THE ATTITUDES OF PUPILS AND STAFF TO PROGRAMMED INSTRUCTION AT THE SECONDARY SCHOOL STAGE.

by

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SUMMARY.

The aim of this research was to assess the attitudes of pupils and staff to programmed instruction. A linear programme on science was administered to seven classes of third and fourth year pupils in a Comprehensive school (N = 192) and percentage improvement scores were used to assess the learning which had taken place. An attitude questionnaire was constructed to measure the attitudes of the pupils towards programmed instruction and the scale was found to be reliable.

The older, more intelligent pupils who were good readers, made the greatest gains from the programme and the errors made on the programme affected the performance of the girls more than the boys. Pre-test scores were a recurrent predictor of success and this suggests that linear programmes can be a useful aid to revision. There were no differences in performance between girls and boys, but the successful boys were anxious and adventurous whereas the successful girls were also anxious, but more extroverted and tenderminded than the boys.

All groups of pupils had favourable attitudes towards programmed instruction but the girls' attitudes were positively related to achievement, although, for the complete sample, favourable attitudes predicted poor performance. The younger pupils who were reserved and mild-mannered displayed the most favourable attitudes towards programmed instruction.

A reliable attitude scale to assess the attitudes of teachers towards programmed instruction was constructed and distributed to teachers in four Comprehensive schools together with a questionnaire to measure their opinions about education. Of the sixty-two replies received only thirty-five felt that they had sufficient knowledge to complete the programmed instruction questionnaire.

The teachers holding the most radical views on education were the most favourably inclined towards programmed instruction, but attitudes were not related to the sex or age of the teachers.

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T. Williams, November, 1971.

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CHAPTER I

INTRODUCTION

A. PROGRAMMED INSTRUCTION.

Programmed instruction was introduced in the United States of America in the 1950's and it has attracted a considerable amount of interest in recent years. A great deal of research was carried out in the 1960's so that in 1962 the "Association for Programmed Learning" was formed in this country and in 1965 a "National Centre for Programmed Learning" was established at Birmingham University to co-ordinate and assess the results of experiments which were being carried out throughout the country.

Early researches tended to use very small groups of subjects and they made extravagant claims about the progress of the subjects concerned, basing the claims on uncertain statistical interpretations. A few teachers heralded the advent of programmed instruction as a panacea in education although it was generally met with the suspicion and resistance that has greeted many discoveries and inventions through the ages.

The 1960's was a decade of confusion as researchers debated the merits of linear/branching programmes, machine/book and various other aspects of presentation. Dissillusionment followed as many studies appeared to lead to conflicting results so that the findings were more provocative than definitive.

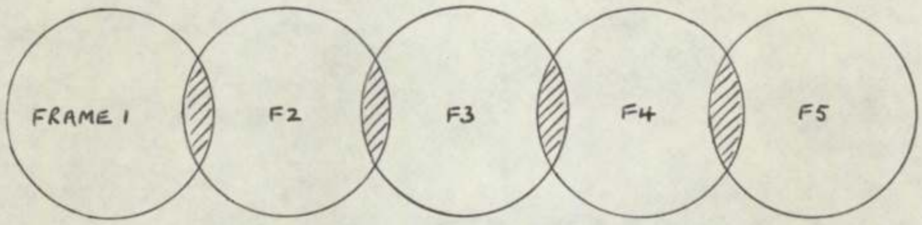
Programmes eventually became more sophisticated and the hardware which accompanied them became more complex and expensive so that very few practising teachers made use of programmed instruction.

There are two basic types of programme which can be used for programmed instruction. The first of these was advocated by Skinner (1954) and his operant conditioning model is referred to as a linear programme. The aim of such a programme is to build up an interlocking sequence of units of information and the student is required to make an overt response to a question which is usually presented after each unit (referred to as a frame). Each frame contains only a very small amount of information and the phrasing and context of the question is presented in such a way that very few errors are made. This type of programme works on the principle that the student is given the correct answer after making his own response and that he is motivated by his success. It is claimed that the student can be guided to any desired behaviour pattern through such a series of small steps.

The sequence of a linear programme is shown schematically in figure 1.

Figure 1.

Schematic presentation of a linear programme.

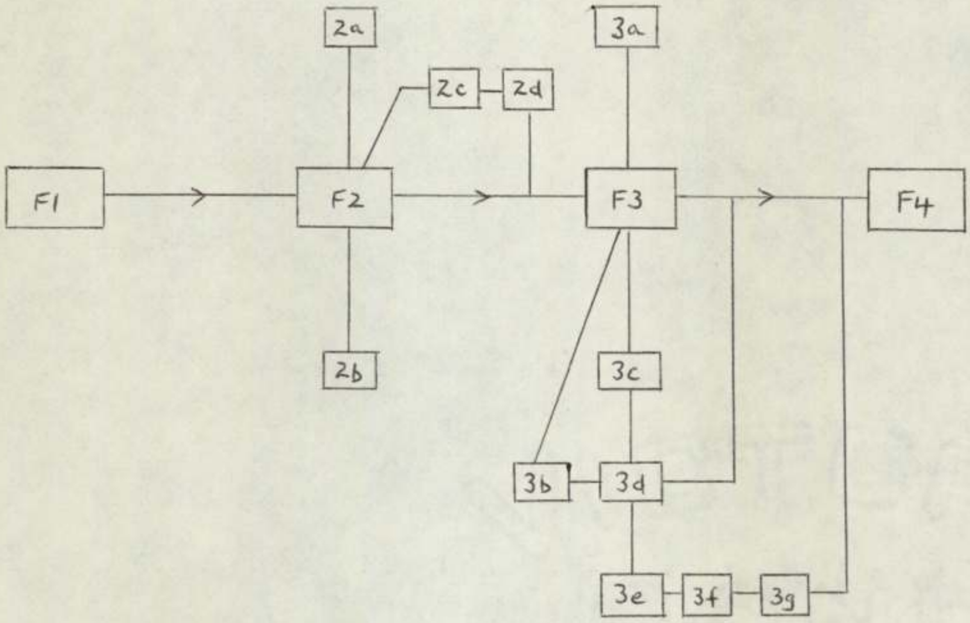


The second basic method of programming is known as the branching, or intrinsic method. This method was devised by Pressey (1950) but it was Crowder (1962) who really introduced intrinsic programming in the 1960's. The intrinsic method gives the student a paragraph of information followed by a multiple choice question. This type of programme is presented either in a machine or a scrambled book and if the student selects the correct answer he is told he is correct and he is directed to the next frame along the main stem of the programme. If his answer is incorrect he is told why it is wrong and he is then asked to try again or is guided through a remedial sequence of frames before returning to the main stem.

The sequence of an intrinsic programme is shown schematically in figure 2.

Figure 2.

Schematic presentation of an intrinsic programme.



In recent years programmers have tended to adhere less rigidly to one type of presentation and many programmes combine both linear and branching techniques. Cybernetics has enabled computerised adaptive (extrinsic) teaching machines to be used so that the pace and level of difficulty of a programme is automatically adjusted according to the progress of the participant.

There is no doubt that adaptive machines will be in more general use in the years ahead, but their expense at the present time makes them prohibitive to the classroom teacher. The number of published programmes, both linear and branching is growing rapidly but very few teachers are prepared to accept fully a published programme. One cause of this could be that individual teachers have their own ideas concerning the learning sequence to be used for a particular topic, whereas a programme tends to usurp the teachers control of the learning situation.

Many teachers feel that the only programmes suitable for their use would be those written by themselves. Intrinsic programmes are difficult to write as it is not easy to find credible 'wrong' answers in the multiple choice questions. Linear programmes on the other hand are relatively easy for amateur programmers to write and many sources such as Thomas et al (1963), Hartley (1963), Markle (1964) and Callender (1969) provide excellent guidance for the beginner. The programme used in this study is a linear one written by Williams (1967) on "The Structure of the Atom" and apart from the main study of attitudes it serves to add evidence that linear programmes can be written by practising teachers and used successfully as a teaching aid in the classroom situation.

B. THE PRESENT PROBLEM.

Many of the early attempts to examine various aspects of programmed instruction were not planned with the care and control which is necessary to produce reliable results and many of the outstanding claims made about the effectiveness of this method of instruction were based on unsound experimental methods. However all the research findings so far published have shown that programmed instruction can be effective in teaching a variety of different subjects to very many different groups of people e.g. in Junior and Secondary schools, in various types of College, in Universities, industry and the military services, and with both gifted and backward children. Schramm (1964) writes that the research leaves us in no doubt of the fact that programmed instruction can teach. Most of the research however has been of a comparative nature i.e. comparing different types of programme (linear and branching), or different modes of presentation (book and machine).

More recent research has tended to examine topics such as self/group pacing, individual/pair working, but Cronbach (1957) in his Presidential address to the American Psychological Association, pointed out that psychologists should not search for the method which will work best for the average person. He suggested that one should search for the best method for each individual with given characteristics. Hartley (1966a) points out that the study of the relationships between individual differences and performance from programmed instruction has only attracted the attention of researchers since 1964. Noble (1966), Leith (1969), Leith and Trown (1970) and Leith and Wisdom (1970) have carried out studies to link personality traits with programmed instruction and there is a growing body of evidence to support the hypothesis that benefit from programmed instruction is linked with characteristics of personality.

It is however only now becoming apparent that the attitude of the student towards programmed instruction is of the utmost importance. A few early researchers asked participants for their opinions about programmed learning after a course of instruction, but this generally took the form of a few subjective statements. In very recent investigations a more objective approach to attitude measurement has been undertaken by Williams (1967), Ellams (1968) and Noble (1968).

None of these studies however gives results concerning the attitudes of students at the secondary school stage following the study of a linear programme.

The evidence so far is that subjects hold a very favourable attitude towards programmed instruction initially, but that the degree of favourability falls off if the programme is prolonged. It would appear that there is a strong case for the use of programmed instruction if the programmes are short and are not used continuously. The present study therefore sets out to use a short linear programme, written and administered by the classroom teacher so that the links between academic gain and characteristics such as personality traits and attitudes can be measured objectively.

The National Foundation for Educational Research has recently carried out an investigation into streaming in Primary schools and the work is reported in Barker Lunn (1970). A significant finding of this study was that the unstreamed groups gained a great deal in social activities only when the teachers concerned were sympathetic to non-streaming and had the associated attitudes. There is now a growing body of evidence that the attitude of the teacher towards a method of teaching is almost as important as the method itself. It would appear therefore that programmed instruction will never gain a general acceptance by classroom teachers unless they have favourable attitudes towards it and it is for this reason that the present study attempts to measure objectively the attitudes of teachers in Comprehensive schools towards programmed instruction. The study also tries to relate these attitudes with the age, sex and personality traits of the teachers concerned.

The emerging realisation of the importance of attitudes and the failure of programmed instruction to continue with its initial momentum are the main reasons why the present investigation is concerned with the attitudes of both pupils and staff in Secondary schools towards the use of programmed instruction.

CHAPTER II

REVIEW OF LITERATURE

A. PROGRAMMED INSTRUCTION AND CAPACITIES.

One aspect of the present study is to measure academic achievement from a linear programme and to relate the gains achieved with factors such as intelligence, age, reading ability, sex, time taken and errors made on the programme. The following research findings are relevant to this aspect of the investigation.

1. Achievement through Programmed Instruction.

It is the author's contention that short programmes which can be shown to teach can be written by practising classroom teachers. It is pointed out by O'Toole (1964) that teachers tend to be concerned with local syllabus requirements (the author is at present using his programme as part of a regional Certificate of Secondary Education syllabus) so that nationally published programmes do not readily fulfil a particular requirement.

Fry (1963) writes that all the concepts which are included in the cognitive domain as defined by Bloom and Krathwahl (1956) can be taught by programmed instruction.

The cognitive domain, as listed in the Bloom Committee's taxonomy contains the following educational objectives:

1.00 Knowledge

2.00 Comprehension

4.00 Analysis

5.00 Synthesis

6.00 Evaluation

Noble (1966) writes that there is very little evidence to substantiate Fry's claim. It is evident however that some classification which indicates the capacity of the method would be useful.

Lankford (1964) used Bloom's taxonomy to classify test items in his linear programme on biology and he found that programmed instruction could teach a knowledge of specifics, and the use of such knowledge. Most published tests to measure learning from programmed instruction tend simply to measure recall, and the test used in the present study could only be seen to test objectives 1.00 and 2.00 of Bloom's taxonomy i.e. knowledge and comprehension.

Noble (1966) suggests that programmed instruction can teach specifics or can build on to existing knowledge rather than teach all the tasks of Bloom's taxonomy and, using the technique of principal component analysis to isolate factors concerned with difficulty levels, he found that programmed instruction is best suited for easier rather than for difficult test items.

All research studies concerned with programmed instruction show that this method can teach and the findings are invariably based on pre-test and post-test results. If post-test scores are to be the sole criterion for a measure of learning then it must be assumed that students have no previous knowledge of the content matter in the programme. As this assumption can rarely be made it would appear that a pre-test is necessary so that gain scores can be worked out. The procedure of measuring gain scores has been the general practice, but Warr et al (1968) point out that pre-tests may have a teaching as well as a testing function. Hartley and Holt (1970) found that doing a pre-test had no significantly measurable effect upon post-test performance following programmed instruction. Hartley, Holt and Swain (1970) found that when the efficiency of a programme is reduced, then pre-test effects were discernible in post-test performance.

Hartley (1966b) stresses that a retention test is one criterion of a good programmed instruction experiment, but Sawiris (1965) doubts the value of retention tests as any short term differences in student gains after programmed instruction tend to reduce to the same level when measured by a retention test. Hartley (1965) found that retention reduced differences and Noble (1966) points out that in school situations teaching is concentrated towards one particular examination, and retention of knowledge after the examination is not necessarily an objective. Williams (1967) found that delayed tests reduced correlations to insignificant levels and the present study did not involve the use of retention tests.

2. Intelligence and Achievement.

From a review of previous research studies there appears to be conflicting evidence concerning the relationship between intelligence and post-test performance after the study of a linear programme. As one of the original intentions of programmed instruction was to cancel out the effects of intelligence it is not surprising that many studies which have attempted to correlate intelligence with performance have found no significant correlation. Ferster and Sapon (1958) found no correlation between intelligence and achievement from a programmed German course with twenty eight adult American students and this finding was repeated in a well designed study by Shay (1961). Following a spelling programme with American schoolchildren Porter (1961) found no correlation for a programmed group, but a significant correlation for a group taught by conventional methods. Middleton (1964) found little relationship between intelligence and learning for a programmed group, except for his higher ability students. Further support for these findings comes from Challinor (1964) using a spelling programme with sixty four first year children in a Secondary school, although the author pointed out that twelve of the children had scored 40+ out of 50 marks on the pre-test and there was also an extremely low error rate of one per cent on the programme compared with a generally accepted rate of about ten per cent from this type of programme. Eigen and Feldhusen (1964) also using a linear programme found no significant correlation between intelligence and transfer of knowledge scores.

In an experiment in Swedish Grammar Schools, Stukat (1965) found that intelligence correlated more highly with speed than with performance on post-test which suggests that ability differences might manifest themselves as differences in speed rather than in level of performance. It should be borne in mind, however, that low correlations between intelligence and performance may be due to a small spread of marks on the performance test which followed the programme.

To confuse the issue concerning this particular correlation there have been several studies which contradict the findings so far reported. Lambert, Miller and Willey (1962) in a very comprehensive study involving a linear programme of eight hundred and forty three frames found that learning was significantly correlated with intelligence. Larkin and Leith (1964) worked with Junior school children and found a significant product moment correlation of +0.495 between intelligence and achievement. Lankford (1964) found that mental age correlated with both achievement and retention and Leith and Davis (1966) also found a high significant correlation between intelligence and achievement in a linear programme. Leith (1963) in a summary of research into programmed learning suggests that the findings of Lambert, Miller and Willey (1962) could partly be attributed to the fact that the programme used was particularly difficult for the lower intelligence groups and that the findings of Lankford (1964) could well be due to the fact that his programme was integrated into a more conventional situation so that the effect of integration may have been such as to make this result the exception rather than the rule.

Studies such as those by Wallis and Wicks (1963), Knight (1963) and Cavanagh, Thornton and Morgan (1963) which used intrinsic programmes, all found that intelligence correlated with performance.

In a very recent and comprehensive study reported by Noble (1969) six samples (each sample consisting of several classes within a school) studied an intrinsic mathematics programme and there were fewer significant correlations between intelligence and gain scores than anticipated. He did find, however, that there were eighteen (out of a possible forty) positive correlations between intelligence and post-test scores and accounted for four out of the five relevant samples tested. Intelligence and pre-test scores were the most significant and recurrent predictors of post-test scores and these results suggest that programmed instruction may best be used to supplement existing knowledge as Gagné (1962) has suggested. This view is also given by Eigen and Feldhusen (1964) when they found that prior knowledge of a subject matter is a better predictor of success than general mental ability when using linear programmes. Noble (1966) suggests that programmed instruction can teach specifics or can build on to existing knowledge rather than teach all the tasks mentioned in the Bloom taxonomy of educational objectives, Bloom and Krathwahl (1956). It is for this reason that the present study uses a linear programme as a revision exercise rather than to present new material.

3. Pace of Learning.

One of the early characteristics of programmed learning as stressed by Stolurow (1961) was that students were allowed to work at their own speed so that they would find an optimum pace level and therefore gain maximum benefit from the programme.

Cavanagh, Thornton and Morgan (1963) in a British European Airways study found that the longer a student took to complete a programme, the less likely it became that he showed a corresponding increase in learning. The Royal Air Force study of Knight (1963) found a negative product moment correlation coefficient between time and post test performance to be -0.57 (significant at the .05 level). These results, however, followed the study of intrinsic programmes, whereas Williams (1967) using the prototype of the linear programme used in the present investigation found a low positive rank order correlation coefficient which was not significant. It would seem reasonable to suppose that better performance on achievement tests might be obtained by those students who work quickly through a programme and that these in turn should be the higher ability students.

Gropper and Kress (1965) in a comprehensive study showed that pace is a unique characteristic of the learner and cannot be manipulated at will without affecting achievement from a linear programme. Hartley (1971) suggests that there is no concrete evidence that individual learning is any better than that produced from pairs working through a programme together. A very recent area of research is concerned with the methods used in forming pairs i.e. pairing through intelligence scores, pre-test scores or personality traits. Hartley (1971) finds that low ability children did not profit from being paired with those of high ability and that the high ability children did not like the situation.

The issue of pairing is a complex one and the motivation behind the research is that if suitable methods can be found for pairing, then this introduces an economic gain into the use of programmed instruction. It would seem reasonable to investigate this aspect of programmed learning if expensive "hardware" is to be utilised, or if published programmed texts are to be purchased, but when teacher-constructed programmes are used and duplicated, the expense involved is not prohibitive. It is for this reason that the present study did not experiment with paired learning, but times taken were noted in order to examine the correlation between pace and other factors.

4. Errors on the Programme.

Several research workers have investigated the effect of errors on achievement after using programmed instruction. One of the earliest works was that of Porter (1959) who found no relationship between the number of errors made by a student on a linear programme on spelling, and the corresponding achievement score. Coulson and Silberman (1960) using a large step intrinsic programme also found that the errors committed do not seem to relate to, or affect, performance. These two findings however do not conform to the pattern of later researches.

Keisler (1959) found a significant rank order correlation of -0.83 between errors and gains for his arithmetic programme. This very high coefficient shows that the student committing least errors on the programme did considerably better on the post test than those students who found the programme difficult. Although this particular coefficient is very high the general trend is found by most other researches.

Wallis and Wicks (1963) found that errors correlated inversely with successful performance for an intrinsic programme using machines and the Royal Air Force study reported by Knight (1963) showed a negative correlation between errors and achievement. The significant product moment coefficient between errors and post-test was -0.71 in this study, although the coefficient was reduced and lost its significance when a retention test was used (three months later) instead of the immediate post-test.

Robson and Austwick (1965) in an elementary algebra programme with second year children of less than average ability in a Secondary Modern school found product moment coefficients between errors and gain scores of -0.519 (not quite significant) for a programmed text group and -0.882 (significant) for the machine group. Noble (1969) in his study of seventeen different samples, found that more frequent errors predicted low post test scores. This was also a finding of the present author in an earlier study, Williams (1967). Leith and Bosett (1967) found correlation between the numbers of errors made and improvement in performance on a problem-solving task with ten-year-old children.

The solution to this problem of errors may be found in a study by Elley (1966). He found that the nature of the task used to measure achievement is a key factor in the relationship between gains and errors. His results show that a concept attainment task did not give rise to a relationship between errors and attainment, whereas a rote-learning task did so. This view is also reinforced by Leith and Wisdom (1970) and they suggest that the stress laid by programmed learning manuals on error-free performance during learning can perhaps be called in question. It is the author's contention that any findings concerning the relationship between errors and gains may merely reflect the nature of the programme or achievement test i.e. rote learning or concept attainment.

5. Reading Ability.

As programmed instruction relies heavily on verbal material it would be expected that reading ability is closely linked with achievement. Lankford (1964) in his experiments concerning integrated programmed instruction found that reading ability correlated positively with gains in all cases and these findings are similar to those of Eigen and Feldhusen (1964). Noble (1969) reports that age and reading accuracy both predicted greater post-test scores and in the present investigations the author felt that measures of reading vocabulary, comprehension and speed would be useful.

6. Differences attributed to sex.

McNeil (1964) found that kindergarten boys scored significantly higher than girls with programmed reading, but significantly lower than girls in a conventional classroom situation with a female teacher. He then suggests that programming may be more appropriate for boys as perhaps female teachers may fail to adjust themselves as well to boys as to girls.

Noble (1966) suggests that there is a general assumption that girls learn more from programmed instruction than boys, but that there are no clear cut results on which to evaluate any differences which may be inherent between the sexes. Hartley (1966a) however, points out that girls tended to make fewer errors than boys and were generally more conscientious, although there were no performance differences between girls and boys.

A very comprehensive study reported by Noble (1969) dealt with seventeen secondary school classes in different schools. He measured performance differences between boys and girls using student tests of significance. Of the seventeen sampled classes there was only one significant difference between the achievement of boys and girls at the 5% level that showed boys higher than girls. Variance ratios were significant for four of the seventeen classes at the 5% level and for two of these classes the variance of the girls' net gain was greater than was that of the boys' net gain and for the other two the converse was true. Noble therefore states that it may reasonably be concluded that in all conditions there were no significant differences between boys' and girls' performances from programmed instruction.

As the present study involved both sexes it seemed sensible to test the null hypothesis concerning sex differences.

B. PROGRAMMED INSTRUCTION AND INCLINATIONS.

The research so far reviewed concerned itself with differences in the capacities of subjects but more recent research has concentrated on individual differences in character. It is becoming increasingly more obvious that certain personality traits may not be conducive to high achievement from programmed instruction and the attitudes of the subjects involved has also been attracting the attention of research workers. This section of the review is therefore concerned with researches into personality and attitude differences associated with programmed instruction.

1. Personality.

Stolurow (1961), Fry (1963) and Leith (1964) of the early researchers suggested that as programmed instruction was under the control of the learner, then individual differences in personality may be important when deciding which pupils could benefit most from programmed instruction. It is pointed out by Leith and Wisdom (1970) that some learners are favoured by a well structured, highly prompted learning situation while others are better off when presented with a high degree of ambiguity and uncertainty. These two extremes of introversion and extroversion can be assessed by a personality questionnaire such as Cattell's High School Personality Questionnaire as used in the present study.

The recent interest in personality measurement could well have implications for curriculum development. The author is particularly concerned with the Nuffield science courses where there is heavy emphasis on uncertainty and discovery. This emphasis would seem to be well suited to children with extrovert tendencies, whereas children who do not possess this personality extreme may well benefit better from a more formal structured approach.

It has been suggested by Smith (1959), referring to linear programmes, that the writer of programmes has introvert, meticulous tendencies, so that such programmes may be more suitable for introverts. It is, however, only since 1964 that empirical studies of relationships between performance from programmed instruction and individual differences in personality have been undertaken.

Traweek (1964) used Sarason Anxiety Scales and found that anxious withdrawal tendencies were significantly related to successful performance from a linear programme. He found no differences in performance related to nervousness as measured on the Californian Test of Personality and he concludes that successful learners are more withdrawn, less self-reliant, and more anxious about tests than unsuccessful learners, when using linear programmes. It would appear that many children who are anxious and inhibited in the conventional classroom situation find a freedom of expression when allowed to control their own learning process, as in programmed instruction. In another early study concerned with individual differences from programmed instruction, Doty and Doty (1964) find that "effective programmed instruction varies as a function of student personality variables".

Leith and Bosett (1967) found with ten-year-olds that the absence of structure and guidance favoured non-anxious children, while a great amount of structuring and prompting was more helpful to the anxious children. This finding, that anxious introverts were the most successful children with programmed instruction, was repeated by Leith and Davis (1969) with twelve-year-olds in a study of social reinforcement and achievement.

Leith (1969) described his experiment with sixty four children aged between ten and eleven years in two Junior schools. The children were given the H.B. Personality Inventory which was constructed from one hundred and twenty five items similar to those of the Junior Maudesley Inventory and contains two orthogonal scales known as 'introversion/extroversion' and 'anxiety'. Four learning situations were arranged to be 'complete discovery', 'guided discovery 1', 'guided discovery 2' and 'complete guidance'. The results of this study show that complete guidance (highly structured) is better than discovery for the anxious children, while the non-anxious children gain more from discovery than from complete guidance. Comparisons were made between the mean gains of the anxious and the non-anxious children in the introvert group and between the corresponding extrovert groups. Of the former, anxious introverts were significantly better than non-anxious introverts, but the extroverts were not significantly different from each other. The study of Leith and Davis (1967) with thirteen-year-old children gave a similar result when they carried out a programmed learning task and the same personality questionnaire was used. Leith and Davis (1966) had earlier found a significant negative correlation between extroversion and achievement and no significant correlation between anxiety and achievement after programmed instruction. This was followed by Leith and Wisdom (1970) in an experiment with seventy eight female students at a college of further education using the Eysenck Personality Inventory. They found that the performance of extroverts was inferior to that of introverts after the study of a fully prompted programme.

Noble (1969), however, found that the children who made the greatest gains from his intrinsic programme were casual, aggressive and enthusiastic i.e. the extroverts. This result is contrary to those of Traweek (1964), Leith and Davis (1966), Leith and Wisdom (1970) and others. It could be that non-anxious extroverts can successfully use intrinsic programmes because they do not worry if they make mistakes, whereas the anxious introverts benefit most from linear programmes where very few errors are made so that anxious tendencies are subdued.

Bosworth (1971) writes that "it becomes necessary to make use of a personality test as the yardstick of those factors, other than I.Q., which might affect the overall performance of the child in the Kibworth Project". This project, described in detail by Bosworth (1967), was an attempt to individualise learning in science and to examine the factors which affected the children's level of success when studying science through a programmed course. All the children in the second year of a Leicestershire High School were tested to obtain two scores, one for introversion and one for extroversion. Success was rated on the results gained on the final test which followed each programme and the Junior Eysenck Personality Inventory was used to obtain the personality scores. When the project was set up, the people concerned expected to find that the more introverted child would do better than in the conventional situation, but the findings were that the correlation between introversion and achievement was not only low, but negative. As the programmes in this study involved a considerable amount of practical science it was an integrated programme and therefore perhaps it is not surprising that the findings tend to support the results from intrinsic programmes, rather than those from linear programmes.

The research evidence leaves no doubt that not all students gain maximum benefit from programmed instruction and that individual characteristics of personality play a large part in determining the benefits which may be derived.

2. Attitudes.

Williams (1967) points out that the concept of attitudes is complex and definitions of the term are numerous. Two authoritative yet different definitions are those of Allport (1935) and Thurstone and Chave (1929). Thurstone and Chave consider the concept of attitude as "..... the sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats and convictions about any specific topic". Allport however writes "An attitude is a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related." The second of these definitions infers a state of readiness leading to action and the first implies a total of ideas about any preconceived topic. Vernon (1953), however, defines attitude in a manner which appears to bring the first two definitions together and interprets the term in the context which the author intends i.e. "a personality disposition or drive which determines behaviour towards, or opinions and beliefs about, a certain type of person, object, or situation, institution or concept".

In many of the experiments mentioned earlier questionnaires were given to the subjects to find out something about their attitudes towards programmed instruction. The general impression was almost always favourable although it is only very recently that the findings have been based on objective attitude scales. Students were usually asked whether they liked or disliked the programme and this tended to give the impression of favourableness.

