differences between treatments for the boys and then the girls.

BOYS	SS	df	M.S.
Treatments	0.0565147	3	0.018838
Error	3.99585	70	0.0570835
Total	4.05236	73	

F = 0.330012 with 3 and 70 df.

Not significant at the 5% level

GIRLS	SS	df	M.S.
Treatments	0.226986	3	0.075662
Error	3.60613	69	0.0522627
Total	3.83312	72	

F = 1.44772 with 3 and 69 d.f.

Not significant at the 5% level

Returning to Hypothesis I

"Pupils receiving comments will perform better on an achievement test than will either those pupils receiving marks only or the control group".

This hypothesis is not supported by the evidence. Any differences between treatments for both, could have been produced by chance.

Hypothesis 2

"Pupils who consistently receive above average perceived comments will perform better on achievement test than either those pupils who do not or the control group".

From the evidence this hypothesis is not supported. Any differences between Treatment 3 and any of the other Treatments for both boys and girls could have been produced by chance.

Hypothesis 3

"Children who receive 'no comments' should perform less well on the achievement test than either those treatments who have received comments or the control group".

This hypothesis is also not supported by the evidence. Any differences between Treatment I and the other treatments for both boys and girls are likely to have been produced by chance.

2. Attitude Change Results

By subtracting the attitude pre-test result from the post-test result a 'Change in Attitude' score was obtained for each attitude factor in each treatment for boys and girls.

So that t-tests of significance could be carried out between the treatments, analysis of any significant difference in their Standard Deviation in groups to be compared and Kolmogorov-Smirnov goodness of fit were carried out, the other criteria being satisfied.

No significant differences were found in the goodness of fit criteria but there were some significant differences between the standard deviations of samples (see Appendix VII).

From these results it can be seen that the comparisons between treatments can be performed by using one-tailed t-tests of significance.

A summary of these results are on the next page.

CHANGE IN ATTITUDE SCORES

FACTOR I Values of t

		Boys Treatments I	2	3	C
Girls	I	—	I.443	3.742 ****	I.055
	2	2.I39 **	—	2.I304 **	0.I899
	3	I.034	3.35I ****	—	2.367 **
	C	0.5497	I.992 *	I.796 *	—

FACTOR 2

		Boys Treatments I	2	3	C
Girls	I	—	0.903	2.333 **	0.I65
	2	I.2I9	—	I.646	0.972
	3	0.393	I.807 *	—	2.675 ***
	C	0.253	I.435	0.083I	—

FACTOR 3

		Boys Treatments I	2	3	C
Girls	I	—	0.I87	0.899	0.673
	2	0.I78	—	0.866	0.709
	3	3.8I4 *****	5.89I ****	—	0.056
	C	I.259	I.8I4 *	2.577 ***	—

FACTOR 4

		Boys Treatments I	2	3	C
Girls	I	—	I.I44	2.742 ***	I.3I3
	2	3.05I ****	—	2.089 **	0.284
	3	I.534	4.307 ****	—	I.7I9 *
	C	2.579 ***	0.8I9	3.9I7 ***	—

FACTOR 5

		Boys Treatments I	2	3	C
Girls	I	—	0.389	0.4I6	0.I85
	2	0.335	—	0.938	0.293
	3	**** 2.789	**** 3.I73	—	0.8II
	C	0.I82	0.080	*** 2.578	—

* = Significant at 5% level

** = Significant at 2.5% level

*** = Significant at I% level

**** = Significant beyond 0.5% level

Return to Hypothesis 6

"'Above average' perceived comments when received consistently will relate to more positive attitudes towards school and/or teacher and/or science, when compared to those pupils who did not receive such comments or the control group".

Science Interest - Factor I

It can be seen that the mean change Factor I (Interest in Science) for Treatment 3 in Boys, is significantly higher than the mean changes in Treatment I or 2 or the Control group. (Significant at I%, 2.5% and 2.5% respectively).

For Boys and 'Science Interest', this hypothesis is upheld.

For Girls on the 'Science Interest' factor, Treatment 3, pupils have a significantly higher gain in attitude score than the control group (5%) and Treatment 2 (0.5%). There is also a significant difference at the 2.5% level with Treatment I having a higher gain than Treatment 2, and the Control group having a higher gain than Treatment 2 (5% level).

Therefore with reference to the matched grade/comment group and the Control group for girls, this hypothesis is upheld.

When comparing the positive comment Treatment 3 with the no comment Treatment I, there is no significant difference. Therefore the hypothesis is not upheld here.

Social Implications of Science - Factor 2

Boys

Here it can be seen that Treatment 3 has significantly higher gains than Treatment I (I% level) and the control group (I% level). The hypothesis is therefore upheld.

Girls

There is only one significant difference here between treatments 3 and 2. Treatment 3 has the higher mean. The hypothesis is therefore rejected, in that there is no significant difference between the treatments which received the positive comments and the no comment and control groups.

Science Learning Activities - Factor 3

Boys

There are no significant differences here so the hypothesis is rejected.

Girls

The position is different here. There are highly significant differences in favour of Treatment 3, when compared to any of the other 3 treatments. For girls the hypothesis is upheld.

Science Teachers - Factor 4

Boys

There were significant differences here between Treatment 3 and the other treatments, all in favour of Treatment 3 (with Treatment I, 1% level; with Treatment 2, 2.5% level and at the 5% level with the control group). The hypothesis is therefore upheld.

Girls

Treatment 3 has made significant gains over Treatment 2 and the control and in this respect the hypothesis is upheld. There is no significant difference in gain scores between Treatments 3 and I and therefore the hypothesis is rejected when a comparison of positive comment and no comment is made.

There is a significant difference between Treatment I gains and the Control group (in favour of Treatment I) and between Treatment I and Treatment 2 (in favour of Treatment I again).

School - Factor 5

Boys

There are no significant differences here therefore the hypothesis is rejected with reference to Boys Attitude to School.

Girls

The three significant differences here are all in favour of treatment 3. With this treatment having higher gain scores than treatment I (0.5% level), treatment 2 (0.5% level) and the control group (I% level).

The hypothesis is therefore upheld.

3. Attitudes and Achievement

Hypothesis 7

"There may be a positive correlation between attitude factor post-test scores and achievement post-test scores".

To test this hypothesis Pearson's product moment correlations were carried out between Attitude factors post-test scores and achievement post-test scores. (See Appendix IX).

Boys n = 74 df = 72

	SAQ				
	Factor I	2	3	4	5
Achievement correlation coefficient	0.36	0.3169	0.37	0.343	0.I83
Two-tailed significance of correlation coefficient =	0.5%	I%	0.5%	I%	n.s.

Girls n = 73, df = 7I

	SAQ				
	Factor I	2	3	4	5
Achievement Corr. Coeff.	0.I93	0.027	0.I94	0.II4	0.II
Significance of correlation coefficient	n.s.	n.s.	n.s.	n.s.	n.s.

Therefore it can be seen for Boys, interest in school, attitude to social implications of science, attitude to learning activities, attitude to science teacher are all correlated significantly to science achievement.

For Girls, there appears to be no such correlation. The hypothesis is upheld for Boys only.

TRIAL 2

The same checks and analyses were performed using raw scores. from the second trial.

Results for Significance of Standard Deviation and Goodness of fit are in Appendix VIII.

There being no significant differences between the variances, two-tailed t-tests of significance can be carried out. Some of the t-tests for Girls Factor 2 must be calculated by the unequal variance method as some standard deviations are significantly different.

EQUIVALENCE OF SAMPLES

Summary of results

t values

Achievement scores

		Boys Treatment I	2	3	C
Girls	I	-	0.208	0.542	0.468
	2	I.003	-	0.253	0.I78
	3	0.I32	I.I72	-	0.I05
	C	0.229	0.756	0.362	-

SAQ Factors

Factor I		Boys Treatment I	2	3	C
Girls	I	-	0.585	0.438	0.247
	2	I.767	-	0.I38	0.444
	3	I.55I	0.I70	-	0.278
	C	I.335	0.386	0.2I3	-

Factor 2		Boys Treatment I	2	3	C
Girls	I	-	I.392	0.085	0.474
	2	0.088	-	I.0I0	0.874
	3	0.I5I	0.289	-	0.302
	C	0.I96	0.309	0.095	-

Factor 3		Boys Treatment I	2	3	C
Girls	I	-	I.955	I.I25	0.77I
	2	I.244	-	0.649	I.264
	3	0.258	I.653	-	0.470
	C	0.886	0.309	I.26I	-

Factor 4		Boys Treatment I	2	3	C
Girls	I	-	0.064	0.238	0.476
	2	0.967	-	0.I82	0.409
	3	0.632	0.292	-	0.I6I
	C	0.I24	0.942	0.574	-

Factor 5		Boys Treatment I	2	3	C
Girls	I	-	I.007	0.466	0.93I
	2	I.000	-	I.386	0.352
	3	0.320	0.728	-	I.4I2
	C	0.642	0.454	0.343	-

All of these t-values are not significant at the 5% level. Therefore the treatments for boys and girls for achievement and attitude can be assumed to be equivalent.

SEX DIFFERENCES

To return to Hypotheses 4, 5a and 5b, on page 110 one-tailed t-tests of significance were performed between boys and girls pretest achievement and SAQ scores.

Results in Appendix 8 are summarised below.

a) Attitudes

			Significance	In favour of
Science Interest	Factor I	t = 2.978	< 0.5%	Boys
Social Implications	Factor 2	t = I.565	> 5%	n.s.
Learning Activities	Factor 3	t = 2.348	< I%	Boys
Science Teacher	Factor 4	t = 0.9II	> 5%	n.s.
School	Factor 5	t = I.004	> 5%	n.s.

b) Achievement

	Mean	S.D.
Girls	I3.05I3	4.205
Boys	I4.387I	4.63I

t = I.262 with 68 d.f.

This is n.s. at 5% level

It can be seen therefore that Hypothesis 5a (that girls will have a significantly less positive interest in science than boys) is upheld at 0.5% level.

Neither Hypotheses 4 and 5b are upheld.

The differences in achievement scores between boys and girls noted in Trial I are not evident here. However, the fact that there are differences between the sexes in some attitude scores indicates that they should be kept separate in the post experimental analyses of results.

I. Achievement post-test results

The same procedure as in Trial I was adopted to produce a fractional gain score based on the gain it was possible to make, by each individual.

The gain scores were subjected to goodness of fit and significance of variance analyses. No significant differences were found in goodness of fit, but some discovered between standard deviations, necessitating any follow up t-test to account for the unequal variance. It might be said that an analysis of variance depends on the fact that the variances within each group do not differ significantly from one another but as Burroughs (1975) points out:

> "the analytical technique is now known to be so robust as to permit major departures from this requirement without hindrance".
>
> p.219

One way analyses of variance were calculated for the Boys and Girls achievement gain scores.

Boys

Source	SS	d.f.	M.S.
Treatments	0.00895	3	0.0029845
Error	0.415612	27	0.015393
Total	0.424565	30	

F = 0.193893 with 3 and 27 d.f.

This is not significant at the 5% level

Hypotheses 1, 2 and 3 are therefore not supported for boys.

Girls

Source	SS	d.f.	M.S.
Treatments	0.250615	3	0.0835382
Error	0.620178	35	0.0177194
Total	0.870792	38	

$F = 4.71452$ with 3 and 35 d.f.

This is significant at the 1% level showing that there is a difference (or some differences) between two or more of the mean gain scores of the treatments.

Follow up one-tailed t-tests (Appendix IX) were performed between the treatments for girls to ascertain where the difference(s) lay.

GIRLS	Treatments			
	1	2	3	C
1	-	1.433	2.176**	0.752
2		-	4.610****	0.523
3			-	3.1085***

Levels of Significance:

*	=	5%
**	=	2.5%
***	=	1%
****	=	0.5%

It can therefore be seen that for Girls in this trial, Treatment 3 (positive comments only) has produced greater achievement than no comments, matching comments or the control group.

Hypothesis 1 is <u>therefore supported partially</u> by the above results. Treatment 3 is significantly better than Treatment 1 but Treatment 2 is not significantly higher in gain scores than Treatment 1.

Hypothesis 2 is supported fully. Girls who received "above average" comments have gained significantly more than any of the other groups.

Hypothesis 3 is not supported by the evidence here, there being no significant differences between Treatment I and Treatment 2 or the Control group.

2. Attitude Change Results

Similar pre t-test calculations were performed on the Attitude change scores for Trial 2.

Several significant differences between standard deviations were found so t-tests utilising unequal variance were used on these treatments.

Change in Attitude Factor Scores

Values of t

FACTOR I		Boys Treatments I	2	3	C
Girls	I	-	0.879	0.399	0.052
	2	I.I42	-	0.325	I.286
	3	0.750	3.453****	-	0.544
	C	0.77	2.7I3***	I.I84	-

FACTOR 2		Boys Treatments I	2	3	C
Girls	I	-	0.908	I.I70	2.535**
	2	0.663	-	0.7I5	2.572***
	3	2.I70**	2.295**	-	0.543
	C	0.484	I.002	I.552	-

FACTOR 3		Boys Treatments			
		I	2	3	C
Girls	I	-	0.54I	0.I26	I.72I
	2	0.764	-	0.73I	2.8II ***
	3	0.443	0.386	-	I.684
	C	0.086	0.582	0.282	-

FACTOR 4		Boys Treatments			
		I	2	3	C
Girls	I	-	2.279 **	I.II3	I.964 *
	2	0.404	-	0.333	0.372
	3	0.022	0.895	-	0.536
	C	0.47I	I.350	0.5I9	

FACTOR 5		Boys Treatments			
		I	2	3	C
Girls	I	-	0.I94	0.I79	I.374
	2	0.488	-	0.047	I.006
	3	0.236	0.337	-	0.83I
	C	0.I65	I.362	0.6I7	-

Level of Significance		
*	=	5%
**	=	2.5%
***	=	I%
****	=	beyond 0.5%

Return to Hypothesis 6

Factor I - Science Interest

The only significant difference relating to this hypothesis in this factor is for girls when Treatment 3 has a significantly higher change than Treatment 2 which actually had a more negative attitude.

This hypothesis is only partially upheld for this factor for girls against one another treatment. There was no significant difference between Treatment 3 and the control. Treatment 3 however was the only treatment to gain in atttiude score, the other 3 treatments had a more negative attitude.

Factor 2 - Social Implications of Science

Boys There are no significant differences between treatment 3 and any of the other groups. The hypothesis is therefore rejected.

Girls Treatment 3 has gained in Attitude score when compared to either the No Comment treatment or Matched comment treatment, but there is no significant difference between it and the control. It is important to note that again Treatment 3 was the only treatment to gain in Attitude score, the other 3 treatments causing a more negative attitude.

The hypothesis is only partly upheld.

Factor 3 - Learning Activities of Science

There are no significant differences relating to this hypothesis for boys or girls, therefore the hypothesis is not upheld.

Factor 4 - Attitude to Science Teacher

There are no significant differences relating to this hypothesis again for boys or girls. Therefore the hypothesis is not upheld.

Factor 5 - Attitude to School

There are no significant differences relating to this hypothesis for boys or girls, therefore for this factor the hypothesis is not upheld.

3. Attitudes and Achievement Hypothesis

Hypothesis 7

To test this hypothesis, as in Trial I, Pearson Product Moment correlations were performed between attitude scores on the different factors and Achievement post test scores.

Boys n = 3I d.f. = 29

	SAQ				
	Factor I	2	3	4	5
Achievement Correlation Coefficient	0.II	0.073	0.I46	0.0295	0.0I8
Two-tailed Significance of correlation coefficient	ns	ns	ns	ns	ns

Girls n = 39 d.f. = 37

	SAQ				
	Factor I	2	3	4	6
Achievement Correlation Coefficient	0.2	0.333	0.I7I	0.II8	0.295
Two-tailed Significance of correlation coefficient	ns	5%	ns	ns	ns

It can therefore be seen that for both sexes there is no significant correlation between attitude scores and achievement, with the exception of Factor 2 (Social Implications of Science) for girls.

The hypothesis is not upheld for boys and girls with the exception of Factor 2 and Achievement for girls.

PUPIL REMARKS ON GRADES AND COMMENTS

The pupils in both trials were asked to comment on several things relating to science a few weeks after the experimental session had ended. This was an attempt to ascertain if any pupil had discovered an experiment concerning comments had been in progress.

Any written statements made by pupils concerning marks, grades or comments are in Appendix VI.

There appears to be no indication that any pupil was aware an experimental session was in progress.

One problem which was found and for which there appeared to be no advice in texts (Garrett 1958; Lewis 1965; Dubois 1965; Burroughs 1975; Crocker 1981), concerns the use of one-tailed and two-tailed t-tests of significance.

Hypotheses made in the research were all of the one tailed type i.e. direction of change indicated. However, results were found which on one-tailed tests would reach significance at the 2.5% level (Trial I, Attitude Change Score, Factor I, Girls Treatment I having a higher mean than Treatment 2), but were not hypothesised to be in that direction.

As it was not in the expected direction should a two-tailed test be used? Discussion with tutors was not able to resolve this problem.

CHAPTER 7

DISCUSSION OF RESULTS

Effect of Treatments on Achievement in Science

It can be seen that there are no significant differences between treatments for achievement gain apart from Girls in Trial 2. Here those who experienced positive comments continuously, had significantly greater gain than girls in any of the other three groups.

In finding the significant difference this result agrees with those of Page (1958), Lesner (1967), Hammer (1972) and Elawar and Corno (1985), although it must be stated that in none of these studies were sex differences studied nor were pupil chosen comments used. There seem to be no studies which have analysed for sex differences. Stewart and White (1976), utilising pupil-chosen comments, found no significant treatment effects.

For girls, in Trial 2 at least, it appears that positively perceived comments act as a source of feedback, producing incentive motivation and increasing their achievement as Kennedy and Willcutt (1964), Beard and Senior (1980) and McAlpine (1982) maintain.

To explain the non-significant results for the boys, it may well be that positively seen comments do not produce incentive motivation, and/or that grades by themselves do not depress performance significantly by removing a source of incentive motivation (i.e. comments). Fish & White (1978) indicate a possible alternative explanation. They say, if the boys are performing to the best of their ability, then reinforcers cannot motivate them to improve. There is however no evidence from this study to support or refute this conjecture.

Ormerod and Duckworth (1975) and H.M.S.O. (1980) have produced evidence that girls have a lower self-esteem in science than boys and feel less confident about science. If this is so then girls, viewing science as more difficult for them than for boys, may not be performing to their maximum capability, and are therefore more susceptible to external manipulation by reinforcement.

Boys on the other hand, may be fulfilling a role expected of them by performing at their maximum and therefore not being open to a change in behaviour as a result of reinforcement to such an extent as the girls. By fulfilling such a role, of course, they are already receiving reinforcement.

Turner (1977) suggests there is pressure on individual girls from girl peers, to conform, to the group norm of liking "girlish" things, and not to do "boyish" things (which could include science). Ormerod and Duckworth (1975) discuss research which suggests that girls' lack of confidence in science is due to stereo-typing from an early age.

Other research which may help to throw some light on the prevalence of insignificance here is that of Thorpe and Darch (1979). They found that by selecting pupils at random for reinforcement in a group situation, when the reinforcement was given to members of the group, it was sufficient to increase the performance of all members of the group. The pupils in my experiment conducted their practical work in groups aiding each other as they normally did, and probably compared grades and/or comments. This may have been more so for boys than for girls although I have no evidence from this or other studies to support or refute this.

Sex Differences in Attitude and Achievement

Science Interest

As hypothesised, boys in both trials have a significantly superior interest in science than girls. This confirms the work of

Meyer and Penfold (1961) and others (Chapter 3) and supports the findings of Warburton et al (1983). They administered the SAQ to 1230 thirteen year old pupils. Boys scored significantly higher than girls on the Science Interest factor ($p<0.0001\%$).

The causes of this difference are various and probably related; ranging from a possible innate variance, to role play stereotyping caused by external pressures on the sexes.

This greater interest in science shown by boys may help to partly explain the difference between the sexes in the pretest achievement scores in Trial 1. That is, for boys a greater interest in science may lead to them reading and/or finding out more about science during their spare time. This "extra-curricular" science would lead to higher pre-test achievement scores. If this is so, then why is this not shown in Trial 2?

The science experienced in the first schools in Trial 2 was different than the science experienced by the pupils in Trial 1 in two important respects:-

1. Trial 2 pupils had experienced one year more 'formal' science lessons than Trial 1 pupils, and
2. Trial 1 pupils had more in the way of 'Nature Study' lessons in their First Schools as opposed to wider aspects of science taught in First Schools for Trial 2 pupils.

These two aspects may have worked together to partly cancel out the 'extra-curricular' science experienced by boys.

Attitude to School

It was also hypothesised that girls would have a more positive attitude to school than boys. Trial 1 certainly supports both this hypothesis and also the findings of Livesey (1981), who, using the SAQ, found a similar sex difference. In Trial 2 there is no significant sex difference.

It is interesting to note that the sex differences noted by Livesey at age eleven years have continued (mellowing somewhat if the sample in my research is equivalent in every other respect to Livesey's). Nuttall (I97I) in reporting the normative data for the SAQ found a slight sex difference for this factor, the pupils being older (candidates for G.C.E./C.S.E. examinations). It would therefore appear that the discrepancy between the sexes for this factor begins early and is still marginally present in pupils who have opted for public examinations in science.

Social Implications of Science

Boys are also seen to have a more positive attitude towards the social implications of science, i.e. that science is improving the lot of mankind. The girls rather than the boys in Trial I tend to believe according to Nuttall (I97I), that:

> "Continuing scientific progress creates more problems than it solves, is harmful to mankind, and wastes money which comes from public funds".
>
> p.9

However, this sex difference is not noticed in the different mean scores of boys and girls in Trial 2 (46.I6 and 43.28 respectively) which is not significant at the 5% level.

Nuttall (I97I) found no significant difference between the sexes at age I5.

It appears therefore that the difference has decreased by the time public examinations are taken.

Other Attitude Factors

There do not appear to be any further significant sex differences or trends in SAQ factor 3 and 4 with the notable exception of Trial 2 Factor 3 where boys are seen to have a much more positive view of experimenting and fieldwork than girls who would prefer to learn about science from books and talks. However, as mentioned in Chapter 5, conclusions concerning this factor must be tempered due to its low reliability.

Livesey (1981) found (a) no significant sex differences for SAQ factors 2 and 3 and (b) highly significant differences in favour of girls for factors 4 and 5. Nuttall (1971) finds no significant sex differences but a trend in favour of girls for factors 4 and 5.

It appears, therefore, that, the more positive attitude for school shown by girls at the ages of eleven and thirteen has disappeared by the time G.C.E./C.S.E. are taken. The girls' more positive liking for the science teacher at eleven has disappeared by the age of thirteen and is still absent at fifteen/sixteen.

Effect of Treatments on Attitude Gain

FACTOR I

For boys in Trial I and Girls in Trials I and 2, Treatment 3 pupils (grades and "above average" comments) have significantly more positive attitudes than Treatments I (boys) and 2 and C (both). This partly ties in with that of Elawar and Corno (1985) who found that comments on pupils homework led to a more favourable attitude to mathematics than when compared to pupils in the 'no comment' treatment.

Other studies on teacher comments which have also focused on attitude, all report no significant treatment effects (Shrago 1969; Starkey 1970; Allen 1972; Hake 1973).

However one important manifestation of an attitude scale needs to be borne in mind when analysing these results, namely, it is possible to have a change in attitude in the negative direction as well as the positive direction.

The direction of change in attitudes are shown in Table 6. This shows, for the significant results mentioned above, that the attitude change for Treatment 3 was positive. The control group in every case had a more negative interest in science and for boys it appears that Treatment I (grades only), depressed their interest in science. For girls in both trials and boys in trial 2, Treatment 2 (grades + matching comments) led to a more negative interest in science. The girls' result when compared to the control group is significant (5% for Trial I; I% for Trial 2).

Why should this be so? Bridgeham (I972) in a study involving high school pupils in the U.S.A. discovered that girls were much more easily discouraged from trying by low grades. Treatment 2 in my research, lacked above average comments for girls obtaining below average grades. Instead they received a comment commensurate with their grade. The girls in Treatment 2, who not only received a low grade but a 'below average' comment as well, may not view the comment as an incentive but as a 'blame' situation. This in a subject in which they do not hold a very positive interest and one in which they feel less confident (HMSO I980).

This may well lead to a more negative interest in science, even more so because girls who received grades C and D would probably, before the experimental period, have obtained occasionally an 'above average' comment. This removal of reinforcement in terms of a reward could lead to a less positive interest in science.

Table 6

Mean change scores to show direction of change of attitude scores

	BOYS Trial I	BOYS Trial 2		GIRLS Trial I	GIRLS Trial 2
Treatment I	-3.53	-0.57	Factor I	+0.94	-0.6
2	+0.42	-2.7I		-4.68	-4.55
3	+6.I7	-I.88		+3.84	+2.22
C	-0.II	-0.44		-0.39	-0.33
Treatment I	-0.89	-6.87	Factor 2	-I.35	-3.3
2	+ 0.737	-4.43		-3.68	-I.9I
3	+3.5	-2.I3		-0.684	+2.22
C	-0.72	-0.33		-0.83	-0.67
Treatment I	+.68	-2.57	Factor 3	-4.I76	-0.4
2	+.89	-3.29		-4.474	+I
3	-0.056	-2.37		+2.II	+0.33
C	0	-0.III		-I.72	-0.22
Treatment I	-0.95	-2.43	Factor 4	+2.06	-0.5
2	+0.53	0		-2.32	-I.55
3	+2.94	-0.5		+4.2I	-0.44
C	+0.83	+0.44		-I.I7	+0.889
Treatment I	-0.58	-I.57	Factor 5	-0.94I	0
2	-I.32	-I.I4		-I.42I	-I.64
3	+0.I7	-I.25		+4.05	-0.89
C	-0.89	+0.III		-I.28	+.556

However, when one examines the differences between Treatments I and 2 the latter reason becomes difficult to support. Girls in Treatment I were also in the position of Treatment 2 girls in having had, previous to the experiment, above average comments with some lower grades. If the removal of such comments led to a more negative interest in science then this group should show it as well. However in both trials Treatment I pupils have made no comparative drop in mean change scores. (In Trial I the difference between Treatments I and 2 is significant at the 2.5% level. In Trial 2 the difference in means has not reached significance at 5% level).

Treatment I would have had no written comments whatsoever during the period of the experiment. Therefore there would be no 'blame' situation set up and no corresponding drop in science interest scores. It certainly appears that for girls a comment viewed as below average works toward a less positive interest in science.

FACTOR 2

There appears to be little pattern in the results here. For boys in Trial I and Girls in Trials I and 2, Treatment 3 produces significantly higher mean scores than the other groups.

However for Girls in Trial I although the score is significantly higher than Treatment 2, it is a negative score showing a deterioration in attitude although not as much as in Treatment 2.

With both sexes the control groups show a slightly more negative attitude here. Treatments I and 2 generally have a more negative attitude also.

Ormerod (I973, I98Ib) has shown that there may be a relationship between attitude towards the social implications of science and science subject choices at I4+ in both sexes but especially in the case of girls. A positive attitude to this factor may also offset any dislike by girls of the science teacher when it come to subject choices. He argues for work to be done in schools on this before the age of I4+. It does appear from the results in my study that by putting above average comments on work a more positive attitude to the social implications of science may be achieved, or at least a deterioration in attitude slowed down.

FACTOR 3

The results from this factor must be viewed in light of it's low reliability figures.

For girls in Trial I it appears that Treatment 3 produces a more positive attitude towards the practical aspects to science than the other 3 treatments. Tentatively it appears that 'above average' comments produce, in girls, a more positive attitude to practical work. This may be due to the reason mentioned earlier i.e. if girls feel less confident doing practical work then reward in terms of an encouraging comment, especially if it refers to the practical work (as several comments did), could produce a positive change in attitude towards the practical aspect of the work.

FACTOR 4

The significant differences found here are again for Trial I with Treatment 3 for both sexes producing more favourable attitude towards the science teacher than the control group or Treatment 2. For boys Treatments 3 and I are also significantly different in favour of 3.

It was argued earlier that if the teacher was seen as the dispenser of the rewards which stimulate incentive motivation then a more positive attitude towards him would be forthcoming. This seems to be the case with Trial I pupils. 'Above average' comments appear to be perceived as a teacher given reward.

Kennedy (I975) and Ducette and Kenney (I982) have found that a pupil's liking for the teacher is influenced by the grades a teacher gives, viz. higher grades mean a more favourable perception of the teacher. It also appears now that favourable comments when put with any grades improve a pupil's attitude to the teacher.

Why therefore, are corresponding patterns not found in Trial 2?

One reason I have considered here concerns my status in the Trial 2 school (Deputy Headteacher and Head of Science) compared to that in the Trial I school (Head of Science). Perhaps I was viewed, when pupils responded to the SAQ, not just as their science teacher, but also as a higher member of the school authority structure who could influence their schoolling in a wider sense, and this affected their answers to Factor 4; or perhaps they just did not like me as a Deputy Head and this tainted their responses!

FACTOR 5

Only in Trial I girls were there any significant differences, with Treatment 3 having a more positive attitude to school than any of the other 3 groups which show a slightly more negative attitude to school.

For boys it does not appear that processes of grading and commenting in science lessons influence their general attitude to school.

Perhaps the girls' attitude to school is altered because they see themselves rewarded at a "difficult" subject, which has an influence on their view of the structure of which science is a part.

Attitude and Achievement

There are significant correlations between Factors I, 2, 3 and 4 and achievement for boys in Trial I. This would appear to agree with the findings of Comber and Keeves (I973).

It differs from those of Wynn and Bledsoe (1967) and Brown and Davis (1973), who found no significant correlation between science interest and attainment.

Nuttall (1971),(during the development of the SAQ) found that Factor I on the SAQ is a good predictor of attainment in science as measured by 'O' level examination grades.

However correlation does not imply causation and it would be difficult here to state categorically that the achievement of the boys in science was the forerunner of attitude change or vice versa. Indeed the correlation may have been there to start with or have developed over the experimental period.

However this result must be tempered by the results from Trial 2 which showed no significant correlation coefficient between achievement and the SAQ factors. The optimism of Mager (1968) discussed in Chapter 3 is subjected to further doubt when my results are borne in mind. The link between achievement and attitude,in science at least, becomes slightly more tenuous.

<u>Differences between Trials</u>

One variation between trials which may have influenced the results has already been mentioned, namely concerning my position as Deputy Head in the Trial 2 school.

Another contamination of Trial 2 could have occured in the grading of the worksheets. Previous to the experiment the pupils were more used to getting a Grade 'A' on their work (albeit very infrequently), compared to pupils in Trial I for whom a Grade 'A' was awarded for a perfect score. Trial 2 pupils may have noticed the absence of any Grade 'A's from their work as only 'B', 'C' and 'D' grades were awarded to be consistent with Trial I. It must be stated though, that no comments were received back from the pupils which indicated any awareness of this.