Skinner (1958) stresses that a programme reinforces the student for every correct response, using immediate feedback not only to shape behaviour most efficiently, but to hold the student's interest. Hartley (1966a), however, points out that although much of the evidence from questionnaires is favourable towards programmed instruction, this is not a universal finding; student interest is not always held, particularly in long-term studies. McKeachie (1963) states that students will learn what they want to learn, and it is probable that they will not learn what is boring. The literature does in fact show that short-term studies such as those of Skinner and Holland (1958), Feldhusen (1961) and Hartley (1964) respond very favourably towards programmed instruction. Hartley (1966a) suggests that in short term studies, between 70 and 90 per cent of subjects respond very favourably to programmed instruction.

Long-term studies on the other hand, such as those of Popham (1962) show that boredom is a characteristic which affects performance. Goldstein and Gotkin (1962) report that the most common comment made by students about programmed instruction after using it for a period of time is that it is a boring way of learning. Dick (1963) found neutral attitudes towards a long programme which was found to be boring.

Fry (1963) introduces the term "pall level" and defines it as the point at which the student loses interest in the subject, becomes bored or tired, and stops learning.

Popham (1962) worked with two groups of sixth-grade children in America who used programmed instruction by machines for three periods of thirty minutes a week for one term (one group) and two terms (the other group). Over half the children became tired of using the machines and did not wish to continue using them.

Knight (1963), Wallis (1964), Hartley (1964), and Leith and Davis (1966) all find that attitudes deteriorate with time as pupils use programmed instruction. The study by Wallis showed boredom as a distaste in the Royal Navy study, even though recruits were anxious to succeed. Hartley (1965) found a significant decline from highly favourable to more neutral attitudes towards his programme on logarithms when attitudes were measured after four weeks and again at the end of the term.

Neidt (1965) gave a similar attitude questionnaire at various intervals to try to assess the change of attitudes as time progresses. The results showed a significant decline in level of motivation between the beginning and the end of the study. It appears that the novelty effect increased motivation and favourability initially and in long term studies there is a slight increase in the level of favourability in the very late stages of the course of instruction as students realise the end is in sight. The questionnaire used was based on a five-point scale. Rayder and Neidt (1964) measured the decline in attitudes over a period of time. They used five point scales and recorded the attitudes of students at weekly intervals. They found that the same questionnaire can be given at weekly intervals without influencing the level of motivation and they also found a significant decline from the initial highly favourable attitudes as recorded on the first week to the lower final attitudes after five weeks. The investigators have felt that a strong novelty appeal affected the level of motivation in the first week.

The problem of novelty, or "Hawthorne" effect, was investigated in the studies of Porter (1959) and Popham (1962) mentioned earlier. Popham contrasted the performance and attitudes of a "low novelty" group with those of a "high novelty" group. The "low novelty" group used an algebra programme for one term and then continued with a geometry programme for another term. The "high novelty" group only studied the geometry programme. Both groups were given performance tests on the geometry programme after two hundred and six hundred frames and again on completion of the programme after nearly two thousand frames.

Porter's spelling programme was used for twenty two weeks and he then compared the results obtained for the two halves of the programme. Both Popham and Porter found no significant differences and both concluded that novelty does not affect results. Porter's study can be criticised on the grounds that the two halves of the programme cannot be equated for difficulty and Popham's "low novelty" group could well have felt some unmeasured novelty effect by the introduction of the second programme. It would seem that any programme which is sequential is bound to increase in difficulty so that initial speed and performance would be better than when measured later.

In the Swedish study by Stukat (1965) questions concerning attitude were given to subjects and scored on a three point scale. The findings here were again strongly favourable at the beginning altering to mildly favourable at the end of a course lasting for almost one complete school year.

Calder (1970) gives a sample of the views of two hundred and ninety female college of education students in response to an attitude questionnaire on completion of a short programme. Over ninety per cent preferred the programme to lectures and eighty nine per cent felt that they had learned more from the programme than they would have done from lectures.

Hodge (1969) used programmed instruction with girls in an approved school and his attitude questionnaire revealed a very favourable attitude towards this method of instruction. He warns however that the study was short-term and that the degree of favourableness shown here may have been influenced by the interest value of the subject matter for these particular girls.

Roebuck (1969) describes an experiment in which ninety five pupils and nine members of staff completed an attitude questionnaire after working on programmes using Grundytutor teaching machines. The work was carried out in a Glasgow senior secondary school and a Likert-type attitude questionnaire was administered. The results showed that the attitudes of both pupils and staff were favourable and that girls held less favourable attitudes than boys.

Noble and Gray (1968) used an attitude questionnaire to assess the attitudes of children in a secondary modern school after programmed instruction. An intrinsic programme on trigonometry was used and the attitude questionnaire was of the "inclined to X or Y" type. Classes of third, fourth and fifth year children were given the questionnaire, and very favourable initial attitudes were seen to decline steadily and significantly over a period of time. Individual differences in this study showed that more favourable attitudes were displayed by mild, adventurous children who did not score highly on the post-test. Attitude scores did not relate to intelligence or speed of progress. Girls displayed more favourable attitudes to programmed instruction and their attitudes did not decline as rapidly as did those of boys.

Eigen and Feldhusen (1963) found that attitudes towards programmed instruction on completion of a programme had no relationship with the amount of learning which took place. This study, however, did suggest that a low correlation may exist with older subjects.

Sawiris (1965) in his study with a short-term geometry programme found that successful children were flexible and adaptable, yet displayed unfavourable attitudes to programmed instruction. He also found that non-neurotic and non-anxious children had favourable attitudes. This result, however, is in disagreement with that of Leith and Davis (1966) who found that favourable attitudes were displayed by anxious introverts.

In the study by Noble (1969) girls always showed more favourable attitudes than boys. Such girls are also likely to be anxious in contrast to boys with favourable attitudes who displayed no anxiety tendencies. Noble also found that older children showed less favourable attitudes and this may be because they are less able to adapt to new teaching methods than are younger children who are less dependent on conventional instruction.

Hartley (1971) makes the point that relatively few investigators have in fact been able to demonstrate clear-cut relationships between student attitude and performance in programmed instruction.

This review suggests that students generally hold favourable attitudes towards programmed instruction but that the favourability declines as the length of the programme increases. It is for this reason that the present study uses a short programme which is a modified version of the one used by Williams (1967). In the earlier study the programme had a mean time of about one hour and the favourability of students towards programmed instruction actually increased on completion of the work. There is evidence that programmed instruction can best teach specific knowledge and build on to existing subject matter, and the present study attempts to do this by using a factual programme as part of a revision scheme.

Individual differences related to performance on programmed instruction are varied and extremely complex. There is evidence, as would be expected, that reading ability is related to performance but there are conflicting results concerning factors such as the aspect of intelligence, errors made and time taken to complete a programme. Recent studies have concentrated on a measure of personality traits and it would appear that anxious extroverts find more freedom and perform better on intrinsic programmes. Sex differences do not seem to manifest themselves in achievement but girls show a more favourable attitude towards programmed instruction.

This review has found that many studies were carried out with American subjects (with the possibility of cross-cultural differences), many used teaching machines for the programmes, others used intrinsic programmes, some dealt with adults, and many were long-term studies.

The author can find no other research which uses a linear programme in science presented in book format, as part of a revision programme with all-ability children in a comprehensive school. It is also important to stress that the study was carried out by the children's usual teacher in a normal school atmosphere i.e. no external researcher and no administrative changes to facilitate the experiment.

The underlying theme behind this research is the belief that if more evidence can be gathered concerning the variables which affect performance from programmed instruction they may be controlled or allowed for, so that greater benefits may accrue from the use of this method of instruction.

C. TEACHERS' OPINIONS.

1. Attitudes to Programmed Instruction.

The author has taught in all types of secondary schools and two colleges of education and from general discussions with colleagues and students it is obvious that there is considerable opposition to the use of programmed instruction in schools. Many teachers have attended no in-service training and openly profess to know nothing about "these new educational gimmicks". Yet, these are very often the people who have formed preconceived unfavourable attitudes concerning programmed instruction.

Many teachers react unfavourably to innovation in the classroom situation and they resent the presence of a research worker. A few studies have, however, attempted to assess staff attitudes towards programmed instruction and recent studies find that the teacher's attitude towards programmed instruction has an effect on the student's attitude.

Noble (1966) and Cavanagh (1967) both found that the attitudes of the teachers cause no significant difference in the achievement of the students, but it did appear that the teachers' attitudes influenced the students' attitudes. Hooley and Jones (1970a) presented a mathematics programme to three matched groups of students and they were given an introduction to their task in such a way that one group felt that the instructor was favourably disposed towards programmed instruction, the second group felt that the instructor had a neutral attitude and the third group felt that the instructor was not favourably disposed programmed instruction. This experiment again showed that achievement was not affected but that significant differences in the attitudes of the students were apparent.

In a replicate experiment Hooley and Jones (1970) found similar results. The differences in attitudes between the three groups in this study, however, were not so clear cut and the authors suspect that this was because of administrative reasons. The programme had to be worked through in one long session and they thought that boredom created by working for long spells at a linear programme would militate against the transference of a positive attitude.

The attitude of the teacher becomes very important when teacher participation is a function of the programme. Wriggle (1964) found that when the teacher supplemented the programme material by periodically revising and summarising the basic concepts involved, then significantly more learning took place. Wallis (1964) had a similar finding from his experiment with an intrinsic programme presented by machines.

Although Deterline (1962), Fry (1963) and others have suggested that the attitudes of teachers towards programmed instruction are major variables, the author can find no comprehensive study which involved the objective assessment of attitudes of classroom teachers towards programmed instruction, especially when they were not directly involved in administering a research experiment. Incidental work by Roebuck (1969) in the experiment in a Glasgow senior secondary school mentioned earlier, gathered completed attitude questionnaires from nine members of staff in addition to the ninety-five pupil participants. He used a Likert-type questionnaire and the staff analysis showed that teachers reacted unfavourably to the noise of the teaching machines used, but that their overall attitudes were favourable. The teachers however were not in favour of complete self-pacing and teacher training and tradition have not prepared teachers for the idea of individual progress in secondary schools. Roebuck writes "Before programmed materials can be fully integrated into school teaching it would appear necessary to show the teacher how to develop methods of turning the student-paced situation into one which is advantageous for the teacher".

In a very recent study, Hartley and Holt (1971) constructed Likert-type scales to measure the attitudes of teachers towards new educational media. They concluded, however, that it would have been more useful to have constructed sub-scales for different media.

A little research has however been carried out to assess the attitudes of teachers-in-training towards programmed instruction. Stolurow (1962) found that although psychology students welcomed programmed methods of instruction, student teachers reacted rather unfavourably towards them, even though they felt their introduction was inevitable. In the earlier study by the author, Williams (1967) the prototype of the attitude questionnaire used in the present investigation was administered to fifty students at a college of education. The questionnaire was given before and after a short linear programme on science and the attitudes of students towards programmed instruction were favourable before the experiment and the degree of favourability increased significantly after working through a programme.

Calder (1970) referring to an experiment at a college of education writes "It is worth noting from this, how important the teacher's attitude is in determining overall harmony in a class working with programmed lessons". He administered a comprehensive attitude questionnaire to a class of two hundred and ninety female teachers-in-training and he found that ninety per cent of the sample preferred the programme to lectures.

It is the author's contention that studies concerning programmed instruction in colleges of education should be encouraged and designed to inculcate favourable attitudes if the method is to gain acceptance by teachers in the years ahead.

The present study uses a questionnaire with practising teachers in comprehensive schools to assess their attitudes towards programmed instruction and to try and relate attitudes to variables such as the age and sex of teachers concerned.

2. Attitudes to Education.

As the present investigation was probing teachers' attitudes towards programmed instruction the author felt that these attitudes may well be linked with the teachers' attitudes towards other aspects of education. In the same way that students attitudes towards programmed instruction are affected by their personalities, then it seemed logical to explore the personal characteristics of the teachers concerned as they affect other aspects of education.

Early work on the assessment of teachers' attitudes to education usually made use of the Minnesota Teacher Attitude Inventory. Evans (1959), however, stresses the need for British norms and, apart from cross-cultural difficulties, she pointed out that the scales were very susceptible to faking. Rushton and Ward (1969) suggest that it is very probable that the principal questionnaire method for the assessment of teacher attitudes here in Britain, will be Oliver and Butcher's "Attitudes to Education" questionnaire.

The construction of these scales can be traced back to Oliver (1953) who attempts to discover the possibility of combining the systematic theories of educational philosophers and the unformulated ideas of practical teachers into a meaningful taxonomy. He recognised naturalism/idealism as a meaningful dimension in establishing the relative position of educational attitudes and opinions. Eysenck (1951) identified two primary social attitudes as radicalism/conservatism and tender/tough-mindedness and Oliver felt that his naturalism/idealism dimension may be an amalgam of Eysenck's primary attitudes.

Oliver and Butcher (1962) establish the independence between Eysenck's two primary attitudes and Oliver's original dimension and they describe the construction of three scales to measure naturalism/idealism, radicalism/conservatism and tender/tough-mindedness. Naturalism in education is defined as a preference for spontaneity in behaviour rather than for a rigid adherence to established norms and conventions. Radicalism is based on the number of changes in the educational system accepted as desirable by the respondent, and tender-mindedness in education is defined as an attitude which places little value on standards and the rule of law in educational contexts.

Oliver and Butcher (1968) describe the use of the scales in an experiment with a sample of three hundred teachers and they found that women teachers were more inclined to naturalism, radicalism and tender-mindedness than men. The results also show that teachers become more idealist, conservative and tough-minded as they become older. The exception to this finding was the youngest teachers (under thirty years) who were more tough-minded than the middle-aged group.

Butcher (1965) used the scales to compare the attitudes of teachers-in-training and practising teachers and he found that students were more naturalistic and more radical in their educational views than practising teachers. He also found that graduate teachers were stricter on questions of morals and discipline. This study was replicated by McIntyre and Morrison (1967) using the same scales in a comparison between English and Scottish students.

McIntyre, Morrison and Sutherland (1966) used the scales with thirty four teachers and found that tough-minded teachers tended to place strong emphasis on quietness, whereas tender-minded teachers stressed qualities of speech and appearance as being important. Radical teachers stressed the importance of behaviour, industriousness and high attainment, whereas conservative teachers agreed with the emphasis on industry and attainment but felt that sociability and leadership were more important than behaviour.

McLeish (1969) uses the scales in a cross-cultural study involving nearly six hundred teachers and students. One relevant aspect of this work is the profile given of "mature" and "satisfied" teachers. He finds that mature teachers are radical, tender-minded, stable and committed. The satisfied teacher, on the other hand, whilst also being radical and committed, is tough-minded and extroverted. His tough-mindedness is, however, mitigated by his naturalistic approach which enables him to value spontaneity in children.

Pollock (1965) in a study involving science teachers and students found that older science teachers were significantly more tough-minded than younger teachers. Idealist and tough-minded teachers emphasised objectives and accuracy, whereas naturalist and tender-minded teachers emphasised the appreciation of the contribution of scientific method.

In the study by Hartley and Holt (1971) the attitudes of college of education students towards new educational media were measured and related to naturalism, conservatism and social desirability. The naturalism scale used was that of Oliver and Butcher (1962), the conservatism scale was part of one by Wilson and Patterson (1968) and social desirability was measured using Marlowe's (1960) scale in Crowne + Marlowe (1960). The important finding from this research is that none of the three scales correlated significantly with attitudes to new educational media. The college of education students were then divided into two groups and asked to complete the educational media questionnaire again. One group was asked to complete it in the way they felt that a "good teacher" would fill it in; the other as a"bad teacher" might fill it in. The results from this experiment indicate that the scale may have been open to "acquiescence", or "social desirability".

All the studies reviewed, together with several unpublished works, show the scales to have high reliability coefficients and the author feels that their use can make a valuable contribution to the present study. There is no evidence to hand that there has been any investigation into the relationship between teachers' attitudes to education and their attitudes towards programmed instruction.

CHAPTER III.

A. AIMS, SAMPLE AND METHOD.

1. Aims.

The main aim of the present study was to apply a pragmatic empirical approach to the measurement of both pupil and teacher attitudes to programmed instruction.

The review of literature shows that a considerable amount of research has been carried out into the assessment of achievement from programmed instruction and one aspect of this study is to attempt to add weight to the finding that programmed instruction can teach effectively. An attempt is made to relate the achievement from the programme to the capacities of the subjects in a "normal" classroom situation. The author attaches great importance here to the fact that the school organisation was not disturbed in any way so that there was no air of expectancy from the children, as is sometimes the case in a research experiment.

The study sets out to relate the achievement from a linear programme to the inclinations of pupils and it is this aspect of the work for which there appears to be relatively little literature to date. The author feels that the personality of the pupil and his attitude towards the particular method of instruction is of paramount importance if we are to make the best use of programmed instruction in our schools. It is for this reason that one very important aim in the present study is to construct a pupil attitude questionnaire which can objectively measure the attitudes of pupils towards programmed instruction when a linear programme is presented in book format.

It is becoming increasingly obvious that not all pupils can benefit equally from programmed instruction and in the multi-activity situations of modern classrooms it is important to establish which group of pupils enjoy and learn most from this self-pacing method.

The teaching staffs in Comprehensive schools are becoming larger and re-organisation of schools is bringing considerable pressure and strains to teachers. These teaching staffs are often an amalgam of people with grammar, secondary modern and technical school experience and they often have conflicting views concerning innovation in the classroom. As stated in the introduction the author feels very strongly that the teacher's attitude to a method of teaching is of vital importance, yet he can find no study which sets out to assess objectively the attitudes of teachers to programmed instruction. A principal aim of this study, therefore, is to establish a scale to assess the attitudes of teachers towards programmed instruction and to investigate the relationship between these attitudes and other inclinations of the teachers. This research uses three scales to assess personality factors of the teachers concerned and it attempts to establish relationships between personality and attitude to programmed instruction. The study also aims to collect data concerning the sex, age and subjects taught by the teachers to examine the possibility that there is a particular type of teacher who is best suited to use programmed instruction in the classroom.

2. The Sample.

(a) The Preliminary Experiment.

The linear programme to be used in the experiment was one which had previously been used by the author with college of education students. The programme concerned was written and evaluated for use with students who had no science background. This meant that the programme was elementary in content, but that the language may have been unnecessarily difficult for schoolchildren. In view of this, the wording of the programme was simplified and a preliminary experiment was set up to further validate the programme. The preliminary experiment was also used to check the difficulty level of the items in the achievement test and it was an attempt to isolate some of the more important variables which affected the amount of learning which had taken place.

The author was not sure at the outset, which group of pupils would benefit most from programmed instruction, so the preliminary experiment was set up with three classes of pupils. The study was carried out in a newly-emerging co-educational comprehensive school in Gloucestershire in the summer term of 1970. The school was evolving from a secondary modern base and was re-organised gradually between 1968 and 1970. This meant that the pupils in the school had not been successful in the eleven plus examination, but there was a general feeling that re-organisation was opening up new opportunities.

Pupils in the school were "setted" for science lessons, according to their ability in science, for the first three years.

All pupils in the school were compelled to study science for the first three years; an option scheme then operated for the fourth and fifth years.

The three classes involved in the preliminary experiment were taken from second, third and fourth year groups. The second year group was a "second set" in general science, the third year group a "top set" in general science and the fourth year option group was a mixed ability general science class. This meant that a total of eighty five pupils were involved and they were all following a C.S.E. general science course. The usual science teacher administered all the tests and the groups involved are summarised in the following table.

Table 1.

Distribution of pupils within the preliminary sample.

Group 1	2nd years	set 2	20
Group 2	3rd years	set 1	25
Group 3	4th years	not setted	40
		Total	85

(b) The Main Experiment.

The results of the preliminary experiment, described later in this chapter, show that second year pupils found the programme difficult and they failed to show the benefits gained by the older pupils. In view of these findings the decision was taken to exclude second year pupils from the main study.

The main experiment was again carried out in the author's school. The total time spent in working through the programme and completing tests was approximately six hours and although the headmaster and science staff at the school were extremely helpful and sympathetic in their attitude towards the research it was not felt practicable to approach other schools. The diverse nature of many of the tests used meant that science departments in other schools could not be expected to co-operate fully, and if year groups were amalgamated for the purpose of the research the "normal" school situation would have been destroyed. It was for these reasons of time and administration that it was considered desirable to complete the experiment within the author's school.

The pupils involved in the main experiment were third and fourth year children pursuing a general science course for the Certificate of Secondary Education. In the Spring term of 1971 the modified programme was administered to four "sets" of third year pupils and three mixed ability option groups in the fourth year.

The third year pupils had been placed into science "sets" on the basis of their performance in science during their first two years in the school. At the end of the third year, pupils selected subjects from an option scheme and it was school policy that all children, except those following a Commerce course, should study at least one science subject. In general, the more able pupils chose combinations of separate sciences (physics, chemistry and biology), and the less able ones opted for general science. At the time of the experiment, the pupils following the fourth year general science course were placed arbitrarily into three groups of mixed ability, although it was understood that none of these groups contained the very able scientists.

The programme and tests were all supervised by the usual science teacher, except for the reading tests which were administered by teachers of English as part of their normal English lessons.

The total sample consisted of 192 pupils, of which 115 were third year and 77 fourth year. Table 2 summarises the distribution of pupils within the sample.

Table 2.

Distribution of pupils within the main sample.

Group No.	Year	Type of group	No.
1	3	1st set	30
2	3	2nd set	30
3	3	3rd set	30
4	3	4th set	25
5	4	mixed ability	25
6	4	mixed ability	26
7	4	mixed ability	26
		Total:	192

The school is situated in a dormitory area for Gloucester and Cheltenham and the catchment extends for about 5 miles. The children are mainly from middle class residential districts with a proportion of working class backgounds from a resettlement area and a sprinkling of children from rural areas. Thus the sample contained a good cross section of socio-economic backgrounds.

(c) <u>The Teachers.</u>

There were forty three teachers on the staff of the "experimental" school at the time of the investigation, twenty five men and eighteen women. The science staff consisted of five teachers with a full time-table teaching the pure sciences, one rural science teacher and two other teachers who were engaged in teaching science for a few periods a week. The school concentrated its efforts on the Certificate of Secondary Education examinations, although a few small groups had recently been set up to follow Ordinary level and Advanced level courses for the G.C.E.

All the forty three teachers on the staff of the school were given a questionnaire to assess their attitudes towards programmed instruction and they were also asked to complete Oliver's "Survey of Opinions about Education" which is a shortened version of the questionnaire established by Oliver and Butcher (1962).

The author's colleagues on the staff at the experimental school were enthusiastic to co-operate and as the task of completing two questionnaires did not seem to be particularly onerous it was decided to approach staffs of other schools. Three other comprehensive schools with varied backgrounds and traditions were therefore contacted.

The first school had been re-organised from secondary modern to comprehensive status in 1966 and had a rural catchment area. The second school was in the throes of re-organisation from grammar to comprehensive and the third school was purpose built as a comprehensive unit and had been opened in 1966. All the schools involved were co-educational, had about eight hundred pupils and between forty and fifty teachers. The purpose built comprehensive school was known to make fairly extensive use of programmed instruction, especially in the teaching of mathematics, whereas the other schools tended to be more traditional in outlook and only made sporadic use of programmed instruction.

(d) Coverage of the Sample.

The sample was thus taken from only one comprehensive school for pupils, but from four such schools for the teachers.

Nearly two hundred children of both sexes were involved in the experiment and both "setted" and "mixed ability" groups took part. The pupils were in the third and fourth years at the school and were of limited ability, as the school was Comprehensive in name, but was only just emerging from a Secondary Modern base.

More than one hundred and sixty teachers from four comprehensive schools were asked to assist in the experiment. This sample covered both men and women teachers and the four schools involved had very diverse backgrounds.

3. Method.

As outlined earlier, it was decided to carry out a preliminary experiment to assess the effectiveness of the programme and to try to isolate some of the more important variables involved.

This took place in the Summer Term 1970 and a detailed analysis of the results is given later in this chapter.

The main experiment with the pupils was carried out in the Spring term 1971 and the staff questionnaires were distributed at the same time.

(a) The Pupils.

(1) The Programme.

At the time of the study the author was involved in teaching general science for the C.S.E. examination and one section of the syllabus was concerned with atomic structure. This particular topic had been dealt with in a simplified form as part of the second year science curriculum, but the material needed revising and expanding and it was felt that the use of a linear programme would be helpful. Several published programmes such as those by Sacerdote (1963), Latchem (1967), Dunn (1968) and Cork (1968) dealt with the topic of atomic structure and they were reviewed by the author. None of these however had the correct combination of subject matter and simplicity so it was decided to use the programme "The Structure of the Atom" written by Williams (1967). This particular programme needed some simplification of vocabulary as it was originally intended for older subjects, but in terms of content it met the requirements of the author.

Following the preliminary experiment, the programme was modified and a copy of the final version is to be found in Appendix I.

Sufficient numbers of the programme were duplicated to allow two groups of pupils to be using them at the same time and this enabled all pupils to complete the programme in two weeks. Each class had four science lessons a week and as third and fourth year science lessons were being taught at different times it was possible to complete the work for all groups in a relatively short time. The usual science teachers supervised the work and each pupil was instructed to record the time of starting work on the programme and the time of finishing. This was the procedure for each lesson until the programme was completed and the total time taken could then be calculated from the record. The pupils were also asked to mark any errors as they worked through the programme and to record the number of errors made at the end of each session.

As the programme was presented in book format, it was realised that it would be possible to cheat. Fry (1963), however, points out there is no clear-cut evidence to show that cheating has any effect on performance, and in the present experiment an appeal was made for honesty as it was explained that the programme itself was not going to be marked. It was also explained that there was to be no time limit and it eventually transpired that the fastest worker finished the programme in 42 minutes and the slowest pupils needed 110 minutes to complete the work. A copy of the record sheet used is in Appendix II.

(ii) <u>The Achievement Test.</u>

A twenty-item objective test of achievement was used to measure the amount of learning that had taken place. A criterion

Criterion behaviour for the programme.

On completion of the programme students should:

1. Be able to differentiate between elements, compounds and mixtures.
2. Have a knowledge of atomic configuration and constituent particles (electron, proton and neutron).
3. Understand the meaning of atomic number and atomic mass.
4. Understand what is meant by an isotope.

behaviour expressing the objectives of the programme is given in Williams (1967) and the achievement test was composed to assess the terminal behaviour of the pupils. The achievement test had a reliability coefficient of $r_{KR} = 0.82$ in the preliminary experiment and following an item analysis the test was modified to the final form shown in Appendix III. This test was used as a pre-test to measure how much of the subject matter was known before the programme was used, and the same test was used again as a post-test. This enabled the effectiveness of the programme to be measured in terms of gain scores.

The test was marked on a binary basis, with a score of one for a correct answer and zero for a wrong answer. For the purpose of the present study, all tests, except the one for reading speed, were treated as "power" tests. They were not given under timed conditions, although the published personality test used was, in the author's opinion, too long.

(iii) <u>The Attitude Questionnaire.</u>

When all pupils had completed the programme an attitude questionnaire was given to measure their attitudes towards programmed instruction. The construction of this questionnaire was a major undertaking and a detailed account is given separately later in this chapter. The questionnaire could be completed by pupils in about twenty minutes and the Likert type scoring technique gave a range of scores from twenty for extremely unfavourable attitudes to one hundred for extremely favourable attitudes. A copy of the questionnaire, with the separate answer sheet used, is in Appendix IV.

A self-rating line was placed at the end of the questionnaire so that pupils could express their own favourability on a seven-point scale.

(iv) Reading Tests.

Recent researchers, such as Noble (1966) have shown that the reading ability of children is linked with their performance from programmed instruction. The author reviewed several reading tests and finally decided to use the recently published N.F.E.R. Secondary Reading Tests 1-3, by Bate. These particular tests were chosen because they have been extensively field tested at national level and their newness ensures that they have a contemporary literary content. The first test gives a measure of vocabulary, the second is concerned with comprehension and the third contains two passages of continuous prose and is used as a test of reading speed. All three tests have a mean score of one hundred, a standard deviation of fifteen and tables of norms are supplied to transmute raw scores into standarised scores.

(v) Personality Assessment.

It was explained earlier that not all pupils can expect to benefit equally from programmed learning and it was decided to use Cattell's High School Personality Questionnaire (H.S.P.Q.) to measure personality traits in the present investigation. The new version (1963) was used and this particular questionnaire was chosen because it has been extensively validated and Noble (1966) found it to be a reliable test when used with a group of pupils similar to that used in the present study.

The questionnaire establishes fourteen personality source traits and these are shown in Table 3 with their universally known factor symbols.

Table 3.

Titles and symbols for designating personality traits.

Low Score	Factor	High Score
Reserved	A	Warmhearted
Dull	B	Bright
Affected by feelings	C	Emotionally stable
Undemonstrative	D	Excitable
Obedient	E	Assertive
Sober	F	Enthusiastic
Disregards rules	G	Conscientious
Shy	H	Adventurous
Tough-minded	I	Tender-minded
Zestful	J	Circumspect individualism
Self-assured	O	Apprehensive
Socially group dependent	Q_2	Self-sufficient
Uncontrolled	Q_3	Controlled
Relaxed	Q_4	Tense

The questionnaire allows for "agree", "disagree" and "don't know" decisions and tables of norms are supplied to convert raw scores into sten scores, which are on a standardised ten-point scale.

(vi) Attitude to Science

A few years ago the author's school was randomly assigned by the N.F.E.R. to take part in an international survey of educational standards. This survey involved the use of many tests and one particular questionnaire was concerned with assessing the attitudes of pupils towards science. The N.F.E.R. eventually published a version of this questionnaire on behalf of the Schools Council and it is known as "Pupil Opinion Poll: Science". Copies of this questionnaire are available from the Guidance and Assessment Service of the N.F.E.R.

The author felt that it would be interesting to use this questionnaire to investigate the relationship between attitudes to science and attitudes to programmed instruction. The Questionnaire allows favourability with statements to be assigned on a five-point scale and it yields five factors as shown in Table 4.

Table 4

Factors assessed by "Pupil Opinion Poll: Science"

Factor	Name	Range of Scoring
I	Science Interest	20-100
II	Social Implications	13-65
III	Learning Activities	7-35
IV	Science Teachers	8-40
V	School	10-50

(vii) Other Information

School records were available for all pupils and it was decided to investigate the relationship between achievement from programmed instruction and achievement from the usual science lessons. School records gave a percentage score for each pupil and a stanine score based on a nine-point scale. The preliminary experiment used percentage scores but it was realised that correlations across year groups would be invalid as different year tests are used. The main study, therefore, used the stanine scores which made it possible to make comparisons across year groups.

The sex of each pupil was recorded and the age at the time of answering the attitude questionnaire was noted. The intelligence quotient was taken as a Moray House Verbal Reasoning Quotient from school records as pupils had already been subjected to over six hours of testing and it did not seem reasonable to administer yet another test which was in no way connected with science.

All tests administered in this study were marked by the author and Table 5 summarises the measures which were available for statistical analysis.

Table 5.

Measures available for statistical analysis.

Test	Measure	Number of variables
Programme	Errors Time	2
Achievement	Pre-test Post-test % Gain	3
Pupil Opinion Questionnaire: Programmed Learning	Attitude to Programmed Learning Self attitude	2
Reading	Vocabulary Comprehension Speed	3
Cattell's H.S.P.Q.	Personality traits	14
Pupil Opinion Poll: Science	Attitude to science	5
Others	Age Sex I.Q. School Science	4

b. <u>The Staff.</u>

The teachers in the sample were given two questionnaires to complete. The first of these was designed to assess attitudes to programmed instruction and the construction of this scale is described later in this chapter. The questionnaire contained twenty statements and it was possible to give five shades of opinion concerning each statement. A "strongly agree" answer to a favourable statement gave four marks and a "strongly disagree" reply gave no marks. The format of the questionnaire was such that all replies to favourable items were in one column and those for unfavourable items were in a separate column. Favourable scores were counted as positive and unfavourable scores as negative so that the range of scores was from +40 to -40 and a neutral score would be zero. A copy of the questionnaire is is Appendix V.

To assess the attitudes of teachers towards other aspects of education Oliver's "Survey of Opinions about Education" was used. It was pointed out earlier that these scales are now becoming accepted as the principal method for the assessment of teacher attitudes in this country and the questionnaire used is the shortened version of the one established by Oliver and Butcher (1962). The scales yield three factors from thirty six items. Ten items yield scores along a naturalism/idealism continuum called the N scale, the R scale consists of 12 items for radicalism/conservatism and the T scale has 14 items as a measure of tender/toughmindedness. A factorial scoring stencil was supplied with the questionnaire to facilitate the marking and participants were invited to add any comments they wished to make in a space provided on the questionnaire.

The author was given time during a school staff meeting to explain the nature of the research and to ask for co-operation. Each teacher at the experimental school was given a copy of "Survey of Opinions about Programmed Learning" and "Survey of Opinions about Education" and these were collected individually by the author in the hope of eliciting a good percentage return.

The headteachers of the other three schools involved in this aspect of the study were contacted and at two of the schools an appointment was made to discuss the matter. The head of the third school indicated that he would be willing to co-operate and asked for copies of the questionnaire to be sent to the school. At the first two schools the research was discussed sympathetically and the headteachers concerned gave an assurance that their staffs would co-operate. It eventually transpired that only small percentage returns were received from the three schools contacted and the results are analysed in Chapter IV.

Facilities at the computer centre at the University of Aston were available to the author and the data were fed into an I.C.L. 1900 computer. The output from the computer gave information concerning mean scores and standard deviations for all the variables included and this facilitated the calculation of t-scores for mean values and analysis of variance for differences between groups. The computer also gave correlation matrices and carried out regression analyses in an attempt to isolate the more important variables which affected performance.

B. CONSTRUCTION OF ATTITUDE QUESTIONNAIRES.

1. Methods of Assessment.

Methods of measuring attitudes vary from the informal and subjective such as assessing chance remarks, to the more formal type of questionnaire or scale.

An attitude is usually accompanied by a tendency to act in a particular way in given circumstances and it is sometimes possible to infer the attitudes of individuals from their behaviour. Since people are rarely in a position to be able to observe a natural behaviour pattern when it is required, then this method is extremely limited. An artificial situation may be set up for observation purposes, but the fact that it is experimental could affect the behaviour pattern.

Another method of assessing attitudes is to study the expressed opinions of subjects. This method again can lead to a false impression of attitude as there is a tendency for subjects to express the attitude that is expected of them rather than their true opinions. This method of assessing attitudes is improved if individual subjects are interviewed. An experienced interviewer can elicit replies to relevant questions, observe gestures and facial expressions and build up a comprehensive impression of the subject's attitude. The information gained from techniques of observation, study of expressed opinion or interview is bound to be subjective and very limited in its statistical reliability.

As research techniques became more sophisticated the need for more objective approaches to attitude measurement became apparent. Various types of attitude scale have been constructed and they usually take the form of several statements with which agreement or disagreement can be expressed. The statements are then scored so that the subjects can be placed along an attitude continuum.

Evans (1965) reviews the various techniques which have been used in the construction of attitude scales. Pioneer work in this connection can be traced to Thurstone and Chave (1929). The procedure used was to compile a list of statements concerned with the attitude to be measured and to have the degree of favourability of each statement assessed by a group of "judges". They were asked to rate each statement along an eleven point scale so that frequencies and cumulative frequencies were obtained for each statement. The median value of the cumulative frequency graph for each statement was taken as the scale value of the attitude and the interquartile range was used to discard ambiguous statements. A final selection of statements was made so that a graduated series of values was possible over the complete range of the scale. Subjects were then asked to mark the statements with which they agreed.

Likert (1932) constructed an attitude scale by a method which dispensed with the "judges" of Thurstone and Chave. This method was to select equal numbers of favourable and unfavourable statements and subjects were asked to indicate the extent of their agreement or disagreement with each statement. A five point scale was used to show the measure of agreement with each statement and the attitude continuum was scored 1 to 5 for favourable statements and 5 to 1 for unfavourable statements. The responses for the highest and lowest twenty five per cent were then analysed to check that the numerical values had been assigned consistently. If the "upper" and "lower" groups produced similar aggregate scores for a particular statement, then that statement was descarded as non-discriminatory. Discarded statements were found to be those which would fall in the middle of the Thurstone range.

Evans (1946) constructed an attitude scale which embodied the Thurstone method of scaling statements and the Likert method of scoring. This particular method uses a nine-point scale for "judges" to assess the statements and then uses a Likert-type five-point scale with two columns for replies. Favourable replies were entered in one column and unfavourable in another, so that the difference between the favourable and unfavourable totals gave the final attitude score.

The Thurstone and Chave technique of using "judges" discloses any ambiguities or irrelevancies in the statements so that the final selection of items is likely to have high internal consistency.

Guttman (1950) describes the construction of an attitude scale which approaches the problem of unindimensionality in a different manner. This method of scalogram analysis depends on the ranking of individuals rather than items and the method implies that an individual holding a given attitude will also hold all those to one side of it and none of those to the other side. A few relatively homogeneous statements are given to about one hundred responsible people who are asked to express agreement or disagreement with each statement. The replies are then weighted as 1 and 0 for agreement and disagreement and the scores for each individual are placed in rank order from high to low. The responses of each subject for each item are tabulated to conform to Guttman's requirements, then, for any item, those subjects who score 1 for that item should rank above those who score 0 for it, and this should be the case for all items. This method of scaling items is laborious and has largely been replaced by modified techniques, but the disadvantage of the Guttman method is that attitudes have to be narrowly defined so that the statements fulfil the criterion of homogeneity of content.

Another recent approach to the objective measurement of attitude is that of the "semantic differential". This method was first evolved by Osgood et al (1957). The differential consists of a number of bipolar adjectives, such as good/bad, strong/weak, active/passive etc., and each subject is asked to judge a particular concept or phrase against the bipolar adjectives. After extensive investigation Osgood and his associates educed fifty bipolar scales and they identified three major factors. The three factors isolated were "evaluative" containing the good/bad type of adjective, "potency" using such items as hard/soft, and "activity" based on adjectives such as slow/fast. Osgood shows that the evaluative dimension offers a way of measuring both the direction and intensity of attitude to a concept and that a selection of scales representing all three factors should be chosen according to their appropriateness to the concept under investigation.

When confronted with the specific task of assessing the attitudes of pupils and teachers towards programmed instruction the author could find no published scale which fulfilled the need. The Guttman scalogram analysis was felt to be laborious and narrowly confined, and the semantic differential would appear to be more applicable to situations where several concepts were being investigated. The "differential" has in fact been used by Tobias (1969) in a multi-concept questionnaire to measure attitudes to new educational media, and Guttman's technique was used, Barker Lunn (1969), in the formulation of scales to measure the attitudes of children aged nine to eleven years for a National Foundation for Educational Research survey.

It was finally decided to adopt the Thurstone and Chave method with Likert-type scoring as used by Williams (1967). Noble (1966) used an attitude scale to assess pupils' attitudes towards programmed instruction, but many of his statements were concerned with the effect of the machine which was used to present an intrinsic programme. Ellams (1968) constructed a more general scale which involved paired statements and an inclined to X or inclined to Y technique of responding. This type of scale has also been used by Hooley and Jones (1970). Roebuck (1969) used a Likert type questionnaire following a machine presentation and Hartley and Holt (1971) describe the use of a scale constructed in a manner similar to the one used in the author's present study, but designed to measure the attitudes of teachers towards new educational media. This technique involves the method of Thurstone and Chave and is scored on a Likert-type scale.

2. The Pupils' Questionnaire.

The first task in the preparation of such a questionnaire is to prepare a list of statements which are directly concerned with the topic for which the attitude is to be measured. In this context a list of fifty four statements was prepared, consisting mainly of comments from colleagues and from pupils who had used programmed instruction in other disciplines within the school situation. In the formulation of these statements, the informal criteria cited by Edwards (1957) were observed. The precautions summarised by Edwards are listed below:

1. Statements must be relevant to the attitude under consideration
2. Statements should be of opinion, not fact.
3. Statements which are merely right or wrong will not discriminate between subjects.
4. Use language which is suitable for the subjects concerned.
5. Simple, short, clear statements should be used, avoiding double negatives.
6. Double-barrelled statements may introduce ambiguity and should be avoided.

The list of fifty four statements was then given to forty persons concerned with education who were considered to be competent "judges" with the following instructions:

"Each of the statements on the enclosed list is concerned with programmed instruction. The statements are written in a simple form so that they may later be used by pupils in an attitude scale.

Please read the first statement and decide whether the person who made it is likely to have a favourable or unfavourable, attitude towards programmed instruction. If favourable, mark that statement A; if unfavourable, mark it C; if you cannot decide, then mark it B. Consider all the statements in the same way.

Now work through all the statements marked A and decide on the degree of favourableness they show. Mark them as follows:

A1 very, very favourable

A2 very favourable

A3 favourable

Continue with the B and C statements.

B1 slightly favourable

B2 strictly neutral

B3 slightly unfavourable

C1 unfavourable

C2 very unfavourable

C3 very, very unfavourable

NOTE: It does not matter whether you yourself agree or disagree with the statements. All that you are required to do is to assess the degree of favourableness of each statement.

A list of the statements used is given in Appendix VI.

When the lists were returned from the "judges" they were scrutinised to check that they had been completed satisfactorily and the classifications were converted into numerical ratings on a nine-point scale, which ranged from nine for A1 to one for C3. From study of these ratings tables were drawn up to show the frequencies and cumulative frequencies of ratings for each statement; these tables are in Appendices VIIa and VIIb respectively. Graphs were then plotted of cumulative frequencies against ratings and from these graphs the median and quartile ratings for each statement were read off. The graphs are given in Appendix VIII and the median scores and interquartile ranges are tabulated in Appendix IX.

Favourable statements with a high median score and unfavourable statements with a low median score were then examined further and if they had a low interquartile range they were considered for selection in the final questionnaire. Statements with an average median score were dismissed as non-discriminatory and those with a high interquartile range were discarded because of ambiguity. Twenty statements, ten favourable and ten unfavourable, were eventually selected for inclusion in the final attitude questionnaire. For each statement included there was another which expressed the opposite attitude with a similar weighting so that the questionnaire covered the expression of all shades of opinion as far as this was possible.

The final list of statements used is given in Table 6 below and the median scores and interquartile ranges for the selected items are given in Table 7.

Table 6

Final list of statements used in pupils' attitude questionnaire.

1. (4) Programmed learning makes concentration difficult.
2. (36) Programmed learning makes difficult work seem easy.
3. (38) Turning the page over after each question is a nuisance.
4. (11) Programmed learning is better than the "usual" science lessons.
5. (14) You learn a lot without realising it.
6. (2,15) It is easy to find the best speed of working with this method.
7. (42) Programmed learning does not allow you to express yourself properly.
8. (18) The "usual" science lessons are better.
9. (19) This method ought to be used all the time.
10. (20) Programmed learning is of no value at all.
11. (37) No real learning takes place.
12. (30) Programmed learning trains you to work independently.
13. (8) Only a few disjointed facts are learnt.
14. (41) Programmed learning trains you to think clearly.
15. (17) It is difficult to find the best speed at which to work.
16. (45) Programmed learning is likely to lead to poor examination results.
17. (48) All the page turning adds interest.
18. (52) Programmed learning makes it easy to concentrate.
19. (50) It makes easy work more difficult to learn.
20. (49) Programmed learning will probably lead to good examination results.

NOTE:

(1) The number in brackets shows the number of the selected statement on the original list of statements issued to judges as in Appendix VI.

(2) Item 6 is an amalgam of items 2 and 15 on the original list.

Table 7

Median scores and interquartile ranges for statements on the pupils' attitude questionnaire.

No. of statement	Median	Interquartile Range
1	1.9	1.0
2	7.7	1.5
3	2.7	1.1
4	7.1	0.9
5	7.6	1.5
6	7.1)) 7.1)	1.3)) 1.6)
7	1.5	1.0
8	2.0	1.1
9	8.6	0.4
10	0.4	0.4
11	0.6	0.6
12	8.0	1.1
13	1.3	1.4
14	8.2	1.1
15	2.5	1.6
16	1.3	1.2
17	6.4	1.0
18	7.8	1.2
19	1.0	1.0
20	7.5	1.2

The statements were arranged so that the unfavourable statements were randomly distributed, but each half of the questionnaire contained equal numbers of favourable and unfavourable statements to facilitate statistical techniques.

When the scale was administered, a self-rating line was inserted and instructions were given for the subjects to place a cross on this line to represent the position of their own attitude towards programmed instruction. This line was three and a half inches long with end A marked extremely favourable and end B marked extremely unfavourable.

For the purpose of scoring this self-rating line, a ruler is placed on the line and a record is made of which particular half inch of the line contains the required cross. This leads to a self-rating score on a seven point scale and the purpose of this scale was to investigate the relationship between the actual score obtained on the questionnaire and the score obtained from the self-rating.

It was decided to administer the questionnaire in such a form that each subject had a copy of the questionnaire and a separate answer sheet. This economised on the number of questionnaires that needed to be duplicated and it reduced the physical bulk of paper that had to be handled for marking.

A copy of the final questionnaire is given in Appendix IV.

3. The Teachers' Questionnaire.

The questionnaire used to measure the attitudes of teachers towards programmed instruction was an amended version of the one used by Williams (1967). The original scale contained twenty four items and was constructed by the Thurstone and Chave/likert method for students at a college of education. Careful scrutiny of the twenty four items led to six statements being discarded as unsuitable according to the criteria established by Edwards (1957). This pruning of the statements left eighteen which were considered suitable and two items from the author's pupil attitude questionnaire (statements 14 and 18) were added to give a list of twenty items. The statements were then randomised, except insofar as equal numbers of favourable and unfavourable statements occurred in each half of the questionnaire. This facilitates the calculation of the split-half coefficient of reliability.

The format of the questionnaire was different from that of the one used by pupils as the subjects were adults. Each statement had two columns alongside it and subjects were asked to score each statement along a five point scale and they were instructed to place their responses in one particular column. This ensured that all favourable replies were in one column and unfavourable replies were in the other and this considerably eased the marking of the questionnaires.

In order to obtain comprehensive data concerning the teachers, they were asked (i) if they had ever used programmed instruction in the classroom and (ii) whether they felt able to express an opinion about this method of teaching. If they answered question (ii) in the affirmative, they were then invited to complete the questionnaire.

The author has filled in many questionnaires on behalf of other people and has often found them rather restricting in their scope for replies. For this reason a space was provided at the end of the questionnaire and participants were invited to add any comments which they felt may be helpful.

A copy of the final questionnaire is given in Appendix V.

C. THE PRELIMINARY EXPERIMENT

The preliminary experiment was designed to fulfil two main functions. The first of these was to evaluate the programme and check the reliability of the achievement test, whereas the second function was to try to isolate some of the more important variables measured.

1. The Programme.

Details of the programme used can be found in Williams (1967) and the responses of the pupils were analysed for errors. The total number of errors recorded was divided by the total number of responses made and the result was expressed as a percentage to give the error rate for the programme. The results are summarised in Table 8.

Table 8

Analysis of errors made on the programme

Group	N	Mean No. of Errors	Error Rate/frame
1	20	23.7	21.7%
2	25	13.2	12.1%
3	40	14.3	12.7%
Total	85	16.2	14.9%

This shows that the second year pupils (Group 1) had an error rate well in excess of that recommended for optimum learning from a linear programme. One would hope for an error rate of about ten per cent and the results show that groups 2 and 3 approach this figure. The third year group performed marginally better than the fourth years and this may be expected as the third years tested were a "top set" in science, whereas the fourth years were of mixed ability.

A further study of the error distribution led to the idea of breaking down the programme into concept areas as shown in Table 9.

Table 9

Concept areas for the programme.

Concept Area	Topic	Frame Numbers
1	Elements/Compounds/Mixtures	1-12
2	Atoms/Molecules	14-26
3	Electrons/Protons/Atomic No.	28-50
4	Neutrons.	52-57
5	Atomic Mass	59-69
6	Atomic Structure	72-88
7	Isotopes	89-115

The distribution of errors within the seven main concept areas was then analysed and the details are shown in Table 10.

Table 10

Distribution of errors within concept areas

Concept Area.	No. of Frames.	Error rate(%) Gp.1	Gp.2	Gp.3
1	12	22.5	14.3	12.7
2	13	18.5	10.8	10.6
3	23	15.0	6.8	5.9
4	6	17.5	16.7	17.9
5	11	11.8	6.2	10.5
6	17	27.4	13.4	18.4
7	27	30.2	16.9	17.4

This table shows that the second year children found great difficulty in applying the knowledge gained in the early part of the programme to more complex structures and isotopes (concepts 6 and 7). The results also show that third and fourth years encountered some difficulty with concepts 4, 6 and 7.

Concept areas 4, 6 and 7 were then completely rewritten and many frames were altered in such a way that the language was simplified. Many pupils had found the word "negligible" difficult to understand and teachers administering the programme had remarked about the number of pupils requesting help with the vocabulary.

The time taken for each pupil to work through the programme was recorded and the times varied from 47 minutes for the fastest to 120 minutes for the slowest. The means and standard deviations for the times taken are given in Table 11.

Table 11

Means and Standard Deviations for the times taken by the three groups.

	Group 1	Group 2	Group 3	Total
Mean Time (min.)	82.3	75.8	72.9	75.9
Standard Deviation	16.8	10.9	15.3	14.8

This table shows that the second years took rather longer than the third and fourth year groups, but that the more homogeneous third year group (setted) displayed less variation in their times.

2. The Achievement Test.

This test, as used by Williams (1967) was adminstered immediately before the programme and again on completion of the programme. Gain scores were calculated, but because of the variation in pre-test scores it was realised that raw gain scores were not good indicators of improvement in performance. The ratio of an actual gain to the total possible gain expressed as a percentage was calculated for each pupil and this was called the percentage improvement score. The means and standard deviations for pre-test, post-test and percentage improvement are shown in Table 12.

Table 12

Means and Standard Deviations for achievement test.

Group	Test	Mean	S.D.
	Pre-test	2.65	1.57
Group 1 (N = 20)	Post-test	10.55	3.24
	% Improvement	44.70	20.69
	Pre-test	8.68	2.73
Group 2 (N = 25)	Post-test	17.16,	2.25
	% Improvement	72.08	25.81
	Pre-test	7.30	4.25
Group 3 (N = 40)	Post-test	14.40	4.22
	% Improvement	59.00	28.87
	Pre-test	6.60	4.00
All (N = 85)	Post-test	14.31	4.21
	% Improvement	59.50	27.79

These results show that the third year pupils (Gp.2) benefitted a great deal from the programme, whereas the second year pupils (Gp.1), who had found the programme difficult, made a less spectacular improvement. The high score of the third year group indicates that the ability to gain from a linear programme is related to their ability to gain from normal school science lessons, as this was a "top set". It is also evident that the second year pupils had very little pre-knowledge of the subject matter in the programme and that the two "setted" groups showed less variability in their scores than the mixed ability fourth year group.

The data were then analysed for boys and girls separately and the results are shown in Table 13.

Table 13

Means and Standard Deviations of achievement test for girls and boys

	Girls (N = 32)		Boys (N = 53)	
Test	Mean	S.D.	Mean	S.D.
Pre-test	6.50	4.65	6.68	3.67
Post-test	14.65	4.29	14.09	4.22
% Improvement	63.53	25.31	57.04	29.18

This analysis showed that the girls had slightly lower pre-test scores than the boys, but higher post-test scores, and accordingly showed greater percentage gains. The null hypothesis that no sex difference exists in percentage improvement scores was examined using the t-test of significance as described in Lewis (1967) and the calculation gave a value of t = 1.08 which fails to reach significance at the 5 per cent level. This means that there are no real differences in the performance of boys and girls for the samples tested.

The mean percentage scores for each group in the sample were then examined separately to find out if any real learning had taken place. This examination was carried out using the t-test for the significance of a single mean and the results are shown in Table 14.

Table 14

t-test for percentage improvement scores (single mean)

Group No.	t-score	Significance Level
1 (N = 20)	7.654	1%
2 (N = 25)	13.960	1%
3 (N = 40)	12.910	1%

These results were all highly significant and they show that real learning did take place for each group of children.

The differences in mean scores for second, third and fourth year pupils were examined using an analysis of variance and the result is shown in Table 15.

Table 15

Analysis of variance of percentage improvement scores for three groups.

Source of variation	Sum of squares	Degrees of freedom	Mean square
Between groups	12,023	2	6,012
Within groups	58,567	82	714
Total	70,590	84	

F ratio = 8.42

This value of the F ratio exceeds that given in Lindley and Miller (1964) ~~which~~ and thus makes it necessary to reject the null hypothesis at the one per cent level of significance. This means that real differences exist between the mean scores of the groups concerned, although each group had in fact made significant gains.

The reliability of the achievement test was found using the Kuder-Richardson coefficient of reliability as in Lewis (1967). This coefficient is based on the consistency of performance on separate items. The Kuder-Richardson coefficient may be regarded as the average of all the split-half coefficients obtained by splitting the test in all possible ways. The calculation gives $r_{KR} = +0.823$ and this is considered by the author to show that the test has a high measure of internal consistency.

A Facility Index was worked out for each test item so that any questions which had a high level of difficulty could be modified. The percentage of correct answers for each item was calculated for all pupils, and for groups 2 and 3 only and the figures can be seen in Appendix X. At the time of analysing test replies for item analysis it was found that eleven answer papers had been misplaced and this explains the discrepancy in the figures given for N in Appendix X.

As second year pupils had found the programme difficult it was decided to omit them from the main experiment, so a Facility Index was calculated for pupils in Groups 2 and 3. The figures in Appendix X show questions 8, 16 and 17 required modification.

On closer examination of the items concerned, question 8 included the word "negligible" which had caused difficulties in the working of the programme, so this question was reworded in a simpler vocabulary. Question 16 was thought to be too difficult because it entailed the manipulation of large numbers. The author felt that it was the arithmetic rather than the science which had caused the difficulty, so the details were altered from an atom of gold to one of chlorine. Item 17 was a diagrammatic representation, again involving large numbers, and details of the sketch were altered in line with those of item 16. The modified version of the achievement test is seen in Appendix III.

The effectiveness of a programme is neatly assessed by a method advocated by Banks (1965). This method of "paired-percentages" expresses the results for a specified group of pupils as a percentage of those obtaining a specified percentage of marks on the post-test. Thus a 90/90 result would mean that ninety per cent of the pupils obtained more than ninety per cent on the post-test. This elegant method of expressing the validity of a programme appeals to the author and it was used in this trial.

Post-test scoreswere expressed as percentages, frequency and cumulative tables were compiled, and the cumulative frequencies were expressed as percentages. Graphs were then drawn of percentage cumulative frequencies against percentage scores for each group in the trial and these can be found in Appendix XI. The curves are seen to be distorted because the distribution curves of the results are seen to be skewed as the linear programme is designed to obtain high marks on the post-test rather than to discriminate between individuals. A"y = x" line is drawn for each graph where the percentages are paired. The results were 52/52 for group 1, 80/80 for group 2 and 64/64 for group 3, and this is further evidence that the programme proved to be too difficult for the second year children.

The percentage improvement scores were examined for normality by compiling a frequency distribution, Appendix XII(a) and drawing frequency distribution histograms as in Appendix XII(b).

These results show reasonable normality for the second year group (except for the 41-50 range), but the distribution is piled up at the top end of the scale for the third and fourth year groups, i.e. it is negatively skewed.

The form in which a set of marks is distributed depends on the purpose for which the test was set. Calder (1970) points out that there is clearly a need for achievement tests whose component items are judged, not according to whether they discriminate between students, but according to whether they accurately represent the objectives of the course. He suggests that with programmed instruction we are striving to bring pupils together in a high-scoring cluster, and we are hoping to wipe out individual differences with respect to attainment of objectives. Lewis (1967) also makes the point that tests such as the one used in this research are expected to yield results which depart from normality.

Many statistical techniques only apply to normal distributions so the data were converted into Normalised T scores. This involved the plotting of graphs of cumulative frequencies against percentage improvement scores and using the graphs to find percentile scores. Tables were then used to convert the percentile scores into Normalised T scores with a mean of 50 and a standard deviation of 10. The graphs showing cumulative frequencies against percentage improvement scores are seen in Appendix XIII. Normalised T scores were then used in the calculation of correlation coefficients.

3. The Attitude Questionnaire.

Each statement on the questionnaire (Appendix IVa) had been marked A, B, C, D or E according to the degree of favourability expressed by the pupil and these grades were given numerical values of 1, 2, 3, 4 or 5. There were twenty statements on the questionnaire, ten favourable and ten unfavourable, so that scores could range from 20 (extremely unfavourable) to 100 (extremely favourable), with a neutral attitude score of 60. The self-attitude scores could range from 1 to 7 with a neutral self-attitude of 4.

The means and standard deviations for the attitude scores are shown in Table 16.

Table 16

Means and Standard Deviations for attitude scores.

	Attitude Score				Self-attitude Scores			
	Gp. 1	Gp. 2	Gp. 4	All	Gp. 1	Gp. 2	Gp. 3	All
Mean	77.7	70.6	71.4	72.7	6.0	5.6	5.4	5.6
S.D.	10.7	10.4	7.9	9.7	1.4	1.5	1.4	1.4

These results show that all three groups displayed a favourable attitude towards programmed instruction. The significance of the mean score for each group was calculated separately using the t-test for a single mean. The results for the t-statistic are t = 7.15, 5.10, and 9.83 for second, third and fourth year groups respectively. These figures show that the mean attitude score for each group was significant at the 1% level.

It was noted that the mean attitude of the second year group, which made more errors on the programme and did less well on the achievement test, is greater than the mean attitude for the other two groups. This finding supports that of Noble (1969) who found that the greatest gains were made by those pupils showing the least favourable attitudes.