CONCLUSIONS AND IMPLICATIONS

Where do these discussions lead? For science at least, there seems to be little point in adding comments believed to be encouraging or above average, on boys' work in the hope of producing greater achievement. Comments make little difference.

On girls' work there would seem to be a tentative case for the inclusion of "positively seen" comments on returned work to produce greater progress. If, as suggested, girls do not consider themselves to be 'good' or 'able' at science compared to boys and this makes them more responsive to reinforcement manipulations, then a test of "Academic self-image in Science" may show a sex difference, with boys showing a more positive self-image.

There are connections however between putting 'above average' comments on children's work in science and attitude change. Specifically it is in science interest, attitude towards the science teacher and in the social implications of science. The results here indicate that by the inclusion of such comments, a more positive (or less negative) attitude towards the three factors may be produced. When one considers the work of Ormerod (1973) who found that attitudes towards a science subject was strongly related to science choice for both boys and girls (0.1% level), then a method of encouraging the development of a favourable attitude to science may increase the number of pupils opting for science subjects, before their attitude to science becomes hardened.

The encouragement of a positive attitude towards the social implications of science for girls may also produce more girls opting for science, especially in the physical sciences, (Ormerod 1973). This may be encouraged through applying comments perceived as 'above average' in nature, although this conclusion must be tentative, based on the differences in results between Trials 1 and 2.

It appears that in one trial encouraging comments do increase positively the pupils' attitude to the teacher. With both sexes their attitude toward the science teacher could have implications later in life. Ormerod (1981b) has demonstrated that a positive attitude towards the science teacher for boys means that there is a greater chance of science subject choice being influenced by a positive attitude to the social implications of science.

In general, a positive attitude to one or more of the composite factors of the SAQ appears to relate to greater achievement in boys. The findings of no significant correlation between attitude and achievement for girls and the second sample of boys,does mean that the link is tenuous at best,and that the important part played by attitudes in any satisfactory explanation of the pupil performance in science may be more by their effect on subject choice matter, rather than directly on attainment (Ormerod and Duckworth 1975).

However, it remains, that a method of improving the attitudes of girls towards science is welcome. This, in an attempt to iron out the attitudal differences between the sexes, present since young childhood and boosted by parent, teacher and peer groups pressure, while their attitudes are still malleable. The application of encouraging comments appears useful in this respect.

Overall, with my results and those of Page and other American workers in mind, it appears that

a) there is little firm evidence on which to base a link between encouraging comments and greater achievement.

b) encouraging comments do appear to enhance more positive attitudes towards different aspects of science and science teachers.

Whilst not claiming my results will alter teachers' behaviour in commenting on children's science work, the justification for such behaviour should be modified. A blanket statement that comments improve achievement is not fully supported, certainly not with boys. However a statement that comments, viewed as encouraging to pupils, promote positive (or less negative) attitudes, does have some foundation and could help to produce a greater number of pupils opting for science. Certainly grades coupled with comments viewed as commensurate with these grades do not have a positive effect on achievement and, to a more limited extent, with attitudes. Generalisations from this research, I feel, should not be made until replication takes place and modifications made to include other subjects and other science topics as well.

Comments on Classroom Research

There are also implications here for classroom research. As far as is possibly known, there was nothing reported, either orally or in writing, which would indicate a "Hawthorne effect" during the experimental period. This is not to assume that there was not such an effect, only that nothing was communicated to me which would lead me to that conclusion.

No note or recording was made of any social interactions which occurred between myself and the pupils and although theoretically such interactions should have been randomised, there exists the possibility they were not and I remained unaware of this.

Power (1973) mentioned in Ormerod and Duckworth (1975) suggests that such interactions are in favour of those pupils who are more confident in science. Judging from previous arguments this would mean boys. In fact this is supported in work by Rains (1970) and HMSO (1980).

Classroom research can also be affected by unforseen circumstances .

a) A third application of treatments involving some 100 children was planned but selective strike action by some unions meant that the trial had to be cancelled as some pupils in my science classes were sent home.

b) Fortunately no children were absent on the days the pre or post-tests were taken. Due to keeping time intervals standard, any absenteeism here would result in further attenuation.

The carefully controlled experiment in a laboratory with one or more researchers and a few children, seems attractive after considering all the possible external influences on classroom research. But in order to produce worthwhile results to aid the teacher in the classroom, then classroom experimentation should continue.

The many variables which may influence pupil performance in the classroom (e.g. age, sex, social influence of the home and peers, type of school, divergent/convergent thinking, personality, attitude, self-esteem etc., to name but a few) are difficult if nigh on impossible to hold constant, so that classroom experimental results can only illuminate part of the total field of influence.

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APPENDIX I

LIST OF COMMENTS

NAME.............................. BOY or GIRL.............

Below is a list of comments which could appear on a piece of your work in science.

In the first column on the right put one of the following letters:-

'A' should be given to comments which you regard are about very good work.

'B' should be given to comments which you regard are about good work.

'C' should be given to comments which you regard are about average work.

'D' should be given to comments which you regard are about weak work.

'E' should be given to comments which you regard are about very poor work.

Number	Comment		
I	Good		
2	Excellent		
3	This is poor work		
4	This is weak work		
5	Very accurate observations		
6	Very good		
7	Very logical		
8	Well done		
9	Spelling could be better		
IO	Why is this?		
II	Use your results more carefully to work out conclusions		
I2	Super detail		
I3	Accurate results		
I4	Carefully done practical work		

15 Well written

16 Use a sharp pencil and ruler

17 Well worked out

18 More thought is needed

19 These need to be the other way round

20 These are jumbled up

21 Well thought out

22 This is not explained well

23 Check your written work

24 Some very silly mistakes

25 You have not thought about this

26 Rewrite this work

27 You have the basic points but have left out a lot of detail

28 Some big gaps here

29 Clear, deductive work

30 Well researched

31 This shows that you have put in a lot of effort

32 Good-so far!

33 Try harder to make your diagrams more accurate

34 Keep this up!

35 Spellings

36 You have the main points

37 Take greater care

38 Always put units

39 Be very tidy

40 This is untidy

41 Underline all headings

42 Take care to be neat and tidy

43 This work lacks thought

44 There is a great lack of understanding here

45 Read the worksheet carefully

46 This needs further explanation

47 Very carefully drawn diagrams

48 Very accurate diagrams

49 A logical conclusion based on your results

50 You carried out the experiment well

51 Check this one again

52 Write on both sides of the paper

53 This could be explained more simply

54 Work out the reasons for this answer

55 Your practical work needs to be done more carefully

56 You have been trying very hard

57 You have misunderstood the purpose of the experiment

58 Be careful with your spellings

59 Make your diagrams larger

60 This is not good

61 You must take more care

62 Well observed

63 Super

64 You have not taken any care

65 Some of these need careful checking

66	You are setting yourself a high standard - Keep it up!		
67	A good conclusion		
68	Well understood		
69	Maintain this standard		
70	You have not understood this		
71	You must give your work ALL your attention		
72	Superbly done		
73	A very scientific piece of work		
74	Your conclusions lack thought		
75	Not very good		
76	More effort needed		
77	This has to be completed		
78	A good start		
79	You can try much harder than this		
80	This is much better		
81	Your observations are muddled		
82	Very poor		
83	This shows what you can do when you try - Keep it up!		
84	Quite a good try		
85	You must take the trouble to read the worksheet carefully		
86	Much more effort needed		
87	This is not specific enough		
88	You can draw better than this		
89	You have not quite succeeded but this is a good attempt		

90 You need some more notes with this diagram

91 Give more thought to your conclusions

92 This shows a keen interest in the work

93 Your effort is improving

94 You have arranged the information well

95 Draw this diagram again

96 More detailed labelling needed

97 Very detailed drawings are required

98 This is better

99 I am very disappointed with this work

100 Why isn't this completed

101 A very clear and precise way of writing up experiments

102 You must give more thought to the presentation of your work

103 You need to use your observations more when thinking about conclusions

104 You have taken time and care

105 Very well explained

106 Your written work is quite good. A pity you cannot try harder in class

107 This is much better

108 Underline titles please

109 You have grasped the points well

110 You have a lot of information but have not arranged it to its best advantage

111 A pity that you cannot produce this standard in the lesson

II2	You have a lot to finish
II3	Keep your diagrams large and clear
II4	Look at your results when you work out a conclusion
II5	Why isn't this finished?
II6	See me!
II7	This does not follow from your results
II8	You read this through and see if it makes sense
II9	Lots of hard work and logical thought
I20	This is poor for you
I2I	This shows the standard I want to see all the time
I22	This shows what can be done with concentration
I23	Lots of hard work needed on this
I24	You need now to take your time
I25	Read the worksheet carefully then you won't miss any instructions
I26	Not all of the important points are here
I27	You could have made more of this conclusion
I28	Methodical and accurate
I29	Some silly mistakes which could have been avoided with thought
I30	Your standard of presentation is low
I3I	You could have found out more about each item had you concentrated fully

I32	Descriptions need more detail
I33	You have observed accurately and have made an attempt to record them accurately
I34	Always take your time
I35	This is the standard of presentation I expect
I36	This is not up to your usual standard
I37	Disappointing work
I38	This is very poor
I39	This is lacking thought

APPENDIX II

SELECTION OF COMMENTS

Appendix II

Selection of Comments

The number of children selecting each comment with each of the five grades was tallied - these are the figures in the second column.

The highest tally for each comment, whether it was for A/B, C or D/E was taken and converted to a % - this is the figure in the third column.

The last column shows if the item was selected for the A/B group, the 'C' group or the D/E group. Only comments of 75% or higher were selected.

n = II6 (58 Boys, 58 Girls)

Comments 80 and I07 due to an oversight were duplicated, i.e. "This is much better".

Comment No.	Number of children selecting comment with grades					Largest % of children selecting comment for A/B, C or D	Comment selected for A/B, C or D/E
	A	B	C	D	E		
I		II0	6			95%	A/B
2	II2	4				97%	A/B
3			I5	54	47	87%	D/E
4			II	95	I0	9I%	D/E
5	49	66	I			99%	A/B
6	6I	55				I00%	A/B
7	I8	8I	I9			84%	A/B
8	24	77	I5			87%	A/B
9		20	89	7		77%	C
I0		I2	88	I6		76%	C
II		II	87	I8		76%	C
I2	76	38	2			98%	A/B
I3	42	70	4			97%	A/B
I4	22	87	7			94%	A/B
I5	22	85	9			92%	A/B
I6		I9	89	I7		77%	C
I7	30	8I	5			96%	A/B
I8		7	90	I7	2	77%	C
I9		29	70	I6	I	60%	
20		8	69	37	2	59%	
2I	36	77	3			97%	A/B
22		3	87	25	I	75%	C
23		9	98	9		84%	C
24		4	I9	78	I5	80%	D/E
25			20	56	40	76%	D/E
26			I	23	92	99%	D/E

No.	A	B	C	D	E	%	Comment
27		32	67	I7		58	
28			I0	66	40	9I	D/E
29	59	56	I			99	A/B
30	66	48	2			98	A/B
3I	69	46	I			99	A/B
32	5	92	I0			84	A/B
33		33	74	9		64	
34	57	57	2			97	A/B
35		II	9I	I4		78	C
36	I	93	I7	4	I	8I	A/B
37		I3	89	24		76	C
38		44	60	I2		5I	
39		20	7I	25		6I	
40			27	65	24	77	D/E
4I		66	47	3		57	
42		33	75	8		65	
43				8I	35	I00	D/E
44			4	79	33	97	D/E
45		2	I06	8		9I	C
46		I2	9I	I3		78	C
47	5I	58	7			94	A/B
48	74	42				I00	A/B
49	3I	70	I5			87	A/B
50	47	69				I00	A/B
5I		I6	90	I0		78	C
52	3	37	6I	II	4	53	
53		52	54	I0		47	
54		34	66	I6		57	

No.	A	B	C	D	E	%	Comment
55		8	90	I8		78	C
56	74	42				I00	A/B
57		9	69	29	9	59	
58		28	76	I2		65½	
59		53	59	5	I	5I	
60			I9	70	27	84	D/E
6I		9	62	42	3	53	
62	43	68	5			96	A/B
63	I00	I5	I			99	A/B
64			I0	96	I0	9I	D/E
65		I5	95	5	I	82	C
66	I06	I0				I00	A/B
67	33	83				I00	A/B
68	27	86	3			97	A/B
69	33	68	I5			87	A/B
70			89	23	44	77	C
7I			28	77	II	76	D/E
72	I08	8				I00	A/B
73	86	28	2			98	A/B
74			I0	76	30	9I	D/E
75		4	47	65		56	
76		I2	66	38		57	
77		I0	65	4I		56	
78	I5	93	8			93	A/B
79			7I	38	7	6I	
80	30	79	7			94	A/B
8I		9	88	I9		76	C
82				24	92	I00	D/E

No.	A	B	C	D	E	%	Comment
83	75	38	3			97	A/B
84	5	94	I7			85	A/B
85		I0	88	I8		76	C
86		4	I4	89	9	84½	D/E
87		6	75	33	2	65	
88		II	9I	I4		78	C
89	5	87	23		I	79	A/B
90		50	6I	I0		53	
9I		I6	95	5		82	C
92	42	70	4			97	A/B
93	I4	86	I6			86	A/B
94	38	78				I00	A/B
95			8	80	28	93	D/E
96		6	89	2I		77	C
97		5	93	I8		80	C
98	I0	78	28			76	A/B
99		I	I6	50	49	85	D/E
I00			6	I00	I0	95	D/E
I0I	64	47	5			96	A/B
I02		4	94	I8		8I	C
I03		20	88	8		76	C
I04	67	42	7			94	A/B
I05	84	30	2			98	A/B
I06	3	6I	47	5		55	
I07	3I	8I	4			97	A/B
I08		57	59			5I	
I09	34	77	5			96	A/B
II0		44	63	9		54	

No.	A	B	C	D	E	%	Comment
111	7	52	49	8		51	
112			61	45	10	53	
113		46	49	14		42	
114		24	92			79	C
115			20	82	14	83	D/E
116			7	26	83	94	D/E
117			93	23		80	C
118		10	56	44	1	48	
119	73	42	1			99	A/B
120			25	67	24	78	D/E
121	80	32	4			96½	A/B
122	63	53				100	A/B
123		17	61	24	3	53	
124		10	99	7		85	C
125		13	88	17		76	C
126		18	73	25		63	
127		14	92	10		79	C
128	72	39	7			94	A/B
129		11	70	35		60	
130			46	58	12	60	
131		5	75	35	1	65	
132		5	91	20		78	C
133	54	43	19			84	A/B
134		22	94			81	C
135	80	31	5			96	A/B
136			5	106	5	96	D/E
137			11	95	10	91	D/E
138			3	53	60	97	D/E
139			10	75	31	91	D/E

APPENDIX III

PRE/POST SCIENCE ACHIEVEMENT TEST

SCIENCE TEST

THE EARTH

You should have a question booklet and an answer sheet.

Put your name on the answer sheet.

Your aim should be to do the best you can.

Do not put more than I tick for each question.

I. Which part of the earthworm moves first?

a) the front b) the back c) the middle

d) the saddle

2. What does the word "anterior" mean?

a) the front b) the back c) the middle

d) the saddle

3. When crude oil was heated which type of thermometer was used?

a) 0-II0°C b) -I0-II0°C c) 0-250°C d) 0-200°C

4. Which of these is an alloy?

a) brass b) iron c) magnesium d) copper

5. On which surface does a worm move best?

a) plastic b) glass c) paper d) a shiny table

6. Which of these is not a metal?

a) copper b) sodium c) potassium d) carbon

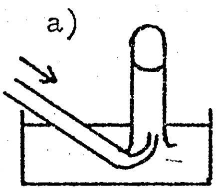
7. If all these blocks were the same thickness, which would allow heat to pass through the quickest?

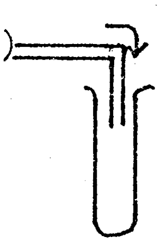
a) glass b) plastic c) sulphur d) lead

8. Which of these is best for making water pipes?

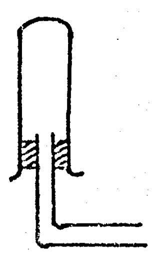
a) calcium b) aluminium c) magnesium d) sodium

9. Which of these ways will be best for collecting a test tube full of hydrogen?

a)


b)


c)


d)


10. A boy dropped a piece of zinc into a beaker of clean liquid that looked like water. The zinc began to fizz and bubbles of a gas came off which exploded with a pop when a light was put to them. The liquid was

a) tap water b) pure water c) indicator d) acid

11. Which one of these will burn to form an oxide which is a gas?

a) calcium b) phosphorus c) sodium d) sulphur

12. Which one of these will make indicator go VERY alkaline?

a) calcium oxide b) phosphorus oxide c) sulphur dioxide d) iron oxide

13. Which of the following will react most quickly when placed in water?

a) sodium b) magnesium c) calcium d) aluminium

14. If soot and smoke is made from carbon, which part of the crude oil has most carbon in it?

a) the first part to boil b) the second part to boil

c) the third part to boil d) the last part to boil

15. In this reaction which substance has been OXIDISED?

Magnesium + copper oxide ⟶ copper + magnesium oxide

a) copper b) magnesium c) copper oxide d) magnesium oxide

16. Which substance has been reduced?

a) copper b) magnesium c) copper oxide d) magnesium oxide

17. Copper and aluminium are among the substances in the world that have never lived. Which of these pairs of substances have never lived?

a) charcoal and coal b) leather and wool

c) coral and cotton d) tin and iron

18. What is the waste material called when Iron is made?

a) bitumen b) slag c) residue d) tar

19. What is zinc ore made from?

a) zinc and rock b) zinc and oxygen c) zinc and iron

d) zinc and sand

20. Which onr of these would give an acid reaction with indicator?

a) sodium oxide b) iron oxide c) phosphorus oxide

d) copper oxide

21. Crude oil can be split up into its different parts by heating. This is because each part has a different

a) melting point b) boiling point c) thickness

d) smell

22. If you wanted to show that water contained hydrogen what would you do?

a) add a piece of copper b) put a lighted splint near water

c) add a piece of calcium d) add acid

23. Which of these <u>best</u> describes what happens when potassium is added to water?

a) the potassium reacts with the water

b) the potassium dissolves in the water

c) the potassium melts in the water

d) the potassium floats on the water

24. John lit his bunsen burner and noticed that the flame was green. He turned it off and tapped it upside down. Little bits of metal fell out. What was the name of the metal?

a) sodium b) calcium c) copper d) aluminium

25. Copper and zinc are the chief metals which make

a) solder b) brass c) bronze d) "silver" coins

26. What is the swelling on an earthworm used for?

a) eating b) burrowing c) making worm casts

d) reproducing

27. Which one of these things does not come from crude oil?

a) plastic b) petrol c) explosives d) rubber

28. What does the "fossil fuel" mean?

a) hydroelectric power b) wood and paper

c) atomic energy d) coal and oil

29. In spring you can often see a farmer spreading a white powder called lime or calciumoxide, onto his land. This is because his soil is too

a) acid b) alkaline c) stoney d) sandy

30. Some metals when mixed with gold, can be separated from it by dissolving them in weak acid. For which metal would this work?

a) copper b) magnesium c) silver d) lead

31. A night watchman notices that a certain type of coal on his fire gives a very sharp acid smell. Therefore in the coal is

a) sulphur oxide b) sodium oxide c) zinc oxide

d) aluminium oxide

32. Which one of these metals is best used in steam boiler tubes?

a) calcium b) copper c) iron d) magnesium

33. The best reason for saying that carbon is a non-metal is because it

a) conducts heat well b) doesn't melt easily

c) breaks easily d) forms an acid oxide

34. Earthworms live in the soil and make burrows. This does the soil good because

a) air and rain get into the soil

b) the soil becomes finer

c) the farmer does not have to make holes for the seeds

d) mounds are made on top of the soil

35. A piece of potassium dropped into a test tube of pure water will fill it with a gas very quickly. Zinc will fill it very slowly and copper will not fill it at all. Which of these lists puts the metals in order, starting with the most reactive one.

a) potassium copper zinc b) potassium zinc copper

c) copper potassium zinc d) copper zinc potassium

36. A red powder is formed when mercury is heated strongly in air. what is it called?

a) mercury b) mercury oxide c) magnesium oxide

d) oxygen

37. Calcium is more reactive than zinc. What will be left when calcium is heated with zinc oxide?

a) calcium and zinc oxide b) calcium and zinc

c) calcium oxide and zinc d) calcium oxide and zinc oxide

38. Why is magnesium needed to light a mixture of Aluminium and Iron oxide?

a) The iron formed will not melt

b) The substances are not reactive enough without it

c) A bunsen burner isn't hot enough to start the reaction

d) You need time to get away from the mixture

39. Which of these discriptions suits a very reactive metal?

a) The metal which scratches best

b) The metal which burns brightest

c) The metal which has a neutral oxide

d) The metal which is the hardest

40. Which of these reactions is the way in which Iron is made on a small scale to fill joints in equipment?

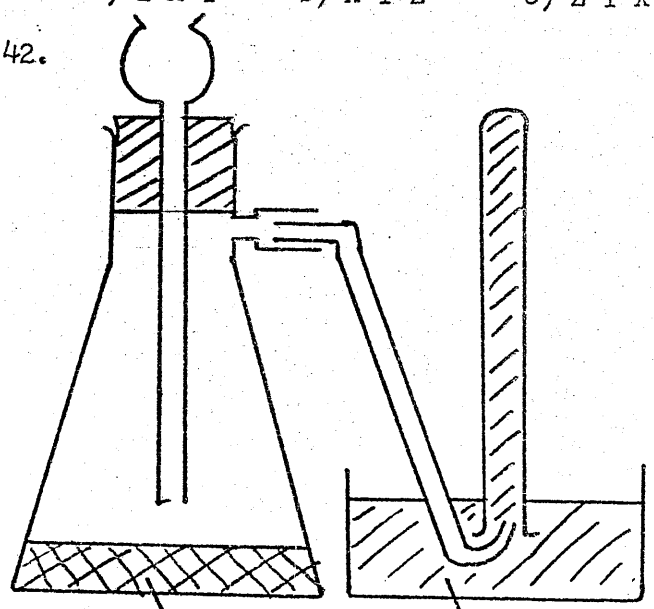
a) Blast furnace b) Oxidation reaction c) Reduction reaction

d) Thermit reaction

41. X Y and Z are 3 metals. Z rusts quickly in air but X and Y do not. Z and X fizz with acid to give a gas but Y doesn't. The order of activity of these metals, most active first, is:-

a) Z X Y b) X Y Z c) Z Y X d) Y X Z

42.



Jim set up this apparatus to make hydrogen. His friend said it wouldn't work unless he

a) put more water in the trough

b) put pure water in the flask instead of acid

c) lowered the thistle funnel

d) put more zinc in

43. If you had to find out which was the more reactive out of lead and silver, which of these would you heat together?

a) lead and silver b) lead oxide and silver

c) silver and silver oxide d) lead oxide and silver oxide

44. The order of reactivity for these metals putting the most reactive first is:- magnesium, aluminium, zinc, iron, copper.

The mixture that is most likely to react to produce new substances when heated is:-

a) copper and zinc b) iron and aluminium oxide

c) iron and magnesium oxide d) iron and copper oxide

45. An earthworm belongs to a group of animals known as annelids meaning "segmented body". Also in this group are leeches, ragworms and bristleworms.

Which of these would you expect leeches and ragworms to have in common?

a) they live in water

b) they live on land

c) they have bristles on their bodies

d) they have bodies in segments

46. John worked out an activity series for metals starting with the most reactive.

Sodium Calcium ↑ Magnesium Zinc Iron Copper Lead
X

He was given another metal 'X' and found that he could place it between calcium and magnesium.

When he heated 'X' he found

a) it burnt violently b) it burnt slowly

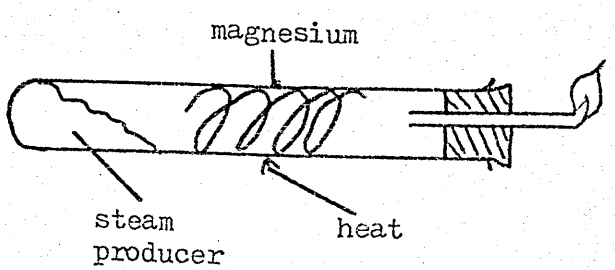
c) it melted and did not burn d) it did not burn or melt

47. Which of the following when heated produces a reaction?

a) metal X and calcium oxide b) metal X and lead oxide

c) copper and metal X oxide d) metal X and sodium oxide

48. In this apparatus, a flame can be produced at the small hole at the end. Why?



a) hydrogen has been produced

b) when steam is heated it burns

c) oxygen has been made

d) magnesium oxide has been made

49. When lead is used in place of magnesium, nothing happens. Why?

a) magnesium likes oxygen

b) lead likes oxygen more than hydrogen does

c) lead likes oxygen more than magnesium does

d) hydrogen likes oxygen more than lead does

50. What is the common name for hydrogen oxide?

a) water b) petrol c) slag d) bitumen

51. The saddle on an earthworm is

a) a place where eggs are stored b) where earthworms join to mate

c) only found on a male worm d) to help the worm grip the soil

52. Which of these is true? Hydrogen is

a) lighter than air b) heavier than air c) does not burn

d) dissolves in water

53. Which of these reactions is the way in which Iron is made on a large scale in industry?

a) the thermit reaction b) the blast furnace

c) the oxidation reaction d) the reduction reaction

54. Why does a new copper pipe soon become black is it carried hot water rather than cold?

a) heat helps some chemical reactions b) hot water is purer than cold

c) the hot pipe collects more dust d) the air keeps the cold pipe clean

55. The substances phosphorus and sodium melt easily, weigh little are both white and can be cut with a knife. Sodium conducts heat and has a shiny appearance beneath its white surface. Phosphorus does not conduct hest and is a dull white colour all through. It is likely that

a) phosphorus and sodium are non-metals

b) phosphorus and sodium are metals

c) phosphorus is a metal and sodium is a non-metal

d) phosphorus is a non-metal and sodium is a metal

56. Look at this results table:-

SUBSTANCE	SCRATCH TEST	APPEARANCE	HEAT CONDUCTION	HAMMER TEST
I	hard	shiny	poor	shatters
2	hard	shiny	poor	tough
3	soft and dull	dull	good	breaks
4	soft and shiny	dull	good	flattens

Which is likely to be glass?

a) substance I b) substance 2 c) substance 3 d) substance 4

57. Which is likely to be lead?

a) substance I b) substance 2 c) substance 3 d) substance 4

58. In a blast furnace which substance reduces the iron ore to iron?

a) carbon b) limestone c) carbon dioxide d) carbon monoxide

59. Which metal is always found in an amalgam?

a) iron b) copper c) aluminium d) mercury

60. Which of these metals is magnetic?

a) gold b) copper c) aluminium d) iron

6I. Which of these statements is true when oil is distilled?

The higher the boiling point:-

a) the lighter the colour of the fraction

b) the thicker the fraction

c) the easier it pours

d) the better paraffin it makes

62. The following metals are placed in a solution of dilute acid.

Which one will not react?

a) zinc b) copper c) magnesium d) calcium

63. How is a worm cast produced? By the worm

a) burrowing b) reproducing c) breathing d) excreting

64. What is the name given to the place where oil is split into fractions?

a) distillery b) blast furnace c) refinery d) oil well

65. In a fractionating column, the part of the oil with the lowest boiling point goes to

a) the top b) the bottom c) the middle d) 3/4 way up

66. Water is made of

a) oxygen and hydrogen b) oxygen and calcium

c) air and oxygen d) nitorgen and oxygen

67. When an experiment is done to find out the most sensitive parts of the earthworm to touch, it is found that the saddle is very sensitive. Why could this be?

a) It is to do with burrowing b) It is to do with feeding

c) It is to do with excreting d) It is to do with reproducing

68. These lists of metals are supposed to be in order of reactivity with water, most reactive first. Which one is correct?

a) calcium sodium magnesium b) sodium iron calcium

c) magnesium calcium iron d) sodium calcium magnesium

69. Balloons used for carrying passengers are not normally filled with hydrogen. Why?

a) hydrogen is not light enough to lift a man off the ground

b) hydrogen is so light that the balloon would not come down

c) the danger of explosion is too high

d) the heat of the sun would burst the balloon.

70. Which of these groups of substances contains metals only?

a) carbon hydrogen oxygen b) copper Iron magnesium

c) Iron sulphur zinc d) Iron oxide, magnesium oxide, sodium

71. Which one of these groups contains non-metals only?

a) carbon hydrogen phosphorus b) copper iron magnesium

c) lead zinc hydrogen d) iron oxide, magnesium oxide potassium

72. Four metals A B C and D are in order of reactivity, A being very reactive and D the least reactive.

Which would react most violently with water?

a) A b) B c) C d) D

73. Which would burn best?

a) A b) B c) C d) D

74. Which would not remove the oxygen from the oxides of any of the others?

a) A b) B c) C d) D

75. Which would remove the oxygen from the oxides of ALL of the others?

a) A b) B c) C d) D

76. Which would remove the oxygen from the oxides of 2 only of the others?

a) A b) B c) C d) D

77. Cu prite is a copper ore. From which of the following could a sample of a copper be obtained?

a) cu prite charcoal b) cu prite hydrogen

c) cu prite heat charcoal d) cu prite heat hydrogen

78. Look at the following descriptions of the liquids obtained when crude oil is distilled.

sample I	sample 2	sample 3	sample 4
easy to light	difficult to light	easily lit	difficult to light
clear	brown	clear	light yellow
burns with no smoke	very smoky flame	little smoke	very smoky

Which is the order in which they were distilled?

a) I 2 3 4 b) 4 3 2 I c) 3 2 4 I d) I 3 4 2

79. Which of the following pairs of metal oxide and metal, when powdered, will react together when heated?

a) zinc oxide and copper b) zinc oxide and lead

c) magnesium oxide and zinc d) iron oxide and magnesium

80. A man lit a fire over some white rocks. After a while he noticed that there was a silvery metal left in the hottest part of the fire. The metal, he found, didn't rust. The rock was

a) lead ore b) a gold ore c) an iron ore d) a copper ore

81. The correct word equation for the reaction between magnesium and copper oxide is

a) magnesium + copper oxide ⟶ magnesium oxide + copper oxide

b) magnesium + copper oxide ⟶ magnesium oxide + copper

c) magnesium + copper oxide ⟶ magnesium + copper

d) magnesium + copper oxide ⟶ magnesium + copper + oxygen

82. When a brown powder was heated strongly on a carbon block, a grey solid was left which was attracted strongly to a magent. The brown powder was

a) copper metal b) copper ore c) lead ore d) iron ore

83. It is correct to say that fractional distillation

a) will only separate petrol from crude oil

b) separates a mixture of liquids with widely differing boiling points.

c) is the evaporation of a liquid mixture and condensing to a single pure liquid

d) separates a mixture of liquids whose boiling points are similar

84. Which of the following statements is correct about metals?

a) they are all shiny and silvery

b) their oxides dissolve easily in water

c) metals low in the reactivity series have only recently been discovered

d) they are all good conductors of heat

85. The earthworm has four pairs of bristles on each segment of its body. These are used for

a) pushing soil out of the way while burrowing

b) giving a good grip in the burrows

c) determining the width of the burrow

d) helping the earthworm to breathe while underground

FINAL SCIENCE ACHIEVEMENT PRE/POST TEST

From item discrimination and item difficulty analyses the following 39 item achievement test was produced.