The attitude scores for the three groups were then subjected to an analysis of variance to find out if any real differences in attitude existed between the groups. The results are shown in Table 17.

Table 17

Analysis of variance of attitude scores for three groups of pupils.

Source of variation	Sum of squares	Degrees of freedom	Mean square
Between	486	2	243
Within	7461	82	91
Total	7947	84	

The value of F = 2.67 fails to reach the significant value at the 5% level for the relevant degrees of freedom. This shows that all the groups displayed favourable attitudes towards programmed instruction, but that no real differences in favourability existed between the groups.

The data were further analysed into sex differences as in Table 18.

Table 18

Means and Standard Deviations of attitude scores for girls and boys.

	Mean	Standard Deviation
Boys	72.6	10.5
Girls	72.7	8.3

This table showed that there are no attitude differences for boys and girls, although the boys have a greater variability in their scores.

4. The Reading Tests.

The three reading tests were scored and the raw scores were converted, using the norms supplied, into transmuted scores with a mean of 100 and a standard deviation of 15. The results for vocabulary, comprehension and speed are given in Table 19.

Table 19

Means and Standard Deviations for reading tests.

	Vocabulary			Comprehension			Speed		
	Gp.1	Gp.2	Gp.3	Gp.1	Gp.2	Gp.3	Gp.1	Gp.2	Gp.3
Mean	101	105	106	100	105	104	98	97	101
S.D.	5.0	8.7	8.7	5.4	10.6	8.0	11.2	8.0	11.1

This table shows that the means differ very little from the standardised means but there is considerably less variation than one might expect. This could be due to the fact that the pupils are from a particular type of school so that although they may have mixed abilities within the school they are still relatively homogeneous groups.

5. The Personality Test.

Cattell's H.S.P.Q. gave fourteen personality factors for each pupil. The raw scores were converted into Stens which are scores ranging from 1 to 10 and the means and standard deviations of the Stens for each personality factor are shown in Appendix XIV.

The mean scores cluster fairly closely around the standardised means of 5.5 except for scores on the Q_2 factor. All three groups scored highly on this factor which shows a measure of self-sufficiency and resourcefulness. This divergence from the standardised mean cannot be explained by cross-cultural differences as Cattell and Cattell (1969) show that this particular factor has an almost identical score for British and American populations. It would appear to the author that this high measure of resourcefulness is a characteristic of the school which is well known for its encouragement of initiative, especially through out-of-school activities.

6. Attitude to Science.

The N.F.E.R. "Pupil Opinion Poll: Science" yields five attitude scores and the data supplied with the tests give population means for boys and girls separately. The means and standard deviations for the pupils in the trial are given in Table 20.

Table 20

Means and Standard Deviations of science attitude scores for girls and boys.

	Girls (N = 32)		Boys (N = 53)	
Factor	Mean	S.D.	Mean	S.D.
I	58.3	12.8	64.9	10.3
II	44.3	8.4	45.4	7.0
III	27.0	3.3	27.1	3.3
IV	27.9	4.3	28.1	3.8
V	36.7	5.9	35.0	5.5

The scores for girls and boys show no sex differences for factors other than Factor 1 where the boys appear to show a stronger interest in science than girls. The t-test of significance for the difference between the mean scores of the boys and girls on Factor 1 gives a value of t = 2.49 which is significant at the 5% level.

The means scores and standard deviations for all pupils were calculated in groups and the results are shown in Table 21.

Table 21

Means and Standard Deviations of attitude to science scores for three groups.

Factor	Group 1		Group 2		Group 3	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
I	58.1	11.6	69.0	11.0	60.4	10.7
II	43.7	6.7	48.3	6.8	43.6	7.8
III	28.2	2.9	26.6	3.4	26.8	7.8
IV	28.7	4.7	29.8	3.5	26.6	3.2
V	38.0	5.1	35.8	5.0	34.4	6.1

The mean score for group 2 on Factor 1 is well above the standardised mean and this shows that the group has very strong science interests; they also place a high value on the place of science in society (Factor II). This group is a "top set" in science and apart from displaying this interest in science, they made few errors on the programme and gained high percentage improvement scores. The second year group show a strong liking for school as they score highly on Factor V.

7. Other Variables.

The sex of each pupil was recorded and its effect on other variables is examined in the correlation matrix. The ages of the pupils, their Intelligence Quotient and their performance on school science records are all shown in Table 22.

Table 22

Means and Standard Deviations for age, intelligence quotient and school science.

Variable	Group 1 Mean	Group 1 S.D.	Group 2 Mean	Group 2 S.D.	Group 3 Mean	Group 3 S.D.
Age (12yrs.+)	36.6	4.9	49.1	3.9	59.8	3.9
School Science	38.2	8.1	81.6	10.2	43.9	16.2
I.Q.	101.7	7.0	102.3	6.3	102.3	6.6

The ages of the pupils were all expressed in months over the age of twelve years. This was simply an expedient to allow the analysis to be carried out with small figures. The school science scores are percentages and the notable feature is the high score of the third year pupils and the variation in the scores of the mixed ability fourth year group.

8. Correlation Coefficients.

The computer at the University of Aston was used to calculate and print out product-moment coefficients of correlation in the form of a matrix. The five per cent level of significance was used in the interpretation of the matrix and Chambers (1952) gives r = 0.207 as the figure to be exceeded for significance at this level. pp314,315

(i) Pre-test.

The pre-test was found to correlate positively and significantly with post-test, percentage improvement and normalised scores. School science scores, reading vocabulary and comprehension were also significant. Errors and time both had significant negative correlations and this indicates that those pupils who had very little pre-knowledge of the subject matter in the programme took longer to complete the work and made the most errors. Personality traits of circumspect individualism and conscientiousness also correlated significantly. Pupils who do well on the pre-test are also likely to be more relaxed and composed, older and interested in science. They also give some thought to the social importance of science in society.

(ii) Post-test.

There were significant correlations with percentage gain and normalised scores, school science and reading ability as measured on the vocabulary and comprehension scales. Errors again correlated in a negative significant manner, but time taken, although still negative, was not quite significant. The successful pupils were brighter, reflective, internally restrained and relaxed. These pupils were also interested in science and its importance in society. They were also older and they preferred a theoretical to a practical approach to their science.

(iii) Percentage Improvement.

The pupils making the greatest gains were those who made the fewest errors on the programme. The time they spent on the programme, however, did not appear to affect their performances. They were also good at school science, intelligent and proficient readers. They were the brighter, impatient and more demanding pupils who also showed a large measure of tough-mindedness. They were also strongly interested in science and were older pupils.

(iv) Normalised Scores.

The correlations for these scores agree very closely with those for percentage improvement. Both Percentage Improvement and Normalised scores correlate negatively with "Dummy 1" and this means that girls achieved more than boys from the programme; this is in agreement with the findings of the mean scores for the different sexes reported earlier.

(v) Attitude Scores.

There were negative correlations with pre-test, post-test, percentage improvement and normalised scores but they were low and not significant. It would appear from these results that performance is not dependent on pupil attitudes. There were, however, significant negative correlations with the personality traits of self-sufficiency and a preference for making one's own decisions, and with self disciplined preciseness. It would appear from this finding that pupils lacking in self-discipline and socially group-dependent have a liking for programmed instruction. Favourable attitudes were also displayed by those pupils who were interested in science and its importance in society and it was enjoyed by those who like an experimental approach to their work, like their science teachers and have a favourable attitude towards school in general. One important result here was that age correlated significantly and negatively with attitude. This means that older children did not like programmed instruction.

(vi) Other Correlations.

The number of errors made on the programme was highly correlated with time and this showed that the longer a pupil worked on the programme the more errors he was likely to make. The coefficients also show that the good readers and those who are good at science made fewer errors on the programme. These were also the more intelligent pupils. The pupils making the most errors were undemonstrative, inactive and group orientated. These pupils also tended to be disinterested in science and could see very little social importance in science for society.

The pupils who worked fastest through the programme, were shown to be the fastest readers. The fast workers were also seen to be shy and sensitive, with symptoms of tenseness and frustration, and they were older.

9. Regression Analysis.

As there were thirty six variables in the correlation matrix it was difficult to draw any precise conclusions from the results. The author felt that a multiple correlation in the form of a regression analysis would help to identify those variables which carried the most weight in accounting for any dependent variable scores. The I.C.L. 1900 computer was again used for the regression analysis. Multiple correlations were calculated for both percentage improvement and normalised scores as dependent variables. Various combinations of independent variables were tried and 't' figures greater than 2.00 in the list of independent variables included were retained, whereas 't' figures less than 2.00 were rejected. If variables not included in the regression have a 't' score greater than 2.00 it means that they would be significant if they were included in the list of independent variables. The process of regrouping the independent variables to be included was repeated several times until eventual multiple correlations of $r_{mult} = 0.72$ and $r_{mult} = 0.70$ were found for percentage improvement and normalised scores respectively.

The multiple correlation describes the significance of all the included variables i.e. $r_{mult} = 0.72$ accounts for $(0.72)^2$ or almost 52% of the factors affecting percentage improvement and $r_{mult} = 0.70$ accounts for 49% of those factors affecting normalised scores.

The final regression analyses are shown in Tables 23 and 24.

Table 23

Regression analysis with percentage improvement as the dependent variable.

Independent variable	t-statistic	Partial correlation
Errors	5.20	-0.51
Intelligence	3.69	0.39
Personality B	2.07	0.23
Personality I	2.11	-0.23
Personality Q_4	1.23	-0.14
Science Attitude Factor III	2.68	-0.29
Dummy 1 (Boys)	0.92	-0.10

Multiple correlation = 0.70

Table 24

Regression analysis with normalised scores as the dependent variable.

Independent variable	t-statistic	Partial correlation
Errors	5.59	-0.54
Intelligence	3.48	0.37
Personality B	2.11	0.23
Personality I	2.49	-0.27
Personality Q_4	1.77	-0.20
Science Attitude, Factor III	2.59	-0.28
Dummy 1 (Boys)	1.72	-0.19

Multiple correlation = 0.72

These analyses show that the number of errors made on the programme is a very important factor in determining achievement from a programme. Intelligence is also a vital factor and tough-mindedness and composure are important. Boys with a theoretical approach to their work would also seem to benefit considerably from programmed instruction.

This preliminary experiment has enabled the linear programme to be validated and the achievement test to be improved. It has also shown that the attitudes of the pupils towards programmed instruction do not affect their achievement but that certain personality traits are linked with favourable attitudes. Many of the personality traits measured showed no relationship with the other variables being considered, but as all the traits were scored from one composite questionnaire, then it was not practicable to reject those particular items which were not likely to contribute significantly to the results. The statistical analysis showed that the normalised scores produced virtually the same figures as percentage improvement. Boneau (1960) describes an experiment with skewed and normal populations and he finds that discrepancies in the 't' statistic are very small for non-normality and Lewis (1968) concludes that the 't' test of significance is extremely robust. Lewis also refers to studies involving the 'F' test and he concludes that both tests are remarkably insensitive to non-normality.

For these reasons the author felt that there was no necessity to convert percentage improvement scores into normalised 't' scores in the main experiment.

CHAPTER IV.

RESULTS AND DISCUSSION.

The results are considered under two main headings; 1. the pupils, 2. the teachers. Essential data are included in tables in the main text, whereas more detailed statistical analysis is given in the Appendices.

A. THE PUPILS' RESULTS.

The first aim of this study concerning the pupils was to assess the effectiveness of the linear programme and the second was to measure the attitudes of the pupils towards programmed instruction. To meet these two major objectives a total of thirty two measures were available for the one hundred and ninety two pupils. The names of the variables measured were coded for use on the computer and a list of the variables with their code names is given in Appendix XV. The means and standard deviations for the variables are given in Appendix XVI and the tables shown in this text make use of the data extracted from Appendix XVI.

1. The Programme.

The effectiveness of a programme is usually expressed in terms of success on an achievement test, but a linear programme operates on the principle that an immediate knowledge of success motivates the student and for this reason, such programmes ought to have a low error rate. Boredom is also a factor which militates against success in any method of instruction so the programme responses were analysed for errors and time taken.

The error rate per frame is expressed as a percentage and details are given in Table 25.

Table 25.

Analysis of errors made on the programme.

Group	N	Mean No. of Errors	Error Rate
3rd yrs.	115	19.00	17.4%
4th yrs	77	16.99	15.5%
All	192	18.19	16.7%
Girls	70	16.93	15.5%
Boys	122	18.92	17.4%

These figures show that all groups found the programme rather more difficult than expected by the author. The generally accepted error rate for maximum learning from a linear programme is about 10% and all groups in the present study exceeded this error rate. The boys found the programme more difficult than the girls and the younger third year group found it more difficult than the fourth year sample.

The time taken for each pupil to work through the programme was recorded and the times varied from 42 minutes for the fastest to 110 minutes for the slowest. The means and standard deviations for the times taken and errors made by the third years, fourth years and all pupils are shown in Table 26 together with an analysis of sex differences.

Table 26.

Means and Standard Deviations for times and errors.

		Time		Errors	
Group	N	Mean	S.D.	Mean	S.D.
3rd yr.	115	77.06	14.75	19.00	10.17
4th yr.	77	68.12	11.82	16.99	10.43
All	192	73.50	14.30	18.19	10.30
Girls	70	73.59	15.76	16.93	9.40
Boys	122	73.45	13.46	18.92	10.75

These results show that the mean time taken for the study of the programme was 73.50 minutes and that there were no real differences in the times of the girls and boys. The third years, however, did take longer to complete the work than the older fourth year group. The older pupils also displayed more variability in the times taken and the boys, although having the same mean score as the girls, were a more homogeneous group from the self-pacing aspect.

It would appear therefore that the younger boys found the programme particularly difficult and these boys also required more time to complete the work.

2. The Achievement Test.

This twenty-item test was administered as a pre-test immediately prior to beginning work on the programme and again as a post-test on completion of the programme. From these two results gain scores were obtained and percentage improvement scores were calculated for all pupils. The means and standard deviations for pre-test, post-test and percentage improvement are shown in Table 27.

Table 27.

Means and Standard Deviations for achievement test.

Group	Test	Mean	S.D.
	Pre-test	5.66	4.43
1. 3rd yrs.	Post-test	10.83	4.37
(N = 115)	% Improvement	40.40	24.40
	Pre-test	5.71	4.50
2. 4th yrs.	Post-test	12.12	5.14
(N = 77)	% Improvement	49.14	27.86
	Pre-test	5.68	4.45
3. All	Post-test	11.34	4.73
(N = 192)	% Improvement	43.91	26.13
	Pre-test	5.13	4.08
4. Girls	Post-test	11.01	4.41
(N = 70)	% Improvement	43.43	22.29
	Pre-test	6.00	4.63
5. Boys	Post-test	11.53	4.89
(N = 122)	% Improvement	44.18	28.18

Table 27 shows that third and fourth year groups had almost the same pre-knowledge of the subject matter in the programme, although the boys in the sample knew a little more than the girls. When the figures for percentage improvement are examined there would appear to be no real sex differences in mean scores but the standard deviations show that the boys were much more variable in their scores than the girls. The older fourth year pupils appeared to benefit most from the programme, but all mean scores and gains were analysed more objectively using t-tests.

The mean percentage improvement scores for all groups in the sample were then examined separately using the t-test for the significance of a single mean, as in Chambers (1952), to see if ahy real learning had taken place. The results of the analysis of single means are given in Table 28.

Table 28

t-test for percentage improvement scores (single mean)

Group	N	t-score	Significance level
3rd yrs.	115	17.76	1%
4th yrs.	77	15.48	1%
All	192	23.29	1%
Girls	70	16.42	1%
Boys	122	17.28	1%

The figures in Table 28 show that, although the programme had proved to be rather more difficult than expected, all groups did make highly significant gains so that real learning did take place.

The differences between the mean scores of third and fourth year pupils, and girls and boys were then examined using the t-test for the significance of the difference between two means as in Lewis (1967). The results of the t-tests are shown in Table 29.

Table 29

t-test for significance of difference between means for percentage improvement scores.

Group	t-score	Significance level
3rd/4th yrs.	2.32	5%
Girls/Boys	0.07	Not significant

This table shows that the earlier subjective deductions concerning the differences between groups is confirmed by the more objective analysis i.e. there are no real sex differences in performances, but the older fourth year pupils made the greatest gains from the programme.

From the analysis of the programme details and achievement test scores, the pupils most likely to benefit from programmed instruction are the older girls and boys who made significant gains and worked quickly through the programme, the girls making fewer errors than the boys.

As in the preliminary experiment the effectiveness of the programme was assessed using the method of paired comparisons as advocated by Banks (1965). Tables were prepared to show the percentage scores on the achievement test and the percentage cumulative frequencies for each score. These tables are given in Appendix XVII(a) and graphs of percentage scores against percentage cumulative frequencies for third years, fourth years and all pupils are given in Appendix XVII(b).

The graphs show that more than fifty one per cent of the third years scored more than fifty one per cent on the achievement test. The figures for the fourth years were 55/55 and for all pupils 53/53. These results show that the fourth years did a little better than the third years, but a better result might have been expected from a linear programme. It could well be that the programme needs further revision to produce a lower error rate and a better result from the achievement test. It must be borne in mind however, that significant learning did take place for all groups.

The author assumes that all learning was due to the programme i.e. the pre-test had no teaching function.

The reliability of the achievement test was calculated using the split-half correlation coefficient as described in Lewis (1967). The scores for the odd numbered questions were correlated with the scores for the even numbered questions and a coefficient of r = +0.670 was obtained. This coefficient was then adjusted using the Spearman-Brown formula to give a measure of reliability for the complete test of r = +0.802.

The validity of the achievement test could not be measured quantitatively, but from a qualitative point of view the test may be considered valid as it was a terminal criterion test which had been constructed from the programme objectives. The terminal test was constructed before the programme was written so that the instructional sequence should meet the requirements of the programme objectives. For this reason the achievement test could be subjectively assessed as being valid.

3. The Attitude Questionnaire.

The attitude questionnaire (Appendix IV) was administered on completion of the programme. There were twenty statements on the questionnaire, ten favourable and ten unfavourable, each of which was rated by the pupils as a measure of agreement with one of five shades of opinion relating to the statement concerned. The five shades of opinion were designated letters on the pupils answer sheet and these letters were converted to a five-point scale for scoring purposes. This meant that attitude scores could range from twenty (extremely unfavourable) to one hundred (extremely favourable), with a neutral attitude score of sixty. The pupils were also asked to mark a self-rating line and this led to a seven point scale for the self-attitude score.

The means and standard deviations for the attitude scores are given in Table 30.

Table 30

Means and Standard Deviations for attitude scores.

Group	N	Mean	S.D.
3rd yrs.	115	64.24	12.88
4th yrs.	77	62.07	12.52
All	192	63.67	12.75
Girls	70	62.57	12.26
Boys	122	63.83	13.06

These results show that all groups of pupils displayed a favourable attitude towards learning by programmed instruction.

The mean attitude score for each group was considered separately to see whether or not the degree of favourability was significant. The t-test for the significance of a single mean was used and a score of sixty was subtracted from each mean so that a neutral attitude would have a score of zero.

The t-scores for the single means are given in Table 31.

Table 31

t-test for attitude scores (single mean).

Group	N	Adjusted mean	t-score	Significance level
3rd yrs.	115	4.24	3.53	1%
4th yrs.	77	2.07	1.45	Not significant
All	192	3.67	3.99	1%
Girls	70	2.57	1.75	Not significant
Boys	122	3.83	3.24	1%

When all the pupils in the sample are considered, then the figures show that significantly favourable attitudes were displayed. On breaking down the figures to examine sex differences and year groups, however, it is seen that the fourth year attitudes, although still favourable, were not significant. Also the girls in the sample were not as favourably inclined towards programmed instruction as the boys. Although the third years showed more favourable attitudes than fourth years, and boys more than girls, the differences between the means were examined using the t-test for the significance of the difference between means and the results are to be found in Table 32.

Table 32

t-test for significance of difference between means for attitude scores.

Groups	t-score	Significance level
3rd/4th yrs.	1.16	Not significant.
Girls/Boys	0.67	Not significant.

These results show that although there are differences in favourability between the groups the differences are not significant.

We may deduce, therefore, that the pupils were favourably inclined towards programmed instruction but that there was a tendency for the younger boys to like it best.

Evans (1965) gives a detailed account of the various methods which have been used to establish the validity of attitude scales and she concludes that it is extremely difficult to find an objective measure of validity for such scales. McNemar (1946) lists five methods of establishing the validity of attitude scales, but none of them is applicable in the present study. The fact that a large number of independent "judges" assessed the degree of favourability of the test items on a nine-point scale could in itself be considered as a subjective measure of content validity. The author, however, used the technique of correlating attitude scores with self-rating obtained from a graphic rating scale. Each pupil had been instructed to place a cross on a self-rating line ranging from extremely favourable to extremely unfavourable. This graphic rating score was then converted to a seven-point scale and a correlation calculated between the self-rating score and the score on the attitude questionnaire.

The means and standard deviations for the self-rating scores are given in Table 33 and the correlations between attitude score and self-attitude score are given in Table 34.

Table 33

Means and Standard Deviations for self-attitude scores.

Group	N	Mean	S.D.
3rd yrs.	115	4.40	2.11
4th yrs.	77	4.33	1.86
All	192	4.37	2.00
Girls	70	4.23	1.94
Boys	122	4.45	2.05

Table 34

Correlation Coefficients for attitude/self-attitude scores

Group	Correlation Coefficient	Significance level
3rd yrs.	+0.76	1%
4th yrs.	+0.76	1%
All	+0.76	1%
Girls	+0.77	1%
Boys	+0.75	1%

These results are considered to be very satisfactory, although it would be dangerous to infer any significance from them concerning the validity of the attitude questionnaire, because the reliability of the self-rating score is not known.

When the attitude questionnaire was constructed, care was taken to ensure that the scale would divide easily into equivalent halves so that a split-half reliability coefficient could be calculated. The items were not scored dichotomously and favourable and unfavourable statements did not alternate. The order of the items had been arranged however so that each half of the questionnaire contained equal numbers of favourable and unfavourable statements. The split-half correlation coefficient was calculated to be r = +0.722 and when the Spearman-Brown formula was used to adjust the coefficient to apply to the whole test, a value of r = +0.839 was obtained. Vernon (1938) considered that attitude scales should have a reliability of between +0.75 and +0.90, and in view of this the author feels that the constructed scale is reliable. In fact, this reliability coefficient is greater than the figure given for four out of five of the N.F.E.R. published scales which were used for the assessment of attitudes to science in the present study.

4. The Reading Tests.

The Bate Reading Tests for vocabulary, comprehension and speed are published tests which have been standardised and the norms give a mean score of one hundred and a standard deviation of fifteen for each test.

Table 35 gives the means and standard deviations for third years, fourth years, girls and boys.

Table 35

Means and Standard Deviations for reading tests.

Test	Group	N	Mean	S.D.
	3rd yr.	115	100.32	8.91
	4th yr.	77	103.05	9.82
Vocabulary	All	192	101.42	9.35
	Girls	70	102.01	9.97
	Boys	122	101.07	9.00
	3rd yr.	115	97.14	8.40
	4th yr.	77	100.10	10.79
Comprehension	All	192	98.33	9.52
	Girls	70	100.46	10.23
	Boys	122	97.10	8.90
	3rd yr.	115	102.02	10.46
	4th yr.	77	99.73	9.46
Speed	All	192	101.10	10.11
	Girls	70	101.74	10.74
	Boys	122	100.73	9.76

These results show that the reading ability of the pupils in this study is 'normal' insofar as the mean scores cluster around the published means. The scores for the boys appear to be marginally lower than those for the girls, but an interesting result is that the standard deviations are all considerably less than the published norms. It would, however, seem likely that this is because the school, although designated Comprehensive, has a limited ability intake in the middle years which were tested in this experiment. This means that very few 'high ability' pupils were involved and as the 'less-able' pupils in the school were not taking part in the experiment, the subjects were of a restricted range, hence the low standard deviation.

5. The Personality Test.

The raw scores from Cattell's H.S.P.Q. were converted into standardised Sten scores and fourteen personality factors were available for each pupil. The means and standard deviations of the Sten scores for all fourteen factors are given in Appendix XVI; the computer code names are in Appendix XV and the personality factors concerned are given their popular interpretations in Table 3.

The mean scores are seen to be a little lower than the standardised means of 5.5. The 'Q_2' factor which shows a measure of self-sufficiency and resourcefulness gave the highest mean score as it did in the preliminary experiment. The 'I' factor showed the lowest mean score and this indicates that the subjects generally tended to be rather tough-minded, especially the girls in the sample.

6. Attitude to Science.

Five attitude scores were obtained from the N.F.E.R. questionnaire "Pupil Opinion Poll: Science". The published norms for these scales are given for boys and girls separately and Table 36 gives the means and standard deviations for the five factors measured.

Table 36

Means and Standard Deviations of Science attitude scores for girls and boys.

	Girls (N = 70)		Boys (N = 122)	
Factor	Mean	S.D.	Mean	S.D.
I	56.06	10.56	63.30	14.22
II	43.77	6.79	43.71	6.74
III	26.33	3.04	27.25	3.29
IV	28.49	4.95	28.51	6.08
V	33.63	5.88	33.33	6.29

Note: Factor I Interest in Science

Factor II Social implications of science

Factor III Learning activities (Theoretical/Practical)

Factor IV Science teachers

Factor V School

When the figures in Table 36 are compared with the published norms the mean scores are seen to be higher for all the scales except Factor V, which is a liking for school. It would appear that the pupils concerned are favourably inclined towards their science teachers (Factor IV), prefer a practical to a theoretical approach to learning (Factor III) and realise the importance of science in society (Factor II). It is in the scores for science interest however that the pupils differ markedly from the published norms. The scores obtained are considerably higher than expected and this shows that both the girls and the boys in the sample have very strong science interests.

7. Other Variables.

The age of each pupil was recorded and expressed in months over the age of twelve years. This was an expedient measure as all the pupils concerned were third and fourth years and months over twelve years gave smaller numbers in order to simplify the statistical calculations. It eventually transpired, however, that the computer was used for much of the statistical analysis. The Intelligence Quotient for each pupil was obtained from school records and the science departmental records gave a score for performance in science from normal science examinations. These school science scores were converted to Stanine scores which range from one to nine. A good science score has a low stanine and a low science score has a high stanine.

The correlational analysis shows the effect that these variables have on performance, but the means and standard deviations are given in Table 37.

Table 37

Means and Standard Deviations for age, intelligence quotient and school science.

Variable	Group	N	Mean	S.D.
Age	3rd yrs.	115	24.66	3.67
	4th yrs.	77	36.14	3.21
	All	192	29.27	6.63
I.Q	3rd yrs.	115	99.17	9.28
	4th yrs.	77	98.20	8.40
	All	192	98.78	8.93
School Science	3rd yrs.	115	4.85	2.06
	4th yrs.	77	4.83	2.27
	All	192	4.84	2.14

8. Correlation Coefficients.

The product moment correlation coefficients are presented in the form of a matrix in Appendix XVIII. The computer code names for the thirty two variables used are given in Appendix XV and a further seven variables were added for the correlational analysis. These extra variables were used to represent the sex of the pupils and to identify which particular group the pupils came from.

These extra code names are listed in Table 38.

Table 38

Code names for extra variables used in the correlational analysis.

Number	Code Name	Variable
33	Dummy 1	1 = boy, 0 = girl
34	Dummy 2	1 = 4th yr., 0 = 3rd yr.
35	Dummy 3	1 = 3rd yr.,group 1 (set 1)
36	Dummy 4	1 = 3rd yr.,group 2 (set 2)
37	Dummy 5	1 = 3rd yr.,group 3 (set 3)
38	Dummy 6	1 = 4th yr.,group 1
39	Dummy 7	1 = 4th yr.,group 2

In the interpretation of the correlation matrix the 5% level of significance is used and Chambers (1952) gives r = 0.142 as the figure to be exceeded for significance at this level when N = 192.

The capacities which correlated significantly with percentage improvement scores are given in Table 39.

Table 39

Significant correlations for percentage improvement scores.

	PERIMP
PRTEST	+ 0.381
POTEST	+ 0.821
INTELL	+ 0.525
ERRORS	- 0.595
RVOCAB	+ 0.588
RCOMPR	+ 0.636
SCHSCI	- 0.773
MONTHS	+ 0.176
PUPOP1	+ 0.189
PUPOP5	+ 0.163
PERSO2	+ 0.214
PERS13	+ 0.163
PERS14	+ 0.147

These figures show that the pupils who gained most from the linear programme were those who already had some knowledge of the subject matter. They were the more intelligent children who were good readers. The successful pupils also made fewer errors on the programme and worked quickly through it, although the negative correlation with time did not quite reach significance level. These pupils were older and had a good school record in science. (The correlation between percentage improvement score and school science is negative because the school stanine scores were low for good marks and high for poor marks.) They showed a strong interest in science and liked school. These children were bright, socially precise and tense. They also held favourable attitudes towards programmed instruction but the degree of favourability failed to reach significance. The 'dummy' variables in the correlation matrix show that the fourth years did significantly well and that, of the third year sets, the top set did best and the degree of success lessened with each set. This shows that the capacities of the pupils to deal with normal science lessons (the basis on which they were setted) coincides with their capacities to be successful with programmed instruction.