Relevant statistical data is as follows -

MEAN	=	20.345
SD	=	7.82
SE_{meas}	=	2.80
RELIABILITY	=	0.87

Correct answers are underlined.

SCIENCE TEST

THE EARTH

You should have a question booklet and an answer sheet.

Put your name on the answer sheet.

Your aim should be to do the best you can.

Do not put more than I tick for each question.

I. On which surface does a worm move best?

a) plastic b) glass c) paper d) a shiny table

2. A boy dropped a piece of zinc into a beaker of clean liquid that looked like water. The zinc began to fizz and bubbles of a gas came off which exploded with a pop when a light was put to them. The liquid was

a) tap water b) pure water c) indicator d) acid

3. Which of the following will react most quickly when placed in water?

a) sodium b) magnesium c) calcium d) aluminium

4. Which substance has been reduced in this reaction

Magnesium + copper oxide $\longrightarrow$ Copper + Magnesium oxide

a) copper b) magnesium c) copper oxide d) magnesium oxide

5. If you wanted to show that water contained hydrogen what would you do?

a) add a piece of copper b) put a lighted splint near water

c) add a piece of calcium d) add acid

6. Which of these best describes what happens when potassium is added to water?

a) the potassium reacts with the water

b) the potassium dissolves in the water

c) the potassium melts in the water

d) the potassium floats on the water

7. John lit his bunsen burner and noticed that the flame was green. He turned it off and tapped it upside down. Little bits of metal fell out. What was the name of the metal?

a) sodium b) calcium (c) copper d) aluminium

8. Which one of these things does not come from crude oil?

a) plastic b) petrol c) explosives (d) rubber

9. In spring you often see a farmer spreading a white powder called lime or calcium oxide onto his land. This is because his soil is too

(a) acid b) alkaline c) stoney d) sandy

10. Which of these descriptions suits a very reactive metal?

a) the metal which scratches best

(b) the metal which burns brightest

c) the metal which has a neutral oxide

d) the metal which is the hardest

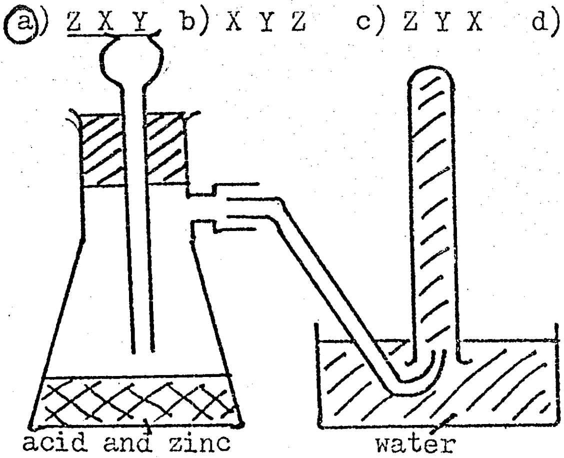
11. Which of these reactions is the way in which Iron is made on a small scale to fill joints in equipment?

a) Blast furnace b) Oxidation reaction c) Reduction reaction

(d) Thermit reaction

12. X Y and Z are 3 metals. Z rust quickly in air but X and Y do not. Z and X fizz with acid to give a gas but Y doesn't. The order of activity of these metals, most active first, is:-

(a) Z X Y b) X Y Z c) Z Y X d) Y X Z

13. 

Jim sets up this apparatus to make hydrogen. His friend said that it wouldn't work unless he

a) put more water in the trough

b) put pure water in the flask instead of acid

(c) lowered the thistle funnel

d) put more zinc in

14. If you had to find out which was the more reactive out of lead and silver, which of these would you heat together?

a) lead and silver (b) lead oxide and silver

c) silver and silver oxide d) lead oxide and silver oxide

15. An earthworm belongs to a group of animals known as annelids meaning "segmented body". Also in this group are leeches, ragworms and bristleworms.

Which of these would you expect leeches and ragworms to have in common?

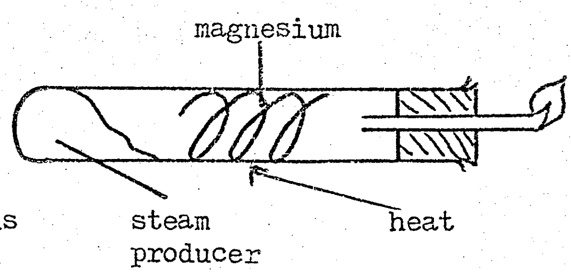
a) they live in water

b) they live on land

c) they have bristles on their bodies

(d) they have bodies in segments

16. In this apparatus, a flame can be produced at the small hole at the end. Why?



(a) hydrogen has been produced

b) when steam is heated it burns

c) oxygen has been made

d) magnesium oxide has been made

17. What is the common name for hydrogen oxide?

(a) water b) petrol c) slag d) bitumen

18. Which of these reactions is the way in which Iron is made on a large scale in industry?

a) the thermit reaction (b) the Blast furnace

c) the oxidation reaction d) the reduction reaction

19. Why does a new copper water pipe soon become black if it carries hot water rather than cold?

(a) heat helps some chemical reactions b) hot Water is purer than cold water

c) the hot pipe collects more dust d) the air keeps the cold pipe clean

20. Which of these statements is true when oil is distilled?

The higher the boiling point:-

a) the lighter the colour of the fraction

(b) the thicker the fraction

c) the easier it pours

d) the better paraffin it makes

21. How is a worm cast produced? By the worm

(a) burrowing b) reproducing c) breathing d) excreting

22. What is the name given to the place where oil is split into fractions?

a) distillery (b) blast furnace c) refinery d) oil well

23. In a fractionating column, the part of the oil with the lowest boiling point goes to

(a) the top b) the bottom c) the middle d) 3/4 way up

24. Water is made of

(a) oxygen and hydrogen b) oxygen and calcium

c) air and oxygen d) nitrogen and oxygen

25. These lists of metals are supposed to be in order of reactivity with water, most reactive first. Which one is correct?

a) calcium sodium magnesium b) sodium iron calcium

c) magnesium calcium iron (d) sodium calcium magnesium

26. Balloons used for carrying passengers are not normally filled with hydrogen. Why?

a) hydrogen is not light enough to lift a man off the ground

b) hydrogen is so light that the balloon would not come down

c) the danger of explosion is too high

d) the heat of the sun would burst the balloon

27. Which one of these groups contains non-metals only?

a) carbon hydrogen phosphorus b) copper iron magnesium

c) lead zinc hydrogen d) iron oxide, magnesium oxide potassium

28. Four metals A B C and D are in order of reactivity, A being very reactive and D the least reactive.

Which would react most violently with water?

a) A b) B c) C d) D

29. Which would burn best?

a) A b) B c) C d) D

30. Which would not remove the oxygen from the oxides of any of the others?

a) A b) B c) C d) D

31. Which would remove the oxygen from the oxides of ALL of the others?

a) A b) B c) C d) D

32. Which would remove the oxygen from the oxides of 2 only of the others?

a) A b) B c) C d) D

33. Look at the following descriptions of the liquids obtained when crude oil is distilled.

Sample I	Sample 2	Sample 3	Sample 4
easy to light	difficult to light	easily lit	difficult to light

I	2	3	4
clear	brown	clear	light yellow
burns with no smoke	very smoky flame	little smoke	very smoky

Which is the order in which they were distilled?

a) I 2 3 4 b) 4 3 2 I c) 3 2 4 I ⓓ I 3 4 2

34. Which of the following pairs of metal oxide and metal, when powdered will react together when heated?

a) zinc oxide and copper b) zinc oxide and lead

c) magnesium oxide and zinc ⓓ iron oxide and magnesium

35. The correct word equation for the reaction between magnesium and copper oxide is

a) magnesium + copper oxide ⟶ magnesium oxide + copper oxide

ⓑ magnesium + copper oxide ⟶ magnesium oxide + copper

c) magnesium + copper oxide ⟶ magnesium + copper

d) magnesium + copper oxide ⟶ magnesium + copper + oxygen

36. When a brown powder was heated strongly on a carbon block, a grey solid was left which was attracted strongly to a magnet. The brown powder was

a) copper metal b) copper ore c) lead ore ⓓ iron ore

37. It is correct to say that fractional distillation

a) will only separate petrol from crude oil

ⓑ separates a mixture of liquids with widely differing boiling points

c) is the evaporation of a liquid mixture and condensing to a single pure liquid

d) separates a mixture of liquids whose boiling points are similar

38. Which of the following statements is correct about metals?

a) they are all shiny and silvery

b) their oxides dissolve easily in water

c) metals low in the reactivity series have only recently been discovered

(d)) they are all good conductors of heat

39. The earthworm has four pairs of bristles on each segment of its body. These are used for

a) pushing the soil out of the way while burrowing

(b)) giving a good grip in the burrows

c) determining the width of the burrow

d) helping the earthworm to breathe while underground

THE EARTH

ANSWER SHEET

NAME: ____________

	A	B	C	D
1				✓
2		✓		
3				✓
4		✓		
5		✓		
6		✓		
7			✓	
8				✓
9	✓			
10		✓		
11			✓	
12	✓			
13		✓		
14			✓	
15		✓		
16			✓	
17		✓		
18	✓			
19	✓			
20		✓		

	A	B	C	D
21	✓			
22	✓			
23				
24		✓		
25	✓			
26		✓		
27	✓			
28	✓			
29				✓
30		✓		
31			✓	
32	✓			
33		✓		
34	✓			
35		✓		
36			✓	
37	✓			
38	✓			
39	✓			

APPENDIX IV

WORKSHEETS

I.a

WONDERFUL WORMS

Worms are big business! There are adverts in newspapers asking you to buy 'super worms' which are guaranteed to do wonders to your soil. I expect you know that you can find worms when you are digging the garden or after a rain-storm. We can, however, find worms any time by looking for signs.

Worm casts are small mounds of soil that the worm has passed out of its body after eating it and taking all the goodness from it. Feel a cast carefully by rubbing it between your fingers.

What does it feel like compared to ordinary soil?

Smoother or less gritty ______ 1 mark

Were there more casts in the open or under trees?

In the open ______ 1 mark

Why? More moisture or wetter/damper ______ 1 mark

Draw a cast carefully.

2 marks

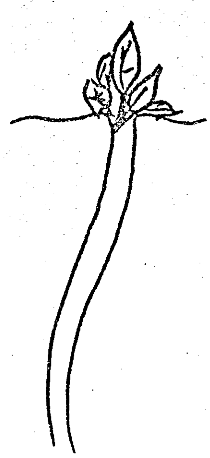
PLUGGED BURROWS are earthworm burrows in which the worm has dragged leaves.

Where were the plugged burrows we found?

Near trees ______ 1 mark

Why did we find them there?

More leaves to plug burrows ______ 1 mark



Let's look at worms more closely.

You will need:- I worm; I sheet of newspaper; I sheet of glass and I hand lens. Handle the worm <u>very</u> <u>very</u> carefully.

Put the worm on the newspaper and watch it move.

Describe how it moves.

Stretching at front - anchors front draws up rear ______ 2 marks

Draw simple diagrams to show:-

the front of the worm (called the ANTERIOR) ______ 1 mark

the back of the worm (called the POSTERIOR) ______ 1 mark

The "rings" on the earthworm are called SEGMENTS. Where are the largest segments?

Middle ______ 1 mark

Put the worm on the sheet of newspaper and listen very carefully as it moves. What can you hear?

Rustling ______ 1 mark

What is the reason for this?

Something gripping the paper ______ 1 mark

Pick the earthworm up and run your finger along its underside.

What do you feel?

Small hairs - prickles ______ 1 mark

Look at the underside with the hand lens and draw what you see.

2 marks

Put the worm on the sheet of glass. Can it move so easily?

No

1 mark

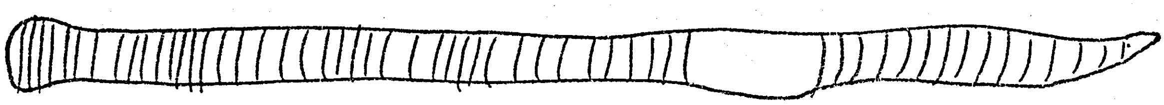
Why?

Cannot grip on glass

1 mark

The swelling on the earthworm is called the saddle and is used in reproduction. At night the earthworms come out of their burrows and attach themselves to each other round the saddle. They swop sperm as worms are both male <u>and</u> female, and then separate.

Label this diagram to show:- saddle, segments, anterior, posterior and the position of the mouth.



5 marks

2 a

CRUDE OIL

One of the substances you saw in the exhibition was crude oil. From the televison programme, charts and booklets, fill in the gaps in the following paragraph with the words below.

gas clay remains died sand pressure oil rock petroleum natural

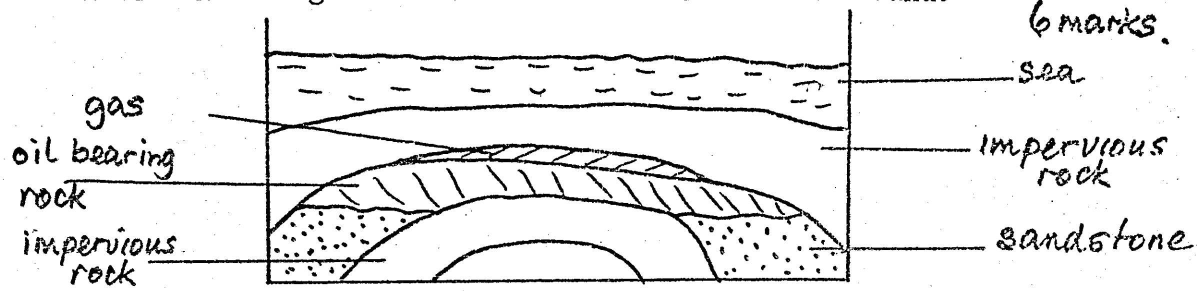
Millions of years ago before man appeared on the earth, there was already a great deal of animal and plant life in the sea. When these plants and animals ______ they sank into the mud at the bottom of the sea. Over millions of years particles of ___________ and ___________ covered the animal and plant ___________ piling up into huge layers hundreds of metres thick. Under this great _________ the sand and clay became ___________ and the animals and plants became droplets of ___________ and ___________.

Crude oil is often called ___________ and gas formed in the same way is called ___________ gas.

10 marks

Label this diagram of an anticline where oil is found.

6 marks.



We call the different parts of oil FRACTIONS. Each fraction has its different uses, and can be made into thousands of things.

In industry thousands of gallons of oil are split up into fractions at one time at an oil REFINERY.

We call this 'refining' the oil. There is another name for this. What is it?

F~~ractional~~ D~~istillation~~

Fractional Distillation

2 marks

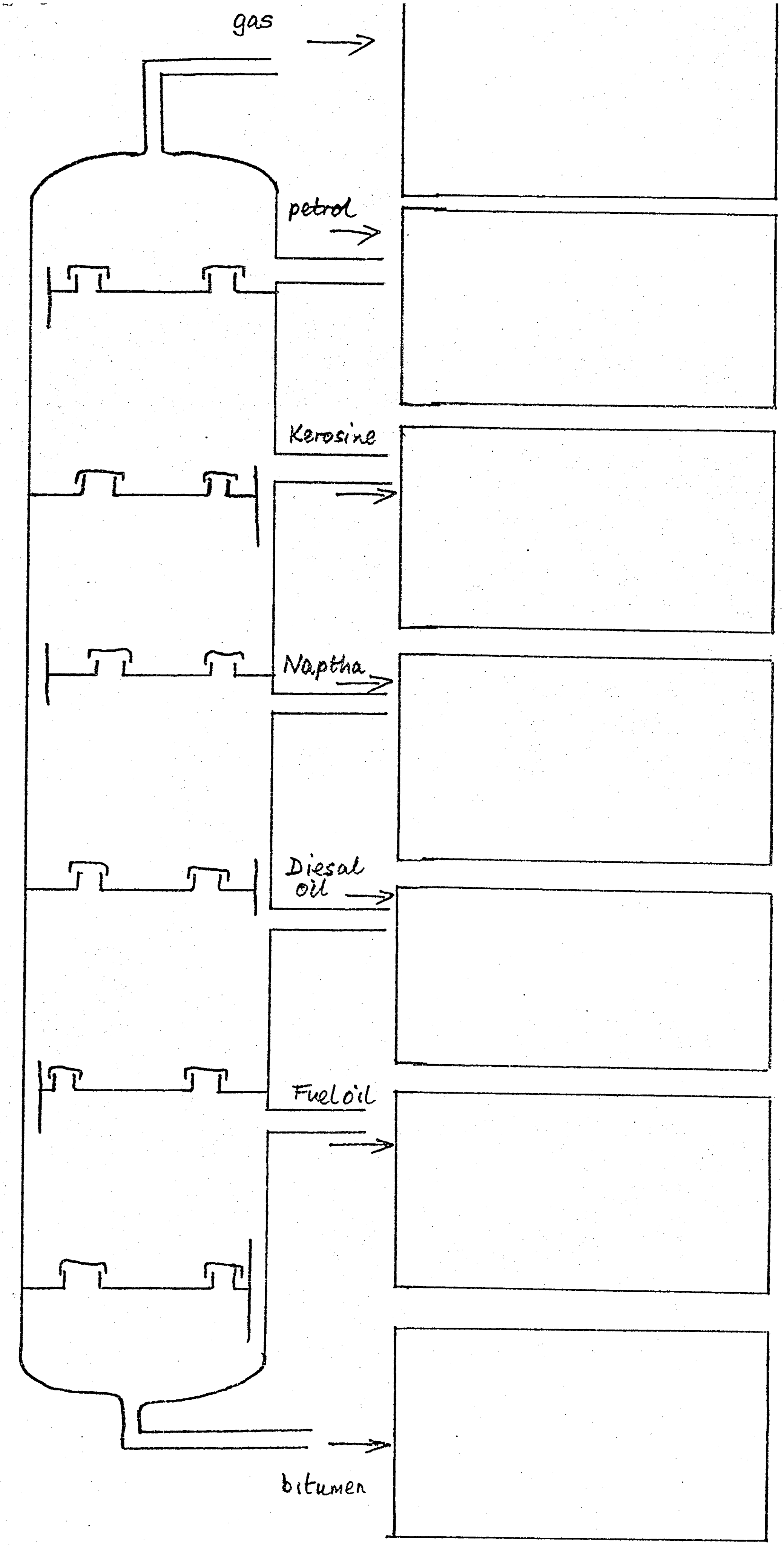
On the next page is a diagram of a fractionating column. In the bottom the oil is heated. The part of the oil which has a low boiling point turns into a gas first and rises to the top of the column before it turns into a liquid (CONDENSES). It is tapped off at the top of the column.

The substance in the crude oil which has the next lowest boiling point travels up the column but does not quite get to the top before it condenses. It is tapped off not quite at the top.

The other substances in the crude oil boil at different temperatures and are tapped at different places in the column. Eventually they are left with a substance which does not boil easily at the very bottom of the column.

On the diagram of the fractionating column over, label the different fractions and write or draw some of their uses in the boxes at the sides.

Use the booklet 'Oil for Everybody'



1 mark for each label

1 mark for uses

14 marks in total.

3\. a Of course, the process of fractional distillation cannot be carried out on this large scale in the laboratory. Therefore we use a scaled down version. In the space below, draw the apparatus we used carefully. Make sure you include the following items:- delivery tube; test tube rack; collecting tube; crude oil; side arm tube; 0 - 250°C thermometer.

6 marks for labels

4 marks for accuracy.

10 marks in total

We will be separating 5 fractions from the crude oil, and testing them for various differences. Fill in the results in the table below.

Fraction	Temp °C	colour	smell	Does it pour?	How does it burn?	Colour of smoke
A	up to 70°C	clear	own descriptions ↓	easily	very easily	white
B	70°C to 110°C	clear		easily	easily	grey
C	110°C to 150°C	slightly yellow		not so easily	fairly easily.	grey-black
D	150°C to 180°C	yellow		thickly	with difficulty	black
E	above 180°C	black		very thickly	with great difficulty	very black

3. b Looking at your results you should be able to see certain patterns.

What fraction has the lowest boiling point? A 1mark

Which fraction has the highest boiling point? E 1mark

What connection is there between the colour of the fractions and their boiling points?

Higher the boiling point, the darker the colour 1mark

What is the connection between the thickness of the liquid fractions and their boiling points?

Higher the boiling point, the thicker the fraction 1mark

Smoke is particles of soot. Soot is almost pure carbon, a substance which occurs in various forms ranging from black things like soot and charcoal, to clear substances like diamond.

The amount of smoke produced by the fraction when it burns, depends on the amount of carbon present in the fraction to start with.

Which fraction had the most carbon in it? E 1mark

You should be able to see lots of other patterns other than those pointed out already. In the space below mention the ones you see explaining each fully.

5marks

METALS AND NON-METALS

4. a Just as oil has to be split up so that we can use the different parts, so some metals have to be purified. Gold and silver are found pure in rocks, but a lot are joined with other substances in the rocks which make it very difficult to purify them. These rocks are called metal ores.

Metals are not found and extracted in the same way, and do not look the same. They are also different in other ways which we will find out. First of all we will look at the different metals and non-metals.

In the tray at the front of the lab. you will find samples of copper, aluminium, sulphur, carbon, iron, zinc, lead. These are to be used for tests I, 2, 3 and 4 only.

Test I:- What does the substance look like, colour - shiny. Describe it carefully.

Test 2:- What does the substance feel like? Can you bend it?

Test 3:- Can you scratch it with your fingernail?

Test 4:- Put a magnet near it. Do they pull together? (Is it magnetic?)

Results

Name of Substance	Test I Look	Test 2 Feel	Test 3 Can you scratch it	Test 4 Is it magnetic

4. b See your teacher for Test 5

Test 5:- Examine the blocks of materials on the glass plate on the front bench. One each block is a damp piece of cobalt chloride paper. If you remember, when the pink paper is heated it turns blue.

The different blocks will be placed on top of some very hot water. This experiment will show how quickly the blocks let heat travel through them. This movement of heat through solids is called conduction.

Results from Test 5 - Conductivity Experiment:-

Write down the order in which the cobalt chloride paper on the blocks changed colour.

Ist ________ 2nd ________ 3rd ________ 4th ________

5th ________ 6th ________ 7th ________

Answer these questions:-

From ALL of your results, which do you think are metals:-

all but Sulphur and Carbon 5 marks

Which do you think are non-metals?

Sulphur Carbon 2 marks

Are all metals shiny? No 1 mark

Are non-metals dull? No 1 mark

Are most metals magentic? No 1 mark

Which conduct heat better - metals or non-metals? metals 1 mark

Why were all the solids used the same shape and size? So that the heat would pass through the same distance to get to the Cobalt chloride paper 1 mark

4. c

From reference books and encyclopaedias, find out how one of the metals you have used (other than Iron) is mined, extracted from its ore, and purified.

10 marks

5. a

READ THIS WORKSHEET VERY CAREFULLY

From the previous experiment we have found out that different metals look different and do different things.

We can find other differences by heating metals strongly.

You need:- I tripod, I gauze

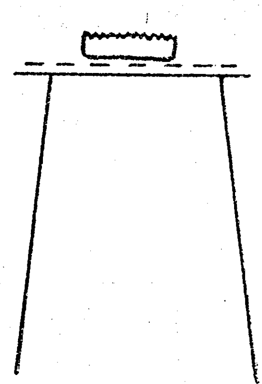
I bunsen burner, 2 bottletops,

I spatula, paper towel,

Put I small piece of metal into the bottletop and heat it strongly from above, using a blue flame for 3 mins.

Fill in the results table and scrape out the bottletop into the powder bin ready for the next substance.

COPY AND LABEL this diagram of the apparatus



Labels 4 marks
Diagram 2 marks.

DANGER!!!

WEAR safety goggles and shirts

DON'T lean over the apparatus

HOLD the bunsen burner at arm's length

DON'T use water to clean the bottletop, use a dry towel

TAKE I piece of metal at a time

LET the bottletop cool before scraping it out

ASK your teacher to do some sodium for you

Results

Metal	Observations (what you saw)
Copper	Greeny-blue flame - went black
Aluminium	Melted - Yellow-white coating
Lead	Melted - Silver ball
Calcium	Turned white - Red flame
Magnesium	Brilliant flame - turned white
Iron	Sparked. - black covering
Zinc	white/yellow coating
Sodium	Orange flame - melted - flamed.

1 mark each

8 marks in total

5. b

Conclusions

Which metal burnt the most brilliantly? Sodium or Magnesium 1 mark

Make a list of the metals in order starting with the one which burnt the best

Ist	Sodium	1 mark (any order)
2nd	Magnesium	
3rd	Calcium	1 mark
4th	Iron	1 mark (any order)
5th	Zinc	
6th	Lead	1 mark (any order)
7th	Aluminium	
8th	Copper	

Let us examine one result in particular.

A white powder appeared after magensium was heated.

Was this powder magnesium or something else? something else 1 mark

If it was something other than magnesium, has the magnesium just suddenly changed into another substance, or could it have joined with something to produce the white powder? joined with something 1 mark

If it did join with something what could this substance be?

<u>THINK</u>: What does a substance need in order to burn? - other than heat? air or oxygen 1 mark

The name of the white powder is MAGNESIUM OXIDE. The magnesium <u>has</u> joined with another substance.

What is the name of the substance? oxygen 1 mark

What do you think is the name of the white powder formed when calcium was burnt? Calcuim oxide 2 marks

To save us writing a description of what happened we usually write a WORD EQUATION.

e.g. Magnesium + Oxygen ⟶ Magnesium Oxide

Fill in the blanks in these word equations:-

Sodium + Oxygen ⟶ sodium oxide 1 mark

copper + oxygen ⟶ copper oxide 1 mark

zinc + oxygen ⟶ zinc oxide. 2 marks

iron + oxygen ⟶ iron oxide 3 marks

It says that non-metals join with oxygen as well. What is formed when hydrogen combines with oxygen? hydrogen oxide 2 marks

Find out the common name of this product. water 1 mark

OXIDES

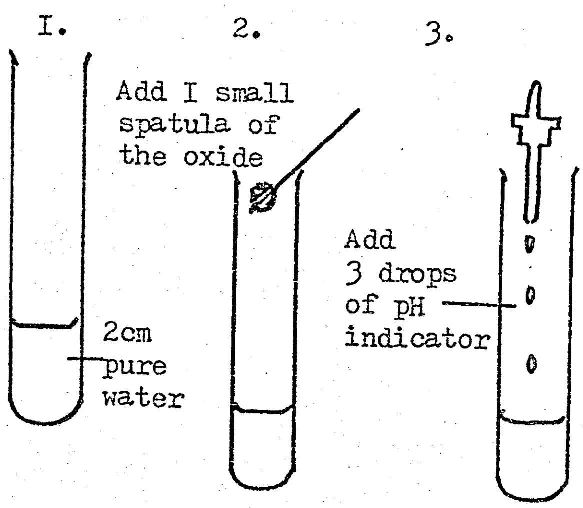
6. a From sheets previously you found that certain metals burnt very brightly some not so brightly and some hardly at all.

We say that the metal which burnt brightest is the most REACTIVE of the metals.

When the very reactive metal burnt it took the oxygen from the air quickly and violently. The less reactive metals do not take the oxygen from the air so quickly.

The list you made at the bottom of 5b is called a REACTIVITY SERIES and you will be making several reactivity series from now on, based on you experimental results. These series are important for they help us to predict what will happen without having to do the actual experiment.

You need:- I test tube rack, I spatula 5 test tubes, pH indicator, I small beaker containing pure water.



DANGER!!!

DON'T get any of the oxides on your hands

CERTAINLY don't taste them

WEAR goggles and shirts

DON'T look over the tube

PLEASE don't put the dropper into the liquid or oxides

DON'T put wet spatulas into a bottle

If you have any difficulty seeing the colour of the pH indicator, let the oxide settle to the bottom of the tube then hold it up to the light.

Check the colour of the indicator against the colour chart. Find out it's pH number and whether it is acid, alkaline or neutral.

6. b

Results

Name of oxide	pH number	Acid, Alkaline or neutral	
Calcium oxide	13/14	Alkaline	1 mark
Magnesium oxide	9/10	Alkaline	1 mark
Aluminium oxide	8/9	Alkaline	1 mark
Zinc oxide	8/9	Alkaline	1 mark
Phosphorus oxide	2/3	Acid	1 mark
Lead oxide	7/8/9	Neutral/Slightly alkaline	1 mark
Copper oxide	7	Neutral	1 mark
Manganese oxide	7	Neutral	1 mark
Sulphur dioxide	3/4	Acid	1 mark
Carbon dioxide	5/6	Acid	1 mark.

ASK YOUR TEACHER FOR THE LAST TWO OXIDES WHICH ARE GASES

6.c We have now examined some of the oxides and have found out whether they are acidic, alkaline or neutral.

Look at your results.

Are the ACIDIC oxides from metals or non-metals? Non-metals 1 mark

Are the ALKALINE oxides from metals or non-metals? Metals 1 mark

Are the NEUTRAL oxides from metals or non-metals? Metals 1 mark

Fill in the gaps in this statement with the words on the right.

"Generally speaking, metal oxides are either alkaline or neutral with non-metals having acid oxides".

alkaline
acid
neutral

3 marks

Arrange the following oxides into the two columns below. An "Ac" means the oxide is acidic, an "A" means it is alkaline and an "N" means that it is neutral.

Hydrogen oxide N	Carbon monoxide AC	Uranium oxide N
Boron oxide AC	Nickel oxide A	Lithium oxide A
Sodium oxide A	Iodic oxide Ac	Nitric oxide Ac
Silicon dioxide Ac	Bismuth oxide N	
Cobalt oxide A	Nitrogen dioxide Ac	
Tin oxide N	Barium oxide N	

METAL OXIDES	NON-METAL OXIDES
Hydrogen Sodium Cobalt Tin Nickel Bismuth Barium Uranium Lithium	Boron Silicon Carbon Iodic Nitrogen Nitric

15 marks

7. a

A GAME OF FOOTBALL!

We are now going to use what we know about reactivity to play a game of chemical football. We found out that some metals take the oxygen from the air more quickly than others.

Some ores in the earth contain a metal + oxygen (e.g. copper oxide). If a reative substance can take the oxygen from copper oxide, we will be left with pure copper.

As magnesium was quite reactive, we will use that to take the oxygen from copper oxide.

Ask your teacher if you can see this experiment.

Draw and label the apparatus used.

5 for labels
2 marks for diagram

Results

When it was heated, what did you see?

1 mark for flashing

1 mark for smoke (white) 2 marks

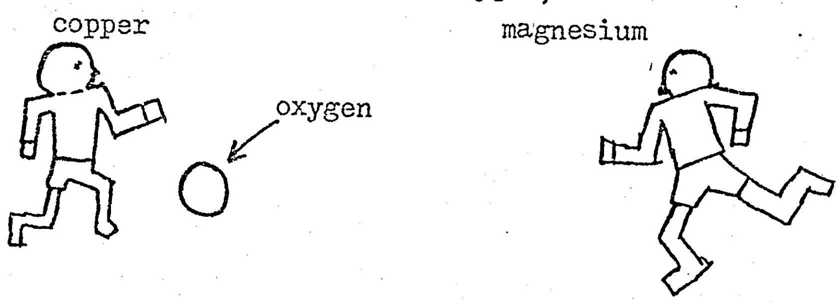
What were the names of the substances formed? Copper / Magnesium oxide 2 marks

Where did the oxygen from the copper oxide go? To the magnesium 1 mark

Here is the game of football.

Copper has the ball of oxygen to begin, but in the tackle (reaction) magnesium is the stronger and takes the ball. This leaves copper and magnesium oxide.

As in any football tackle, the stronger, more skilful player (the more reactive) wins the ball (gets the oxygen).



Which substance is the most reactive, magnesium or copper?

Magnesium — 1 mark

Fill in the gaps in this word equation which explains the result.

Copper oxide + magnesium ⟶ copper + magnesium oxide — 2 marks

Magnesium and lead oxide

In your own words write down what happened, what was left and explain the result when these two substances were heated together.

1 mark for result

1 mark for explanation

Fill in the gaps in the euation:-

Magnesium + lead oxide ⟶ Lead + magnesium oxide — 2 marks

Out of the three metals, copper, lead and magnesium, which is the most reactive? Magnesium — 1 mark

You cannot tell which is the least readive, why not? Copper and lead have not been compared — 1 mark

What experiment would you do to find out the least reactive metal?

Heat either Copper and lead oxide
or Lead and copper oxide
or both of these — 2 marks

A LITTLE BIT OF GIVE AND TAKE

We have now found out that magnesium has the ability to take the oxygen from copper oxide and lead oxide. The magnesium becomes that white powder magnesium oxide.

IMPORTANT We say that when a substance gains oxygen, it has been oxidised. A substance has been oxidised even when it only gain a small amount of the available oxygen.

When a substance loses oxygen, it has been REDUCED. It may only have lost a small bit of it's oxygen.

So, the magnesium has been oxidised (had oxygen added to form magnesium oxide),

and the copper oxide has been reduced (had oxygen taken away to leave copper).

Look at this reaction:-

magnesium + lead oxide ⟶ lead + magnesium oxide

Which substance has been oxidised? Magnesium 1 mark

Which substance has been reduced? Lead oxide 1 mark

CHECK THIS WITH YOUR TEACHER BEFORE CONTINUING

Further investigation into oxidation and reduction

you need:- I tripod, I bunsen burner, I piece of fireproof paper, I spatula, powdered carbon, copper oxide.

Make a thorough mixture of 2 spatulas of carbon and 2 spatulas of copper oxide on a piece of fireproof paper.

SAFETY
DO wear goggles and shirts
DON'T lean over when heating

Support the paper on a tripod (no gauze) and heat it using a medium size blue bunsen burner flame under I end of the paper only

8.b

Take the burner away when you see a red glow in the mixture.

When it has cooled, look through the residue.

Results

What happens to the red glow when the burner is taken away?

Continues ________ 1 mark

What was left among the residue? Copper ________ 1 mark

Which substance was oxidised? Carbon ________ 1 mark

Which substance was reduced? Copper Oxide ________ 1 mark

Where could the energy come from to keep the red glow spreading after the bunsen burner had been taken away?

The reaction ________ 1 mark

____

The next stage is to try the same experiment, but this time with 2 spatulas of carbon and 2 spatulas of iron oxide.

Making sure that you put the bunsen burner under one end only, carry out the experiment and write up your experiment below. Include results and conclusions, which was oxidised and which was reduced. See if you can predict this before you do the experiment.

____

________ 2 marks for conclusio[n]

____

____

____

____

____

____

THE THERMIT REACTION

Now we know that more reactive metals take the oxygen from less reactive ones, we can look at one example where this is used in industry. This reaction using aluminium and iron oxide is one way of getting pure iron.

Ask your teacher to see the experiment.

Draw a diagram of the apparatus used and label it with the words on the right.

test tube, mixture of aluminium and iron oxide, sand, magnesium ribbon.

4 marks for labels
2 marks for diagram

Why did we need a magnesium fuse? To create a high temperature to start the reaction — 1 mark

What did you see happening? Sparks, white hot glow, molten tube. — 2 mark

What was left behind in the tube? Iron and aluminium oxide — 2 marks

Which substance had the oxygen taken from it? Iron oxide — 1 mark

Which substance took the oxygen? Aluminium — 1 mark

Write the equation for this reaction.

Aluminium + iron oxide → iron + aluminium oxide — 2 marks

Often the thermit mixture is placed around a hole or gap in some metal. The fuse is lit and the molten iron formed flows into the hole and seals the two edges together. The rough surfaces can then be filed off.

List and describe as many ways as you can find of preventing iron from rusting. (Continue on a sheet of paper if needed).

Painting, galvanising, electroplating — 10 marks

THE BLAST FURNACE

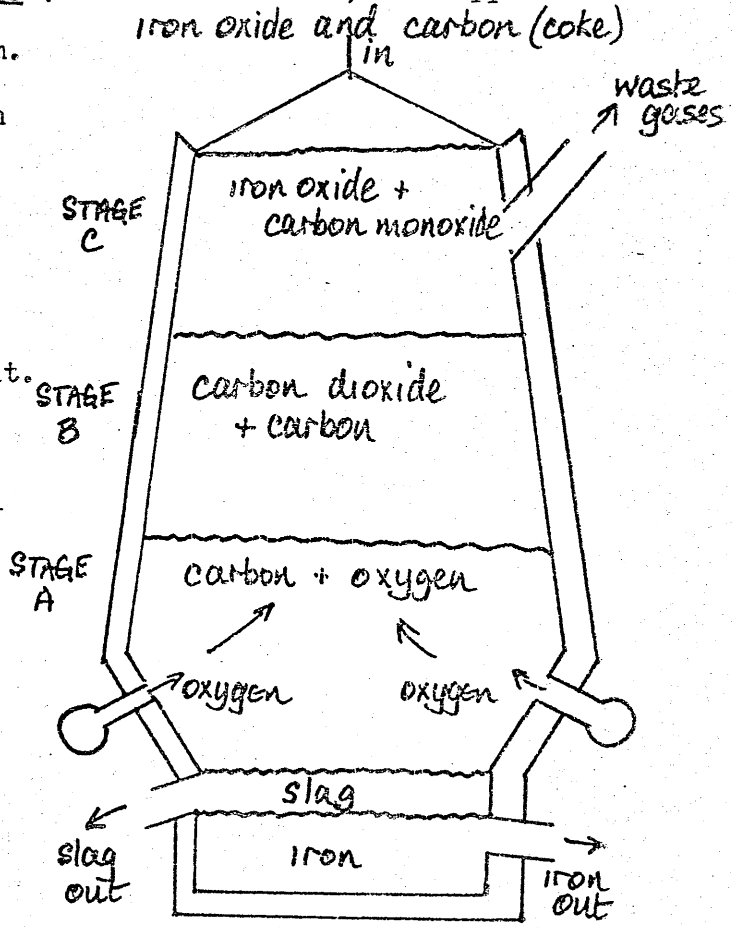
Now that you have seen how metals are obtained from their oxides by the process of reduction, we are going to have a look at the way in which IRON is obtained industrially.

The blast furnace is the place where the iron ore (iron oxide) is changed into iron.

The iron ore, carbon and limestone are fed into the furnace through the top and molten iron and slag (the waste material) are tapped off through the holes at the bottom.

Once the blast furnace has been started, it works continuously for a month.

Study the diagram and answer the following questions about it.



1. At stage A on the diagram carbon and oxygen are heated together. What gas would you expect to be formed?

   carbon dioxide 2 marks

2. What to we call the process in stage A – oxidation or reduction?

   oxidation 1 mark

3. In stage B, the carbon dioxide gas meets more carbon at a very high temperature. This causes the carbon dioxide to share out it's oxygen to form carbon monoxide. Is this process oxidation or reduction? reduction 1 mark

4. At stage C the carbon monoxide gas meets the iron oxide. At 1000°C, the iron's hold over its oxygen is weakened. The carbon monoxide

IO.b

has a chance to regain the oxygen it lost at stage B.

What is the iron oxide changed to? Iron ______ 1 mark

5. What gas is formed at stage C? carbon dioxide ______ 1 mark

6. What is the name of the substance which actually reduces the iron oxide? Carbon monoxide ______ 1 mark

Slag is a mixture of waste materials from the iron ore and limestone.

Find out some uses for this slag. (Hint:- crude oil and gardening).

____

____ 2 marks

____

____

Before you have probably found out about some alloys containing iron called steels.

Find out, and in the space below write or draw how one type of steel is produced. (If you write, remember to be neat). 4 marks

II.a

MORE OXYGEN SWOPS

Another way to find out the reactive metals is to add them to water and study their reaction.

You will be using pure water and clean metals.

Why? They react well together   1 mark

SAFETY!!!!

WEAR goggles and shirts

THERE should be no flames near the apparatus

DO NOT wash out tubes in the sink but empty metals into the bucket at the front

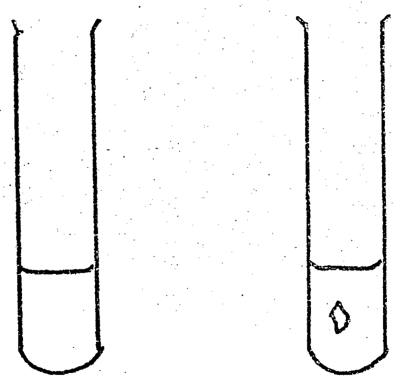
DO NOT get the product of any reaction on hands

You need:-

I test tube rack; 5 test tubes,

I sample of each of the metals

I.   2.



1. Put 2 cm of pure water into a tube

2. Add I piece of the metal

NOTICE   Any change in colour or bubbles

ASK your teacher to see the last two metals at the front.

Write the results in this table.

Metals	Reaction
Magnesium	Bubbles rising to surface
Iron	No reaction for 2 days
Zinc	Small bubbles
Copper	No reaction
Lead	Slight reaction - small bubbles
Aluminium	Slight reaction - small bubbles
Calcium	Heavy bubbling - water turns white
Sodium	Floats - gives off smoke - disappears
Potassium	Floats - burns (pink flame) smoke - disappears

9 marks

II.b

Which metal is the most reactive? Potassium 1 mark

Which metal is the least reactive? Copper 1 mark

Make a REACTIVITY SERIES of the metals starting with the one which is the most reactive and ending with the one which is the least reactive.

Ist. Potassium

2nd. Sodium

3rd. Calcium

4th. Magnesium

5th. Zinc

6th. Aluminium

7th. Lead

8th. Iron

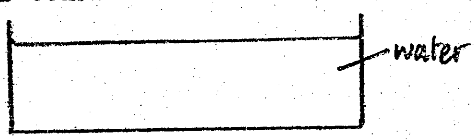
9th. Copper

1 mark each
9 in total

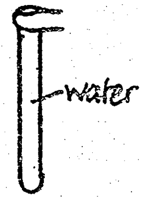
You found that sodium, potassium and calcium gave off a gas when they reacted with water. Some of the other metals may have given off a gas as well, but it was probably a very small quantity.

We can collect some of this gas to find out some of it's properties.

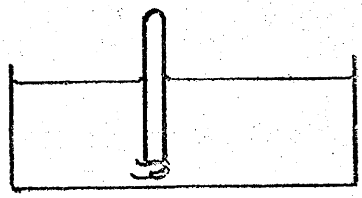
You need:- I plastic trough, I test tube, I piece of calcium and I cork.



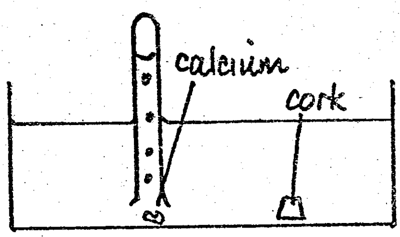
I. Fill the trough with water.



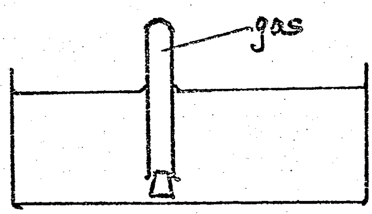
2. Fill the tube with water and put your thumb on the top.



3. Turn the tube upside down and put the mouth under the water.



4. Put the piece of calcium into the water and put the mouth of the tube over it to collect the gas.



5. When the tube is full, carefully put it on the cork. Do not take the tube out of the water until the cork is on firmly.

6. Take the tube out of the water.

Now let us test the gas.

Get a lighted splint, put it over the mouth of the tube and quickly take off the cork, making sure the splint is near the mouth of the tube.

What did you see and hear? Pop - condensation - slight flame

3 marks

II.d

The gas you have produced which explodes is called HYDROGEN. It was the gas which used to be pumped into airships, but was discontinued for obvious reasons!

Let's find out where the hydrogen came from. It couldn't be the calcium because the calcium is a pure substance. What is the name of the only other substance where the hydrogen could have come from? water 1 mark

Water is a mixture of two substances, hydrogen and oxygen. We could call it hydrogen oxide. In the reaction, calcium has taken away the oxygen from the hydrogen oxide to form calcium oxide and hydrogen.

HYDROGEN

The method of making hydrogen by adding water to some metals is very inconvenient and expensive. We use the method invented by Robert Boyle a famous English scientist, several hundred years ago. He found that hydrogen could be given off if acid (sulphuric acid) was added to metal (zinc).

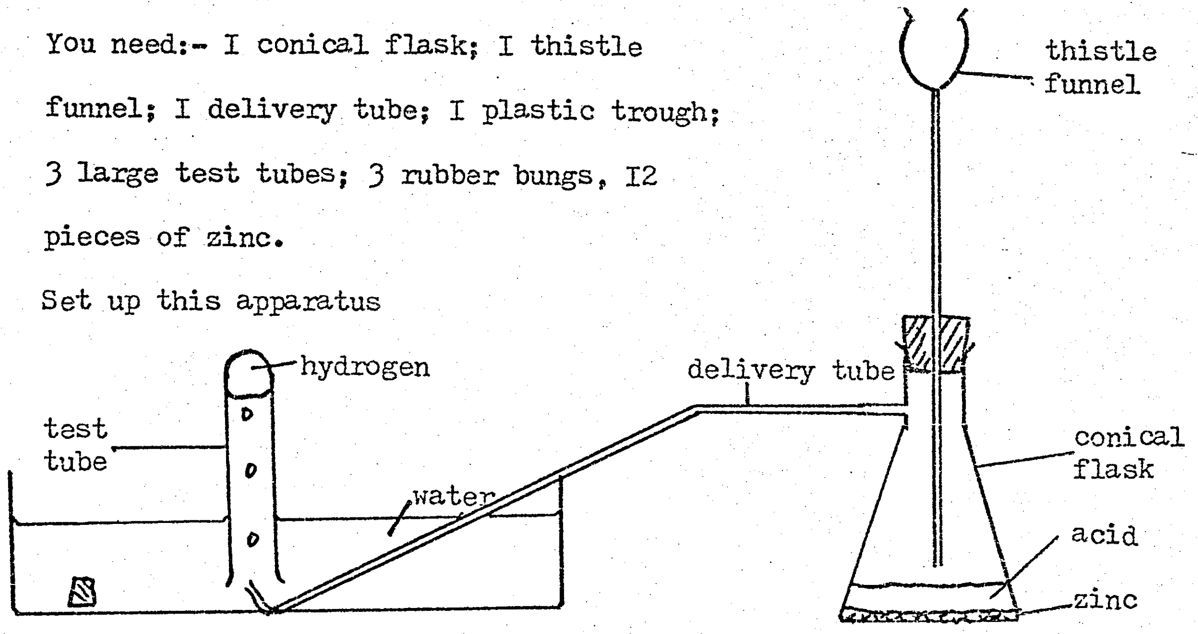
V E R Y   I M P O R T A N T

Do not allow flames anywhere near the apparatus

Hydrogen is highly flammable

You need:- I conical flask; I thistle funnel; I delivery tube; I plastic trough; 3 large test tubes; 3 rubber bungs, I2 pieces of zinc.

Set up this apparatus



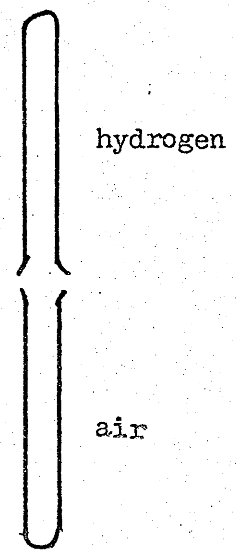
Pour acid slowly down the thistle funnel until the bottom of the thistle funnel is covered.

Collect several test tubes of the gas. Remember to stopper each tube tightly. WHEN FINISHED DISMANTLE THE APPARATUS

Put a lighted splint to the mouth of one of the test tubes.

THE QUIETER THE 'POP' THE PURER THE HYDROGEN

12.b NOW TRY THIS



Get an empty test tube and put a test tube containing hydrogen on top of the other tube and remove the bung and hold them closely together for 2 minutes.

Now test each tube with a lighted splint.

Which one pops? top

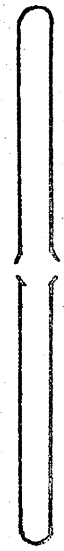
1 mark

What does this mean about the weight of hydrogen? lighter than air

1 mark

I2.c Now see if hydrogen will rise by trying this.

After 30 seconds test each tube with a lighted splint. Describe what happens to each tube.



air

hydrogen

Top tube pops
Bottom tube pops occasionally

1mark

What did you see forming inside the tube which popped? Condensation

1mark

Fill in the gaps in this paragraph with the words on the right.

Hydrogen is an invisible gas which is lighter than air. It is found combined with oxygen in water. It is a flammable gas which is no longer used in airships and balloons. When it burns in air it combines with the oxygen to form water. The purer the hydrogen the quieter it burns. It is usually prepared by adding acid to metal.

8 marks

metal
flammable
oxygen
heavier
lighter
purer
acid
alkali
non-metal
water
invisible
non-flammable

APPENDIX V

SCIENCE ATTITUDE QUESTIONNAIRE

DIRECTIONS FOR ADMINISTRATION AND

SCORING GRID

Science Attitude Questionnaire

he purpose of this questionnaire is to find out what you think about SCIENCE as it is taught to you in :hool and how important you think it is in the world today. The questionnaire contains a large number of atements about SCIENCE. We want to know what you feel and think about these ideas and whether you jree with them or not. This is not a test and *there are no right or wrong answers*. We would like you to *give our own opinion* of each of the statements in the booklet.

IRECTIONS

lease fill in your name and number, the name and number of your school and the other information :quested below, as instructed by your teacher.

AME OF SCHOOL .... TODAY'S DATE ....

UPIL'S NAME .... PUPIL'S DATE OF BIRTH ....

UPIL'S SEX (BOY OR GIRL)............ SCHOOL NO.................. PUPIL'S NUMBER ......

/hen you have completed all the information above, try the practice question.

RACTICE QUESTIONS.

1 Studying mathematics is fun.

strongly agree   agree   not sure   disagree   strongly disagree

he answer 'strongly agree' has been chosen here by underlining the words 'strongly agree'. If your answer was trongly disagree' you would have underlined the words 'strongly disagree'.

ow try the next practice question yourself, underlining your answer heavily in the same way.

2 Mathematics should be taught only to boys and girls who want to learn it.

strongly agree   agree   not sure   disagree   strongly disagree

ach statement in the booklet looks like the practice statements. When you read each one carefully, also read ach of the choices given below it. Then decide which *one* answer best fits your feeling and underline the nswer boldly. Please choose only one answer for each problem and try to answer every question. *Rub out 'early any answer you wish to change*. Do not think too long on any one statement – give the first 'natural' nswer as it comes to you. *Try to answer every one of the questions in the booklet.*

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

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3BN 0 7005 0162 2

(LXXi)

Science lessons are a waste of time.

strongly disagree _disagree_ not sure agree strongly agree

I enjoy other lessons more than science lessons.

much more _slightly more_ about the same less much less

My science teacher is a good sort of teacher. (My science teachers are good sorts of teachers.)

definitely not no maybe yes _definitely yes_

I look forward to the time I can leave school.

very much much some _a little_ not at all

There are too many facts to learn in science.

strongly disagree _disagree_ not sure agree strongly agree

Scientists make things which are a nuisance.

strongly disagree disagree not sure agree strongly agree

I would like to be given a science book or a piece of scientific equipment as a present.

very much / I would be pleased / _it would be all right_ / I don't think I would like it / not in the least

I like my science teacher(s).

not at all a little some much _very much_

People have long managed without the scientific discoveries we now have, and we too should be able to do without them.

strongly agree agree not sure disagree _strongly disagree_

Scientific discoveries are doing more good than harm, therefore we are happier because of them.

strongly disagree disagree not sure _agree_ strongly agree

Scientists are too taken up with their work.

strongly agree agree not sure _disagree_ strongly disagree

My mother wants me to be a scientist.

not at all some not sure quite a bit very much

I would like to work with people who make scientific discoveries.

never _seldom_ occasionally most of the time all the time

Scientists are wasting public money.

strongly disagree _disagree_ not sure agree strongly agree

There is not enough concern about science nowadays.

strongly agree agree _not sure_ disagree strongly disagree

School is fun.

strongly disagree disagree not sure _agree_ strongly agree

I think the school should have less science periods each week.

strongly disagree disagree _not sure_ agree strongly agree

I can learn a lot by studying plants and animals in their natural surroundings.

strongly agree _agree_ not sure disagree strongly disagree

A lot more money should be spent on science.

strongly disagree disagree _not sure_ agree strongly agree

My science teacher livens up our class. (My science teachers liven up our classes.)

never seldom sometimes most of the time always

Most of the money spent in Britain on science should be spent building more houses.

strongly disagree disagree not sure agree strongly agree

Problems are being solved in science nowadays which will lead to a bettering of life for mankind.

strongly agree agree not sure disagree strongly disagree

I do badly in science.

very badly badly average well very well

Science teachers have a worse sense of humour than other teachers.

strongly agree agree not sure disagree strongly disagree

We have good science teachers in this school.

strongly agree agree not sure disagree strongly disagree

I should like to be anything but a scientist.

strongly agree agree not sure disagree strongly disagree

Going to school is depressing.

always most of the time sometimes seldom never

I want to learn for myself why science experiments turn out the way they do.

very much much a little not sure not at all

Two hours of work in a science laboratory are more fun than a week of work in other subjects.

strongly disagree disagree not sure agree strongly agree

I like my school.

very much some a little not sure I hate it

It is the experiments in science that make me understand it.

strongly agree agree not sure disagree strongly disagree

I enjoy school work.

none of it a bit of it some of it most of it all of it

Field trips in science are a waste of time.

strongly disagree disagree not sure agree strongly agree

This school is

very poorly run poorly run it's okay well run extremely well run

I like to talk with people about new scientific discoveries.

not at all a little some much very much

I do science experiments in my spare time about:

once a week once a month once every three months once a year never

I find science difficult to understand.

extremely difficult difficult in between easy very easy

Scientific progress solves more problems than it creates.

strongly agree agree not sure disagree strongly disagree

I would much rather do experiments in science than read about them.

never seldom sometimes most of the time always

I like the teachers in this school.

very much some a little not sure not at all

My father wants me to become a scientist.

very much much some not sure not at all

My science teacher is (science teachers are):

very unkind somewhat unkind fairly kind very kind extremely kind

I look forward to science lessons.

always most of the time sometimes seldom never

We learn more by studying plants and animals in their natural surroundings than by studying them in the classroom.

strongly agree agree not sure disagree strongly disagree

School is boring.

strongly agree agree not sure disagree strongly disagree

It is fun to guess the outcome of science experiments.

strongly disagree disagree not sure agree strongly agree

I would rather do a science experiment than listen to a lecture on the same topic.

strongly agree agree not sure disagree strongly disagree

I enjoy working for my science teacher(s).

not at all some not sure much very much

Scientists are "show-offs".

strongly agree agree not sure disagree strongly disagree

Scientific discoveries have spoilt the peace and quiet of this world.

strongly agree agree not sure disagree strongly disagree

My science teacher is one (science teachers are some) of the nicest teachers on the staff.

strongly disagree disagree not sure agree strongly agree

I would enjoy school more if there were no science lessons.

much more slightly more just as much less a great deal less

In this school, I am treated as I would like to be treated.

never seldom sometimes most of the time always

I would specialise in science if I had the chance.

never not likely maybe very likely definitely yes

The progress of science is to blame for killing millions of people.

strongly agree agree not sure disagree strongly disagree

Going out to work is better than going to school.

strongly disagree disagree not sure agree strongly agree

I would rather be a member of a "pop group" than a member of a science research team.

strongly agree agree not sure disagree strongly disagree

I should like to belong (or I like belonging) to a science club.

very much some a little not sure not at all

SCORING GUIDE SCHOOL NAME ________ NO. ________

PUPIL'S NAME ________ NO. ________

	Direction of scoring	Item score on Factor: I	II	III	IV	V
	5 - 1					
	1 - 5					
	1 - 5					
	1 - 5					
	5 - 1					
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SCORING GUIDE

	Direction of scoring	Item score on Factor: I	II	III	IV	V
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side 2)	——					
ls (side 1)	——					
TOTALS	——					

DIRECTIONS FOR ADMINISTRATION

The following is the script for use by teachers when administering the questionnaire. Advance preparations should be made for each step. If the testing session is to be successful, the instructions given below must be read beforehand by the administrator and supervisors.

Step 1

Introduction: The administrator should introduce the session by saying, "TODAY WE HAVE A QUESTIONNAIRE FOR YOU TO FILL IN. IT IS NOT A TEST. THE PURPOSE IS TO FIND OUT WHAT YOU THINK OF SCIENCE, HOW IT IS TAUGHT, AND HOW IMPORTANT YOU THINK SCIENCE IS IN THE WORLD YOU LIVE IN."

Step 2*

The Booklets: The booklets should now be distributed face up. The pupils should be instructed to fill in the information required at the top of the front page and the supervisors should circulate among the pupils to be sure that they are following directions. 'Today's date' should be written on the blackboard.

If code numbers are required, the pupils should enter them in the appropriate boxes. (Two-digit school code numbers and three-digit pupil numbers are allowed for.)

Step 3

Directions: When everyone has filled in the identification information correctly, the pupils should be asked to follow along while the supervisor reads aloud the paragraph of directions on the front of the test (reprinted below).

---

* If machine-scoring is used, this step should be replaced by the version given in the Annex to this Manual, which is provided to any person using the document-reading service.

(Read aloud) "DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO. 'HE PURPOSE OF THIS QUESTIONNAIRE IS TO FIND OUT WHAT YOU THINK ABOUT CIENCE AS IT IS TAUGHT TO YOU IN SCHOOL AND HOW IMPORTANT YOU THINK IT 5 IN THE WORLD TODAY. THE QUESTIONNAIRE CONTAINS A LARGE NUMBER OF TATEMENTS ABOUT SCIENCE. WE WANT TO KNOW WHAT YOU FEEL AND THINK BOUT THESE IDEAS AND WHETHER YOU AGREE WITH THEM OR NOT. THIS IS NOT TEST AND THERE ARE NO RIGHT OR WRONG ANSWERS. WE WOULD LIKE YOU TO IVE YOUR OWN OPINION OF EACH OF THE STATEMENTS IN THE BOOKLET."

"YOU HAVE ALREADY FILLED IN THE REQUIRED INFORMATION, SO LET 'S GO ON AND LOOK AT THE PRACTICE QUESTIONS TOGETHER."

'RACTICE QUESTIONS

1. Studying mathematics is fun.

strongly agree   agree   not sure   disagree   strongly disagree

"THE ANSWER 'strongly agree' HAS BEEN CHOSEN HERE BY UNDERLINING 'HE WORDS 'strongly agree'. IF YOUR ANSWER WAS 'strongly disagree', YOU WOULD IAVE UNDERLINED YOUR ANSWER IN THE SAME WAY.

NOW TRY THE NEXT PRACTICE QUESTION YOURSELF, UNDERLINING YOUR NSWER IN THE SAME WAY."

llow one or two minutes for every pupil to complete the second practice question, which is:

2. Mathematics should be taught only to boys and girls who want to learn it.

strongly agree   agree   not sure   disagree   strongly disagree

nd then continue: "EACH STATEMENT IN THE BOOKLET LOOKS LIKE THE PRACTICE TATEMENTS. WHEN YOU READ EACH ONE CAREFULLY, ALSO READ EACH OF 'HE CHOICES GIVEN BELOW IT. THEN DECIDE WHICH ONE ANSWER BEST FITS OUR FEELINGS AND UNDERLINE THAT ANSWER. PLEASE CHOOSE ONLY ONE NSWER FOR EACH PROBLEM AND TRY TO ANSWER EVERY QUESTION. RUB OUT LEARLY ANY ANSWER YOU WISH TO CHANGE. DO NOT THINK TOO LONG ON ANY 'NE STATEMENT - GIVE THE FIRST 'NATURAL' ANSWER AS IT COMES TO YOU.

TRY TO ANSWER EVERY ONE OF THE ITEMS IN THE BOOKLET."

After the front page of the booklet has been read aloud with the pupils, continue as follows:

"IF YOU SHOULD NEED ANOTHER PENCIL DURING THE ANSWERING TIME, RAISE YOUR HAND. ARE THERE ANY QUESTIONS? (These should be easy to answer.)

PLEASE OPEN YOUR TEST BOOKLETS TO QUESTION ONE. BEGIN!"

Step 4

Timing: A forty-five minute limit is suggested for the questionnaire, but this time limit need not be rigidly kept. The teacher should encourage pupils who finish early to check over their answers, but if some of the pupils have finished with time to spare, their questionnaires may be collected and these pupils should go on with other quiet work until everyone has finished. Any pupil not completing all the questions within 45 minutes should be encouraged to continue until he has finished, if this is at all possible administratively.