The pupils who made the most errors on the programme were those who gained least from the programme and these were the less intelligent pupils who were poor

* The correlation $r = +0.381$ is to some extent a consequence of the criterion used to assess learning.

readers and not very good at science. These pupils were not very favourably inclined towards programmed instruction and they took a long time to work through the programme. These children were not interested in science and they could not see the social importance of the subject; they also disliked school and their science teachers. The lower sets in the third year made the greatest number of errors, but there were no real differences between the fourth year mixed ability groups.

The pupils who took the most time to work through the programme were the poor readers who read slowly. These were generally the younger pupils who preferred an experimental rather than theoretical approach towards science. These slow workers were also reserved, emotionally less stable than their peers, serious, rather shy, group dependent and not easily frustrated.

Favourable attitudes to programmed instruction were displayed by those pupils who gained most from the programme, although this correlation failed to reach significance. The more intelligent, good readers who were good at science showed favourable attitudes and these children made fewer errors on the programme. Favourable attitudes to programmed instruction were also shown by those pupils who were interested in science, recognised the social importance of it and liked school. They were also the reserved, mild mannered, undemonstrative and placid pupils who were very relaxed, secure and composed. The degree of favourability towards programmed instruction lessened for the lower sets in the third year.

Correlation matrices were also worked out for girls and boys separately and those correlations which showed considerable variability between girls and boys are listed in Table 40.

Table 40.

Correlational differences for girls and boys on percentage improvement scores.

	Girls	Boys
Time	-0.029	-0.172
ATTIT1	+0.157	+0.100
PUPOP2	-0.066	+0.166
PUPOP4	-0.070	+0.214*
PUPOP5	-0.017	+0.225*
PERSO2	+0.088	+0.282*
PERSO5	+0.193	+0.003
PERSO6	+0.170	+0.041
PERSO7	+0.170	+0.032
PERSO8	-0.112	+0.178*
PERSO9	+0.156	+0.022
PERS11	+0.207	-0.071

* = significant at 5% level.

Note: r = 0.177 for significance for boys (N = 122)
r = 0.230 for significance for girls (N = 70)

These figures show unexpected variability in the correlations for boys and girls. The sex analysis shows that the time spent on the programme did not really affect the performance of the girls, whereas the longer a boy spent on the programme, it became less likely that he would be successful. It also appears that the successful girls have more favourable attitudes towards programmed

REGRESSION ANALYSIS FOR PERCENTAGE IMPROVEMENT.	
INDEPENDENT VARIABLE	PARTIAL CORRELATION
INTELL	+0.39
ERRORS	-0.47
ATTIT1	+0.03
MONTHS	+0.18
PUPOP3	+0.02
PERSO2	+0.05
PERSO9	-0.02
DUMMY1	+0.16
Variable not in the regression set:	
SCHSCI	-0.58

instruction than the boys, but the successful boys realise the social importance of science and have a strong liking for school and their science teachers. The successful boys are also bright, adventurous and socially bold, whereas the girls are assertive, enthusiastic, persistent and tender-minded with a tendency to worry more than the boys.

The author realised the difficulty in extracting precise information from such an all-embracing matrix so it was decided to run regression analyses using percentage improvement scores and attitude towards programmed instruction as dependent variables. The I.C.L. 1900 statistical analysis was used to calculate partial regression coefficients. This is a multiple correlation technique which gives the appropriate "weight" of each variable in accounting for the dependent variable score.

P127A. The regression for percentage improvement scores showed that the errors made on the programme was one of the most important factors in predicting performance on the achievement test. The partial correlation coefficient was $r = -0.47$ and this shows that pupils making the least number of errors on the programme would learn most from it. School science had a partial correlation of $r = -0.58$ (negative stanine score means high marks) and for intelligence, $r = +0.39$. Reading ability was also seen to be very important and older pupils made a considerable contribution in accounting for performance. Of the personality traits measured, the tense, precise, controlled pupils benefitted most. The regression analysis also confirmed that the pupils in the lower

REGRESSION ANALYSIS FOR ATTITUDE SCORES.

INDEPENDENT VARIABLE	PARTIAL CORRELATION
PRTEST	+0.15
POTEST	-0.06
PERIMP	+0.05
INTELL	+0.04
ERRORS	-0.05
TIMESS	+0.01
MONTHS	-0.03
PUPOP3	+0.06
DUMMY1	+0.04

sets in the third year were less likely to do well than those in the top sets and that fourth years would gain more than third years.

p128A. The regression for attitude scores showed that performance on the pre-test was an important predictive factor in determining the attitudes of pupils towards programmed instruction. It is interesting to note however that although pre-test scores correlated positively with attitudes, there was a negative partial correlation coefficient of $r = -0.06$ for post-test scores. Those pupils who were interested in science and liked school also made a positive contribution in accounting for attitudes towards programmed learning. All of the personality traits measured had very low or negative partial correlations and those characteristics which made the greatest contribution were aloofness, deliberateness, complacency, self-assuredness and composure. The lower sets in the third year were also seen to contribute less towards favourability than the top sets.

p129 Regression analyses were also calculated for girls and boys separately and there were one or two very important differences. The partial correlation coefficient for girls between attitude to programmed instruction and percentage improvement was $r = +0.20$ whereas for boys it was -0.06. These results show that the attitudes of the girls are more important in predicting success from programmed instruction than the boys and the contributions are in opposite directions. The figures also show that the errors made on the programme affect the boys rather more than the girls. Science interest is a factor which is more important in determining success for the boys than it is for the girls and tough-minded boys do well, whereas tender-mindedness is a factor which helps to determine success for the girls.

REGRESSION ANALYSIS FOR PERCENTAGE IMPROVEMENT.

INDEPENDENT VARIABLE	PARTIAL CORRELATION	
	GIRLS	BOYS
INTELL	+0.47	+0.36
ERRORS	-0.43	-0.48
ATTIT1	+0.20	-0.06
MONTHS	+0.13	+0.17
PUPOP3	-0.06	+0.03
PERSO2	-0.11	+0.14
PERSO9	+0.02	-0.04

B. THE TEACHERS' RESULTS.

Two questionnaires, "Survey of Opinions about Education" and "Survey of Opinions about Programmed Learning" were distributed to four Comprehensive schools in Gloucestershire. The author's colleagues in the experimental school were approached directly and this elicited a good response of thirty four returns from a staff of about forty five teachers. One of the other three schools contacted was a recently opened, purpose-built school and fifteen replies were received from forty teachers. Of the other two schools involved, one returned only six completed questionnaires and the other only seven. This meant that a total of sixty two replies were received by the author, but of these, only thirty four felt that they knew enough about programmed instruction to have formulated any opinion about it.

The distribution of completed returns is shown in Table 41.

Table 41.

Responses of schools to attitude questionnaires.

	Opinions about Education		Opinions about Programmed Instruction
School	No.of responses	% of staff replying	No. of responses
C	34	77%	19
B	15	38%	8
W	7	16%	5
G	6	13%	3
Totals	62		35

This analysis shows a general lack of enthusiasm towards research in schools other than those which are relatively new and those where the teachers can be actively coerced into taking part. The replies also show an abysmal lack of knowledge concerning programmed instruction. Of the sixty two replies received, only thirty five felt able to express any opinions about programmed instruction. This indicates that almost half of the teachers who replied had insufficient knowledge concerning programmed instruction to make considered judgements about the method. One may reasonably assume that those teachers who did reply show some interest in research and modern teaching methods and they may not represent an accurate cross-section of all teachers in Comprehensive schools. If this is the case, then the percentage of teachers having a knowledge of programmed instruction could be considerably less than fifty per cent.

Of the twenty seven teachers who felt unable to answer the questionnaire concerned with programmed learning, two had actually used the method in the classroom. This disconcerting fact may indicate that there are teachers who will use a method of teaching, yet make no effort to find out anything about that method of instruction.

The thirty five replies to the programmed learning questionnaire were further analysed and it was found that only twenty had actually used programmed instruction in the classroom. This means that fifteen teachers in the sample gave their opinions without an actual working knowledge of the method, so that only about one third of the total sample had actually used programme instruction. The proportion of teachers in Comprehensive schools who have actually used programmed instruction is likely to be considerably less than one in three as the particular sample involved may not be a true cross-section of all teachers for reasons outlined earlier.

A further analysis of the replies to the programmed learning questionnaire showed that of those teachers who had used the method, forty per cent taught arts subjects and sixty per cent taught science subjects. The greater percentage using science programmes is in keeping with the fact that there are more published science programmes than arts programmes.

1. Opinions about Education.

The Questionnaire concerned with attitudes towards education yielded three scores. The scales were marked using a factorial scoring stencil and means and standard deviations were calculated for Naturalism, Radicalism, and Tendermindedness. The results are shown in Table 42 for the thirty five teachers who also completed the questionnaire concerned with programmed instruction.

Table 42.

Means and Standard Deviations for "Opinions about Education". (N = 35).

Variable	Mean	S.D.
Naturalism	55.91	6.11
Radicalism	73.14	9.19
Tendermindedness	80.26	12.00

As the sample of teachers completing all the questionnaires was much smaller than had been anticipated, separate analyses for the age and sex of the teachers concerned were not carried out. Mean scores however for the teachers in the sample who did not complete the programmed learning questionnaire are given in Table 43.

Table 43.

Means and Standard Deviations for Opinions about Education. (N = 27).

Variable	Mean	S.D.
Naturalism	57.30	5.61
Radicalism	71.85	9.14
Tendermindedness	82.48	14.36

These results show that the teachers who had some knowledge of programmed instruction were more radical in their opinions concerning education; they were also more toughminded and idealistic than their colleagues.

The differences in the mean scores for the two groups were then tested for significance using the t-test for the significance between two means. The results are summarised in Table 44.

Table 44.

t-test for significance of difference between means for "Opinions about Education".

Variable	t-score	Significance level
Naturalism	0.93	Not significant
Radicalism	0.55	Not significant
Tendermindedness	0.65	Not significant

These results show that the differences between the groups are too small to be significant.

The questionnaire concerned with opinions about education invited subjects to add to the answers given in a separate space provided. Many teachers did in fact take the opportunity to qualify their answers and the most frequently recurring comments are given in Table 45.

Table 45

Teachers' comments on "Opinions about Education".

Part 1.	Debatable opinions about Education.
Q.1.	The time to begin reading lessons is when the children feel the need for them.
Comment:	It all depends on the type of child.
Q.2.	You cannot expect children to write good English unless they have a good foundation in grammar.
Comment:	What is meant by "good English"?
Q.8.	The teacher should not stand in the way of a child's efforts to learn in his own fashion.
Comments:	(a) Child could be disruptive. (b) Basic code is necessary. (c) Sometimes yes, sometimes no.
Part 11.	Suggested changes in education.
Q.1.	Fewer free school meals.
Comment:	What has this to do with education?
Part 111.	Reasons for teaching different subjects.
Q.4.	Reasons for Religious Instruction.
Comment:	Religious Instruction should be replaced with Religious Education.

Twenty five teachers out of the total sample of sixty two took the opportunity to comment on the questionnaire. When these replies were further analysed, forty three per cent of the teachers who had a knowledge of programmed instruction made comments, and thirty seven per cent of those who had little or no knowledge of programmed instruction qualified their answers.

2. Opinions about Programmed Learning.

The questionnaire used to measure the attitudes of teachers towards programmed instruction was constructed by the author and a copy is in Appendix V. The questionnaire contained twenty statements concerning programmed instruction and each statement was marked on a five point scale ranging from 4 marks for strongly agreeing with a statement to zero marks for strongly disagreeing with a statement. Ten statements were favourable towards programmed instruction and ten were un-favourable and the scoring was arranged so that the favourable statements were scored positive and the un-favourable statements negative. This gave a range of scores from +40 to -40 so that a neutral attitude had a score of zero.

The mean attitude score for the sample was +13.26 and the standard deviation was 8.05. This shows that the teachers concerned had favourable attitudes towards programmed instruction and the t-test for the significance of a single mean was applied to the result. The t-score was calculated to be $t = 7.74$ and this figure is significant at the 1% level of significance. This means that the group of teachers who had a knowledge of programmed instruction were favourably inclined towards it.

The "Opinions about Programmed Learning" questionnaire also invited teachers to comment on the questionnaire if they wished to qualify their answers in any way. Of the thirty five teachers who completed the questionnaire, twenty one (60%) took advantage of the invitation and the main points arising from the comments are summarised as follows:-

1. The replies to many of the statements depend on the quality of the programme.
2. The questionnaire assumes programmed learning/no programmed learning.
3. The replies are given assuming that programmed learning is used as an adjunct to conventional teaching.
4. It depends on the subject being taught.
5. It depends on the type of child,
   e.g. Q.7. Programmed learning causes pupils to become bored with their work.

   Comment: Some do, some do not.
6. Opinion C given to some statements, because the reply depends on the particular situation.

As pointed out earlier in this chapter the validity of attitude questionnaires is particularly difficult to assess and one can only assume that the content validity of the questionnaire used is satisfactory as the statements were assessed for favourability by a group of competent independent "judges".

The questionnaire was constructed in a similar manner to the pupil attitude scale and it was therefore suitable for splitting into equivalent halves to measure the reliability. The split-half correlation coefficient was $r = +0.753$ and when this was adjusted by the Spearman-Brown formula for the complete questionnaire it yielded a value of $r = +0.859$. This result falls within the range of +0.75 and +0.90 suggested by Vernon (1938) and the author feels that this shows the questionnaire to be very reliable.

3. Correlational Analysis.

Scores for naturalism, radicalism, tendermindedness in education and attitude to programmed instruction, together with the age and sex of the teachers in the sample, were correlated and the correlation matrix is shown in Table 46.

Table 46.

Correlation matrix for teachers' variables.

Key:
1. Naturalism
2. Radicalism
3. Tendermindedness
4. Age
5. Sex (male = 1, female = 0)
6. Attitude to programmed instruction

	1	2	3	4	5	6
1	1.00	0.24	0.59*	-0.42*	0.23	0.31
2		1.00	0.15	-0.06	0.03	0.51*
3			1.00	-0.24	0.00	-0.02
4				1.00	0.18	-0.02
5					1.00	0.05
6						1.00

* Significant at 5% level.

These results show that the teachers holding the most favourable attitudes towards programmed instruction are those with radical views on education. They also have a naturalistic rather than idealistic viewpoint of education, although this particular correlation $r = +0.31$ marginally failed to reach the significance level. There appeared to be no age or sex differences.

The naturalistic teachers were seen to be very tenderminded and they were the younger teachers. These teachers were also more radical (not significant) and the men were more naturalistic than the women (not significant). The younger teachers were also more tenderminded than their older colleagues although this correlation was not significant.

C. DISCUSSION OF RESULTS.

1. The Pupils.

The analysis of the programme details showed that the pupils made rather more errors than one would expect from a linear programme. Skinner (1954) advocated an error rate of about 5% from this type of programme for optimum learning, although the generally accepted figure now is about 10%. The error rate in the present study varied between 15% for the older pupils and 17% for the younger ones and this was in spite of the fact that the programme had been validated in the preliminary experiment. The fact that the pupils found the programme more difficult than expected, however, did not prevent significant learning from taking place. This study supports the work of Schramm (1964) who writes that the research leaves us in no doubt of the fact that programmed instruction can teach.

The linear programme and the achievement test used are considered by the author to test the first two objectives of Bloom's taxonomy i.e. knowledge and comprehension, and as the programme was used as part of a revision scheme, support is given to the contention of Noble (1966) that programmed instruction can teach specifics or can build on existing knowledge rather than teach all the tasks of Bloom's taxonomy. The significant positive correlation between percentage improvement and pre-test scores showed that the pupils who gained most from the programme were those who already had some knowledge of the subject matter.

This is also in agreement with the view of Gagné (1962) who suggests that programmed instruction can best be used to supplement existing knowledge.

The successful pupils were those who made fewer errors on the programme and worked quickly through it. This finding is in agreement with that of Knight (1963) in the Royal Air Force study and gives no support for the early studies of Porter (1959) and Coulson and Silberman (1960) who found that errors committed did not relate to performance. The author feels that the work of Elley (1966) is important in this discussion. Elley found that the nature of the task was the important factor when considering errors and that a concept attainment task would not be expected to show a relationship between errors and performance, whereas a rote-learning task would show some correlation. As the present study was concerned with factual, objective material the significant negative correlation between percentage improvement and errors contributes further evidence in support of Elley's findings.

The significant correlation of $r = +0.525$ between percentage improvement scores and intelligence supports the findings of Lambert, Miller and Willey (1962), Larkin and Leith (1964), Leith and Davis (1966) and others. The issue concerning intelligence is confusing as several researchers had found no relationship between performance and intelligence following a linear programme. Leith (1963) however, suggests that the relationship may only be apparent when the programme is sufficiently difficult to test even the most able of students.

The present study could well support this viewpoint as the programme did in fact turn out to be rather more difficult than expected.

Reading speed was not an important variable in determining performance, but reading vocabulary and comprehension were significant. As programmed instruction relies heavily on verbal material the author felt that reading ability would be important and the results are similar to those obtained by Lankford (1964), Eigen and Feldhusen (1964) and Noble (1969).

The study found that there were no differences in the performance of girls and boys. This finding supports that of Noble (1969) and Hartley (1966b) who points out that although girls tended to make fewer errors than boys, there were no performance differences between the sexes. Apart from making fewer errors than the boys, the girls were also less affected by the errors they made. This indicates that girls are better able than boys to benefit from difficult programmes such as the one used in the present study.

The children in this study were found to be rather self-sufficient and resourceful and the author feels that this could well be a characteristic of the school which has a high reputation for developing these particular personality traits. Cattell's H.S.P.Q. also showed that the pupils making the greatest gains from programmed instruction were tense and overwrought i.e. anxious. This result supports the findings of Traweek (1964), Leith and Bosett (1967), Leith (1969) and others that anxious children gain most from linear programmes.

When the results of the present study were analysed for boys and girls separately it was found that the successful girls were rather aggressive, impatient, enthusiastic and persistent. These tendencies are characteristic of extroversion as defined by Cattell & Cattell (1969) and it would appear that the successful girls are the tenderminded, anxious extroverts. The analysis for the boys showed that success was more likely for those with adventurous tendencies; these boys were, however, less tenderminded and less aggressive than the girls. Noble (1969) found that aggressive enthusiastic extroverts gained most from programmed instruction and Bosworth (1971) also found extroversion to be an important factor.

The fact that the successful children were anxious could be because few errors are made on a linear programme so that anxious tendencies are subdued, whereas in a conventional classroom situation tendencies to be anxious may hinder success. Very few of the earlier researchers analysed the results for girls and boys separately and this study shows that the link between extroversion and success is only evident for the girls.

All groups of pupils in the experiment were found to have favourable attitudes towards programmed instruction and the questionnaire used was found to be reliable. This results is in agreement with the view of Hartly (1966a) and others that short-term programmes create favourable attitudes. The analysis of attitude scores for the boys and girls separately again showed very important differences. The results indicate that the attitudes of girls are far more important in predicting success from programmed instruction than the attitudes of boys. Noble and Gray (1968), using an intrinsic programme, also found that girls held more favourable attitudes than boys. In the present study the regression analysis, using percentage improvement as the dependent variable, gave partial correlation coefficients for the attitudes of girls and boys as +0.20 and -0.06 respectively. Page 129. This shows that the regression relationship for girls is positive and for boys negative, so that in an analysis which does not separate the sexes, the effect of attitude is partially cancelled out. It could well be that attitude scales with different norms for girls and boys are needed and this suggests a possible area for further research.

The older children in the sample showed less favourable attitudes than the younger ones and this could be because they are less able to adapt to new teaching methods than are younger children who are less dependent on conventional instruction. The older children are also orientated towards external examinations and they may feel that any innovation is an unwelcome distraction. The fact that the younger pupils who benefitted least from the programme held the most favourable attitudes is in agreement with the findings of Noble and Gray (1968).

The general picture which emerges from this study is that the pupils who gained most from the programme were the older more intelligent pupils with good reading ability who made fewest errors on the programme, worked quickly through it and had some pre-knowledge of the subject matter. The successful pupils also showed a strong interest in science, liked school and displayed anxious tendencies. The successful girls were more extrovert than the boys; they were also tender-minded and had less interest in science than boys. The fact that the successful girls were tenderminded and not as interested in science as the boys could well be due to role-expectancy. Society expects boys to be more tough-minded and more interested in science than girls and success from programmed learning reflects these expectations. Programmed instruction was favourably accepted by all groups of pupils but there was a tendency for younger pupils to favour the method most, especially the younger girls. The self-assured, composed children held the most favourable attitudes and these tended to be those who benefitted least from the programme.

2. The Teachers.

This particular aspect of the study showed that teachers generally are not very enthusiastic about taking part in educational research, and of those that did co-operate, there was a considerable lack of knowledge concerning programmed instruction. Only a small proportion of teachers had actually used programmed instruction in the classroom, and more use was made of science rather than arts programmes.

The teachers who had some knowledge of programmed instruction were found to be more radical in their opinions about education and more tough-minded and idealistic than their colleagues, but none of these differences were significant. The teachers with a knowledge of programmed instruction were favourably inclined towards it. Those holding the most favourable attitudes to programmed instruction held the most radical views on education and they were also naturalistic rather than idealistic. This result differs from that of Hartley and Holt (1971) who found that attitudes to new educational media did not correlate with any of the three scales for naturalism, radicalism and tendermindedness. Hartley and Holt suggest, however, that their composite scale may not be particularly useful and that separate scales for different media would be more appropriate. This study did, in fact, establish a reliable scale for the assessment of teachers' attitudes to programmed instruction and it has shown that the radical, naturalistic teachers hold the most favourable attitudes. This is a very important finding as the studies of Cavanagh (1967) and of Hooley and Jones (1970) suggest that although the attitudes of teachers do not affect the achievement of the pupils, they do affect the pupils' attitudes towards programmed instruction.

This study found that the age and sex of the teachers had no bearing on their attitudes towards programmed instruction. The idealistic teachers were generally older and more tough-minded than their colleagues and this is in agreement with the findings of Pollock (1965). The naturalistic teachers were alsoseen to be more radical than their colleagues and this supports the finding of Rushton & Ward (1969) that both radicalism and tendermindedness are correlated with naturalism. There was further agreement with the finding that the sex of the teachers is not significantly related to any of the three scales.

....

This study has shown that a practising teacher can write a a linear programme which is an effective teaching aid. All groups of pupils made significant gains and there were no performance differences for the boys and girls. It is evident that there are certain personality differences which affect performance and attitudes, and in the multi-activity, mixed-ability classrooms of today it is extremely important that some attempt is made to select those children who will gain most academically, or be happiest using, programmed instruction.

As the attitudes of teachers are important in moulding the attitudes of pupils it is necessary to find out which type of teacher is best equipped to use programmed instruction. This study isolated some of the characteristics of teachers who favoured programmed instruction and it established a reliable scale specifically designed to assess the attitudes of teachers to programmed instruction.

CHAPTER V

CONCLUSIONS AND PROPOSALS.

A. CONCLUSIONS.

1. The pupils who made the greatest gains from the linear programme were the older, more intelligent children who were good readers.
2. The successful children made fewer errors on the programme and the error rate affected the performance of the boys rather more than the girls.
3. There were no significant performance differences between the girls and the boys.
4. The boys who made the greatest gains from the programme were anxious but adventurous, whereas the successful girls were also anxious, but more extroverted and tenderminded than the boys. The successful boys also had very strong science interests.
5. Pre-test scores were a recurrent predictor of success and this suggests that programmed instruction can be a useful aid to revision. The relationship between pre-test and success, however, may to some extent be a consequence of the criterion used to assess learning.
6. All groups of children had favourable attitudes towards programmed instruction.
7. Favourable attitudes towards programmed instruction were positively related to achievement, but the attitudes of girls were more important than those of boys in predicting success.

8. More favourable attitudes towards programmed instruction were shown by younger pupils who were reserved, mild mannered and undemonstrative.

9. The sample of teachers participating in the research was too small to enable the author to reach any firm conclusions concerning the attitudes of teachers towards programmed instruction. The following points did, however, emerge from the study:

(a) Teachers holding the most favourable attitudes towards programmed instruction appeared to have more radical views on education and they also had naturalistic tendencies.

(b) There was no indication that attitudes towards programmed instruction were related to the age or sex of the teachers.

B PROPOSALS

1. The attitudes of girls appear to be more important in predicting success from programmed instruction than the boys. A possible area for further research could be an examination of the different methods that could be used for the assessment of attitudes and a large scale experiment could investigate sex differences in attitude measurement.

2. Only a small proportion of practising teachers had a knowledge of programmed instruction and it would appear advisable for more short courses to be available for teachers to acquaint themselves with new teaching techniques.

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LIST OF APPENDICES.

APPENDIX I

A LINEAR PROGRAMME ON THE STRUCTURE OF THE ATOM.

Notes on the use of this booklet.

1. Do NOT read down the page as in a normal text book.
2. The work has been arranged in short steps called frames.
3. Read Frame 1 on page 1, and record your answer on the piece of paper provided.
4. The answer to Frame 1 is alongside Frame 2 on page 2. Check your answer and mark it right or wrong.
5. Read Frame 2 and record your answer. Check the answer on page 3 and work through the booklet.
6. When you reach Frame 20 turn back to page 1 and continue as before.
7. You MUST write out your answers on the SEPARATE piece of paper provided. Do NOT write any answers in this booklet.
8. Tell your teacher when you have completed the work.

1. All objects in the universe, living or non-living are made ofmatter.

Both you and the chair you occupy are made of.________

21. A molecule of carbon dioxide is formed when __________ of carbon and oxygen join chemically.

ATOM.

ATOM.

The compound carbon dioxide is formed when the elements carbon and oxygen combine chemically in a particular way.

41. The atom can now be thought of as a very small solar system. The nucleus acts as the SUN and the orbiting ---_______ as the planets.

ELECTRONS

PROTONS

61. We can now say that the atomic mass of an element is the number of times that 1 atom of the element is heavier than 1 atom of hydrogen.

HYDROGEN.

A hydrogen atom has 1 electron in orbit (with a mass which is too small to be considered), and 1 __________ in the nucleus.

81. The number of protons plus the number of __________ gives the atomic mass of uranium to be 238.

92

92

101. Sketch an oxygen atom of atomic mass 16 and atomic number 8.

10.

MATTER.

2. Matter can exist in three basic states:
solids, liquids, and gases.
Wood is a solid; water is a ——; hydrogen is a gas.

ATOMS.

22. The basic building block of an element such as tin is the —— and the basic building block of a compound such as water is the ——.

ELECTRONS.

42. The atoms of different elements differ from one another by having different numbers of orbiting electrons.

An atom of the element iron has a different number of orbiting —— from an atom of the element lead.

PROTON.

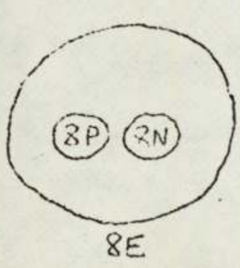
62. The helium atom contains 2 protons and 2 neutrons.

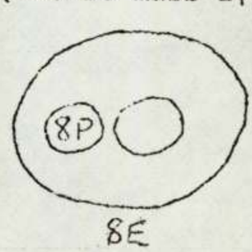
Therefore the atomic mass of helium is ——.

NEUTRONS.

82. Since the atomic number of uranium is 92 and the atomic mass is 238, a uranium atom must have —— neutrons in the nucleus.

102. Complete this sketch of the second isotope of oxygen (atomic mass 17).





LIQUID.

3. Wood, water, and hydrogen are three different states of ------.

ATOM.

MOLECULE.

23. The atoms of an element sometimes combine to form molecules of the element.
When an element such as hydrogen exists as a gas, two atoms of hydrogen combine to form a ------ of hydrogen.

ELECTRONS.

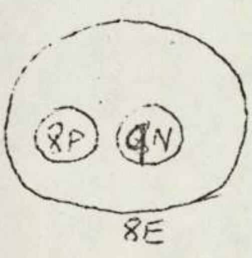
43. We have seen previously that ordinary atoms are electrically neutral which means that they must contain equal numbers of protons and electrons.
A carbon atom has 6 protons and ------ electrons.

4.

63. The mass of any atom is concentrated at the centre in the ------ which is a very dense core made up of protons and neutrons. The hydrogen atom is the exception as it has no ------ in the nucleus.