If a pupil has a query about procedure during testing then advice should be given, but no discussion of the preferred or 'right' answers should occur. One answer should be given to each question and this may mean suggesting to some pupils that an arbitrary choice between two alternatives should be taken.

Step 5

Collection of Materials: When every pupil has completed the questionnaire, the booklets should be collected. Before the pupils are excused, the booklets should be counted to be sure that every single one has been returned. A final check should be made to make sure that the pupils have entered all the necessary information on the front page of their booklets and the pupils may then be dismissed.

SCORING THE QUESTIONNAIRE

Scoring by document-reader

Scoring the questionnaire using a document-reader and a computer is economically feasible only if the number of booklets to be scored exceeds about 500. The larger the number the booklets, the less the cost per candidate becomes. Any person contemplating using the questionnaire with samples of 500 or more is advised to contact the Research Officer, Guidance and Assessment Service, before any materials are ordered, to discuss the document-reading service.

coring by hand

A sample hand-scoring guide is appended to this manual and it is recommended ıat this section is read with the sample guide to hand. Each item in the questionnaire ›longs to one, and only one, of the five factors and the items vary in their direction of ›oring, sometimes the leftmost response being allocated the maximum score of 5 and ›metimes the rightmost. The scoring guide is designed to allocate the item score ıtomatically to the appropriate factor and also to indicate the direction of scoring.

One of these guides is needed for each pupil who has taken the questionnaire*, d space is provided where brief identification details about the pupil can be entered on e guide. The scoring for each pupil would proceed as follows:

Item 1 Direction of scoring: 5 - 1 i.e. the leftmost response 'strongly disagree' is allocated a score of 5, 'disagree' 4, 'not sure' 3, 'agree' 2 and 'strongly agree' 1. Thus if the pupil had marked 'agree', a score of 2 would be entered in the blank box opposite item 1 on the scoring guide. (In the case of item 1, the blank occurs in the column for Factor I.)

Item 2 Direction of scoring: 1 - 5 i.e. 'much more' scores 1, 'slightly more' 2, 'about the same' 3, 'less' 4 and 'much less' 5. Thus if a pupil had marked 'about the same', a score of 3 would be entered in the blank box opposite item 2 on the scoring guide.

The remaining items are scored applying the same principles. After item 30 scored, the scores in each column should be added and entered in the boxes provided he foot of each column. These scores should then be transferred to the appropriate es at the foot of the other side of the guide, and the scoring of items 31 to 58 performed. columns on side 2 should then be summed and finally, the totals for sides 1 and 2 ed to provide the final scores.

If a pupil fails to mark any response for a particular item, a score of 3 (not zero) uld automatically be awarded. If a pupil has marked two or more answers for any item l there is no indication that he has attempted to rub any of them out), a score of 3 should in be awarded.

APPENDIX VI

Quotes concerning marks,
grades and comments made
by pupils in Trials I and
2.

"I think my marks and comments are fairly fair. Some I think were a bit too high though".

"I think that there should be comments on the work to the pupils where they went wrong and to help correct their mistakes. The comments should be longer and more descriptive".

"The marks and comments should be put in greater detail sometimes to help us correct what we have done wrong".

"I think that the marking system is quite good but why do teachers have to take up half the page when writing comments? Why can't they just write Good, Bad, O.K., Terrible or Brilliant".

"I think commenting is a good idea because if there wasn't any commenting you wouldn't know how to improve your work".

"I think the marks are fair, but there could be more comments. Because you may have thought you did a perfect piece of work but you might get a 'B' and not understand what was wrong. You need a comment so you could correct what you did wrong next time".

"I think my marks and comments were just right for the work I did. Even though I thought some grades should have been better. I think comments should be put in because then you can understand where you went wrong and learn spellings for a later time".

"I think the comments and grades I have had were pretty good".

"I was pleased with my grades and the comments have been encouraging and helpful".

"I think the grades and comments I have been given during the course have been fairly given".

"I think the marks and comments were fairly accurate".

"Generally the comments were fair and very constructive".

"The comments were sometimes a bit lengthy and boring. They should be short, quick comments".

"I thought that the marks we were given were quite fair and the comments were very helpful".

"I think my marks and comments were true but not very good".

"Well, you don't splash out on the grades but the comments you put are quite good and tell you what you did wrong".

"I love having my work marked and I always like to know what my teacher thinks of it. If red marks surround my work I think perhaps I will do better next time. If I get a piece of work back with just a tick I don't think that the teacher has looked at my work because it always has at least one spelling mistake".

"All work should have comments to pinpoint your weaknesses. The teacher should not splat red marks all over the page because the red marks make the pages look worse than they already are".

"I always take notice of the comment then I think of ways to improve my work from what I have read".

"I like my work to be marked often, then I can see whether I am improving or not".

"I don't like great big comments for bad work at the beginning of a piece of work because it makes a great big effort look useless".

"Grades give you the ability to compare pieces of work".

APPENDIX VII

RAW SCORES

Abbreviations used:-

Pre	=	Pretest score
Post	=	Post test score
Chge	=	Change in score
$\frac{\text{Chge}}{\text{Possible Chge}}$	=	Change in score $\div$ Possible maximum score

TRIAL 1

BOYS - TREATMENT 1

Pupil	SAQ Factor 1 Pre	Factor 1 Post	Factor 1 Chge	Factor 2 Pre	Factor 2 Post	Factor 2 Chge	Factor 3 Pre	Factor 3 Post	Factor 3 Chge	Factor 4 Pre	Factor 4 Post	Factor 4 Chge	Factor 5 Pre	Factor 5 Post	Factor 5 Chge	Science Achievement Test Pre	Post	Chge	Chge/Possible Chge
1	64	60	-4	40	42	2	28	29	1	32	28	1	40	30	-10	22	30	8	.471
2	57	53	-4	48	43	-5	30	30	0	31	35	4	26	28	2	12	28	16	.593
3	84	83	-1	48	59	11	34	35	1	33	37	4	39	44	5	11	31	20	.714
4	68	67	-1	45	53	8	31	30	-1	34	31	-3	35	32	-3	12	14	2	.07
5	74	68	-6	46	43	-3	32	28	-4	33	21	-12	32	22	-10	10	25	15	.517
6	48	51	3	45	44	-1	30	30	0	27	26	-1	20	21	1	11	27	16	.571
7	54	60	6	41	39	-2	27	24	-3	26	26	0	12	21	9	14	12	-2	-.08
8	74	68	-6	56	58	2	34	34	0	34	35	1	33	35	2	14	27	13	.52
9	55	52	-3	40	38	-2	27	26	-1	30	30	0	31	38	7	13	17	4	.154
10	22	33	11	28	31	3	20	26	6	10	19	9	11	24	13	8	10	2	.065
11	73	57	-16	56	46	-10	27	29	2	36	31	-5	41	33	-8	10	19	9	.31
12	72	67	-5	47	42	-5	31	30	-1	28	26	-2	36	27	-9	9	29	20	.667
13	57	47	-10	48	45	-3	31	30	-1	32	27	-5	36	34	-2	5	7	2	.059
14	69	57	-12	44	42	-2	29	29	0	34	30	-4	28	27	-1	13	16	3	.115
15	62	77	15	41	45	4	30	31	1	27	31	4	32	30	-2	16	16	0	0
16	43	28	-15	40	24	-16	19	26	7	30	26	-4	25	20	-5	13	13	0	0
17	72	68	-4	52	48	-4	27	29	2	26	24	-2	33	34	1	14	10	-4	-.16
18	70	67	-3	47	51	4	28	31	3	35	39	4	42	39	-3	11	25	14	.5
19	60	48	-12	37	39	2	27	28	1	30	28	-2	26	28	2	9	14	5	.167

TRIAL 1

BOYS - TREATMENT 2

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	67	63	-4	46	50	4	26	26	0	26	26	0	24	26	2	16	23	7	.304
2	79	72	-5	56	52	-4	34	26	-8	35	34	-1	42	30	-12	11	15	4	.143
3	85	72	-13	48	47	-1	29	30	1	36	36	0	36	23	-13	10	23	13	.448
4	59	76	17	42	48	6	28	32	4	34	38	4	35	38	5	13	29	16	.615
5	65	57	12	40	38	-2	28	29	1	31	32	1	45	41	-4	17	26	9	.409
6	63	67	4	42	42	0	23	28	5	25	25	0	31	36	5	12	28	16	.593
7	58	56	-2	45	37	-8	18	24	6	34	32	-2	29	24	-5	10	12	2	.069
8	39	52	13	37	39	2	19	25	6	25	32	7	12	14	2	7	20	13	.406
9	63	64	1	46	46	0	28	31	3	32	35	3	28	29	1	7	17	10	.313
10	80	80	0	48	39	-9	31	34	3	32	31	-1	33	28	-5	11	27	16	.571
11	58	70	12	35	41	6	24	26	2	29	33	4	29	30	1	7	17	10	.313
12	58	60	2	38	42	4	20	25	5	33	30	-3	32	30	-2	9	18	9	.3
13	51	33	-18	38	39	1	26	19	-7	25	25	0	15	19	4	9	16	7	.233
14	63	60	-3	49	49	0	31	28	-3	37	33	-4	36	38	2	14	22	8	.32
15	62	63	1	39	46	7	27	29	2	29	27	-2	25	25	0	15	16	1	.042
16	53	50	-3	27	38	11	25	21	-4	22	27	5	22	18	-4	7	13	6	.188
17	57	50	-7	45	45	0	24	27	3	34	31	-3	25	30	5	7	21	14	.438
18	80	81	1	58	57	-1	33	34	1	38	36	-2	45	42	-3	24	30	6	.24
19	63	63	0	46	44	-2	30	27	-3	25	29	4	30	26	-4	17	26	9	.409

TRIAL 1

BOYS - TREATMENT 3

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	72	72	0	47	51	4	28	28	0	29	30	1	27	26	-1	20	28	8	.421
2	40	48	8	42	38	-4	27	26	-1	25	26	1	22	20	-2	4	16	12	.343
3	86	89	3	51	49	-2	32	30	-2	38	39	1	42	37	-5	11	28	16	.571
4	90	87	-3	46	44	-2	29	29	0	35	36	1	35	38	3	7	16	9	.281
5	81	72	-9	54	50	-4	32	32	-1	36	36	0	40	36	-4	15	14	-1	-.042
6	60	76	16	42	48	6	27	27	0	31	38	7	26	29	3	8	25	17	.548
7	65	63	-2	44	50	6	24	30	6	33	39	6	39	41	2	15	14	-1	-.042
8	43	61	18	41	42	1	26	26	0	22	27	5	27	35	8	6	22	16	.485
9	58	54	-4	40	49	9	28	27	-1	36	36	0	33	34	1	7	23	16	.5
10	60	72	12	40	49	9	29	30	1	24	32	8	30	28	-2	12	28	16	.593
11	31	39	8	34	39	5	20	20	0	22	29	7	16	20	4	12	15	3	.111
12	80	88	8	50	61	11	30	33	3	32	36	4	23	17	-6	24	27	3	.2
13	67	78	11	52	54	2	34	29	-5	36	29	-7	35	30	-5	13	21	8	.308
14	62	73	11	49	49	0	29	30	1	31	37	6	38	35	-3	8	26	18	.581
15	60	61	1	40	41	1	27	26	-1	22	23	1	21	29	8	11	11	0	.0
16	63	70	7	48	47	-1	31	31	0	28	29	1	28	29	1	15	11	-4	-.167
17	65	79	14	45	54	9	33	30	-3	30	39	9	27	31	4	7	20	13	.406
18	52	64	12	40	53	13	24	26	2	36	38	2	35	32	3	8	28	20	.645

TRIAL 1

BOYS - TREATMENT 4

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	48	55	8	41	43	2	21	19	-2	28	27	-1	33	33	0	6	10	4	.121
2	72	75	3	45	45	0	30	28	-2	36	37	1	36	40	4	11	20	9	.321
3	62	63	1	56	54	-2	26	24	-2	30	25	-5	31	30	-1	14	11	-3	-.12
4	80	65	-18	40	38	-2	34	32	-2	28	35	8	41	36	-5	18	26	8	.381
5	43	56	13	48	45	-3	27	28	1	22	30	8	22	20	-2	10	32	22	.759
6	54	58	4	42	43	1	24	27	3	37	36	-1	25	22	-3	8	13	5	.161
7	38	37	-1	37	25	-12	19	28	9	25	27	2	15	18	3	5	21	16	.471
8	62	68	6	39	43	4	31	25	-6	29	32	3	30	34	4	16	24	8	.348
9	78	70	-8	46	48	2	34	31	-3	32	32	0	33	30	-3	13	14	1	.039
10	58	59	1	46	46	0	29	29	0	26	29	3	38	29	-9	9	13	4	.133
11	81	74	-7	52	44	-8	31	34	3	27	24	-3	35	34	-1	7	17	10	.313
12	60	65	5	45	46	1	25	28	3	33	31	-2	23	27	4	14	27	13	.52
13	65	60	-5	54	52	-2	28	24	-4	34	35	1	27	27	0	17	24	7	.318
14	74	60	-14	34	37	3	27	24	-3	32	36	4	32	30	-2	16	13	-3	-.13
15	63	58	-4	44	43	-1	31	30	-1	31	30	-1	34	36	2	15	29	14	.583
16	53	69	16	40	44	4	32	34	2	34	35	1	31	28	-3	6	18	12	.364
17	67	63	-4	42	45	3	24	26	2	31	30	-1	30	30	0	10	20	10	.345
18	65	64	-1	44	41	-3	38	30	2	30	28	-2	31	27	-4	14	12	-2	-.08

TRIAL 1

GIRLS- TREATMENT 1

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	47	50	3	39	37	-2	28	24	-4	28	30	2	32	31	-1	7	12	5	.156
2	35	36	1	48	41	-7	24	24	0	22	22	0	16	13	-3	12	20	8	.296
3	51	56	5	50	50	0	27	20	-7	36	39	3	39	40	1	6	21	15	.455
4	62	67	5	50	42	-8	24	25	1	28	32	4	36	33	-3	16	6	-10	.435
5	59	65	6	42	42	0	30	30	0	30	32	2	38	34	-4	11	19	8	.286
6	35	32	-3	30	25	-5	23	24	1	15	25	10	23	25	2	12	11	-1	-.037
7	58	70	12	40	34	-6	28	20	-8	33	37	4	39	39	0	8	6	-2	-.065
8	57	54	-3	45	40	-5	26	28	2	32	32	0	38	34	-4	7	30	23	.719
9	57	65	8	44	46	2	34	27	-7	36	34	-2	41	41	0	8	20	12	.387
10	54	28	-26	43	30	-13	31	18	-13	32	26	-6	40	29	-11	4	14	10	.286
11	50	51	1	32	40	8	26	19	-7	25	27	2	26	30	4	16	20	4	.174
12	44	45	1	50	47	-3	30	31	1	25	24	-1	32	27	-5	19	22	3	.15
13	40	46	6	36	38	2	20	21	1	23	26	3	20	23	3	3	12	9	.25
14	61	64	3	50	47	-3	27	25	-2	35	34	-1	32	37	5	9	18	9	.3
15	48	55	7	38	44	6	34	22	-12	20	27	7	33	27	-6	12	10	-2	.074
16	59	51	-8	46	48	2	24	25	1	28	34	6	26	30	4	8	11	3	.097
17	60	58	-2	45	50	5	38	20	-18	38	40	2	36	38	2	16	17	1	.044

TRIAL 1

GIRLS- TREATMENT 2

Pupil	SAQ															Science Achievement Test			
	Factor 1			Factor 2			Factor 3			Factor 4			Factor 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	29	29	0	30	29	-1	23	23	-2	21	19	-2	19	27	8	9	14	5	.167
2	31	24	-7	36	30	-6	21	16	-5	23	17	-6	36	35	-1	7	11	4	.125
3	55	49	-6	42	42	0	30	29	-1	37	31	-6	27	30	3	13	15	2	.077
4	48	35	-13	39	30	-9	22	17	-5	23	23	0	22	21	-1	15	19	4	.167
5	50	54	4	40	38	-2	30	24	-6	27	31	4	39	32	-7	8	18	10	.323
6	53	43	-10	40	34	-6	26	16	-10	29	19	-10	18	20	2	11	15	4	.143
7	56	53	-3	41	37	-4	31	26	-5	36	33	-3	42	38	-4	14	29	15	.6
8	46	37	-9	45	31	-14	26	18	-8	30	21	-9	40	32	-8	10	12	2	.069
9	42	47	5	41	40	-1	25	23	-2	33	33	0	34	32	-2	15	26	11	.458
10	51	32	-19	43	38	-5	29	22	-7	33	38	5	40	30	-10	3	22	19	.528
11	65	68	3	40	40	0	33	27	-6	27	27	0	22	17	-3	7	19	12	.375
12	56	51	-5	52	40	-12	27	17	-10	29	30	1	27	31	4	7	9	2	.0625
13	83	79	-4	51	48	-3	30	29	-1	40	36	-4	46	42	-4	5	11	6	.176
14	56	37	-19	41	43	2	25	21	-4	37	27	-10	22	20	-2	16	15	-1	.044
15	49	49	0	50	39	-11	30	29	-1	31	30	-1	42	44	2	7	20	13	.406
16	44	48	4	37	35	-2	24	26	2	27	31	4	30	28	-2	2	22	20	.541
17	35	38	3	34	44	10	25	26	1	32	35	3	40	41	1	15	7	-8	.333
18	54	50	-4	41	43	2	32	26	-6	25	18	-7	36	35	-1	10	12	2	.069
19	49	40	-9	38	30	-8	29	20	-9	30	27	-3	34	32	-2	12	20	8	.296

TRIAL 1

GIRLS, TREATMENT 3

Pupil	SAQ Factor 1 Pre	SAQ Factor 1 Post	SAQ Factor 1 Chge	SAQ Factor 2 Pre	SAQ Factor 2 Post	SAQ Factor 2 Chge	SAQ Factor 3 Pre	SAQ Factor 3 Post	SAQ Factor 3 Chge	SAQ Factor 4 Pre	SAQ Factor 4 Post	SAQ Factor 4 Chge	SAQ Factor 5 Pre	SAQ Factor 5 Post	SAQ Factor 5 Chge	Science Achievement Test Pre	Science Achievement Test Post	Science Achievement Test Chge	Chge / Possible Chge
1	50	58	8	51	50	-1	31	33	2	29	39	10	30	46	16	4	19	15	.429
2	64	56	-8	45	40	-5	33	30	-3	32	33		40	37	-3	16	15	-1	.0435
3	72	64	-8	54	45	-9	31	31	0	34	36	2	44	40	-4	4	23	19	.543
4	56	62	6	44	39	-5	30	32	2	34	38	4	40	43	3	4	25	11	.314
5	42	52	10	45	46	1	30	27	-3	30	33	3	29	31	2	21	30	9	.5
6	35	57	22	38	43	5	23	27	4	21	27	6	24	30	6	10	7	-3	-.103
7	53	51	-2	43	43	0	25	26	1	34	36	2	42	47	5	3	10	7	.194
8	60	70	10	41	41	0	22	30	8	27	39	2	30	40	10	14	23	9	.360
9	40	32	-8	29	39	10	24	27	3	23	29	6	27	27	0	11	8	-3	-.107
10	51	59	8	25	28	3	33	33	0	28	28	0	37	42	5	7	13	6	.188
11	45	59	14	45	41	-4	21	30	9	29	37	8	29	34	5	13	27	14	.538
12	56	54	-2	48	48	0	28	27	-1	34	39	5	26	24	2	9	19	10	.333
13	59	59	0	46	48	2	26	27	1	30	34	4	35	38	3	8	17	9	.291
14	59	59	0	44	38	-6	28	29	1	35	29	-6	38	36	-2	14	32	18	.72
15	51	63	12	44	40	-4	30	33	3	29	40	11	31	47	16	18	26	8	.381
16	45	47	2	46	46	0	26	26	0	27	24	-3	29	32	3	15	28	13	.542
17	68	63	-5	52	48	-4	30	31	1	37	40	3	47	42	-5	3	14	11	.306
18	50	60	10	43	45	2	26	32	6	23	30	7	24	32	8	10	20	10	.345
19	60	64	4	37	39	2	24	30	6	25	38	13	28	39	11	15	27	12	.5

TRIAL 1

GIRLS - TREATMENT 4

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	69	75	6	55	53	-3	33	30	-3	38	40	2	36	38	2	14	13	-1	-.04
2	89	82	-7	56	57	1	30	26	-4	40	40	0	46	45	-1	13	25	12	.462
3	49	52	3	40	48	8	24	30	6	36	36	0	24	30	6	8	12	4	.129
4	44	49	5	33	37	4	27	28	1	32	29	-3	37	35	-2	4	14	10	.286
5	54	60	6	46	37	-5	20	18	-2	23	19	-4	29	30	1	21	29	8	.444
6	56	48	-8	50	41	-9	30	30	0	25	21	-4	38	35	-3	8	22	14	.452
7	49	47	-2	37	39	2	31	25	-6	21	21	0	31	20	-11	10	23	13	.448
8	48	39	-9	38	31	-7	33	20	-13	23	26	3	22	31	9	7	17	10	.313
9	46	51	5	39	42	3	29	27	-2	21	23	2	25	32	7	9	17	8	.267
10	50	54	4	49	41	-8	25	19	-6	29	29	0	27	28	1	9	12	3	.1
11	50	53	3	42	40	-2	31	34	3	33	24	-9	34	29	-5	15	11	-4	-.167
12	55	51	-4	30	33	3	26	25	-1	20	22	2	36	30	-6	5	11	6	.176
13	70	60	-10	50	35	-15	30	22	-8	31	33	2	40	30	-10	16	30	14	.609
14	49	52	3	37	39	2	24	25	1	37	30	-7	23	31	8	10	23	13	.448
15	35	30	-5	45	56	11	28	19	-9	31	34	3	38	25	-13	8	10	2	.065
16	50	46	-4	38	39	1	28	26	-2	36	36	0	31	31	0	3	12	9	.25
17	48	52	4	45	41	-4	23	30	7	32	25	-7	32	31	-1	4	9	5	.143
18	31	34	3	27	29	2	21	28	7	15	14	-1	36	31	-5	15	23	8	.333

TRIAL 2

BOYS - TREATMENT 1

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	57	63	6	51	36	-15	30	27	-3	27	28	1	26	26	0	14	21	7	.28
2	53	54	1	50	43	-7	31	24	-7	30	27	-3	31	29	-2	9	16	7	.233
3	80	76	-4	52	42	-10	33	30	-3	38	34	-4	37	37	0	14	24	10	.4
4	82	80	-2	39	37	-2	34	30	-4	30	26	-4	28	27	-1	23	30	7	.269
5	66	60	-6	44	41	-3	25	26	1	27	24	-3	35	29	-6	15	23	8	.333
6	61	69	8	44	47	3	26	28	2	25	26	1	32	29	-3	22	28	6	.353
7	66	59	-7	55	41	-14	33	29	-4	31	26	-5	29	30	1	19	29	10	.5

TRIAL 2

BOYS - TREATMENT 2

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	46	44	-2	55	49	-6	25	22	-3	28	27	-1	30	26	-4	20	28	8	.421
2	47	43	-4	43	37	-6	26	22	-4	26	26	0	25	20	-5	19	29	10	.5
3	91	89	-2	48	43	-5	27	27	0	36	36	0	41	40	-1	23	29	6	.375
4	66	64	-2	33	31	-2	30	26	-4	35	35	0	23	26	3	9	22	13	.433
5	66	58	-8	40	33	-7	27	23	-4	28	27	-1	22	23	1	10	16	6	.207
6	63	61	-2	35	35	0	30	25	-5	27	26	-1	30	26	-4	12	23	11	.407
7	57	58	1	46	41	-5	26	23	-3	27	30	3	27	28	1	9	14	5	.167

TRIAL 2

BOYS - TREATMENT 3

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	68	67	-1	57	42	-15	29	28	-1	31	27	-4	30	29	-1	12	20	8	.296
2	55	61	6	49	51	2	26	21	-5	29	26	-3	35	35	0	16	22	6	.261
3	57	61	4	40	39	-1	23	21	-2	23	26	3	31	30	-1	10	21	11	.379
4	66	61	-5	41	43	2	31	25	-6	30	28	-2	26	29	3	8	15	7	.226
5	46	49	3	45	37	-8	30	27	-3	24	27	3	33	33	0	11	22	11	.393
6	62	60	-2	36	49	13	27	29	2	27	33	6	33	34	1	14	21	7	.28
7	97	82	-15	66	56	-10	34	29	-5	40	35	-5	40	29	-11	23	26	3	.188
8	56	51	-5	46	46	0	26	27	1	29	27	-2	29	28	-1	17	28	11	.5

TRIAL 2

BOYS - TREATMENT 4

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	64	67	3	46	51	5	29	29	0	30	27	-3	32	29	-3	14	21	7	.28
2	72	70	-2	55	50	-5	28	26	-2	28	26	-2	30	30	0	8	10	2	.065
3	76	71	-5	50	47	-3	30	32	2	27	30	3	32	30	-2	17	19	12	.545
4	53	56	3	32	35	3	24	28	4	25	29	4	24	29	5	20	27	7	.368
5	55	55	0	37	39	2	27	30	3	28	29	1	26	27	1	12	21	9	.333
6	81	77	-4	55	56	1	34	33	-1	36	32	-4	37	35	-2	15	28	13	.542
7	62	67	5	47	42	-5	31	30	-1	29	32	3	30	32	2	7	14	7	.219
8	70	72	2	49	47	-2	26	24	-2	32	30	-2	28	27	-1	19	29	10	.5
9	53	47	-6	45	46	1	32	28	-4	24	28	4	24	25	1	15	23	8	.333

TRIAL 2

GIRLS - TREATMENT 1

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	52	56	4	49	46	3	27	26	-1	30	29	-1	37	36	-1	13	20	7	.269
2	49	57	8	45	45	0	30	29	-1	26	32	6	39	45	6	21	25	4	.222
3	41	42	1	44	46	2	20	23	3	19	24	5	31	37	6	18	28	10	.476
4	26	26	0	32	30	-2	21	19	-2	21	32	11	19	24	5	20	24	4	.211
5	70	67	-3	54	55	1	31	30	-1	35	29	-6	45	40	-5	15	28	13	.542
6	65	71	6	57	53	-4	29	32	3	36	29	-7	33	38	5	12	23	11	.407
7	28	38	10	39	32	-7	20	28	8	17	24	7	12	17	5	8	17	9	.29
8	32	36	4	29	29	0	23	19	-4	29	25	-4	13	20	7	10	14	4	.138
9	52	41	-11	37	36	-1	31	26	-5	24	22	-2	19	17	-2	12	20	8	.296
10	57	32	-25	49	30	-19	25	21	-4	35	21	-4	47	21	-26	7	27	20	.625

TRIAL 2

GIRLS TREATMENT 2

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	39	35	-4	39	37	-2	23	31	8	25	23	-2	19	23	4	6	14	8	.242
2	67	65	-2	52	53	1	33	30	-3	32	30	-2	44	38	-6	11	15	4	.143
3	51	48	-3	35	36	1	25	30	5	27	22	-5	16	11	-5	12	16	4	.148
4	48	41	-7	30	28	-2	23	30	7	23	22	-1	26	21	-5	11	19	8	.286
5	76	73	-6	51	42	-9	27	27	0	30	25	-5	37	32	-5	14	16	2	.08
6	45	39	-6	40	38	-2	24	25	1	30	30	0	36	35	-1	8	15	7	.226
7	66	63	-3	42	41	-1	28	25	-3	33	29	-4	41	38	-3	14	27	13	.52
8	67	64	-3	48	46	-2	32	29	-3	34	27	-3	37	39	2	13	21	7	.269
9	66	54	-12	50	47	-3	32	35	3	38	36	-2	40	37	-3	13	19	6	.231
10	41	42	1	44	44	0	28	29	1	25	28	3	43	47	4	18	25	7	.333
11	76	71	-5	51	49	-2	33	28	-5	29	33	4	40	40	0	10	21	11	.379

GIRLS - TREATMENT 3

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	45	44	-1	37	41	4	23	23	0	24	23	-1	33	33	0	11	25	14	.5
2	57	61	4	45	48	3	27	26	-1	32	31	-1	37	37	0	9	22	13	.433
3	65	58	-7	44	43	-1	25	24	-1	32	29	-3	27	28	1	11	28	17	.607
4	50	56	6	41	46	5	21	24	3	25	26	1	30	37	7	21	28	7	.389
5	63	65	2	41	49	8	26	26	0	36	32	-4	16	20	4	20	29	9	.474
6	82	78	-4	51	51	0	27	27	0	37	35	-2	47	43	-4	19	30	11	.55
7	48	57	9	46	41	-5	25	24	-1	26	27	1	40	25	-15	11	23	12	.429
8	66	72	8	46	55	9	32	28	-4	25	29	4	34	34	0	12	25	13	.481
9	40	43	3	36	33	-3	21	28	7	24	25	1	17	16	-1	11	22	11	.393

TRIAL 2

GIRLS TREATMENT 4

Pupil	SAQ															SCIENCE ACHIEVEMENT TEST			
	FACTOR 1			FACTOR 2			FACTOR 3			FACTOR 4			FACTOR 5						
	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Pre	Post	Chge	Chge / Possible Chge
1	63	64	1	43	43	0	29	30	1	26	30	4	31	33	2	13	20	7	.269
2	48	50	2	26	25	-1	26	22	-4	29	29	0	27	32	5	8	16	8	.258
3	32	35	3	34	38	4	23	27	4	17	22	5	19	21	2	10	25	15	.517
4	41	38	-3	43	40	-3	20	30	10	24	33	9	28	25	-3	15	17	2	.082
5	62	65	3	50	52	2	32	30	-2	34	27	-7	33	30	-3	6	19	13	.394
6	74	73	-1	55	52	-3	31	27	-4	35	30	-5	44	39	-5	14	15	1	.04
7	67	59	-8	48	50	2	31	30	-1	27	28	1	40	42	2	17	27	10	.455
8	55	53	-2	35	31	-4	29	22	-7	26	29	3	37	38	1	15	21	6	.25
9	62	64	2	50	47	-3	26	27	1	30	28	-2	35	39	4	20	27	7	.368

APPENDIX VIII

SIGNIFICANCE OF STANDARD DEVIATIONS AND GOODNESS OF FIT

TRIALS I and 2

TRIAL I

Significance of Standard Deviations

Achievement Pretest Scores — Values of "F"

		Boys Treatments I	2	3	C
	I	–	I.00	2.I32	I.38
Girls	2	I.I8	–	2.I3	I.38
Treatments	3	I.35	I.657	–	I.54
	C	I.I3	I.334	I.242	–

Attitude Pretest Scores

Factor I

		Boys Treatments I	2	3	C
	I	–	I.56I	I.22	I.33
Girls	2	I.835	–	I.905	I.I7
Treatments	3	I.I6I	I.58I	–	I.62
	C	2.I62	I.I78	I.862	–

Factor 2

		Boys Treatments I	2	3	C
	I	–	I.2	I.56	I.33
Girls	2	I.294	–	I.867	I.597
Treatments	3	I.274	I.648	–	I.I69
	C	I.468	2.I3I	I.293	–

Factor 3

		Boys Treatments I	2	3	C
	I	–	I.332	I.22I	I.II4
Girls	2	I.73	–	I.627	I.I96
Treatments	3	I.576	I.0995	–	I.36I
	C	I.253	I.253	I.I39	–

Factor 4

		Boys Treatments			
		I	2	3	C
	I	-	I.423	I.I	2.I6
Girls	2	I.489	-	I.294	I.5I7
Treatments	3	I.989	I.336	-	I.963
	C	I.308	I.947	2.602 *	-

Factor 5

		Boys Treatments			
		I	2	3	C
	I	-	I.002	I.465	2.03
Girls	2	I.349	-	I.46I	2.025
Treatments	3	I.I56	I.559	-	I.386
	C	I.308	I.76	I.I32	-

All values of F are not significant at the 5% level with the exception of *

'F' Tests of significance of standard deviation were also carried out between the standard deviations of the combined boys treatments and the combined girls treatments.