146

83. An atom of gold has 79 protons and 118 neutrons.
The atomic mass of gold is ------.



103. Sketch the third isotope of oxygen. Atomic mass 18, atomic number 8.

MATTER.

4. Wood is an example of matter in the ----- state.

Matter can be classified into three groups: elements, compounds and mixtures.

Wood must be an element, a compound, or a mixture.

MOLECULE.

24. Nitrogen is an element existing as a gas in the mixture called air.

Two ----- of nitrogen combine to form a ----- of nitrogen.

6.

44. An atom of sodium has 11 electrons and ----- protons.

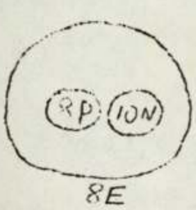
NUCLEUS.

NEUTRONS.

64. Although the mass of an atom (neutrons and protons) is concentrated in the -----, the space (volume) taken up by these particles is only a very tiny fraction of the total space (volume) taken up by the atom itself.

197.

84. Sketch a gold atom. (118 neutrons, atomic mass 197).



104. Hydrogen has the atomic number 1. In its normal form it has 1 ----- and 1 ----- and an atomic mass -----.

SOLID.

5. An element is a substance which cannot be split up by chemical means into other simpler substances.
Iron cannot be split up by chemical means into other simpler substances.
Therefore iron must be an example of a ——.

ATOMS.
MOLECULE.

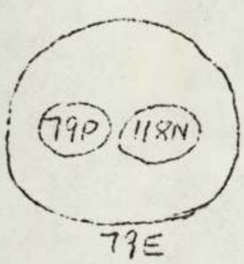
25. There are about 90 different naturally occurring elements known to scientists and several which can be artificially made.
Because the atom is the basic building block of all elements there must be about 90 different kinds of naturally occurring ——.

11.

45. The different elements in existence are listed in order from those whose atoms are simplest to those which are most complicated; this list is called the Periodic Table. The position of each element in this table is determined by the number of protons each of its atoms contains.
The number of protons in an atom will be the same as the number of ——.

NUCLEUS.

65. The orbiting electrons are at large distances from the nucleus. In fact, the diameter of an atom is about 10,000 times the diameter of its nucleus. This means that a —— is mostly empty space.



85. All atoms of the same element have the same atomic number.
All such atoms have the same number of —— and ——.

PROTON &
ELECTRON
or
ELECTRON &
PROTON

1.

105. It is found in nature that 1 atom in about 6,500 of hydrogen has an atomic mass 2.
This isotope of hydrogen must have 1 proton and 1 —— in the nucleus.

ELEMENT.

6. A COMPOUND is a substance which is made up of two or more elements joined together chemically.

When the elements hydrogen and oxygen join together chemically they can make a ----- called water.

ATOMS.

26. The 90 different kinds of atoms can combine in different ways to form many different kinds of molecules in the same way that the 26 letters of the alphabet can form many different words.

Thus a vast number of different substances exist in the universe although there are only about ----- different kinds of naturally occurring atoms.

ELECTRONS.

46. The number of protons in an atom of an element decide its position in the Periodic Table and this is called the ATOMIC NUMBER of the element.

The atomic number of an element is equal to the number of ----- there are in the nucleus of an atom of the element.

ATOM.

66. Although an atom is mostly empty space it behaves as if it were a very hard solid. This is because the orbiting ----- are moving at very high speeds. (about 30,000,000 metres/sec.)

PROTONS & ELECTRONS or ELECTRONS & PROTONS.

86. It is possible however for atoms of the same element to have different masses, i.e. different atomic masses.

Thus, certain elements are found to have different atomic masses but the same atomic -----.

NEUTRON.

106. This isotope of hydrogen with atomic mass 2 is called deuterium and is sometimes referred to as heavy hydrogen.

A deuterium atom is ----- as heavy as an ordinary hydrogen atom.

COMPOUND.

7. Sodium and chlorine are elements. They can be joined together chemically to form a substance called sodium chloride (common salt).

Sodium chloride is an example of a ------.

90.

27. REVISION FRAME.

A molecule of a substance is formed by the combination of atoms. There are only about 90 different kinds of natural atoms but there are many different kinds of molecules.

PROTONS.

47. The simplest atom that is known to exist is the hydrogen atom; it has one proton in the nucleus.

This means that hydrogen has the atomic number ------.

ELECTRONS.

67. The high speed orbiting electrons protect an atom and make it very difficult for anything to penetrate and reach the ------ of the atom.

NUMBER.

87. Elements with the same atomic number but different atomic masses are called ISOTOPES.

The difference between isotopes of the same element is in the atomic ------ of the atoms.

TWICE.

107. Sketch a deuterium atom.

COMPOUND.

8. A MIXTURE is formed when elements, compounds, or elements and compounds come together WITHOUT joining chemically,

Brass is formed when the elements copper and zinc come together in certain amounts without joining chemically.

Brass is an example of a ——.

28. Scientists originally thought that atoms were small hard indivisible particles, but it is now known that they have a complicated structure of their own,

We do know, however, that all —— of the same element must have the same internal structure.

1.

48. An atom of hydrogen (atomic number 1) has —— proton and —— electron.

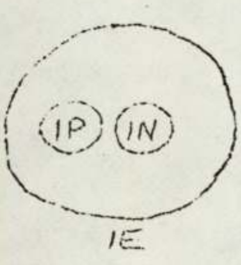
NUCLEUS.

68. Individual atoms are very small. The diameter of a hydrogen atom is about 0.0000000001 metre.

This means that about ten thousand million hydrogen —— would be needed to make a line 1 metre long.

MASSES.

88. Atoms of the same element having different atomic masses are called ——.



108. A third very rare isotope of hydrogen called tritium can be produced artificially and a tritium atom has an atomic mass 3.

As it is still hydrogen however it has the atomic number ——.

MIXTURE.

9. Air is made up mainly of nitrogen and oxygen with small amounts of water vapour, carbon dioxide and other gases which are NOT joined together chemically.
Air is an example of a ------.

ATOMS.

29. Every atom is now known to be made up of small,particles, many of which are electrically charged. Some of these particles carry a positive charge and some a negative charge.
Atoms therefore contain both positive and ------ electricity.

1.
1.

49. A hydrogen atom can now be pictured as having 1 ------ orbiting round 1 ------ in the nucleus of the atom.

ATOMS.

69. Because of their small size atoms also have an extremely small mass. An atom is too ------ to be seen with the most powerful microscope and too light to be weighed with the most sensitive balance.

ISOTOPES.

89. Since normal atoms are electrically neutral the number of protons in the nucleus must be equal to the number of ------ and this is called the atomic number.

1.

109. Because the third isotope of hydrogen (tritium) has the atomic number 1 and the atomic mass 3, it must have ------ neutrons in the nucleus,

MIXTURE.

10. An element is the simplest form of matter which can exist.
Compounds and ------ can both be broken down into simpler forms of matter (elements).

NEGATIVE.

30. Ordinary atoms of a substance are electrically neutral.
This means that an atom contains equal amounts of ------ and ------ electricity.

ELECTRON.
PROTON.

50. Helium is an element with atomic number 2.
A helium atom must therefore have ------ protons and ------ planetary electrons.

SMALL.

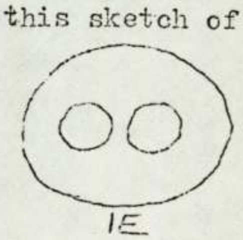
70. REVISION FRAME.
The atomic number of an element is the number of protons within the nucleus of an atom of the element. The atomic mass of an element is the number of times that 1 atom of the element is heavier than 1 atom of hydrogen.

ELECTRONS.

90. This means that the difference in mass between 2 atoms of the same element cannot be due to a different number of protons.
The difference in mass must therefore be due to a different number of ------.

2.

110. Complete this sketch of a tritium atom.



MIXTURES.

11. Copper is a substance which cannot be split up chemically into other substances.
Copper is an example of a ——.

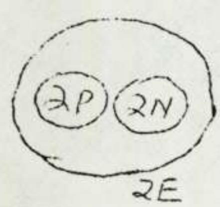
POSITIVE &
NEGATIVE
or
NEGATIVE &
POSITIVE.

31. The first particle to be found INSIDE an atom was the ELECTRON, and all atoms contain electrons within their structure.
All atoms of the element lead must contain small particles called —— within their structure.

2.
2.

51. REVISION FRAME.
The number of protons in an atom of an element is equal to the number of electrons (so that the atom is electrically neutral) and this number is called the atomic number of the element.

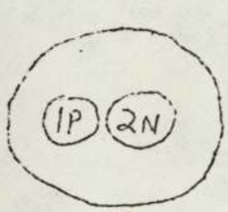
71. DIAGRAMMATIC REPRESENTATION.
A helium atom can be sketched as shown:



KEY: E - electron
P - proton
N - neutron.

NEUTRONS.

91. The difference between isotopes of the same element is in the number of —— contained in the nucleus of the atoms.



111. All three isotopes of hydrogen have the atomic number 1 and so have only 1 proton. They have different atomic —— because they have different numbers of neutrons in the ——.

ELEMENT.

12. The following three substances have been mentioned earlier in the programme: air, hydrogen, water. Write down which is an element, which is a compound, and which is a mixture.

ELECTRONS.

32. Electrons are extremely small particles and they carry a fixed amount of negative electricity.

Ordinary atoms are electrically neutral. As electrons carry negative electricity there must be other particles carrying ----- electricity.

52. The hydrogen atom has 1 proton and 1 electron; the helium atom has 2 protons and 2 electrons.

This means that the hydrogen atom has two particles and the helium atom has four particles so that it may be expected that a helium atom is ----- as heavy as a hydrogen atom.

72. Sketch a hydrogen atom. (1 proton, 1 electron).

NEUTRONS.

92. There are two atoms of the element chlorine which have the same atomic number but a different atomic mass.

These are called ----- of chlorine.

MASSES.

NUCLEUS.

112. Nitrogen has an atomic number 7 and the atoms exist in two forms.

These different forms of the same element are called ----- of nitrogen.

ELEMENT: hydrogen
COMPOUND: water.
MIXTURE: air.

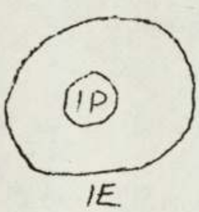
13. REVISION FRAME.
An element is a substance which cannot be split up by chemical means into other simpler substances.
A compound is a substance which is composed of two or more elements chemically combined.

POSITIVE.

33. The particles within an atom carrying the positive electric charges are called PROTONS.
Atoms contain small particles called ----- which carry a fixed amount of positive electricity.

TWICE.

53. It is found, however, that a helium atom is FOUR times as heavy as a hydrogen atom. This extra mass is due to TWO EXTRA particles in the nucleus of the ----- atom.



73. Lithium is an element; it has 3 orbiting electrons and three protons in the nucleus so that it is electrically neutral.
The atomic number of lithium is -----.

ISOTOPES.

93. One atom of chlorine has an atomic number 17 and an atomic mass 35.
This particular atom has ----- electrons, ----- protons, and ----- neutrons.

ISOTOPES.

113. The most common nitrogen atom has the atomic mass 14 and the atomic number 7.
Sketch this isotope of nitrogen.

14. All matter is found to be made up of small pieces called particles. This means that when matter is broken down into smaller pieces a stage is reached when it cannot be broken down any further without destroying its nature.

The 3 basic states of matter, solids, liquids and ------ are made up of particles.

PROTONS.

34. All atoms of every element contain negatively charged particles called ------ and positively charged particles called ------.

HELIUM.

54. The two extra particles in the ------ of the helium atom are called NEUTRONS.

The nucleus of a helium atom must contain 2 protons and 2 ------.

3.

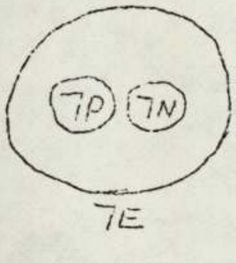
74. A normal lithium atom has 4 neutrons in the nucleus together with the three protons.

There are ------ heavy particles within the nucleus of a lithium atom

17.
17.
18.

94. The second atom of chlorine however has the atomic number 17 and atomic mass 37.

This isotope must have ------ electrons, ------ protons, and ------ neutrons.



114. The second isotope of nitrogen has 8 neutrons in the nucleus.

The atomic mass of this isotope must be ------.

[redacted]

GASES.

15. When an element is broken down to the smallest particles possible without destroying its nature, then the particle is called an ATOM.
The ——— is the basic building block of an element.

ELECTRONS.

PROTONS.

35. The amount of electric charge carried by 1 proton is equal to the amount carried by 1 electron.
Therefore an ordinary neutral atom has equal numbers of ——— and ———.

NUCLEUS.

NEUTRONS.

55. A helium atom (with 2 protons and 2 neutrons) is 4 times as heavy as a hydrogen atom (1 proton).
This means that the mass of a proton must be equal to the mass of a ———.

7.

75. A hydrogen atom has only 1 proton as its nucleus. This means that a lithium atom is 7 times as heavy as a hydrogen atom.
The atomic mass of lithium must be ———.

17.

17.

20.

95. The chemical properties of elements depend only on the number of electrons contained in the atoms.
Therefore isotopes of an element, although having different atomic ———, have the same chemical properties.

15.

115. Sketch the second isotope of nitrogen.
(atomic number 7, atomic mass 15.)

ATOM.

16. Lead is an element.
The smallest particle of lead which can exist alone and maintain the characteristics of lead is a(n) ------.

PROTONS & ELECTRONS or ELECTRONS & PROTONS.

36. The mass of a proton is found to be about 1850 times greater than the mass of an electron.
An electron has a very much smaller mass than a ------.

NEUTRON.

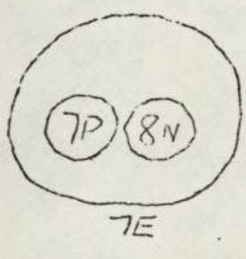
56. Ordinary atoms are electrically neutral. We have seen earlier that a proton carries a ------ charge which balances out the charge carried by an electron.

7.

76. Sketch a lithium atom.
(4 neutrons, 3 protons).

MASSES.

96. The two isotopes of chlorine must have the same chemical properties because they have the same number of electrons.
They also have the same atomic number but different atomic ------.



116. REVISION FRAME.
Isotopes are elements having the same chemical properties but different atomic masses. Their atoms have the same number of electrons and protons but different numbers of neutrons.

YOU HAVE NOW COMPLETED THE PROGRAMME.

ATOM.

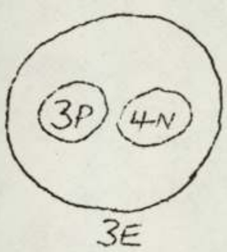
17. All atoms of a particular element are alike, but they are different from atoms of other elements.
All atoms of gold are alike but they are ----- from atoms of silver.

PROTON.

37. In considering the total mass of an atom, the mass of the ----- can be neglected (not taken into account) because it is so much smaller than the mass of the -----.

POSITIVE.

57. The ----- is therefore an extra particle inside the nucleus of an atom, having the same mass as a proton, but having NO electric charge.



77. The element with atomic number 4 is called beryllium.
A beryllium atom must have ----- protons and ----- electrons.

MASSES.

97. The average atomic mass of the element chlorine is 35.5. This is because there are more atoms of atomic mass 35 than there are of atomic ----- 37.

DIFFERENT.

18. The smallest particle (grain) of a compound capable of existing alone and maintaining the characteristics of a compound is called a MOLECULE.
The molecule is the basic building block of a(an) ------.

ELECTRONS.
PROTON

38. The protons in an atom are always packed closely together in the centre of the atom which is called the NUCLEUS.
The nucleus of an atom must therefore contain ------ electricity.

NEUTRON.

58. REVISION FRAME.
Atoms are made up of three basic particles: electrons, protons and neutrons. Electrons are orbiting particles of very small mass carrying a negative charge, Protons and neutrons contain most of the mass of an atom and they are found in the nucleus. Protons carry a positive charge and neutrons are uncharged.

4.
4.

78. The atomic mass of beryllium is 9.
Since a beryllium atom has only 4 protons in the nucleus, it must have ------ neutrons to give it an atomic mass of 9.

MASS.

98. Three types of oxygen are found; they have atomic masses 16, 17, and 18.
These three isotopes of oxygen must all have the same ------ 8.

COMPOUND.

19. Common salt is a compound.
The smallest particle of common salt which can exist alone and maintain the characteristics of common salt is a ——.

POSITIVE.

39. The electrons in an atom are not packed closely together; they are whirling in orbits around the nucleus at very high speeds.
The orbiting particles of an atom are the ——.

59. As the atoms of different elements have different numbers of the ~~relatively~~ heavy particles called —— and —— in the nucleus they will have different atomic masses.

5.

79. Sketch a beryllium atom.
(atomic number 4, atomic mass 9.)

NUMBER.

99. Because all these isotopes of oxygen have the same atomic number 8 they must all contain 8 —— and 8 ——.

MOLECULE.

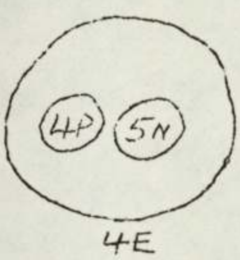
20. A molecule is a combination of atoms.
A molecule of common salt is formed when one ------ of the element sodium combines chemically with one ------ of the element chlorine.

ELECTRONS.

40. The picture we now have of the atom is one of negatively charged ------ orbiting at great speed around a nucleus containing positively charged ------.

NEUTRONS &
PROTONS
or
PROTONS &
NEUTRONS.

60. For accurate scientific work, the mass of a particular carbon atom is used as a standard. However, if we use the HYDROGEN atom as a standard and give it ATOMIC MASS 1, we have a satisfactory approximation.
We shall therefore use the ------ atom as our standard mass.



80. The atom of the heaviest naturally occurring element (uranium) has the atomic number 92.
The uranium atom has ------ protons and ------ electrons.

PROTONS &
ELECTRONS
or
ELECTRONS &
PROTONS.

100. As the atomic masses of the three isotopes of oxygen are 16, 17, and 18, the atoms of these isotopes must contain 8, 9, and ------ neutrons respectively.

APPENDIX II

Record Sheet used by Pupils.

RECORD SHEET.

NAME:

CLASS:

Date:

Time started:

Time finished:

Time taken:

Errors made:

Frame number reached:

Date:

Time started:

Time finished:

Time taken:

Errors made:

Frame number reached:

Date:

Time started:

Time finished:

Time taken:

Errors made:

Frame number reached:

Total time taken =

Total number of errors made =

APPENDIX III.

THE ACHIEVEMENT TEST

ANSWER THE FOLLOWING QUESTIONS:-

1. What is the name given to a substance which cannot be split up by chemical means into other simpler substances?

2. Name the smallest particle of an element which is capable of existing alone and maintaining the characteristics of the element.

3. Name the smallest particle of a compound which is capable of existing alone and maintaining the characteristics of the compound.

4. Which particles within an atom carry a negative electric charge?

5. Which particles within an atom carry a positive electric charge?

6. Which particles within an atom are uncharged?

7. What is the name given to the very dense core at the centre of an atom?

8. Which particle has a mass which is too small to be taken into account when considering the mass of an atom?

9. Is the atomic number of an element (a) the number of protons, or (b) the number of neutrons, within the nucleus of an atom of the element?

10. Is the mass of a neutron (a) greater than that of a proton? (b) less than that of a proton? (c) Approximately equal to that of a proton?

11. Which element is given the atomic mass 1 and used as a standard for comparing the masses of elements?

12. Sketch a helium atom. (2 protons, 2 neutrons, 2 electrons.)

13. What is the atomic number of helium?

14. What is the atomic mass of helium?

? 15. An atom of the element beryllium has 4 protons and 5 neutrons. What is the atomic mass of beryllium?

? 16. An atom of chlorine has an atomic number 17 and an atomic mass 35. How many neutrons does it contain?

17. Sketch a chlorine atom.

18. What is the name given to elements which have the same atomic number but different atomic masses?

? 19. Atoms of nitrogen (atomic number 7) can exist in two forms. One form has 7 neutrons in the nucleus; what is its atomic mass?

? 20. The second form of nitrogen atom has the atomic mass 15. How many neutrons must it contain within the nucleus?

APPENDIX IV(a)

PUPIL OPINION QUESTIONNAIRE: PROGRAMMED LEARNING.

You have recently been using PROGRAMMED LEARNING in your science lessons and the purpose of this questionnaire is to find out what you think about this method of learning. The questionnaire contains statements about PROGRAMMED LEARNING and you are asked to indicate what you feel and think about these statements. This is NOT a test and there are no right or wrong answeres. You are to give your own opinion about each of the statements.

DIRECTIONS.

Please fill in the details on the front page of your separate answer sheets.

Practice Items.

1. Studying science is fun.

A ✓	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

The answer 'A' - strongly agree - has been chosen here and the space for that answer has already been marked on your answer sheet. If the answer 'strongly disagree' had been chosen, then the space under 'E' would have been marked in the same way.

Now try the next practice question yourself, marking the answer in the PRACTICE SECTION in the same way.

2. For science I would rather have theory lessons than do practical work.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

Each statement on the questionnaire looks like the practice items. Read each one carefully and also read each one of the choices given below it. Then decide which ONE answer best fits your feelings and mark the space for that answer on your answer sheet. Choose only one answer for each statement and try to answer each question. Do not write any answers on the test booklet. You will have plenty of time to complete the questionnaire.

QUESTIONNAIRE.

1. Programmed learning makes concentration difficult.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

2. Programmed learning makes difficult work seem easy.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

3. Turning the page over after each question is a nuisance.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

4. Programmed learning is better than the 'usual' science lessons.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

5. You learn a lot without realising it.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

6. It is easy to find the best speed of working with this method.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

7. Programmed learning does not allow you to express yourself properly.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

8. The 'usual' science lessons are better.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

9. This method ought to be used all the time.

A B C D E

strongly agree agree not sure disagree strongly disagree

10. Programmed learning is of no value at all.

A B C D E

strongly agree agree not sure disagree strongly disagree

11. No real learning takes place.

A B C D E

strongly agree agree not sure disagree strongly disagree

12. Programmed learning trains you to work independently.

A B C D E

strongly agree agree not sure disagree strongly disagree

13. Only a few disjointed facts are learnt.

A B C D E

strongly agree agree not sure disagree strongly disagree

14. Programmed learning trains you to think clearly.

A B C D E

strongly agree agree not sure disagree strongly disagree

15. It is difficult to find the best speed at which to work.

A B C D E

strongly agree agree not sure disagree strongly disagree

16. Programmed learning is likely to lead to poor examination results.

A B C D E

strongly agree agree not sure disagree strongly disagree

17. All the page turning adds interest.

A B C D E

strongly agree agree not sure disagree strongly disagree

18. Programmed learning makes it easy to concentrate.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

19. It makes easy work more difficult to learn.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

20. Programmed learning will probably lead to good examination results.

A	B	C	D	E
strongly agree	agree	not sure	disagree	strongly disagree

APPENDIX IV(b)

OPINION QUESTIONNAIRE. PROGRAMMED LEARNING.

ANSWER SHEET.

NAME: ....

BOY/GIRL: ....

SCHOOL: ....

YEAR, SCIENCE CLASS/SET: ....

DATE OF BIRTH: ....

TODAY'S DATE: ....

PRACTICE ITEMS.

1.	A ✓	B	C	D	E
2.	A	B	C	D	E

PLEASE DO NOT WRITE IN THIS SPACE.

YEARS: COMPLETED MONTHS:

ATTITUDE:

SELF RATING:

ANSWER SHEET

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E
9.	A	B	C	D	E
10.	A	B	C	D	E
11.	A	B	C	D	E
12.	A	B	C	D	E
13.	A	B	C	D	E
14.	A	B	C	D	E
15.	A	B	C	D	E
16.	A	B	C	D	E
17.	A	B	C	D	E
18.	A	B	C	D	E
19.	A	B	C	D	E
20.	A	B	C	D	E

The line below represents a scale for attitude towards programmed learning. The scale ranges from extremely favourable at end 'A' to extremely unfavourable at end 'B'. Place a cross on the line to represent your own attitude towards programmed learning.

e.g. If you had an extremely favourable attitude you would place your cross at the end 'A', if unfavourable at end 'B', and if you are not sure you will place your cross in the middle.

NOTE: You may place your cross at ANY point between 'A' and 'B'.

A -------------------------------- B

Extremely favourable. — Extremely unfavourable.

APPENDIX V

SURVEY OF OPINIONS ABOUT PROGRAMMED LEARNING.

NAME:

SUBJECTS TAUGHT:

SCHOOL:

1. Have you ever used Programmed Learning in the classroom? YES/NO.
2. Are you able to give any opinions about statements concerning Programmed Learning? YES/NO.

   If you have answered YES to Question 2, please fill in the following Questionnaire.

PROGRAMMED LEARNING: ATTITUDE QUESTIONNAIRE.

The following statements are opinions about programmed learning which have been expressed by students at a College of Education. You are asked to show agreement or disagreement with each of these statements.

Mark the statements in the following way:

Strongly agree	A
Agree	B
Not sure	C
Disagree	D
Strongly disagree	E

Place your grading on the heavy line alongside each statement.

1. Programmed learning is a gimmick which has no educational value. _ _ _ ______
2. A pupil working through programmed material has a thorough understanding of each step before proceeding to the next. ______ _ _ _
3. The shy, nervous pupil is helped by programmed learning. ______ _ _ _
4. Programmed learning destroys creative thought. _ _ _ ______
5. Pupils lose their individuality when using programmed learning. _ _ _ ______

6. Programmed learning is a valuable teaching aid.
7. Programmed learning causes pupils to become bored with their work.
8. Programmed learning trains a pupil to think clearly.
9. Programmed learning makes it easy to concentrate.
10. Programmed learning is an innovation which will seriously harm progress in education.
11. Programmed learning trains pupils to work independently.
12. Programmed learning is a novelty which will soon lose its appeal.
13. With programmed learning the pupil is encouraged when he/she has the right answer.
14. Pupils using programmed learning acquire only a superficial knowledge.
15. Programmed learning destroys the personal relationship between pupil and teacher.
16. Programmed learning treats pupils as individuals and caters for their individual needs.
17. Pupils using programmed learning grasp only a series of disjointed facts.
18. Programmed learning destroys the literary style of a pupil.
19. Programmed learning is a revolutionary educational aid which will gain universal recognition.
20. Programmed learning trains a student to think logically about everything.

Please use the space below if you wish to add any comments.

APPENDIX VI

LIST OF STATEMENTS CONCERNED WITH PROGRAMMED INSTRUCTION

ISSUED TO FORTY "JUDGES"

1. It is only useful when used for short periods.
2. It helps the slow worker.
3. It would be useful after being absent.
4. It makes concentration difficult.
5. It makes learning easy.
6. It is easy to cheat and this helps you to do well.
7. It is boring.
8. Only a few disjointed facts are learnt.
9. It takes the interest out of learning.
10. It is very useful for homework.
11. It is better than 'usual' class learning.
12. It is no advantage to cheat.
13. It is not a very useful teaching aid.
14. You learn a lot without realising it.
15. It is a good method for the fast worker.
16. You learn more with a programme if you work slowly.
17. It is difficult to pace yourself.
18. The 'usual' methods of teaching are better.
19. This method ought to be used all the time.
20. It is of no value at all.
21. It is useful for revision.
22. It is a good method for older pupils.
23. It is a novelty which will not last.
24. It makes it easier for nervous pupils.

25. It needs too much concentration.

26. It can only be used for small sections of any course.

27. It prevents discussion.

28. Very little thought is required to work through a programme.

29. It is just a gimmick.

30. It trains you to work independently.

31. It is encouraging when you get the right answer.

32. There is less contact with the teacher.

33. You don't take an active part in the lesson.

34. The quietness in the classroom is a bad thing.

35. It can only deal with basic facts.

36. It makes difficult work seem easy.

37. No real learning takes place.

38. Turning the page over after each question is a nuisance.

39. It is difficult to carry on again after a break from it.

40. It takes a long time to learn a small amount.

41. It trains you to think clearly.

42. It does not allow you to express yourself properly.

43. There is no competition with classmates.

44. It is not very suitable for homework.

45. It is likely to lead to poor examination results.

46. Facts learnt by this method are quickly forgotten.

47. Having the right answer all the time makes it dull.

48. All the page turning adds interest.

49. It will probably lead to good examination results.

50. It makes easy work more difficult to learn.

51. It creates a quiet classroom atmosphere.

52. It makes concentration easy.

53. The small steps are too easy to be of any value.

54. It is a very useful teaching aid.

APPENDIX VII(a)

Frequencies of ratings of attitude statements by judges.

(40 judges)

STATE -MENT	FREQUENCIES OF RATINGS 1	2	3	4	5	6	7	8	9
1	0	4	18	5	3	5	5	0	0
2	0	0	1	0	0	2	15	15	7
3	0	0	2	0	0	4	15	10	9
4	7	16	15	0	2	0	0	0	0
5	0	0	0	0	0	0	5	11	24
6	6	13	7	2	3	2	5	1	1
7	29	9	2	0	0	0	0	0	0
8	16	13	6	3	1	1	0	0	0
9	22	11	5	2	0	0	0	0	0
10	0	0	0	2	1	3	11	16	7
11	0	0	0	1	1	2	14	15	7
12	1	1	0	5	8	6	10	6	3
13	14	10	14	2	0	0	0	0	0
14	0	0	0	0	1	1	10	12	16
15	0	0	0	2	1	3	13	12	9
16	1	0	2	5	10	14	5	2	1
17	2	8	17	5	5	2	1	0	0
18	7	13	16	1	3	0	0	0	0
19	0	0	0	0	0	1	5	1	33
20	39	0	1	0	0	0	0	0	0
21	0	0	0	0	0	5	16	11	8
22	0	0	1	1	2	5	16	11	4
23	19	12	7	2	0	0	0	0	0
24	0	0	0	0	1	8	8	15	8
25	6	16	14	1	1	2	0	0	0
26	1	8	14	11	3	1	1	0	1
27	5	16	15	4	0	0	0	0	0
28	10	14	9	3	1	3	0	0	0
29	38	0	1	0	1	0	0	0	0

STATE -MENT	1	2	3	4	5	6	7	8	9
	FREQUENCIES OF RATINGS								
30	0	0	0	0	1	0	4	14	21
31	0	0	0	0	0	4	12	12	12
32	5	7	12	2	9	4	1	0	0
33	5	14	16	2	2	1	0	0	0
34	7	8	16	6	2	1	0	0	0
35	6	9	7	5	7	2	3	1	0
36	0	0	0	0	0	3	9	13	15
37	32	6	2	0	0	0	0	0	0
38	7	2	17	8	5	1	0	0	0
39	2	17	14	4	3	0	0	0	0
40	9	20	10	1	0	0	0	0	0
41	0	0	0	0	0	0	5	11	24
42	13	18	5	1	2	1	0	0	0
43	5	6	13	8	6	1	1	0	0
44	2	8	16	7	5	1	1	0	0
45	14	16	8	2	0	0	0	0	0
46	26	9	3	0	0	1	1	0	0
47	10	7	14	5	3	1	0	0	0
48	0	0	1	0	5	6	21	5	2
49	0	0	0	0	2	3	6	17	12
50	20	18	1	1	0	0	0	0	0
51	0	0	0	1	6	7	11	7	8
52	0	0	0	0	0	1	6	16	17
53	14	11	9	4	1	1	0	0	0
54	0	0	0	0	0	1	10	11	18

APPENDIX VII(b)

Cumulative frequencies of ratings of Attitude statements.

STATE -MENT	CUMULATIVE FREQUENCIES OF RATINGS 1	2	3	4	5	6	7	8	9
1	0	4	22	27	30	35	40	40	40
2	0	0	1	1	1	3	18	33	40
3	0	0	2	2	2	6	21	31	40
4	7	23	38	38	40	40	40	40	40
5	0	0	0	0	0	0	5	16	40
6	6	19	26	28	31	33	38	39	40
7	29	38	40	40	40	40	40	40	40
8	16	29	35	38	39	40	40	40	40
9	22	33	38	40	40	40	40	40	40
10	0	0	0	2	3	6	17	33	40
11	0	0	0	1	2	4	18	33	40
12	1	2	2	7	15	21	31	37	40
13	14	24	38	40	40	40	40	40	40
14	0	0	0	0	1	2	12	24	40
15	0	0	0	2	3	6	19	31	40
16	1	1	3	8	18	32	37	39	40
17	2	10	27	32	37	39	40	40	40
18	7	20	36	37	40	40	40	40	40
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21	0	0	0	0	0	5	21	32	40
22	0	0	1	2	4	9	25	36	40
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24	0	0	0	0	1	9	17	32	40
25	6	22	36	37	38	40	40	40	40
26	1	9	23	34	37	38	39	39	40
27	5	21	36	40	40	40	40	40	40
28	10	24	33	36	37	40	40	40	40
29	38	38	39	39	40	40	40	40	40
30	0	0	0	0	1	1	5	19	40

STATE -MENT	CUMULATIVE FREQUENCIES OF RATINGS 1	2	3	4	5	6	7	8	9
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32	5	12	24	26	35	39	40	40	40
33	5	19	35	37	39	40	40	40	40
34	7	15	31	37	39	40	40	40	40
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37	32	38	40	40	40	40	40	40	40
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41	0	0	0	0	0	0	5	16	40
42	13	31	36	37	39	40	40	40	40
43	5	11	24	32	38	39	40	40	40
44	2	10	26	33	38	39	40	40	40
45	14	30	38	40	40	40	40	40	40
46	26	35	38	38	38	39	40	40	40
47	10	17	31	36	39	40	40	40	40
48	0	0	1	1	6	12	33	38	40
49	0	0	0	0	2	5	11	28	40
50	20	38	39	40	40	40	40	40	40
51	0	0	0	1	7	14	25	32	40
52	0	0	0	0	0	1	7	23	40
53	14	25	34	38	39	40	40	40	40
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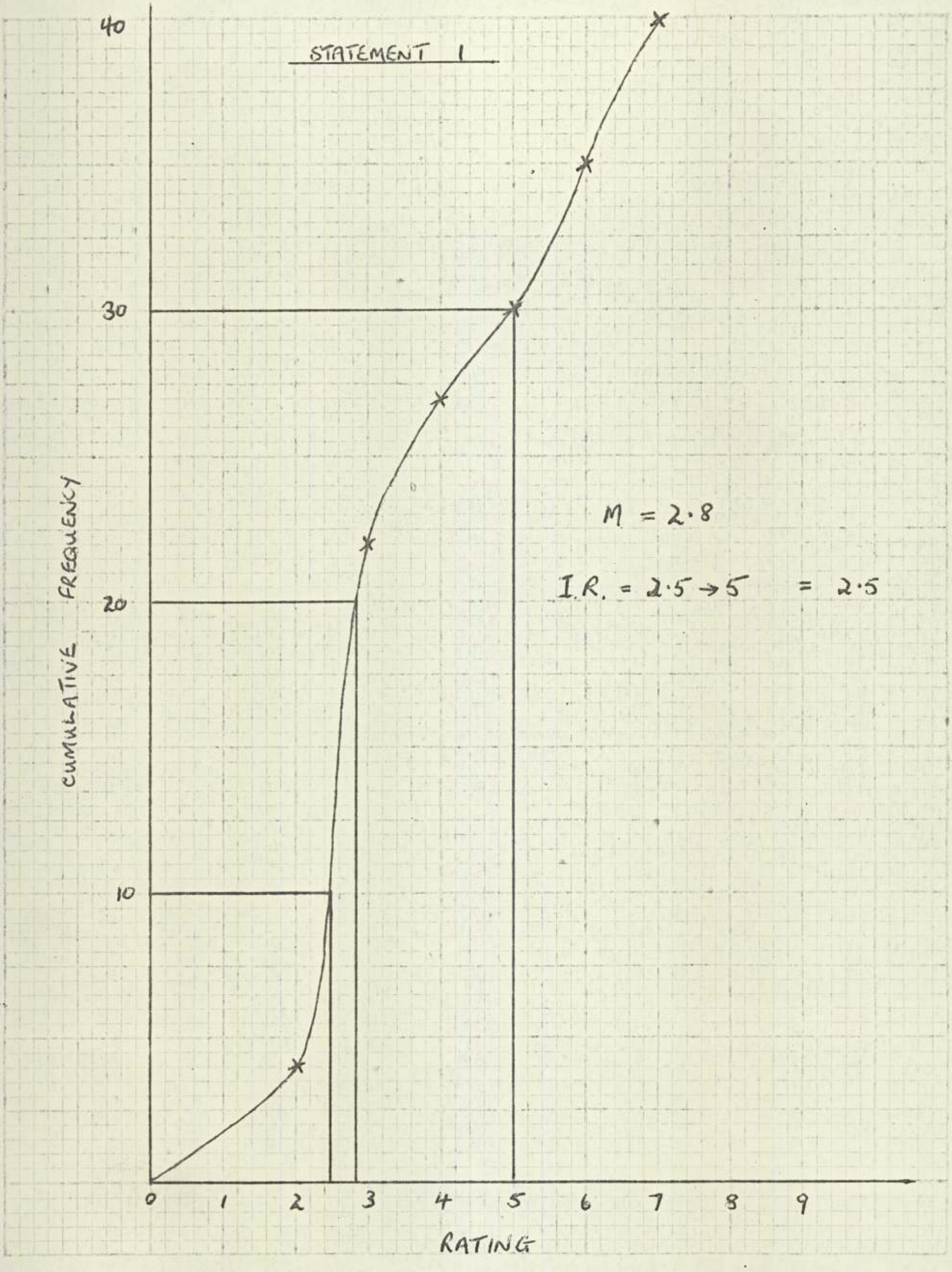
APPENDIX VIII.

GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.



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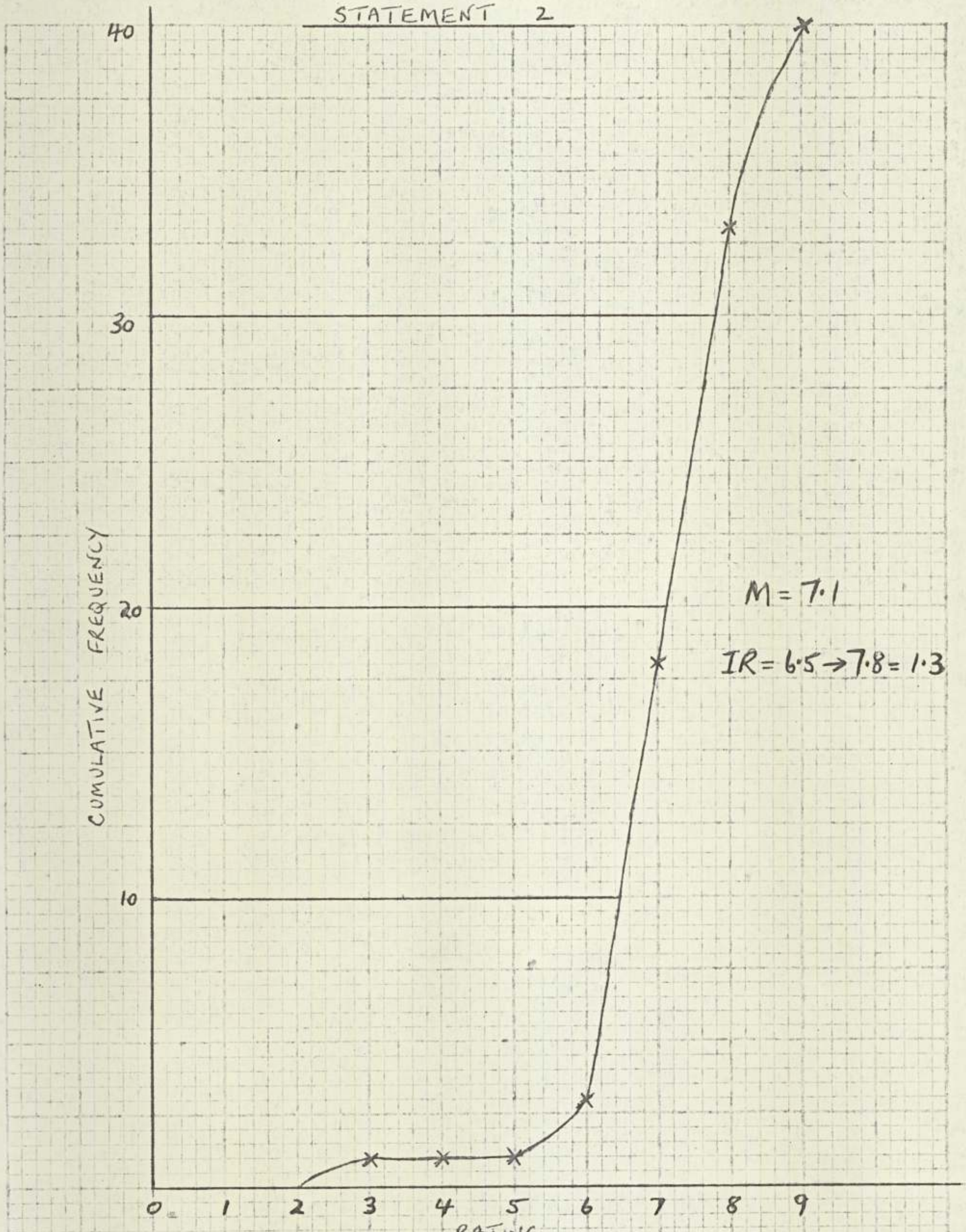

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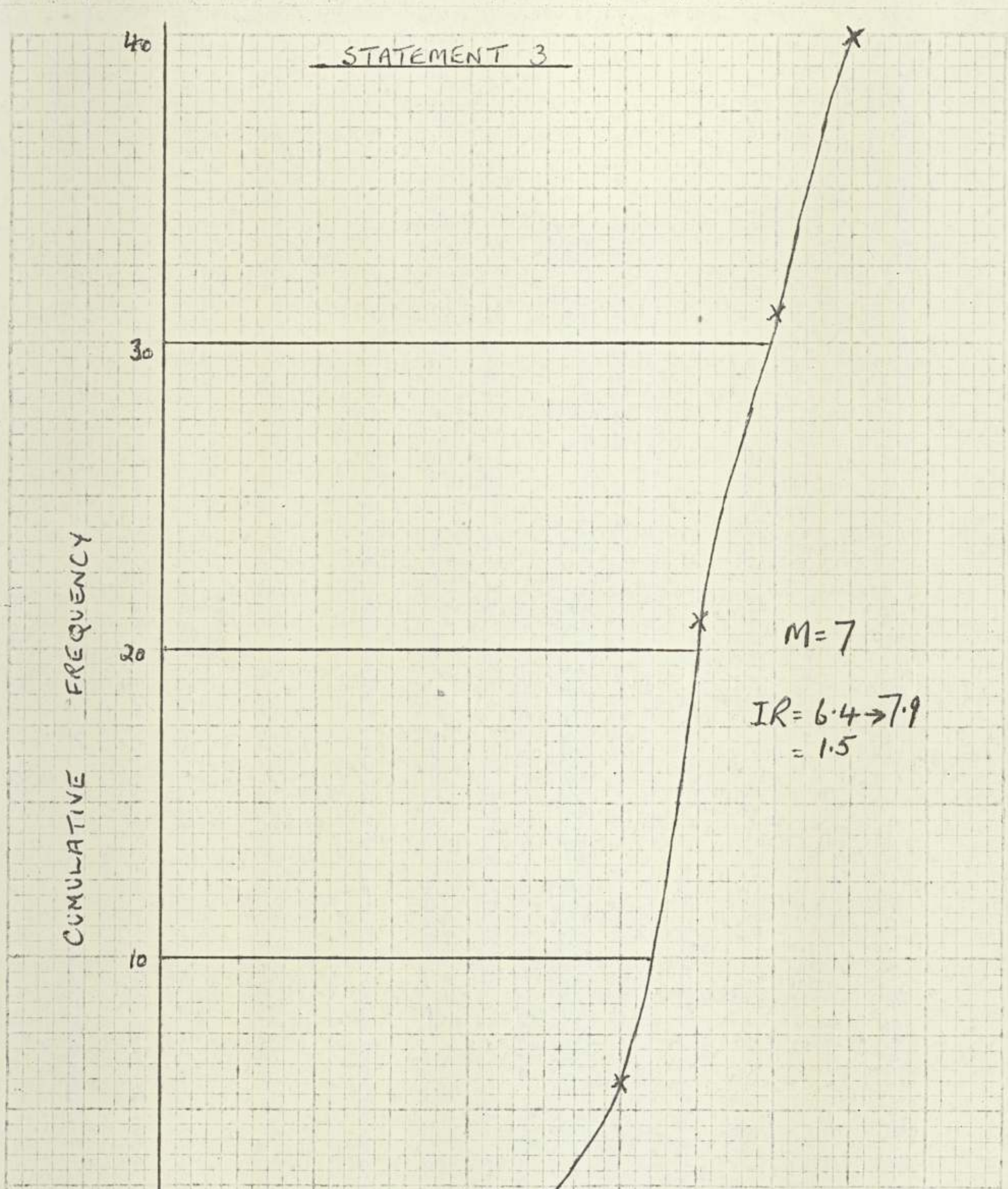

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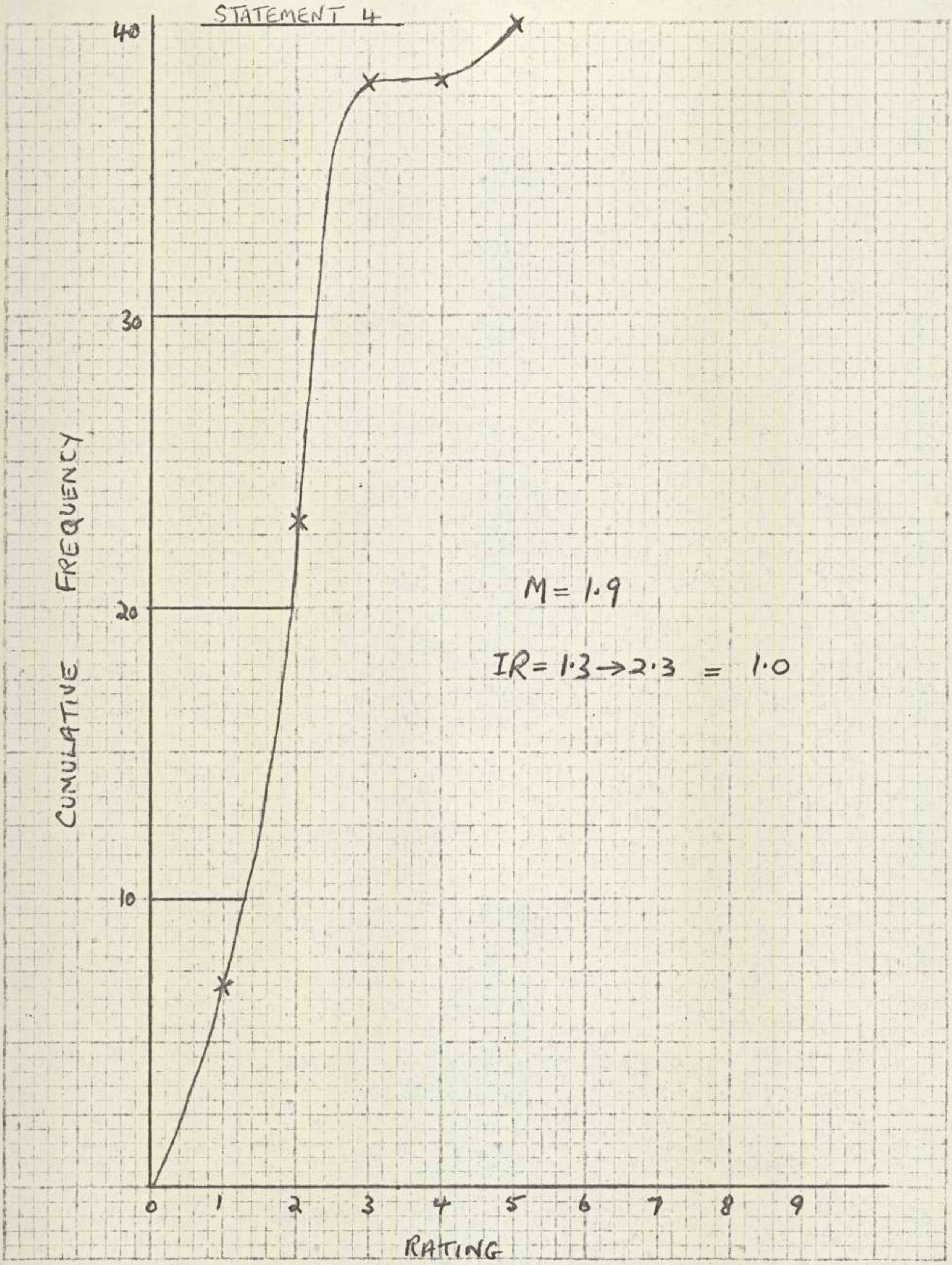
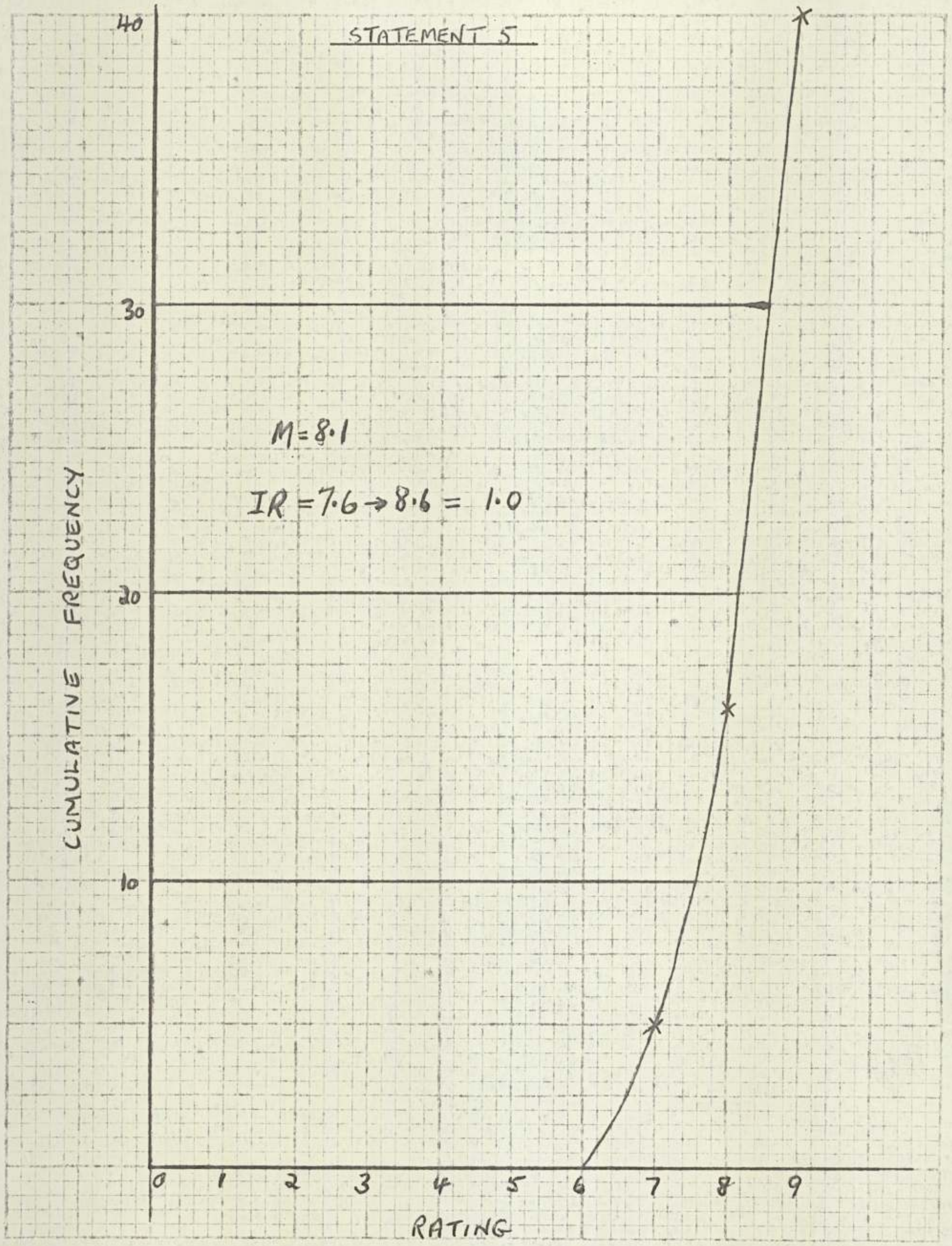


GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.



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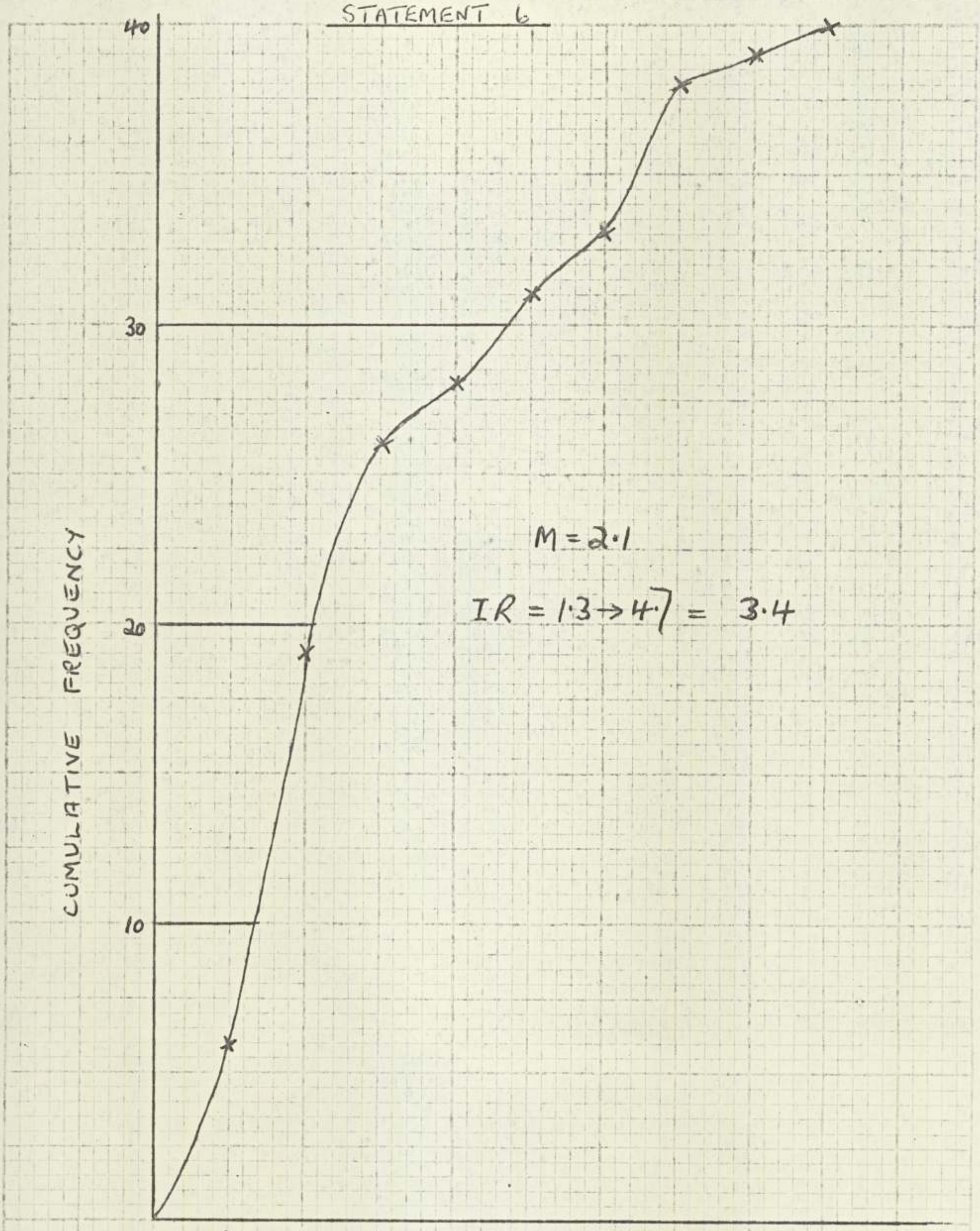