	Attitude Factor				
	I	2	3	4	5
'F' Value =	I.439	I.I8I	I.097	I.386	I.II

TRIAL I

Significance of Standard Deviations

Achievement Gain Scores — Values of "F"

		Boys Treatment I	2	3	C
Girls Treatment	I	-	2.9I	I.I85	I.284
	2	I.22	-	2.46	2.26
	3	I.29	I.05	-	I.08
	C	I.6I5	I.32	I.25	-

Attitude Change Scores

Factor I

		Boys Treatment I	2	3	C
Girls Treatment	I	-	I.I53	I.I34	I.045
	2	I.35	-	I.303	I.I03
	3	I.037	I.302	-	I.I9I
	C	2.26	I.67	2.I7	-

Factor 2

		Boys Treatment I	2	3	C
Girls Treatment	I	-	I.538	I.348	2.I97
	2	I.0I6	-	I.I42	I.428
	3	I.688	I.66I	-	I.63I
	C	I.223	I.243	2.065	-

Factor 3

		Boys Treatment I	2	3	C
Girls	I	-	2.44	I.278	I.752
	2	2.874*	-	3.II8*	I.393
	3	3.32**	I.I56	-	2.238
	C	I.20	2.395	2.77*	-

Factor 4

		Boys Treatment I	2	3	C
	I	-	2.246	I.427	I.827
Girls	2	I.623	-	I.574	I.23
Treatment	3	I.5I6	I.07I	-	I.28
	C	I.022	I.66	I.55	-

Factor 5

		Boys Treatment I	2	3	C
	I	-	I.468	2.I9	3.33**
Girls	2	I.003	-	I.495	2.27
Treatment	3	2.065	2.059	-	I.5I9
	C	2.234	2.227	I.082	-

* Significant at 5% level

** Significant at I% level

TRIAL 2

Significance of Standard Deviations

Achievement Pre-test Scores

Values of "F"

		Boys Treatments I	2	3	C
	I	–	I.96I	I.246	I.087
Girls	2	2.28	–	I.574	I.805
Treatments	3	I.05	2.I6	–	I.I5
	C	I.I77	I.937	I.II6	–

Attitude Pre-test Scores

Factor I

		Boys Treatments I	2	3	C
	I	–	I.90I	I.883	I.I8
Girls	2	I.2I9	–	I.009	2.24
Treatments	3	I.329	I.09	–	2.227
	C	I.29	I.056	I.032	–

Factor 2

		Boys Treatments I	2	3	C
	I	–	I.84	2.96	I.765
Girls	2	I.592	–	I.6II	I.042
Treatments	3	3.7I	2.33	–	I.679
	C	I.048	I.669	3.89	–

Factor 3

		Boys Treatments I	2	3	C
	I	–	3.2I4	I.343	I.343
Girls	2	I.298	–	2.974	2.394
Treatments	3	I.7I	I.3I7	–	I.242
	C	I.232	I.054	I.388	–

Factor 4

		Boys Treatments I	2	3	C
	I	—	I.054	I.492	I.409
Girls	2	2.4I7	—	I.572	I.336
Treatments	3	I.708	I.4I5	—	2.I0
	C	I.62I	I.49	I.054	—

Factor 5

		Boys Treatments I	2	3	C
	I	—	2.724	I.I53	I.I46
Girls	2	I.809	—	2.368	2.378
	3	I.605	I.I27	—	I.006
	C	2.94	I.625	I.882	—

All values of "F" are not significant at 5% level

Significance of Standard Deviations

between combined Boys scores and combined Girls scores

	Achievement	Attitude Factor I	2	3	4	5
Value of "F" =	I.22I	I.274	I.047	I.643	I.838	2I.208**

All values of "F" are not significant at 5% level with the exception of ** which is significant beyond I% level.

TRIAL 2

Significance of Standard Deviation

Achievement Gain Scores

Values of "F"

		Boys Treatments 1	2	3	C
Girls Treatments	1	–	1.85	1.25	2.95
	2	1.69	–	1.48	1.57
	3	4.756*	2.807	–	2.33
	C	1.03	1.75	4.92*	–

Attitude Change Scores

Factor 1

		Boys Treatments 1	2	3	C
Girls Treatments	1	–	4.48*	1.289	2.234
	2	9.975****	–	5.78**	2.007
	3	3.732*	2.673	–	2.881
	C	8.307****	1.201	2.226	–

Factor 2

		Boys Treatments 1	2	3	C
Girls Treatments	1	–	6.971**	1.696	3.563
	2	5.174***	–	11.82****	1.956
	3	1.59	3.254	–	6.042
	C	4.162**	1.122	2.90	–

Factor 3

		Boys Treatments 1	2	3	C
Girls Treatments	1	–	3.74	1.147	1.454
	2	1.433	–	3.257	2.571
	3	1.365	1.956	–	1.267
	C	1.962	1.369	2.678	–

Factor 4

		Boys Treatments I	2	3	C
	I	–	2.977	2.585	I.664
Girls	2	6.866****	–	7.697**	4.955*
Treatments	3	9.66****	I.407	–	4.956**
	C	2.296	2.99I	4.208*	–

Factor 5

		Boys Treatments I	2	3	C
	I	–	I.509	3.027	I.049
Girls	2	7.4I5****	–	2.006	I.438
Treatments	3	2.632	2.8I8	–	2.885
	C	8.404****	I.I33	3.I93	–

Level of Significance:			
	*	<	5%
	**	<	2.5%
	***	<	I%
	****	=	beyond 0.5%

TRIAL I

Kolmogorov-Smirnov

test for Goodness of Fit

Achievement Pre-test Scores

Values of 'D'

	Treatment I	2	3	C
Boys	0.055	0.103	0.104	0.062
Girls	0.075	0.05	0.103	0.062

Attitude Pre-test Scores

Factor I	Treatment I	2	3	C
Boys	0.107	0.132	0.062	0.056
Girls	0.042	0.055	0.055	0.166

Factor 2	Treatment I	2	3	C
Boys	0.079	0.055	0.104	0.104
Girls	0.088	0.184	0.132	0.062

Factor 3	Treatment I	2	3	C
Boys	0.055	0.055	0.062	0.056
Girls	0.042	0.026	0.055	0.056

Factor 4	Treatment I	2	3	C
Boys	0.184	0.103	0.062	0.049
Girls	0.075	0.05	0.055	0.062

Factor 5	Treatment I	2	3	C
Boys	0.132	0.055	0.062	0.111
Girls	0.042	0.103	0.079	0.089

None of these values of 'D' are significant at the 5% level.

χ^2 Goodness of Fit

Trial I

Combined boys treatments and combined girls treatments

	Achievement	Attitude Factor				
		I	2	3	4	5
Boys	I.006	I.I59	0.508	I.8	I.453	0.895
Girls	8.0II*	2.48	2.56	I.07	2.7II	2.045

All d.f. = 3

All of these values of χ^2 are not significant at the 5% level with the exception of *.

TRIAL I

Goodness of Fit

Achievement Gain Scores

Values of 'D'

	Treatment I	2	3	C
Boys	0.055	0.079	0.062	0.III
Girls	0.IOI	0.079	0.I07	0.I04

Attitude Change Scores

Factor I	Treatment I	2	3	C
Boys	0.079	0.055	0.III	0.049
Girls	0.I47	0.I03	0.079	0.062

Factor 2	Treatment I	2	3	C
Boys	0.079	0.079	0.II8	0.056
Girls	0.075	0.I07	0.079	0.056

Factor 3	Treatment I	2	3	C
Boys	0.055	0.I84	0.II2	0.I04
Girls	0.IOI	0.079	0.055	0.062

Factor 4	Treatment I	2	3	C
Boys	0.I03	0.I32	0.I04	0.049
Girls	0.088	0.05	0.079	0.I67

Factor 5	Treatment I	2	3	C
Boys	0.05I	0.055	0.056	0.063
Girls	0.075	0.026	0.026	0.062

All values of 'D' are not significant at the 5% level

TRIAL 2

Goodness of Fit Test

Achievement Pretest Scores — Values of "D"

	Treatment I	2	3	C
Boys	0.2I4	0.I6	0.035	0.062
Girls	0.I	0.069	0.28	0.062

Attitude Pretest Score

Factor I	Treatment I	2	3	C
Boys	0.2I4	0.I26	0.I25	0.062
Girls	0.I73	0.046	0.06	0.062

Factor 2	Treatment I	2	3	C
Boys	0.0I8	0.I26	0.I25	0.062
Girls	0.0I	0.069	0.062	0.I67

Factor 3	Treatment I	2	3	C
Boys	0.I26	0.2I4	0.035	0.056
Girls	0.I73	0.204	0.089	0.062

Factor 4	Treatment I	2	3	C
Boys	0.0I8	0.2I4	0.I25	0.062
Girls	0.I4	0.069	0.I6	0.062

Factor 5	Treatment I	2	3	C
Boys	0.07I	0.I6	0.035	0.I67
Girls	0.0I	0.227	0.062	0.056

None of these values of "D" are significant at 5% level

χ^2 Goodness of Fit Test for Combined Boys and Combined Girls Treatments using Yates Correction

	Achievement	Attitude Factor				
		I	2	3	4	5
Boys	3.84I	2.48	I.068	0.538	2.466	2.0I5
Girls	4.023	0.732	0.60	2.90	2.7II	5.I45

All d.f. = 3

None of these values of χ^2 are significant at 5% level.

TRIAL 2

Goodness of Fit

Achievment Gain Scores — Values of "D"

	Treatment I	2	3	C
Boys	0.071	0.214	0.125	0.062
Girls	0.1	0.069	0.062	0.062

Attitude Change

Factor 1	Treatment I	2	3	C
Boys	0.126	0.214	0.035	0.062
Girls	0.02	0.069	0.284	0.16

Factor 2	Treatment I	2	3	C
Boys	0.126	0.214	0.125	0.062
Girls	0.2	0.136	0.062	0.06

Factor 3	Treatment I	2	3	C
Boys	0.214	0.137	0.09	0.062
Girls	0.2	0.069	0.278	0.108

Factor 4	Treatment I	2	3	C
Boys	0.214	0.263	0.125	0.284
Girls	0.1	0.136	0.089	0.062

Factor 5	Treatment I	2	3	C
Boys	0.018	0.018	0.375	0.069
Girls	0.16	0.069	0.167	0.173

All of these values of "D" are not significant at the 5% level

APPENDIX IX

T-TESTS OF SIGNIFICANCE

AND

CORRELATION COEFFICIENTS,

Trials I and 2

TRIAL 1 - BOYS

ACHIEVEMENT PRETEST

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	11.9474	3.535
2	C	18	11.6111	4.15

Pooled Deviation is 3.8442. The Students t value is .266 at 35 degrees of freedom

1	2	19	11.21	3.54
2	C	18	11.6111	4.15

Pooled Deviation is 3.845 and the Students t value is .317 at 35 degrees of freedom.

1	3	18	11.278	5.154
2	C	18	11.6111	4.15

Pooled Deviation is 4.68 The Students t value is .214 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	11.9474	3.53512
2	2	19	11.2105	3.53677

THE STUDENTS T VALUE IS .64229 AT 38 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .64229 WITH 38 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	11.9474	3.53512
2	3	18	11.2778	5.15416

THE POOLED DEVIATION IS 4.39661 AND THE STUDENTS T VALUE IS .463024 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .463024 WITH 35 DEGREES OF FREEDOM
IS .323107

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	11.2105	3.53677
2	3	18	11.2778	5.15416

THE POOLED DEVIATION IS 4.3973 AND THE STUDENTS T VALUE IS-.0464972 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0464972 WITH 35 DEGREES OF FREEDOM
IS .481589

TRIAL 1 - BOYS

ATTITUDE SCORES

PRETEST

FACTOR 1

Sample	Treatment	Size	Mean	Standard De viation
1	1	19	62.000	14.08
2	C	18	62.33	12.19

Pooled Deviation is 13.2 The Students t value is .077 at 35 degrees of freedom.

1	2	19	63.32	11.265
2	C	18	62.33	12.19

Pooled Deviation is 11.72. The Students t value is .255 at 35 degrees of freedom

1	3	18	63.06	15.535
2	C	18	62.33	12.19

Pooled Deviation is 13.96. The Students t value is .155 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	62	14.0831
2	2	19	63.3158	11.2648

THE POOLED DEVIATION IS 12.7521 AND THE STUDENTS T VALUE IS-.318029 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.318029 WITH 36 DEGREES OF FREEDOM IS .37615

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	62	14.0831
2	3	18	63.0556	15.5355

THE POOLED DEVIATION IS 14.8064 AND THE STUDENTS T VALUE IS-.216743 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.216743 WITH 35 DEGREES OF FREEDOM IS .414833

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	63.3158	11.2648
2	3	18	63.0556	15.5355

THE POOLED DEVIATION IS 13.5088 AND THE STUDENTS T VALUE IS .0585671 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0585671 WITH 35 DEGREES OF FREEDOM IS .476815

FACTOR 2

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	44.68	6.61
2	C	18	44.17	5.72

Pooled Deviation is 6.19. The Students t value is .254 at 35 degrees of freedom.

1	2	19	43.42	7.24
2	C	18	44.17	5.72

Pooled Deviation is 6.55. The Students t value is .346 at 35 degrees of freedom

1	3	18	44.72	5.289
2	C	18	44.17	5.72

Pooled Deviation is 5.51. The Students t value is .3025 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	44.6842	6.60847
2	2	19	43.4211	7.24424

THE POOLED DEVIATION IS 6.93365 AND THE STUDENTS T VALUE IS .561512 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .561512 WITH 36 DEGREES OF FREEDOM IS .288964

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	44.6842	6.60847
2	3	18	44.7222	5.28922

THE POOLED DEVIATION IS 6.00401 AND THE STUDENTS T VALUE IS-.0192471 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0192471 WITH 35 DEGREES OF FREEDOM IS .492377

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	43.4211	7.24424
2	3	18	44.7222	5.28922

THE POOLED DEVIATION IS 6.37004 AND THE STUDENTS T VALUE IS-.621018 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.621018 WITH 35 DEGREES OF FREEDOM IS .269306

FACTOR 3

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	28.52	3.89
2	C	18	27.67	4.10

Pooled Deviation is 4.00. The Students t value is .654 at 35 degrees of freedom.

1	2	19	26.526	4.49
2	C	18	27.67	4.10

Pooled Deviation is 4.30. The Students t value is .805 at 35 degrees of freedom.

1	3	18	28.33	3.515
2	C	18	27.67	4.10

Pooled Deviation is 3.819. The Students t value is .524 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	28.5263	3.89264
2	2	19	26.5263	4.48914

THE POOLED DEVIATION IS 4.20149 AND THE STUDENTS T VALUE IS 1.4672 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.4672 WITH 36 DEGREES OF FREEDOM IS .0755024

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	28.5263	3.89264
2	3	18	28.3333	3.51471

THE POOLED DEVIATION IS 3.71388 AND THE STUDENTS T VALUE IS .157979 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .157979 WITH 35 DEGREES OF FREEDOM IS .437691

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	26.5263	4.48914
2	3	18	28.3333	3.51471

THE POOLED DEVIATION IS 4.04527 AND THE STUDENTS T VALUE IS-1.35809 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.35809 WITH 35 DEGREES OF FREEDOM IS .0915633

FACTOR 4

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	29.9	5.724
2	C	18	30.28	3.89

Pooled Deviation is 4.92. The Students t value is .24 at 35 degrees of freedom.

1	2	19	30.63	4.798
2	C	18	30.28	3.89

Pooled Deviation is 4.38. The Students t value is .245 at 35 degrees of freedom.

1	3	18	30.33	5.45
2	C	18	30.28	3.89

Pooled Deviation is 4.732. The Students t value is .035 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	29.8947	5.72419
2	2	19	30.6316	4.79826

THE POOLED DEVIATION IS 5.28156 AND THE STUDENTS T VALUE IS-.430005 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.430005 WITH 36 DEGREES OF FREEDOM IS .334878

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	29.8947	5.72419
2	3	18	30.3333	5.44491

THE POOLED DEVIATION IS 5.59029 AND THE STUDENTS T VALUE IS-.23853 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.23853 WITH 35 DEGREES OF FREEDOM IS .40643

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	30.6316	4.79826
2	3	18	30.3333	5.44491

THE POOLED DEVIATION IS 5.12256 AND THE STUDENTS T VALUE IS .17701 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .17701 WITH 35 DEGREES OF FREEDOM IS .42026

FACTOR 5

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	30.42	8.86
2	C	18	30.39	6.21

Pooled Deviation is 7.69. The Students t value is .0127 at 35 degrees of freedom.

1	2	19	30.21	8.85
2	C	18	30.39	6.21

Pooled Deviation is 7.69. The Students t value is .0706 at 35 degrees of freedom.

1	3	18	30.22	7.31
2	C	18	30.39	6.21

Pooled Deviation is 6.79. The Students t value is .074 at 34 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	30.4211	8.85886
2	2	19	30.2105	8.84801

THE POOLED DEVIATION IS 8.85343 AND THE STUDENTS T VALUE IS .0732924 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0732924 WITH 36 DEGREES OF FREEDOM IS .47099

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	30.4211	8.85886
2	3	18	30.2222	7.31284

THE POOLED DEVIATION IS 8.14467 AND THE STUDENTS T VALUE IS .0742205 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0742205 WITH 35 DEGREES OF FREEDOM IS .470629

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	30.2105	8.84801
2	3	18	30.2222	7.31284

THE POOLED DEVIATION IS 8.1386 AND THE STUDENTS T VALUE IS-4.36913E-03 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-4.36913E-03 WITH 35 DEGREES OF FREEDOM IS .498269

TRIAL 1 - GIRLS

ACHIEVEMENT PRETEST

Sample	Treatment	Size	Mean	Standard Deviation
1	1	17	10.24	4.56
2	C	18	9.95	4.86

Pooled Deviation is 4.716. The Students t value is .182 at 33 degrees of freedom.

1	2	19	9.79	4.21
2	C	18	9.95	4.86

Pooled Deviation is 4.54. The Students t value is .104 at 35 degrees of freedom.

1	3	19	10.47	5.42
2	C	18	9.95	4.86

Pooled Deviation is 5.154. The Students t value is .312 at 35 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	10.2353	4.56248
2	2	19	9.78947	4.21082

THE POOLED DEVIATION IS 4.37983 AND THE STUDENTS T VALUE IS .304897 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .304897 WITH 34 DEGREES OF FREEDOM IS .381152

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	10.2353	4.56248
2	3	19	10.4737	5.4198

THE POOLED DEVIATION IS 5.03458 AND THE STUDENTS T VALUE IS-.141832 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.141832 WITH 34 DEGREES OF FREEDOM IS .444025

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	9.78947	4.21082
2	3	19	10.4737	5.4198

THE POOLED DEVIATION IS 4.8531 AND THE STUDENTS T VALUE IS-.434542 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.434542 WITH 36 DEGREES OF FREEDOM IS .333244

TRIAL 1 - GIRLS

ATTITUDE SCORES
PRETEST

Sample	Treatment	Size	Mean	Standard Deviation
1	1	17	51.588	8.881
2	C	18	52.333	13.08

Pooled Deviation is 11.244. The Students t value is .196 at 33 degrees of freedom.

1	2	19	50.105	12.069
2	C	18	52.333	13.08

Pooled Deviation is 12.57. The Students t value is .538 at 35 degrees of freedom.

1	3	19	53.474	9.6
2	C	18	52.333	13.08

Pooled Deviation is 11.425. The Students t value is .303 at 35 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	51.5882	8.88157
2	2	19	50.1053	12.0688

THE POOLED DEVIATION IS 10.688 AND THE STUDENTS T VALUE IS .41561 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .41561 WITH 34 DEGREES OF FREEDOM IS .340153

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	51.5882	8.88157
2	3	19	53.4737	9.59958

THE POOLED DEVIATION IS 9.26862 AND THE STUDENTS T VALUE IS-.609326 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.609326 WITH 34 DEGREES OF FREEDOM IS .27318

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	50.1053	12.0688
2	3	19	53.4737	9.59958

THE POOLED DEVIATION IS 10.9043 AND THE STUDENTS T VALUE IS-.952115 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.952115 WITH 36 DEGREES OF FREEDOM IS .173694

FACTOR 2

Sample	Treatment	Size	Mean	Standard Deviation
1	1	17	42.824	6.267
2	C	18	41.833	8.06

Pooled Deviation is 7.247. The Students t value is .404 at 33 degrees of freedom.

1	2	19	41.105	5.527
2	C	18	41.833	8.06

Pooled Deviation is 6.875. The Students t value is .322 at 35 degrees of freedom.

1	3	19	43.158	7.104
2	C	18	41.833	8.06

Pooled Deviation is 7.58. The Students t value is .531 at 35 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	42.8235	6.26739
2	2	19	41.1053	5.5267

THE POOLED DEVIATION IS 5.88688 AND THE STUDENTS T VALUE IS .874289 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .874289 WITH 34 DEGREES OF FREEDOM IS .194047

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	42.8235	6.26739
2	3	19	43.1579	7.10441

THE POOLED DEVIATION IS 6.72351 AND THE STUDENTS T VALUE IS-.148962 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.148962 WITH 34 DEGREES OF FREEDOM IS .441232

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	41.1053	5.5267
2	3	19	43.1579	7.10441

THE POOLED DEVIATION IS 6.36463 AND THE STUDENTS T VALUE IS-.99403 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.99403 WITH 36 DEGREES OF FREEDOM IS .163422

FACTOR 3

Sample	Treatment	Size	Mean	Standard Deviation
1	1	17	27.88	4.581
2	C	18	27.39	3.898

Pooled Deviation is 4.243. The Students t value is .344 at 33 degrees of freedom.

1	2	19	27.26	3.493
2	C	18	27.39	3.898

Pooled Deviation is 3.695. The Students t value is .103 at 35 degrees of freedom.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATIUN
1	3	19	27.4211	3.65625
2	C	18	27.3889	3.89776

THE POOLED DEVIATION IS 3.77548 AND THE STUDENTS T
VALUE IS .0259003 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0259003 WITH 35 DEGREES OF FREEDOM
IS .489742

1	1	17	27.8824	4.58095
2	2	19	27.2632	3.49349

THE POOLED DEVIATION IS 4.04185 AND THE STUDENTS T
VALUE IS .458878 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .458878 WITH 34 DEGREES OF FREEDOM
IS .324621

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	27.8824	4.58095
2	3	19	27.4211	3.65625

THE POOLED DEVIATION IS 4.11736 AND THE STUDENTS T
VALUE IS .335595 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .335595 WITH 34 DEGREES OF FREEDOM
IS .369619

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	27.2632	3.49349
2	3	19	27.4211	3.65625

THE POOLED DEVIATION IS 3.5758 AND THE STUDENTS T
VALUE IS-.136099 AT 36 DEGREES OF FREEDOM

FACTOR 4

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	28.5882	6.34489
2	C	18	29.0556	7.2718

THE POOLED DEVIATION IS 6.8381 AND THE STUDENTS T
VALUE IS-.202072 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.202072 WITH 33 DEGREES OF FREEDOM
IS .420551

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	30	5.21745
2	C	18	29.0556	7.2718

THE POOLED DEVIATION IS 6.29951 AND THE STUDENTS T
VALUE IS .455808 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .455808 WITH 35 DEGREES OF FREEDOM
IS .325672

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	29.5263	4.51381
2	C	18	29.0556	7.2718

THE POOLED DEVIATION IS 6.01352 AND THE STUDENTS T
VALUE IS .238004 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .238004 WITH 35 DEGREES OF FREEDOM
IS .406633

1	1	17	28.5882	6.34489
2	2	19	30	5.21745

THE POOLED DEVIATION IS 5.77549 AND THE STUDENTS T
VALUE IS-.732189 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.732189 WITH 34 DEGREES OF FREEDOM
IS .234535

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	28.5882	6.34489
2	3	19	29.5263	4.51381

THE POOLED DEVIATION IS 5.45263 AND THE STUDENTS T
VALUE IS-.515328 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.515328 WITH 34 DEGREES OF FREEDOM
IS .304829

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	30	5.21745
2	3	19	29.5263	4.51381

THE POOLED DEVIATION IS 4.87833 AND THE STUDENTS T
VALUE IS .299281 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .299281 WITH 36 DEGREES OF FREEDOM
IS .383223 .

FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	32.1765	7.50197
2	C	18	32.5	6.57308

THE POOLED DEVIATION IS 7.03878 AND THE STUDENTS T
VALUE IS-.135907 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.135907 WITH 33 DEGREES OF FREEDOM
IS .44636

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	32.3684	8.73824
2	C	18	32.5	6.57308

THE POOLED DEVIATION IS 7.76239 AND THE STUDENTS T
VALUE IS-.0515356 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0515356 WITH 35 DEGREES OF FREEDOM
IS .479596

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	33.1579	7.00213
2	C	18	32.5	6.57308

THE POOLED DEVIATION IS 6.79712 AND THE STUDENTS T
VALUE IS .294268 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .294268 WITH 35 DEGREES OF FREEDOM
IS .385146

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	32.1765	7.50197
2	2	19	32.3684	8.73824

THE POOLED DEVIATION IS 8.17977 AND THE STUDENTS T
VALUE IS-.0702898 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0702898 WITH 34 DEGREES OF FREEDOM
IS .472187

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	32.1765	7.50197
2	3	19	33.1579	7.00213

THE POOLED DEVIATION IS 7.24165 AND THE STUDENTS T
VALUE IS-.405946 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.405946 WITH 34 DEGREES OF FREEDOM
IS .343663

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	32.3684	8.73824
2	3	19	33.1579	7.00213

THE POOLED DEVIATION IS 7.91791 AND THE STUDENTS T
VALUE IS-.307319 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.307319 WITH 36 DEGREES OF FREEDOM
IS .380186

TRIAL 1 - PRETEST

BOYS/GIRLS

ACHIEVEMENT

Boys Actual Scores	1	14	16	19	17	7	
Boys Expected Scores	6.5	12.5	17.5	14.5	17	5.5	
$\sum \frac{(A-E)^2}{E}$							6.769
Girls Actual Scores	12	11	19	10	17	4	
Girls Expected Scores	6.5	12.5	17.5	14.5	17	5.5	
$\sum \frac{(A-E)^2}{E}$							6.769

df = 5. Total $\chi^2 = \underline{13.558}$

ATTITUDE PRETEST

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SAMPLE            SAMPLE SIZE    MEAN              STANDARD DEVIATION
 1       Boys      74             62.6757           13.0868
 2       Girls     73             51.8767           10.9073          Factor 1
THE POOLED DEVIATION IS 12.0539 AND THE STUDENTS T
VALUE IS 5.4309 AT 145 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 5.4309 WITH 145 DEGREES OF FREEDOM
IS 0
SAMPLE            SAMPLE SIZE    MEAN              STANDARD DEVIATION
 1       Boys      74             44.2432           6.17503
 2       Girls     73             42.2192           6.70871          Factor 2
THE POOLED DEVIATION IS 6.44556 AND THE STUDENTS T
VALUE IS 1.90363 AT 145 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.90363 WITH 145 DEGREES OF FREEDOM
IS .0294699
SAMPLE            SAMPLE SIZE    MEAN              STANDARD DEVIATION
 1       Boys      74             27.7568           4.01651
 2       Girls     73             27.4795           3.83369          Factor 3
THE POOLED DEVIATION IS 3.92679 AND THE STUDENTS T
VALUE IS .428091 AT 145 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .428091 WITH 145 DEGREES OF FREEDOM
IS .33461


SAMPLE            SAMPLE SIZE    MEAN              STANDARD DEVIATION
 1       Boys      74             30.2838           4.92556
 2       Girls     73             29.3151           5.79728          Factor 4
THE POOLED DEVIATION IS 5.37611 AND THE STUDENTS T
VALUE IS 1.09231 AT 145 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.09231 WITH 145 DEGREES OF FREEDOM
IS .138254
SAMPLE            SAMPLE SIZE    MEAN              STANDARD DEVIATION
 1       Boys      74             30.3108           7.75289
 2       Girls     73             32.5616           7.3617           Factor 5
THE POOLED DEVIATION IS 7.56117 AND THE STUDENTS T
VALUE IS-1.80457 AT 145 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.80457 WITH 145 DEGREES OF FREEDOM
IS .0366092
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TRIAL 1 - GIRLS

ATTITUDE CHANGE

FACTOR 1

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	.941177	8.46663
2	C	18	-.388889	5.64789

THE POOLED DEVIATION IS 7.15461 AND THE STUDENTS T
VALUE IS .549685 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .549685 WITH 33 DEGREES OF FREEDOM
IS .293118

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-4.68421	7.31097
2	C	18	-.388889	5.64789

THE POOLED DEVIATION IS 6.5561 AND THE STUDENTS T
VALUE IS-1.99188 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.99188 WITH 35 DEGREES OF FREEDOM
IS .0271159

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	3.84211	8.34175
2	C	18	-.388889	5.64789

THE POOLED DEVIATION IS 7.16101 AND THE STUDENTS T
VALUE IS 1.79631 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.79631 WITH 35 DEGREES OF FREEDOM
IS .0405409

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	.941177	8.46663
2	2	19	-4.68421	7.31097

THE POOLED DEVIATION IS 7.87596 AND THE STUDENTS T
VALUE IS 2.13943 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.13943 WITH 34 DEGREES OF FREEDOM
IS .0198321

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	.941177	8.46663
2	3	19	3.84211	8.34175

THE POOLED DEVIATION IS 8.40075 AND THE STUDENTS T
VALUE IS-1.03435 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.03435 WITH 34 DEGREES OF FREEDOM
IS .154136

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-4.68421	7.31097
2	3	19	3.84211	8.34175

THE POOLED DEVIATION IS 7.84331 AND THE STUDENTS T
VALUE IS-3.35061 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-3.35061 WITH 36 DEGREES OF FREEDOM
IS 9.51797E-04

FACTOR 2

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-1.35294	5.74392
2	C	18	-.833333	6.36396

THE POOLED DEVIATION IS 6.07125 AND THE STUDENTS T
VALUE IS-.253061 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.253061 WITH 33 DEGREES OF FREEDOM
IS .400896

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-3.68421	5.71599
2	C	18	-.833333	6.36396

THE POOLED DEVIATION IS 6.03941 AND THE STUDENTS T
VALUE IS-1.43515 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.43515 WITH 35 DEGREES OF FREEDOM
IS .0800607

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	-.684211	4.43537
2	C	18	-.833333	6.36396

THE POOLED DEVIATION IS 5.45791 AND THE STUDENTS T
VALUE IS .0830673 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0830673 WITH 35 DEGREES OF FREEDOM
IS .467136

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-1.35294	5.74392
2	2	19	-3.68421	5.71599

THE POOLED DEVIATION IS 5.72915 AND THE STUDENTS T
VALUE IS 1.21886 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.21886 WITH 34 DEGREES OF FREEDOM
IS .115644

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-1.35294	5.74392
2	3	19	-.684211	4.43537

THE POOLED DEVIATION IS 5.09321 AND THE STUDENTS T
VALUE IS-.393287 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.393287 WITH 34 DEGREES OF FREEDOM
IS .348282

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-3.68421	5.71599
2	3	19	-.684211	4.43537

THE POOLED DEVIATION IS 5.11591 AND THE STUDENTS T
VALUE IS-1.80743 AT 36 DEGREES OF FREEDOM

FACTOR 3

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-4.17647	6.02324
2	C	18	-1.72222	5.50727

THE POOLED DEVIATION IS 5.76321 AND THE STUDENTS T VALUE IS-1.25916 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.25916 WITH 33 DEGREES OF FREEDOM IS .108403

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-4.47368	3.56477
2	C	18	-1.72222	5.50727

THE POOLED DEVIATION IS 4.61163 AND THE STUDENTS T VALUE IS-1.81394 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.81394 WITH 35 DEGREES OF FREEDOM IS .0391343

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	2.10526	3.31486
2	C	18	-1.72222	5.50727

THE POOLED DEVIATION IS 4.51474 AND THE STUDENTS T VALUE IS 2.57747 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.57747 WITH 35 DEGREES OF FREEDOM S 7.16192E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-4.17647	6.02324
2	2	19	-4.47368	3.56477

THE STUDENTS T VALUE IS .177527 AT 26.5285 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .177527 WITH 26.5285 DEGREES OF FREEDOM IS .417096

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-4.17647	6.02324
2	3	19	2.10526	3.31486

THE STUDENTS T VALUE IS-3.81418 AT 25.2751 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-3.81418 WITH 25.2751 DEGREES OF FREEDOM IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-4.47368	3.56477
2	3	19	2.10526	3.31486

THE POOLED DEVIATION IS 3.44209 AND THE STUDENTS T VALUE IS-5.8911 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-5.8911 WITH 36 DEGREES OF FREEDOM IS 0

FACTOR 4

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	2.05882	3.71602
2	C	18	-1.16667	3.68223

THE POOLED DEVIATION IS 3.69865 AND THE STUDENTS T VALUE IS 2.57857 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.57857 WITH 33 DEGREES OF FREEDOM IS 7.28464E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-2.31579	4.74988
2	C	18	-1.16667	3.68223

THE POOLED DEVIATION IS 4.26482 AND THE STUDENTS T VALUE IS-.819177 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.819177 WITH 35 DEGREES OF FREEDOM IS .209114

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	4.21053	4.58959
2	C	18	-1.16667	3.68223

THE POOLED DEVIATION IS 4.17358 AND THE STUDENTS T VALUE IS 3.91705 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 3.91705 WITH 35 DEGREES OF FREEDOM IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	2.05882	3.71602
2	2	19	-2.31579	4.74988

THE POOLED DEVIATION IS 4.29448 AND THE STUDENTS T VALUE IS 3.05126 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 3.05126 WITH 34 DEGREES OF FREEDOM IS 2.19959E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	2.05882	3.71602
2	3	19	4.21053	4.58959

THE POOLED DEVIATION IS 4.20119 AND THE STUDENTS T VALUE IS-1.53412 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.53412 WITH 34 DEGREES OF FREEDOM IS .0671267

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-2.31579	4.74988
2	3	19	4.21053	4.58959

THE POOLED DEVIATION IS 4.67043 AND THE STUDENTS T VALUE IS-4.30699 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-4.30699 WITH 36 DEGREES OF FREEDOM IS 0

FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-.941177	4.27888
2	C	18	-1.27778	6.40593

THE POOLED DEVIATION IS 5.47875 AND THE STUDENTS T VALUE IS .181661 AT 33 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .181661 WITH 33 DEGREES OF FREEDOM IS .42848

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-1.42105	4.29878
2	C	18	-1.27778	6.40593

THE POOLED DEVIATION IS 5.42545 AND THE STUDENTS T VALUE IS-.0802872 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0802872 WITH 35 DEGREES OF FREEDOM IS .468233

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	19	4.05263	6.16868
2	C	18	-1.27778	6.40593

THE POOLED DEVIATION IS 6.28504 AND THE STUDENTS T VALUE IS 2.57849 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.57849 WITH 35 DEGREES OF FREEDOM IS 7.14412E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-.941177	4.27888
2	2	19	-1.42105	4.29878

THE POOLED DEVIATION IS 4.28943 AND THE STUDENTS T VALUE IS .335104 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .335104 WITH 34 DEGREES OF FREEDOM IS .369803

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	17	-.941177	4.27888
2	3	19	4.05263	6.16868

THE POOLED DEVIATION IS 5.36297 AND THE STUDENTS T VALUE IS-2.78918 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.78918 WITH 34 DEGREES OF FREEDOM IS 4.29755E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-1.42105	4.29878
2	3	19	4.05263	6.16868

THE POOLED DEVIATION IS 5.31659 AND THE STUDENTS T VALUE IS-3.17328 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-3.17328 WITH 36 DEGREES OF FREEDOM IS 1.54036E-03

TRIAL 1 - BOYS

ATTITUDE CHANGE

FACTOR 1

Sample	Treatment	Size	Mean	Standard Deviation
1	1	19	-3.52632	8.12656
2	C	18	-.111111	8.29521

Pooled Deviation is 8.32171 and the Students t value is -1.05543 at 35 df.

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.421053	8.72618
2	C	18	-.111111	8.29521

THE POOLED DEVIATION IS 8.51957 AND THE STUDENTS T VALUE IS .189906 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .189906 WITH 35 DEGREES OF FREEDOM IS .42524

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	18	6.16667	7.60225
2	C	18	-.111111	8.29521

THE POOLED DEVIATION IS 7.95627 AND THE STUDENTS T VALUE IS 2.3671 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.3671 WITH 34 DEGREES OF FREEDOM IS .011881

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-3.52632	8.12656
2	2	19	.421053	8.72618

THE POOLED DEVIATION IS 8.4317 AND THE STUDENTS T VALUE IS-1.44296 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.44296 WITH 36 DEGREES OF FREEDOM IS .0788386

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-3.52632	8.12656
2	3	18	6.16667	7.60225

THE POOLED DEVIATION IS 7.87625 AND THE STUDENTS T VALUE IS-3.74154 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-3.74154 WITH 35 DEGREES OF FREEDOM IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.421053	8.72618
2	3	18	6.16667	7.60225

THE POOLED DEVIATION IS 8.19953 AND THE STUDENTS T VALUE IS-2.13039 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.13039 WITH 35 DEGREES OF FREEDOM IS .0201215

FACTOR 2

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.894737	6.12731
2	C	18	-.722222	4.12746

THE POOLED DEVIATION IS 5.23741 AND THE STUDENTS T
VALUE IS-.164642 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.164642 WITH 35 DEGREES OF FREEDOM
IS .435087

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.736842	4.94236
2	C	18	-.722222	4.12746

THE POOLED DEVIATION IS 4.56476 AND THE STUDENTS T
VALUE IS .971782 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .971782 WITH 35 DEGREES OF FREEDOM
IS .168914

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	18	3.5	5.27201
2	C	18	-.722222	4.12746

THE POOLED DEVIATION IS 4.73445 AND THE STUDENTS T
VALUE IS 2.67542 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.67542 WITH 34 DEGREES OF FREEDOM
IS 5.69776E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.894737	6.12731
2	2	19	.736842	4.94236

THE POOLED DEVIATION IS 5.56645 AND THE STUDENTS T
VALUE IS-.903424 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.903424 WITH 36 DEGREES OF FREEDOM
IS .186153

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.894737	6.12731
2	3	18	3.5	5.27201

THE POOLED DEVIATION IS 5.72785 AND THE STUDENTS T
VALUE IS-2.33267 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.33267 WITH 35 DEGREES OF FREEDOM
IS .0127704

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.736842	4.94236
2	3	18	3.5	5.27201

THE POOLED DEVIATION IS 5.10514 AND THE STUDENTS T
VALUE IS-1.64555 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.64555 WITH 35 DEGREES OF FREEDOM
IS .0544044

FACTOR 3

Treatment

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	.684211	2.64686
2	C	18	0	3.4979

THE POOLED DEVIATION IS 3.08964 AND THE STUDENTS T
VALUE IS .673278 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .673278 WITH 35 DEGREES OF FREEDOM
IS .252596

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.894737	4.13514
2	C	18	0	3.4979

THE POOLED DEVIATION IS 3.83886 AND THE STUDENTS T
VALUE IS .708607 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .708607 WITH 35 DEGREES OF FREEDOM
IS .241631

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	18	-.0555556	2.33823
2	C	18	0	3.4979

THE POOLED DEVIATION IS 2.97512 AND THE STUDENTS T
VALUE IS-.0560203 AT 34 DEGREES OF FREEDOM

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	.684211	2.64686
2	2	19	.894737	4.13514

THE STUDENTS T VALUE IS-.186908 AT 32.0329 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.186908 WITH 32.0329 DEGREES OF FREEDOM
IS .42578

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	.684211	2.64686
2	3	18	-.0555556	2.33823

THE POOLED DEVIATION IS 2.50171 AND THE STUDENTS T
VALUE IS .89902 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .89902 WITH 35 DEGREES OF FREEDOM
IS .187393

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.894737	4.13514
2	3	18	-.0555556	2.33823

THE STUDENTS T VALUE IS .866157 AT 29.9476 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .866157 WITH 29.9476 DEGREES OF FREEDOM
IS 0

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.947368	4.6723
2	C	18	.833333	3.45134

THE POOLED DEVIATION IS 4.12465 AND THE STUDENTS T VALUE IS-1.31255 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.31255 WITH 35 DEGREES OF FREEDOM IS .0989383

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.526316	3.1157
2	C	18	.833333	3.45134

THE POOLED DEVIATION IS 3.28302 AND THE STUDENTS T VALUE IS-.284317 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.284317 WITH 35 DEGREES OF FREEDOM IS .388922

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	18	2.94444	3.90282
2	C	18	.833333	3.45134

THE POOLED DEVIATION IS 3.68401 AND THE STUDENTS T VALUE IS 1.71914 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.71914 WITH 34 DEGREES OF FREEDOM IS .047341

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.947368	4.6723
2	2	19	.526316	3.1157

THE STUDENTS T VALUE IS-1.14384 AT 32.8507 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.14384 WITH 32.8507 DEGREES OF FREEDOM IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.947368	4.6723
2	3	18	2.94444	3.90282

THE POOLED DEVIATION IS 4.31573 AND THE STUDENTS T VALUE IS-2.74164 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.74164 WITH 35 DEGREES OF FREEDOM IS 4.78241E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	.526316	3.1157
2	3	18	2.94444	3.90282

THE POOLED DEVIATION IS 3.52007 AND THE STUDENTS T VALUE IS-2.08853 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.08853 WITH 35 DEGREES OF FREEDOM IS .0220453

FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.578947	6.36235
2	C	18	-.888889	3.47916

THE STUDENTS T VALUE IS .185127 AT 29.3323 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .185127 WITH 29.3323 DEGREES OF FREEDOM
IS .348918

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-1.31579	5.2499
2	C	18	-.888889	3.47916

THE STUDENTS T VALUE IS-.292984 AT 32.9379 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.292984 WITH 32.9379 DEGREES OF FREEDOM
IS .332843

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	18	.166667	4.28747
2	C	18	-.888889	3.47916

THE POOLED DEVIATION IS 3.90429 AND THE STUDENTS T
VALUE IS .811074 AT 34 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .811074 WITH 34 DEGREES OF FREEDOM
IS .211482

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.578947	6.36235
2	2	19	-1.31579	5.2499

THE POOLED DEVIATION IS 5.83271 AND THE STUDENTS T
VALUE IS .389373 AT 36 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .389373 WITH 36 DEGREES OF FREEDOM
IS .349647

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	19	-.578947	6.36235
2	3	18	.166667	4.28747

THE POOLED DEVIATION IS 5.45405 AND THE STUDENTS T
VALUE IS-.415631 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.415631 WITH 35 DEGREES OF FREEDOM
IS .340109

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	19	-1.31579	5.2499
2	3	18	.166667	4.28747

THE POOLED DEVIATION IS 4.80656 AND THE STUDENTS T
VALUE IS-.937691 AT 35 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.937691 WITH 35 DEGREES OF FREEDOM
IS .177414

TRIAL 1 - BOYS

ACHIEVEMENT AND ATTITUDE

POSTTEST SCORES

	Mean	Standard Deviation
Factor 1	63.041	12.45
Achievement	20.081	6.564

Correlation coefficient = .36
% variance in Achievement scores explained by Factor 1 =12.9%

Factor 2	44.878	6.689
Achievement	20.081	6.564

Correlation coefficient = .3169
% variance in Achievement scores explained by Factor 2 = 10.04%

Factor 3	28.149	3.37
Achievement	20.081	6.564

Correlation coefficient = .37
% variance in achievement scores explained by Factor 3 = 13.61%

Factor 4	31.08	4.745
Achievement	20.081	6.564

Correlation coefficient = .343
% variance in Achievement scores explained by Factor 4 = 11.79%

Factor 5	29.62	6.59
Achievement	20.081	6.564

Correlation coefficient = .183
% variance in Achievement scores explained by Factor 5 = 3.36%

TRIAL 1 - GIRLS

ACHIEVEMENT AND ATTITUDE

POSTTEST SCORES

	Mean	Standard Deviation
Factor 1	51.78	12.185
Achievement	17.55	6.723

Correlation coefficient = .193
% variance in Achievement scores explained by Factor 1 = 3.73%

Factor 2	40.507	6.59
Achievement	17.55	6.723

Correlation coefficient = .027
% variance in Achievement scores explained by Factor 2 = .0739%

Factor 3	25.47	4.673
Achievement	17.55	6.723

Correlation coefficient = .194
% variance in Achievement scores explained by Factor 3 = 3.77%

Factor 4	30.11	6.59
Achievement	17.55	6.723

Correlation coefficient = .114
% variance in Achievement scores explained by Factor 4 = 1.3%

Factor 5	32.699	7.102
Achievement	17.55	6.723

Correlation coefficient = .11
% variance in Achievement scores explained by Factor 5 = 1.21%

TRIAL 2 - GIRLS

ACHIEVEMENT PRETEST

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SAMPLE Treatment  SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      1          10            13.6         4.83505
 2      C          9             13.1111      4.42844
THE POOLED DEVIATION IS 4.64814 AND THE STUDENTS T
VALUE IS .228916 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .228916 WITH 17 DEGREES OF FREEDOM
IS .410833
SAMPLE            SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      2          11            11.8182      3.21926
 2      C          9             13.1111      4.42844
THE POOLED DEVIATION IS 3.80442 AND THE STUDENTS T
VALUE IS-.756117 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.756117 WITH 18 DEGREES OF FREEDOM
IS .229681
SAMPLE            SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      3          9             13.8889      4.67558
 2      C          9             13.1111      4.42844
THE POOLED DEVIATION IS 4.55369 AND THE STUDENTS T
VALUE IS .362326 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .362326 WITH 16 DEGREES OF FREEDOM
IS .360925
SAMPLE            SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      1          10            13.6         4.83505
 2      2          11            11.8182      3.21926
THE POOLED DEVIATION IS 4.06549 AND THE STUDENTS T
VALUE IS 1.00308 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.00308 WITH 19 DEGREES OF FREEDOM
IS .164212
SAMPLE            SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      1          10            13.6         4.83505
 2      3          9             13.8889      4.67558
THE POOLED DEVIATION IS 4.76067 AND THE STUDENTS T
VALUE IS-.132071 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.132071 WITH 17 DEGREES OF FREEDOM
IS .448239
SAMPLE            SAMPLE SIZE   MEAN        STANDARD DEVIATION
 1      2          11            11.8182      3.21926
 2      3          9             13.8889      4.67558
THE POOLED DEVIATION IS 3.93365 AND THE STUDENTS T
VALUE IS-1.17119 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.17119 WITH 18 DEGREES OF FREEDOM
IS .128398
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TRIAL 2 - BOYS

ACHIEVEMENT PRETEST

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	15.1429	4.22013
2	C	9	14.1111	4.48454

THE POOLED DEVIATION IS 4.37318 AND THE STUDENTS T VALUE IS .468151 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .468151 WITH 14 DEGREES OF FREEDOM IS .323441

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	14.5714	5.91206
2	C	9	14.1111	4.48454

THE POOLED DEVIATION IS 5.14506 AND THE STUDENTS T VALUE IS .177532 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .177532 WITH 14 DEGREES OF FREEDOM IS .430817

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	13.875	4.76407
2	C	9	14.1111	4.48454

THE POOLED DEVIATION IS 4.6171 AND THE STUDENTS T VALUE IS-.105242 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.105242 WITH 15 DEGREES OF FREEDOM IS .458789

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	15.1429	4.22013
2	2	7	14.5714	5.91206

THE POOLED DEVIATION IS 5.13624 AND THE STUDENTS T VALUE IS .208138 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .208138 WITH 12 DEGREES OF FREEDOM IS .419306

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	15.1429	4.22013
2	3	8	13.875	4.76407

THE POOLED DEVIATION IS 4.52116 AND THE STUDENTS T VALUE IS .541837 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .541837 WITH 13 DEGREES OF FREEDOM IS .298548

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	14.5714	5.91206
2	3	8	13.875	4.76407

THE POOLED DEVIATION IS 5.32476 AND THE STUDENTS T VALUE IS .252712 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .252712 WITH 13 DEGREES OF FREEDOM IS .402222

PRETEST

ATTITUDE FACTOR 1

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	47.2	15.1643
2	C	9	56	13.3791

THE POOLED DEVIATION IS 14.3519 AND THE STUDENTS T
VALUE IS-1.3345 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.3345 WITH 17 DEGREES OF FREEDOM
IS .0998207

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	58.3636	13.8005
2	C	9	56	13.3791

THE POOLED DEVIATION IS 13.6149 AND THE STUDENTS T
VALUE IS .386251 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .386251 WITH 18 DEGREES OF FREEDOM
IS .351919

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	57.3333	13.0768
2	C	9	56	13.3791

THE POOLED DEVIATION IS 13.2289 AND THE STUDENTS T
VALUE IS .213807 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .213807 WITH 16 DEGREES OF FREEDOM
IS .416699

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	47.2	15.1643
2	2	11	58.3636	13.8005

THE POOLED DEVIATION IS 14.4626 AND THE STUDENTS T
VALUE IS-1.76663 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.76663 WITH 19 DEGREES OF FREEDOM
IS .0466752

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	47.2	15.1643
2	3	9	57.3333	13.0768

THE POOLED DEVIATION IS 14.2202 AND THE STUDENTS T
VALUE IS-1.55093 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.55093 WITH 17 DEGREES OF FREEDOM
IS .0696676

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	58.3636	13.8005
2	3	9	57.3333	13.0768

THE POOLED DEVIATION IS 13.4837 AND THE STUDENTS T
VALUE IS .170004 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .170004 WITH 18 DEGREES OF FREEDOM
IS .433452

ATTITUDE FACTOR 2

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	43.5	9.1924
2	C	9	42.6667	9.35409

THE POOLED DEVIATION IS 9.26884 AND THE STUDENTS T VALUE IS .195676 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .195676 WITH 17 DEGREES OF FREEDOM IS .423592

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	43.8182	7.31869
2	C	9	42.6667	9.35409

THE POOLED DEVIATION IS 8.28528 AND THE STUDENTS T VALUE IS .309218 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .309218 WITH 18 DEGREES OF FREEDOM IS .380353

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	43	4.74352
2	C	9	42.6667	9.35409

THE STUDENTS T VALUE IS .0953459 AT 12.8241 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0953459 WITH 12.8241 DEGREES OF FREEDOM IS .451249

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	43.5	9.1924
2	2	11	43.8182	7.31869

THE POOLED DEVIATION IS 8.2594 AND THE STUDENTS T VALUE IS-.0881681 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0881681 WITH 19 DEGREES OF FREEDOM IS .465333

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	43.5	9.1924
2	3	9	43	4.74352

THE STUDENTS T VALUE IS .151099 AT 14.8496 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .151099 WITH 14.8496 DEGREES OF FREEDOM IS .420894

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	43.8182	7.31869
2	3	9	43	4.74352

THE POOLED DEVIATION IS 6.30538 AND THE STUDENTS T VALUE IS .288696 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .288696 WITH 18 DEGREES OF FREEDOM IS .388056

PRETEST

ATTITUDE FACTOR 3

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	25.7	4.49812
2	C	9	27.4444	4.0346

THE POOLED DEVIATION IS 4.28625 AND THE STUDENTS T
VALUE IS-.885777 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.885777 WITH 17 DEGREES OF FREEDOM
IS .194048

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	28	3.97491
2	C	9	27.4444	4.0346

THE POOLED DEVIATION IS 4.00155 AND THE STUDENTS T
VALUE IS .308889 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .308889 WITH 18 DEGREES OF FREEDOM
IS .380477

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	25.2222	3.41971
2	C	9	27.4444	4.0346

THE POOLED DEVIATION IS 3.73981 AND THE STUDENTS T
VALUE IS-1.2605 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.2605 WITH 16 DEGREES OF FREEDOM
IS .112781

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	25.7	4.49812
2	2	11	28	3.97491

THE POOLED DEVIATION IS 4.23082 AND THE STUDENTS T
VALUE IS-1.2442 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.2442 WITH 19 DEGREES OF FREEDOM
IS .114279

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	25.7	4.49812
2	3	9	25.2222	3.41971

THE POOLED DEVIATION IS 4.02677 AND THE STUDENTS T
VALUE IS .258235 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .258235 WITH 17 DEGREES OF FREEDOM
IS .399663

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	28	3.97491
2	3	9	25.2222	3.41971

THE POOLED DEVIATION IS 3.73835 AND THE STUDENTS T
VALUE IS 1.65318 AT 18 DEGREES OF FREEDOM

PRETEST

ATTITUDE FACTOR 4

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	27.2	6.92503
2	C	9	27.5556	5.41093

THE POOLED DEVIATION IS 6.25832 AND THE STUDENTS T
VALUE IS-.12365 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.12365 WITH 17 DEGREES OF FREEDOM
IS .451521

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	29.6364	4.47823
2	C	9	27.5556	5.41093

THE POOLED DEVIATION IS 4.91466 AND THE STUDENTS T
VALUE IS .941978 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .941978 WITH 18 DEGREES OF FREEDOM
IS .179338

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	29	5.26779
2	C	9	27.5556	5.41093

THE POOLED DEVIATION IS 5.33984 AND THE STUDENTS T
VALUE IS .573824 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .573824 WITH 16 DEGREES OF FREEDOM
IS .287033

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	27.2	6.92503
2	2	11	29.6364	4.47823

THE POOLED DEVIATION IS 5.76811 AND THE STUDENTS T
VALUE IS-.966708 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.966708 WITH 19 DEGREES OF FREEDOM
IS .172917

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	27.2	6.92503
2	3	9	29	5.26779

THE POOLED DEVIATION IS 6.20058 AND THE STUDENTS T
VALUE IS-.631808 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.631808 WITH 17 DEGREES OF FREEDOM
IS .267959

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	29.6364	4.47823
2	3	9	29	5.26779

THE POOLED DEVIATION IS 4.84505 AND THE STUDENTS T
VALUE IS .29222 AT 18 DEGREES OF FREEDOM

PRETEST

ATTITUDE FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	29.5	12.9379
2	C	9	32.6667	7.49997

THE POOLED DEVIATION IS 10.7279 AND THE STUDENTS T
VALUE IS-.642438 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.642438 WITH 17 DEGREES OF FREEDOM
IS .264579

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	34.4545	9.66811
2	C	9	32.6667	7.49997

THE POOLED DEVIATION IS 8.77091 AND THE STUDENTS T
VALUE IS .453519 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .453519 WITH 18 DEGREES OF FREEDOM
IS .327798

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	31.2222	10.1462
2	C	9	32.6667	7.49997

THE POOLED DEVIATION IS 8.92173 AND THE STUDENTS T
VALUE IS-.343446 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.343446 WITH 16 DEGREES OF FREEDOM
IS .367867

IS .38673

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	29.5	12.9379
2	2	11	34.4545	9.66811

THE POOLED DEVIATION IS 11.3352 AND THE STUDENTS T
VALUE IS-1.00038 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.00038 WITH 19 DEGREES OF FREEDOM
IS .16485

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	29.5	12.9379
2	3	9	31.2222	10.1462

THE POOLED DEVIATION IS 11.7074 AND THE STUDENTS T
VALUE IS-.320165 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.320165 WITH 17 DEGREES OF FREEDOM
IS .376372

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	34.4545	9.66811
2	3	9	31.2222	10.1462

THE POOLED DEVIATION IS 9.88344 AND THE STUDENTS T
VALUE IS .727628 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .727628 WITH 18 DEGREES OF FREEDOM
IS .2381

TRIAL 2 - BOYS

PRETEST

ATTITUDE FACTOR 1

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	66.4286	10.9979
2	C	9	65.1111	10.3011

THE POOLED DEVIATION IS 10.6053 AND THE STUDENTS T VALUE IS .246504 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .246504 WITH 14 DEGREES OF FREEDOM IS .404435

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	62.2857	15.1625
2	c	9	65.1111	10.3011

THE POOLED DEVIATION IS 12.6161 AND THE STUDENTS T VALUE IS-.444392 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.444392 WITH 14 DEGREES OF FREEDOM IS .331776

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	63.375	15.2497
2	C	9	65.1111	10.3011

THE POOLED DEVIATION IS 12.8499 AND THE STUDENTS T VALUE IS-.278049 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.278049 WITH 15 DEGREES OF FREEDOM IS .392385

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	66.4286	10.9979
2	2	7	62.2857	15.1625

THE POOLED DEVIATION IS 13.2449 AND THE STUDENTS T VALUE IS .585174 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .585174 WITH 12 DEGREES OF FREEDOM IS .284636

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	66.4286	10.9979
2	3	8	63.375	15.2497

THE POOLED DEVIATION IS 13.4553 AND THE STUDENTS T VALUE IS .438493 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .438493 WITH 13 DEGREES OF FREEDOM IS .334114

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	62.2857	15.1625
2	3	8	63.375	15.2497

THE POOLED DEVIATION IS 15.2095 AND THE STUDENTS T VALUE IS-.13838 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.13838 WITH 13 DEGREES OF FREEDOM IS .44603

PRETEST
ATTITUDE FACTOR 2

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	47.8571	5.63988
2	C	9	46.2222	7.6286

THE POOLED DEVIATION IS 6.84739 AND THE STUDENTS T
VALUE IS .473786 AT 14 DEGREES OF FREEDOM

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	42.8571	7.64692
2	C	9	46.2222	7.6286

THE POOLED DEVIATION IS 7.63646 AND THE STUDENTS T
VALUE IS-.874406 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.874406 WITH 14 DEGREES OF FREEDOM
IS .198325

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	47.5	9.81253
2	C	9	46.2222	7.6286

THE POOLED DEVIATION IS 8.71613 AND THE STUDENTS T
VALUE IS .301699 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .301699 WITH 15 DEGREES OF FREEDOM
IS .383512

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	47.8571	5.63988
2	2	7	42.8571	7.64692

THE POOLED DEVIATION IS 6.71877 AND THE STUDENTS T
VALUE IS 1.39224 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.39224 WITH 12 DEGREES OF FREEDOM
IS .0945563

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	47.8571	5.63988
2	3	8	47.5	9.81253

THE POOLED DEVIATION IS 8.1564 AND THE STUDENTS T
VALUE IS .0846043 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0846043 WITH 13 DEGREES OF FREEDOM
IS .466933

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	42.8571	7.64692
2	3	8	47.5	9.81253

THE POOLED DEVIATION IS 8.87889 AND THE STUDENTS T
VALUE IS-1.01036 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.01036 WITH 13 DEGREES OF FREEDOM
IS .16538

PRETEST
ATTITUDE FACTOR 3

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	30.2857	3.54559
2	C	9	29	3.12242

THE POOLED DEVIATION IS 3.31041 AND THE STUDENTS T VALUE IS .770679 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .770679 WITH 14 DEGREES OF FREEDOM IS .226854

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	27.2857	1.97605
2	C	9	29	3.12242

THE POOLED DEVIATION IS 2.69158 AND THE STUDENTS T VALUE IS-1.26382 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.26382 WITH 14 DEGREES OF FREEDOM IS .113467

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	28.25	3.45378
2	C	9	29	3.12242

THE POOLED DEVIATION IS 3.28122 AND THE STUDENTS T VALUE IS-.4704 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.4704 WITH 15 DEGREES OF FREEDOM IS .322418

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	30.2857	3.54559
2	2	7	27.2857	1.97605

THE POOLED DEVIATION IS 2.87019 AND THE STUDENTS T VALUE IS 1.95544 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.95544 WITH 12 DEGREES OF FREEDOM IS .0371103

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	30.2857	3.54559
2	3	8	28.25	3.45378

THE POOLED DEVIATION IS 3.49645 AND THE STUDENTS T VALUE IS 1.12496 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.12496 WITH 13 DEGREES OF FREEDOM IS .140473

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	27.2857	1.97605
2	3	8	28.25	3.45378

THE POOLED DEVIATION IS 2.86798 AND THE STUDENTS T VALUE IS-.649648 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.649648 WITH 13 DEGREES OF FREEDOM IS .263616

PRETEST
ATTITUDE FACTOR 4

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	29.7143	4.23137
2	C	9	28.7778	3.63238

THE POOLED DEVIATION IS 3.90037 AND THE STUDENTS T
VALUE IS .476448 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .476448 WITH 14 DEGREES OF FREEDOM
IS .320553

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	29.5714	4.11731
2	C	9	28.7778	3.63238

THE POOLED DEVIATION IS 3.8477 AND THE STUDENTS T
VALUE IS .409296 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .409296 WITH 14 DEGREES OF FREEDOM
IS .344258

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	29.125	5.22192
2	C	9	28.7778	3.63238

THE POOLED DEVIATION IS 4.44547 AND THE STUDENTS T
VALUE IS .160743 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .160743 WITH 15 DEGREES OF FREEDOM
IS .437221

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	29.7143	4.23137
2	2	7	29.5714	4.11731

THE POOLED DEVIATION IS 4.17473 AND THE STUDENTS T
VALUE IS .0640186 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0640186 WITH 12 DEGREES OF FREEDOM
IS .475005

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	29.7143	4.23137
2	3	8	29.125	5.22192

THE POOLED DEVIATION IS 4.79026 AND THE STUDENTS T
VALUE IS .237692 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .237692 WITH 13 DEGREES OF FREEDOM
IS .407912

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	29.5714	4.11731
2	3	8	29.125	5.22192

THE POOLED DEVIATION IS 4.74416 AND THE STUDENTS T
VALUE IS .181819 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .181819 WITH 13 DEGREES OF FREEDOM
IS .429264

PRETEST
ATTITUDE FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	31.1429	3.89153
2	C	9	29.2222	4.23617

THE POOLED DEVIATION IS 4.09202 AND THE STUDENTS T VALUE IS .931359 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .931359 WITH 14 DEGREES OF FREEDOM IS .183726

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	28.2857	6.42167
2	C	9	29.2222	4.23617

THE POOLED DEVIATION IS 5.28467 AND THE STUDENTS T VALUE IS-.351644 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.351644 WITH 14 DEGREES OF FREEDOM IS .365171

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	32.125	4.22361
2	C	9	29.2222	4.23617

THE POOLED DEVIATION IS 4.23031 AND THE STUDENTS T VALUE IS 1.41216 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.41216 WITH 15 DEGREES OF FREEDOM IS .0891562

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	31.1429	3.89153
2	2	7	28.2857	6.42167

THE POOLED DEVIATION IS 5.30951 AND THE STUDENTS T VALUE IS 1.00673 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.00673 WITH 12 DEGREES OF FREEDOM IS .166968

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	31.1429	3.89153
2	3	8	32.125	4.22361

THE POOLED DEVIATION IS 4.07371 AND THE STUDENTS T VALUE IS-.465837 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.465837 WITH 13 DEGREES OF FREEDOM IS .324521

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	28.2857	6.42167
2	3	8	32.125	4.22361

THE POOLED DEVIATION IS 5.35148 AND THE STUDENTS T VALUE IS-1.3862 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.3862 WITH 13 DEGREES OF FREEDOM IS .0945017

TRIAL 2 - SEX DIFFERENCES

ACHIEVEMENT PRETEST

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Girls	39	13.0513	4.20494
2	Boys	31	14.3871	4.63091

THE POOLED DEVIATION IS 4.39795 AND THE STUDENTS T
VALUE IS-1.26229 AT 68 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.26229 WITH 68 DEGREES OF FREEDOM
IS .105578

ATTITUDE PRETEST

Factor

1

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Girls	39	54.718	14.1067
2	Boys	31	64.3226	12.4563

THE POOLED DEVIATION IS 13.4036 AND THE STUDENTS T
VALUE IS-2.97798 AT 68 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.97798 WITH 68 DEGREES OF FREEDOM
IS 2.00927E-03

2

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Girls	39	43.2821	7.58101
2	Boys	31	46.1613	7.72914

THE POOLED DEVIATION IS 7.64671 AND THE STUDENTS T
VALUE IS-1.56483 AT 68 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.56483 WITH 68 DEGREES OF FREEDOM
IS .0611326

3

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Boys	31	28.7097	3.1325
2	Girls	39	26.641	4.02943

THE POOLED DEVIATION IS 3.66091 AND THE STUDENTS T
VALUE IS 2.34835 AT 68 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 2.34835 WITH 68 DEGREES OF FREEDOM
IS .010886

4

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Girls	39	28.3846	5.45133
2	Boys	31	29.4516	4.00703

THE POOLED DEVIATION IS 4.86726 AND THE STUDENTS T
VALUE IS-.911052 AT 68 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.911052 WITH 68 DEGREES OF FREEDOM
IS .182743

5

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	Girls	39	32.0256	10.0694
2	Boys	31	30.1936	4.74982

THE STUDENTS T VALUE IS 1.00434 AT 57.6828 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.00434 WITH 57.6828 DEGREES OF FREEDOM
IS 0

ACHIEVEMENT GAINS

Sample	Treatment	Size	Mean	Standard Deviation
1	1	10	.3476	.158213
2	2	11	.259727	.121984

THE POOLED DEVIATION IS .140316 AND THE STUDENTS T VALUE IS 1.43329 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.43329 WITH 19 DEGREES OF FREEDOM IS .084013

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	.3476	.158213
2	3	9	.472889	.072173

THE POOLED DEVIATION IS .125312 AND THE STUDENTS T VALUE IS-2.17602 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.17602 WITH 17 DEGREES OF FREEDOM IS .0219727

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	.3476	.158213
2	C	9	.292667	.159689

THE POOLED DEVIATION IS .158909 AND THE STUDENTS T VALUE IS .75237 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .75237 WITH 17 DEGREES OF FREEDOM IS .23106

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	.259727	.121984
2	3	9	.472889	.072173

THE POOLED DEVIATION IS .102868 AND THE STUDENTS T VALUE IS-4.61034 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-4.61034 WITH 18 DEGREES OF FREEDOM IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	.259727	.121984
2	C	9	.292667	.159689

THE POOLED DEVIATION IS .140001 AND THE STUDENTS T VALUE IS-.523465 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.523465 WITH 18 DEGREES OF FREEDOM IS .303518

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	.472889	.072173
2	C	9	.292667	.159689

THE POOLED DEVIATION IS .123914 AND THE STUDENTS T VALUE IS 3.08527 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 3.08527 WITH 16 DEGREES OF FREEDOM IS 3.54767E-03

TRIAL 2 - GIRLS

ATTITUDE CHANGE

FACTOR 1

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.6	10.4584
2	C	9	-.333333	3.60555

THE STUDENTS T VALUE IS-.0757826 AT 11.8318 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0757826 WITH 11.8318 DEGREES OF FREEDOM
IS .319416

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-4.54545	3.32757
2	C	9	-.333333	3.60555

THE POOLED DEVIATION IS 3.45388 AND THE STUDENTS T
VALUE IS-2.71329 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.71329 WITH 18 DEGREES OF FREEDOM
IS 7.12192E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	2.22222	5.38
2	C	9	-.333333	3.60555

THE POOLED DEVIATION IS 4.57954 AND THE STUDENTS T
VALUE IS 1.18378 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.18378 WITH 16 DEGREES OF FREEDOM
IS .126896

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.6	10.4584
2	2	11	-4.54545	3.32757

THE STUDENTS T VALUE IS 1.1416 AT 11.0168 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.1416 WITH 11.0168 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.6	10.4584
2	3	9	2.22222	5.38

THE STUDENTS T VALUE IS-.750161 AT 14.8201 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.750161 WITH 14.8201 DEGREES OF FREEDOM
IS .147789

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-4.54545	3.32757
2	3	9	2.22222	5.38

THE POOLED DEVIATION IS 4.3607 AND THE STUDENTS T
VALUE IS-3.45291 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-3.45291 WITH 18 DEGREES OF FREEDOM
IS 1.41916E-03

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	.5	7.0119
2	C	9	-.666667	2.82843

THE STUDENTS T VALUE IS .4842 AT 12.8047 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .4842 WITH 12.8047 DEGREES OF FREEDOM
IS .264515

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.90909	2.70017
2	C	9	-.666667	2.82843

THE POOLED DEVIATION IS 2.75791 AND THE STUDENTS T
VALUE IS-1.00229 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.00229 WITH 18 DEGREES OF FREEDOM
IS .164745

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	2.22222	4.81606
2	C	9	-.666667	2.82843

THE POOLED DEVIATION IS 3.94933 AND THE STUDENTS T
VALUE IS 1.55172 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO 1.55172 WITH 16 DEGREES OF FREEDOM
IS .0701414

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-3.3	6.11101
2	2	11	-1.90909	2.70017

THE STUDENTS T VALUE IS-.663297 AT 12.8232 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.663297 WITH 12.8232 DEGREES OF FREEDOM
IS .186004

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-3.3	6.11101
2	3	9	2.22222	4.81606

THE STUDENTS T VALUE IS-2.16966 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.16966 WITH 17 DEGREES OF FREEDOM
IS .0222484

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.90909	2.70017
2	3	9	2.22222	4.81606

THE STUDENTS T VALUE IS-2.29518 AT 12.9795 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.29518 WITH 12.9795 DEGREES OF FREEDOM
IS 0

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.4	4.00555
2	C	9	-.222222	5.04425

THE POOLED DEVIATION IS 4.52415 AND THE STUDENTS T
VALUE IS-.0855233 AT 17 DEGREES OF FREEDOM

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	1	4.3589
2	C	9	-.222222	5.04425

THE POOLED DEVIATION IS 4.67592 AND THE STUDENTS T
VALUE IS .581549 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .581549 WITH 18 DEGREES OF FREEDOM
IS .284042

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	.333333	3.08221
2	C	9	-.222222	5.04425

THE POOLED DEVIATION IS 4.17998 AND THE STUDENTS T
VALUE IS .281942 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .281942 WITH 16 DEGREES OF FREEDOM
IS .390801

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SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.4	4.00555
2	2	11	1	4.3589

THE POOLED DEVIATION IS 4.19524 AND THE STUDENTS T
VALUE IS-.763763 AT 19 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.763763 WITH 19 DEGREES OF FREEDOM
IS .227195

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.4	4.00555
2	3	9	.333333	3.08221

THE POOLED DEVIATION IS 3.60065 AND THE STUDENTS T
VALUE IS-.443266 AT 17 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.443266 WITH 17 DEGREES OF FREEDOM
IS .331581

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	1	4.3589
2	3	9	.333333	3.08221

THE POOLED DEVIATION IS 3.84419 AND THE STUDENTS T
VALUE IS .38584 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .38584 WITH 18 DEGREES OF FREEDOM
IS .352069

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.5	7.67753
2	C	9	.888889	5.03598

THE STUDENTS T VALUE IS-.470544 AT 17.2036 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.470544 WITH 17.2036 DEGREES OF FREEDOM
IS .177337

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.54545	2.94495
2	C	9	.888889	5.03598

THE STUDENTS T VALUE IS-1.35023 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.35023 WITH 18 DEGREES OF FREEDOM
IS .0968376

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	-.111111	2.848
2	C	9	.888889	5.03598

THE STUDENTS T VALUE IS-.518536 AT 13.8029 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.518536 WITH 13.8029 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.5	7.67753
2	2	11	-1.54545	2.94495

THE STUDENTS T VALUE IS .404412 AT 11.9113 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .404412 WITH 11.9113 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	-.5	7.67753
2	3	9	-.444445	2.45515

THE STUDENTS T VALUE IS-.0216839 AT 11.4507 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0216839 WITH 11.4507 DEGREES OF FREEDOM
IS .480241

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.54545	2.94495
2	3	9	-.444445	2.45515

THE POOLED DEVIATION IS 2.7381 AND THE STUDENTS T
VALUE IS-.894632 AT 18 DEGREES OF FREEDOM

FACTOR 5

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	0	10.0111
2	C	9	.555556	3.43188

THE STUDENTS T VALUE IS-.165043 AT 11.8013 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.165043 WITH 11.8013 DEGREES OF FREEDOM
IS .16194

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.63636	3.69521
2	C	9	.555556	3.43188

THE POOLED DEVIATION IS 3.58056 AND THE STUDENTS T
VALUE IS-1.362 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.362 WITH 18 DEGREES OF FREEDOM
IS .0950011

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	9	-.888889	6.13279
2	C	9	.555556	3.43188

THE POOLED DEVIATION IS 4.96935 AND THE STUDENTS T
VALUE IS-.616606 AT 16 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.616606 WITH 16 DEGREES OF FREEDOM
IS .273085

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	0	10.0111
2	2	11	-1.63636	3.69521

THE STUDENTS T VALUE IS .487576 AT 11.7009 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .487576 WITH 11.7009 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	10	0	10.0111
2	3	9	-.888889	6.13279

THE STUDENTS T VALUE IS .235876 AT 16.5401 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .235876 WITH 16.5401 DEGREES OF FREEDOM
IS .391931

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	11	-1.63636	3.69521
2	3	9	-.888889	6.13279

THE POOLED DEVIATION IS 4.9297 AND THE STUDENTS T
VALUE IS-.337349 AT 18 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.337349 WITH 18 DEGREES OF FREEDOM
IS .369878

TRIAL 2 - BOYS

ATTITUDE CHANGE

Treatment FACTOR 1

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SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          1         7           -.571429          5.82687
 2          C         9           -.444445          3.97213
THE POOLED DEVIATION IS 4.85457 AND THE STUDENTS T
VALUE IS-.0519049 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.0519049 WITH 14 DEGREES OF FREEDOM
IS .479669
SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          2         7           -2.71429          2.75162
 2          C         9           -.444445          3.97213
THE POOLED DEVIATION IS 3.50154 AND THE STUDENTS T
VALUE IS-1.28631 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.28631 WITH 14 DEGREES OF FREEDOM
IS .1096
SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          3         8           -1.875            6.68554
 2          C         9           -.444445          3.97213
THE POOLED DEVIATION IS 5.41047 AND THE STUDENTS T
VALUE IS-.544141 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.544141 WITH 15 DEGREES OF FREEDOM
IS .29717
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SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          1         7           -.571429          5.82687
 2          2         7           -2.71429          2.75162
THE STUDENTS T VALUE IS .87982 AT 9.39899 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .87982 WITH 9.39899 DEGREES OF FREEDOM
IS 0
SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          1         7           -.571429          5.82687
 2          3         8           -1.875            6.68554
THE POOLED DEVIATION IS 6.30378 AND THE STUDENTS T
VALUE IS .39956 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .39956 WITH 13 DEGREES OF FREEDOM
IS .347984
SAMPLE              SAMPLE SIZE   MEAN            STANDARD DEVIATION
 1          2         7           -2.71429          2.75162
 2          3         8           -1.875            6.68554
THE STUDENTS T VALUE IS-.325005 AT 10.3033 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.325005 WITH 10.3033 DEGREES OF FREEDOM
IS .3668
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FACTOR 2

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-6.85714	6.61888
2	C	9	-.333333	3.57071

THE POOLED DEVIATION IS 5.10502 AND THE STUDENTS T
VALUE IS-2.53579 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.53579 WITH 14 DEGREES OF FREEDOM
IS .0118814

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-4.42857	2.50713
2	C	9	-.333333	3.57071

THE POOLED DEVIATION IS 3.15905 AND THE STUDENTS T
VALUE IS-2.57237 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.57237 WITH 14 DEGREES OF FREEDOM
IS .0110676

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	-2.125	8.70858
2	C	9	-.333333	3.57071

THE STUDENTS T VALUE IS-.542765 AT 9.6566 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.542765 WITH 9.6566 DEGREES OF FREEDOM
IS 0

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-6.85714	6.61888
2	2	7	-4.42857	2.50713

THE STUDENTS T VALUE IS-.907824 AT 8.24935 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.907824 WITH 8.24935 DEGREES OF FREEDOM
IS .179681

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-6.85714	6.61888
2	3	8	-2.125	8.70858

THE POOLED DEVIATION IS 7.81396 AND THE STUDENTS T
VALUE IS-1.17015 AT 13 DEGREES OF FREEDOM

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-4.42857	2.50713
2	3	8	-2.125	8.70858

THE STUDENTS T VALUE IS-.715068 AT 8.67797 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.715068 WITH 8.67797 DEGREES OF FREEDOM
IS .199543

ATTITUDE CHANGE

FACTOR 3

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.57143	3.10146
2	C	9	-.111111	2.61937

THE POOLED DEVIATION IS 2.83603 AND THE STUDENTS T VALUE IS-1.72143 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.72143 WITH 14 DEGREES OF FREEDOM IS .0535919

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-3.28571	1.60357
2	C	9	-.111111	2.61937

THE POOLED DEVIATION IS 2.24113 AND THE STUDENTS T VALUE IS-2.81081 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.81081 WITH 14 DEGREES OF FREEDOM IS 6.94081E-03

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	-2.375	2.92465
2	C	9	-.111111	2.61937

THE POOLED DEVIATION IS 2.76603 AND THE STUDENTS T VALUE IS-1.68438 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.68438 WITH 15 DEGREES OF FREEDOM IS .0563978

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.57143	3.10146
2	2	7	-3.28571	1.60357

THE POOLED DEVIATION IS 2.46885 AND THE STUDENTS T VALUE IS .541266 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .541266 WITH 12 DEGREES OF FREEDOM IS .299115

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.57143	3.10146
2	3	8	-2.375	2.92465

THE POOLED DEVIATION IS 3.00755 AND THE STUDENTS T VALUE IS-.126195 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.126195 WITH 13 DEGREES OF FREEDOM IS .450754

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-3.28571	1.60357
2	3	8	-2.375	2.92465

THE POOLED DEVIATION IS 2.40678 AND THE STUDENTS T VALUE IS-.73113 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.73113 WITH 13 DEGREES OF FREEDOM

FACTOR 4

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.42857	2.43975
2	C	9	.444445	3.2059

THE POOLED DEVIATION IS 2.90242 AND THE STUDENTS T
VALUE IS-1.96421 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.96421 WITH 14 DEGREES OF FREEDOM
IS .0348382

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	0	1.41421
2	C	9	.444445	3.2059

THE STUDENTS T VALUE IS-.371964 AT 12.4956 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.371964 WITH 12.4956 DEGREES OF FREEDOM
IS .357482

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	-.5	3.96413
2	C	9	.444445	3.2059

THE STUDENTS T VALUE IS-.535868 AT 15.2571 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.535868 WITH 15.2571 DEGREES OF FREEDOM
IS .121664

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.42857	2.43975
2	2	7	0	1.41421

THE POOLED DEVIATION IS 1.99404 AND THE STUDENTS T
VALUE IS-2.27851 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-2.27851 WITH 12 DEGREES OF FREEDOM
IS .0208953

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-2.42857	2.43975
2	3	8	-.5	3.96413

THE POOLED DEVIATION IS 3.34795 AND THE STUDENTS T
VALUE IS-1.11302 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.11302 WITH 13 DEGREES OF FREEDOM
IS .142928

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	0	1.41421
2	3	8	-.5	3.96413

THE STUDENTS T VALUE IS .333333 AT 9.53407 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .333333 WITH 9.53407 DEGREES OF FREEDOM
IS .171373

<u>ATTITUDE CHANGE</u>

<u>FACTOR 5</u>

SAMPLE	Treatment	SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-1.57143	2.37045
2	C	9	.111111	2.47207

THE POOLED DEVIATION IS 2.42904 AND THE STUDENTS T
VALUE IS-1.37449 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.37449 WITH 14 DEGREES OF FREEDOM
IS .0954465

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-1.28571	3.09377
2	C	9	.111111	2.47207

THE POOLED DEVIATION IS 2.75574 AND THE STUDENTS T
VALUE IS-1.00581 AT 14 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-1.00581 WITH 14 DEGREES OF FREEDOM
IS .165789

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	3	8	-1.25	4.16619
2	C	9	111111	2.47207

THE POOLED DEVIATION IS 3.37035 AND THE STUDENTS T
VALUE IS-.831114 AT 15 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.831114 WITH 15 DEGREES OF FREEDOM
IS .209471

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-1.57143	2.37045
2	2	7	-1.28571	3.09377

THE POOLED DEVIATION IS 2.75595 AND THE STUDENTS T
VALUE IS-.193952 AT 12 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.193952 WITH 12 DEGREES OF FREEDOM
IS .424729

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	1	7	-1.57143	2.37045
2	3	8	-1.25	4.16619

THE POOLED DEVIATION IS 3.45537 AND THE STUDENTS T
VALUE IS-.179737 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO-.179737 WITH 13 DEGREES OF FREEDOM
IS .430065

SAMPLE		SAMPLE SIZE	MEAN	STANDARD DEVIATION
1	2	7	-1.28571	3.09377
2	3	8	-1.25	4.16619

THE POOLED DEVIATION IS 3.67218 AND THE STUDENTS T
VALUE IS .0469793 AT 13 DEGREES OF FREEDOM
PROBABILITY OF T>=TO .0469793 WITH 13 DEGREES OF FREEDOM
IS .481622

TRIAL 2 - BOYS

ACHIEVEMENT AND ATTITUDE

POSTTEST SCORES

	Mean	Standard Deviation
Factor 1	62.97	10.99
Achievement	22.55	5.334

Correlation coefficient = .11

% variance in Achievememt scores explained by Factor 1 = 1.2%

Factor 2	42.97	6.40
Achievement	22.55	5.334

Correlation coefficient = .073

% variance in Achievement scores explained by Factor 2 = .53%

Factor 3	26.747	3.151
Achievement	22.55	5.334

Correlation coefficient = .146

% variance in Achievement scores explained by Factor 3 = 2.12%

Factor 4	28.62	3.34
Achievement	22.55	5.334

Correlation coefficient = .00295

% variance in Achievement scores explained by Factor 4 = .00087%

Factor 5	29.25	4.05
Achievement	22.55	5.334

Correlation coefficient = .018

% variance in Achievement scores explained by Factor 5 = .032%

TRIAL 2 - GIRLS

ACHIEVEMENT AND ATTITUDE

POSTTEST SCORES

	Mean	Standard Deviation
Factor 1	53.744	13.74
Achievement	21.872	4.819

Correlation coefficient = .2

% variance in Achievement scores explained by Factor 1 = 3.99%

Factor 2	42.26	8.217
Achievement	21.872	4.819

Correlation coefficient = .333

% variance in Achievement scores explained by Factor 2 = 11.1%

Factor 3	26.85	3.54
Achievement	21.872	4.819

Correlation coefficient = .171

% variance in Achievement scores explained by Factor 3 = 2.915%

Factor 4	27.82	3.81
Achievement	21.872	4.819

Correlation coefficient = .118

% variance in Achievement scores explained by Factor 4 = 1.38%

Factor 5	31.462	9.231
Achievement	21.872	4.819

Correlation coefficient = .295

% variance in Achievement scores explained by Factor 5 = 8.69%

TEACHER WRITTEN COMMENTS AND PUPIL PERFORMANCE - PRELIMINARY FINDINGS

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Each year, teachers spend hours writing comments on children's work with the justification that these comments will produce some change in behaviour which in turn will lead to an increase in achievement. To save time, some teachers dispense with comments leaving only marks or grades, often with the stated justification that children take no notice of the comments.

The process of marking and commenting on work is rooted in the "Knowledge of Results" field of Educational Psychology, which proposes that the learner requires to perceive his degree of success, and requires knowledge of where he has succeeded and where he has failed, if he is to make progress. This may be given the term 'reinforcement' by some authorities, 'feedback' by others. Indeed there has been argument as to whether these terms and others (e.g. 'information feedback') are

(i) distinct concepts; or
(ii) they are related in varying degrees to each other; or
(iii) whether they are just different terms for essentially the same process

It is not intended to develop the arguments here but just to point out that they all have certain empirical properties.

(i) They strengthen responses
(ii) They sustain performance
(iii) They can lead to the elimination of previously established responses.

This article will refer mainly to the term 'Knowledge of Results' (K of R) and its effects on academic performance.

It has long been agreed that by providing knowledge of results of someone's performance, subsequent performance on tasks can be improved. (Spitzer 1939; Plowman and Stroud 1942; Berglund 1969). There is disagreement, however, as to when K of R, should be given. Weitzman and McNamara (1949) and Paige (1966) favouring immediate K of R, and Sassenrath and Yonge (1968) showing that a short delay (up to two days) had no effect on subsequent performance. In the normal teaching situation with normal pressures on teaching staff it is not usually possible, nor practical to return work, or tests, to pupils immediately; a delay of a few days being common.

It is generally agreed that giving a pupil K of R causes an increase in motivation, with a subsequent rise in academic performance on that particular subject. This K of R may be given in several ways, e.g. by a satisfying score "out of 10"; as a percentage; by grades "A B C D E"; by "Pass" or "Fail", etc. Stephens (1965) suggests that these by themselves may elicit motivation without any need for comments as accompaniment. It is, however, K of R in the form of comments on children's work which has been put forward by researchers to be a more major motivating source. A comment containing praise is said to produce increase motivation whereas a comment which "blames" decreases motivation (Kennedy and Willcut, 1964).

It may therefore be hypothesised that pupils who consistently receive K of R as praising or encouraging comments would show increased motivation and perform better on achievement tests.

Knowledge of Results and Attitudes

Within the last fifteen years or so there has been concern felt at school and ministerial level on the so-called "Swing from Science". The Dainton Committee (1968) identified the growth of arts students and the decline of science students, in the sixth form.

It has been suggested that choice of subject is influenced by pupil attitude towards that subject (Butcher 1969). If this is the case then any strategy to change pupil's attitudes more positively towards science may eventually produce more scientists.

It is generally accepted, judging from surveys in the field of attitude formation and change, that attitudes are not innate but are learned (Evans 1965; Halloran 1967). If this is so then learning theory may be applied to them. Halloran (1967) concentrates on the theory that an individual possesses 'needs' which require to be satisfied. If satisfaction occurs then the attitude towards that 'need', already possessed may be intensified. Lunzer (1968) makes mention that once this 'need' is satisfied then the individual may be motivated to receive further reward (to satisfy another perceived 'need') by achieving more.

The strategy employed here is that by giving pupils, what may be perceived as "positive reinforcement" in the form of praising comments then one of many pupil 'needs' may be satisfied. If this is so, then attitudes towards the subject would be intensified and this should then lead to a significantly more favourable attitude to science. In its turn, this improved attitude (as Barker Lunn 1969 and Aiken and Aiken 1969 suggest) should produce greater achievement levels in the subject. If a pupil then perceives himself as doing well another 'need' may be satisfied and produce further attitude intensification, etc.

Relevant Research

The major study concerning the effects that teachers' written comments have on pupil learning was by E.B. Page in 1958 using a large sample (N = 2,139). Various U.S. researches have partly replicated Page's study but no British research to date has been reported. Page's research techniques and conclusions have been used by British researchers to support theories concerning the way pupils learn in the classroom. (Barker 1970; Rowntree 1977)

Page, in his research, kept classroom conditions as close to normal as possible, using the regular class teachers thereby avoiding any reaction by pupils to the presence of an outsider entering the classroom.

There were 3 treatment groups:-

1. No comment group. One test was returned to the pupils bearing a letter grade (A B C D or F) only.

2. Free comment group. One test was returned bearing a letter grade and any comment the teacher desired to make.

3. Specified comment group. The test was returned bearing a grade and a comment thought appropriate to that grade by the experimenter.

The next test (no matter in what subject that test was taken) was taken as a criterion test.

Page found that the free-comment group achieved the highest scores (the difference between this and the no-comment group was significant at the 0.1% level).

The difference between the specified comment and no comment group was significant at the 5% level with no significant difference reported between the free comment and specified comment groups.

Stewart and White (1976) summarise U.S. research projects which have used Page's research as a basis for their own. Out of sixteen, only two (Hammer 1972 and Lesner 1967) find significant "comment" effects.

Allen (1972) found no significant relationship between comments/lack of comments, on work, and children's attitudes towards mathematics. Starkey (1970), Shrago (1969) and Hake (1973) who undertook attitude assessment as part of their researches also found no significant relationship.

Design of the Experiment

The field researcher collected comments that he had placed on 12/13 year old children's work over a two year period. The comments were duplicated and given to 116 mixed ability thirteen year old pupils the following year. The pupils were asked to place an A B C D or E grade against each comment.

From the responses given comments were chosen which showed up as being highly polarised. The 'A' and 'B' comments were grouped together as were the 'D' and 'E' for the purposes of the treatments. There were 48 comments in the 'A/B' section, 30 in the 'C' section and 25 in the 'D/E' section.

The following year 159 mixed ability pupils of both sexes were given a 39 item objective pre-test which tested the topic "The Earth" as taught in top-year middle school science. The test had been designed during the previous two years and had a reliability coefficient of 0.87. Pupils were also given the Science Attitude Questionnaire (Skurnik and Jeffs 1971). This tested the pupils'

(i) Science Interest

(ii) Awareness of Social Implications of Science

(iii) Attitude to Learning Activities

(iv) Attitude to Science Teachers

(v) Attitude to School

They were then randomly assigned to one of four treatments.

Treatment 1 The work would be handed back with only a letter grade on it.

Treatment 2 The work would be handed back with a letter grade and a matching relevant comment chosen from the lists prepared.

Treatment 3 The work would be given back with a letter grade and no matter what letter grade a comment chosen from the 'B' grade section, i.e. a favourable comment that was also professionally possible in the light of the quality of the work.

Treatment 4 The work would receive a letter grade and any comment the teacher thought appropriate. This treatment was the control group, this being no different treatment to normal practice.

The topic "The Earth" was taught to all classes by the field researcher, thus eliminating any "between teachers" effect.

The pupils were used to working from worksheets for certain topics in science and so to have a series of worksheets for this topic came as no surprise. The worksheets themselves contained details of experiments for the pupils to carry out and space for experimental results and conclusions to be written. Almost all answers could be written as one word or a short phrase and thus could be marked objectively.

Each pupil completed nine worksheets, (each worksheet being handed in, marked and commented on according to the treatments above) and returned before the pupils began the next worksheet. The time taken to do this was three days. After the completion of the ninth, the pupils took the post tests (identical to the pre-test) of science knowledge and Science Attitude.

A careful record was kept of the comments written on the children's work, so that no comment used in either treatment two or three was repeated.

Attenuation, as a result of some children being ill during the course of the experiment and others going on holiday, led to sample reduction to 147 children (74 boys and 73 girls).

Results

	Treatment	Girls mean gain score	Boys mean gain score
1.	Grades only	5.59	7.53
2.	Grades plus "matching comment	6.84	9.26
3.	Grade plus "positive" comment	9.68	9.39
4.	Controls	7.44	7.50

Using Jonckheeres trend test for non-related samples, only the girls showed a significant trend towards improved scores with passage through the treatments.

A follow-up t-test showed a significant difference ($t = 1.963$, sig at the 0.05 level) between the performance of the girls receiving grades only and those receiving grades plus matching comments. When those receiving grades only were matched with those receiving grades plus positive, encouraging comments the difference became highly significant ($t = 2.88$, sig beyond the 0.01 level).

These preliminary findings would seem to suggest that whilst end of assignment comments made little differences to the boy's attitude or performance in science, for girls the additional feedback of written encouragement leads to a marked improvement in their tested knowledge of science.

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