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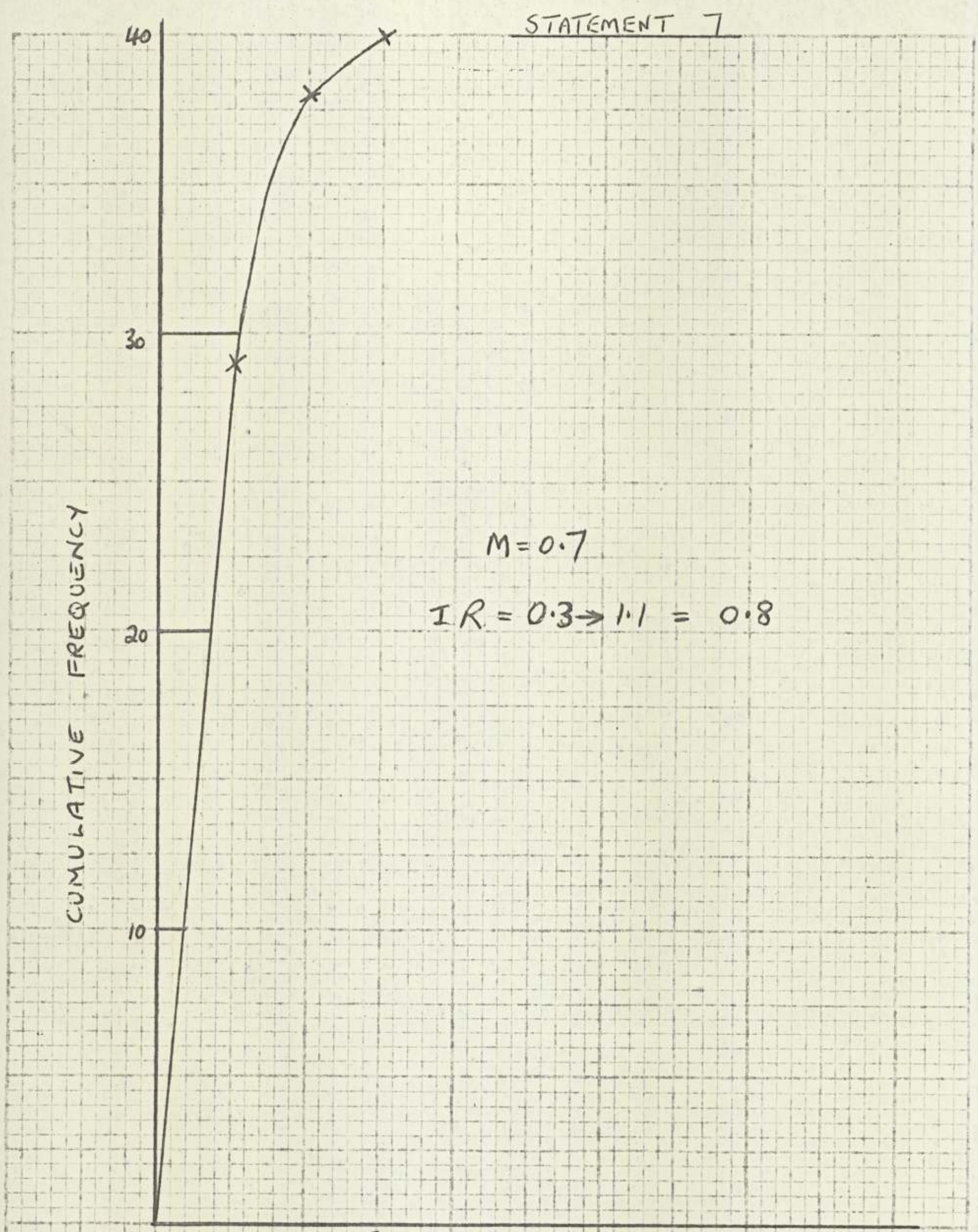

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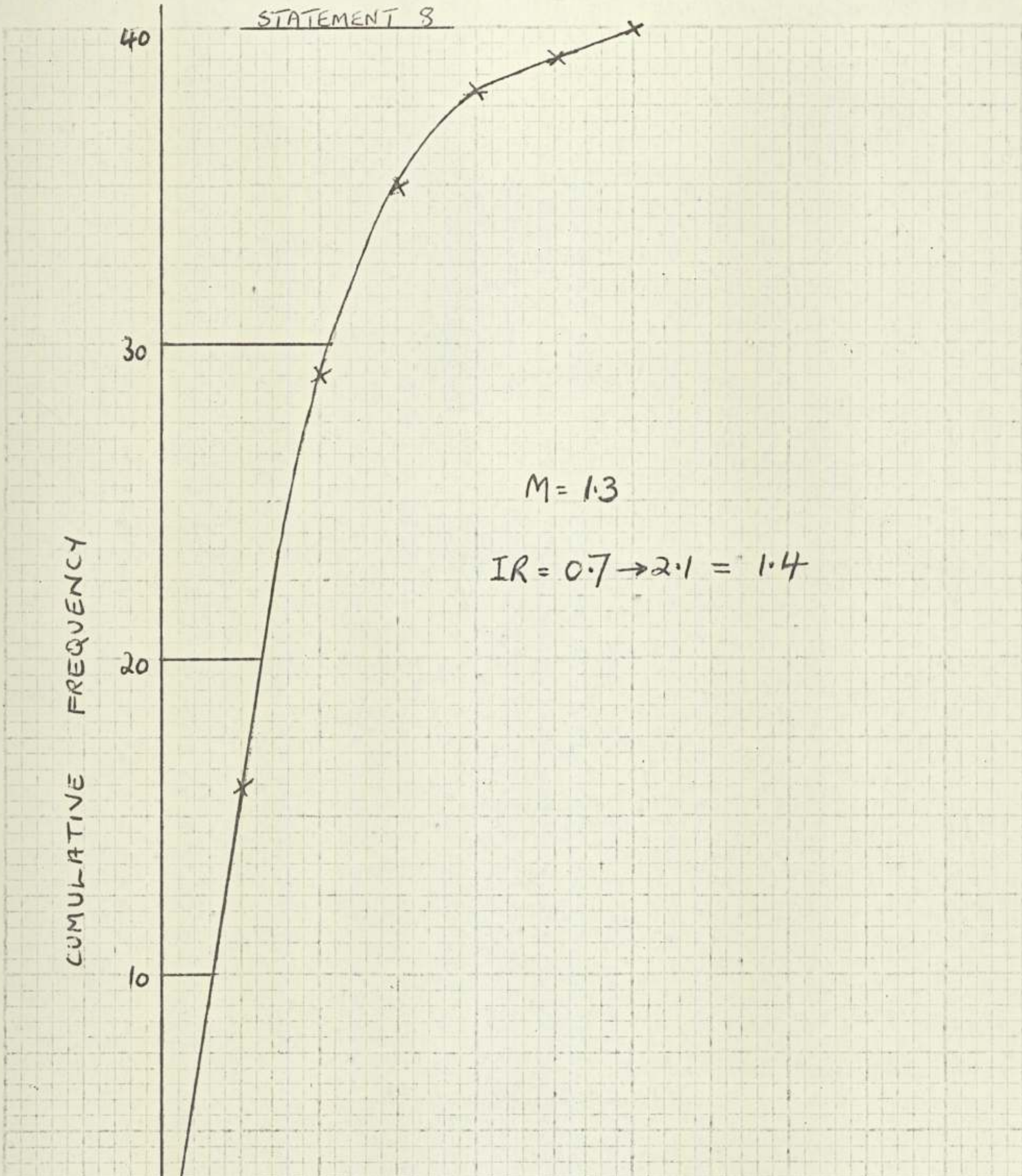

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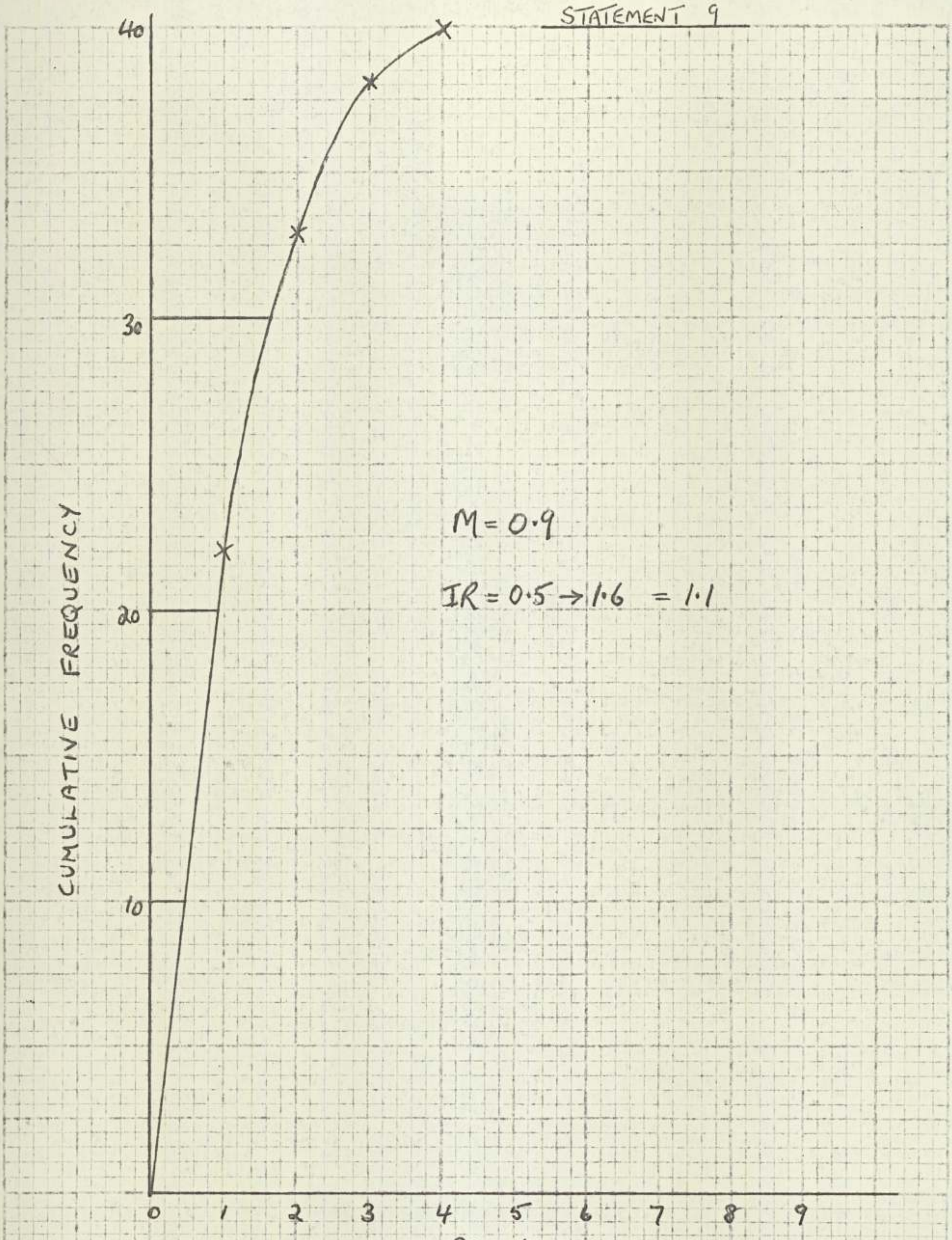

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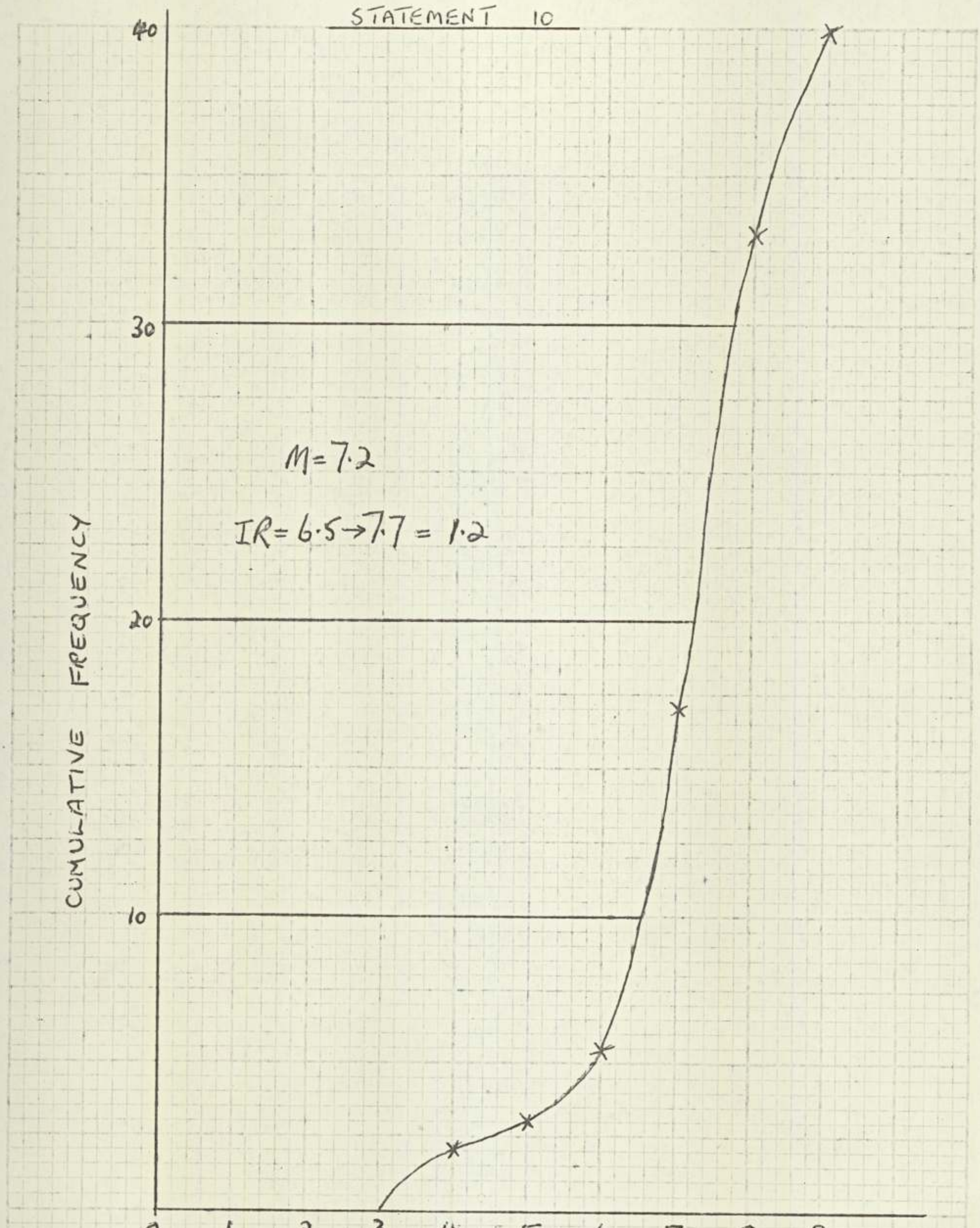

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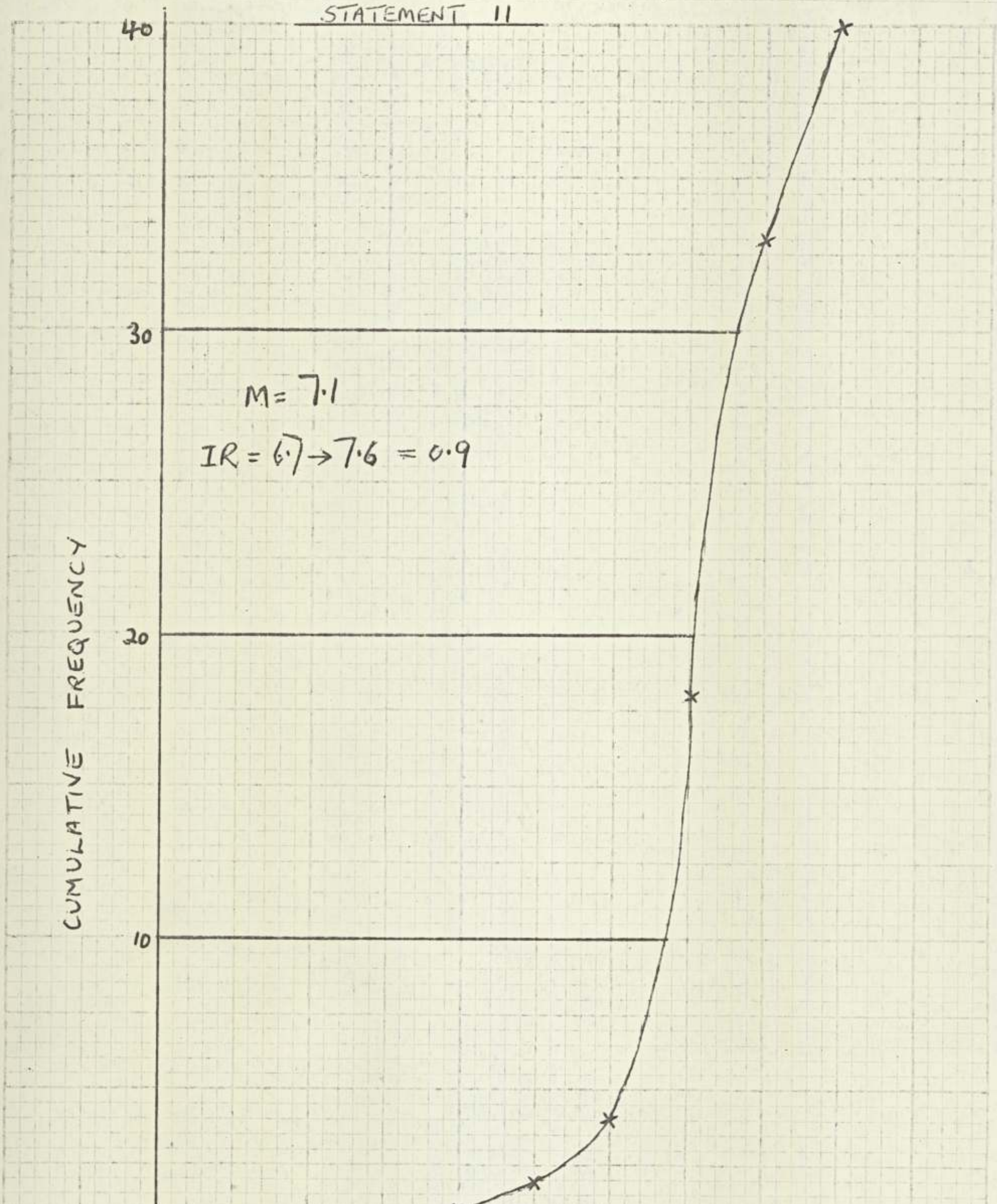

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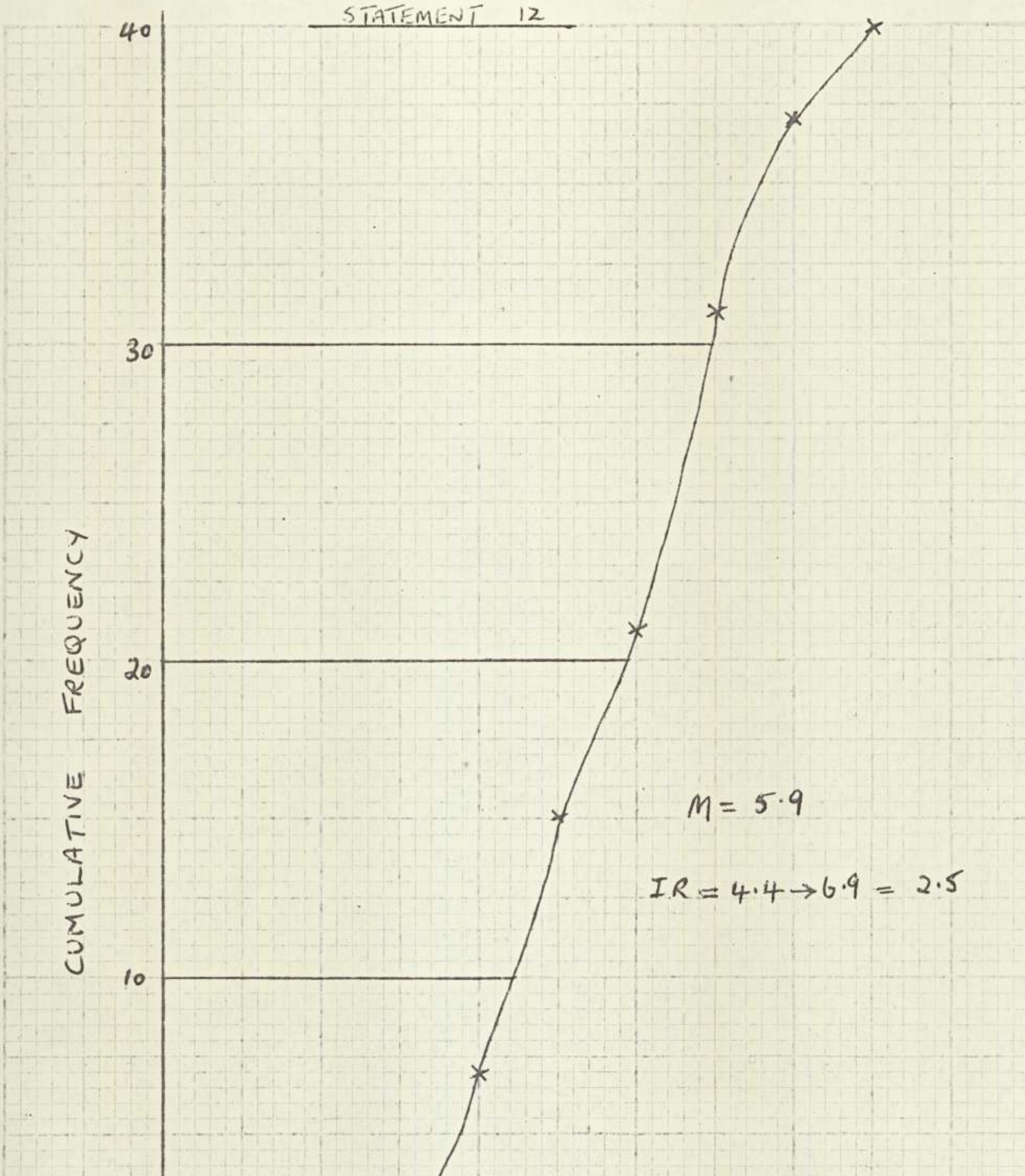

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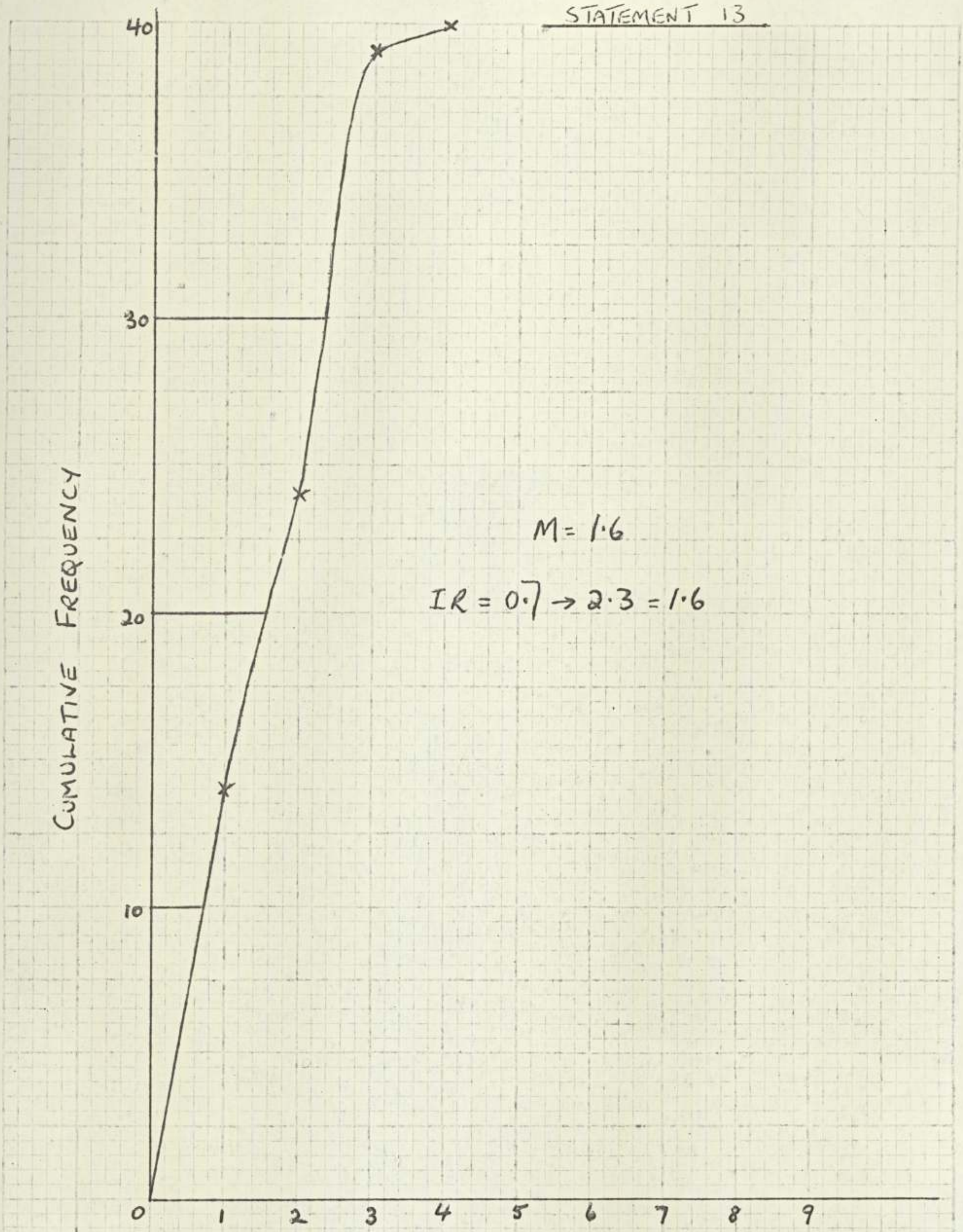

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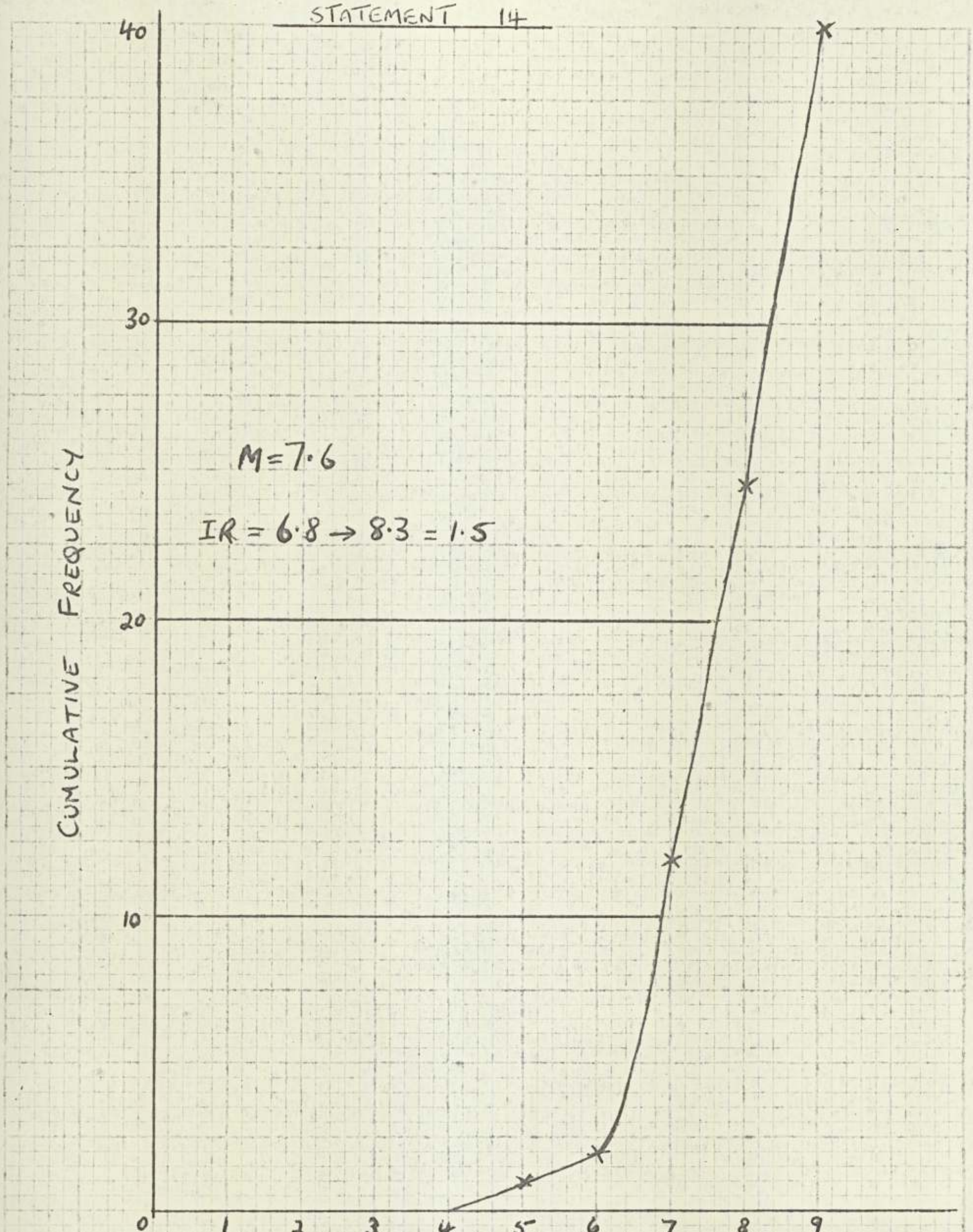

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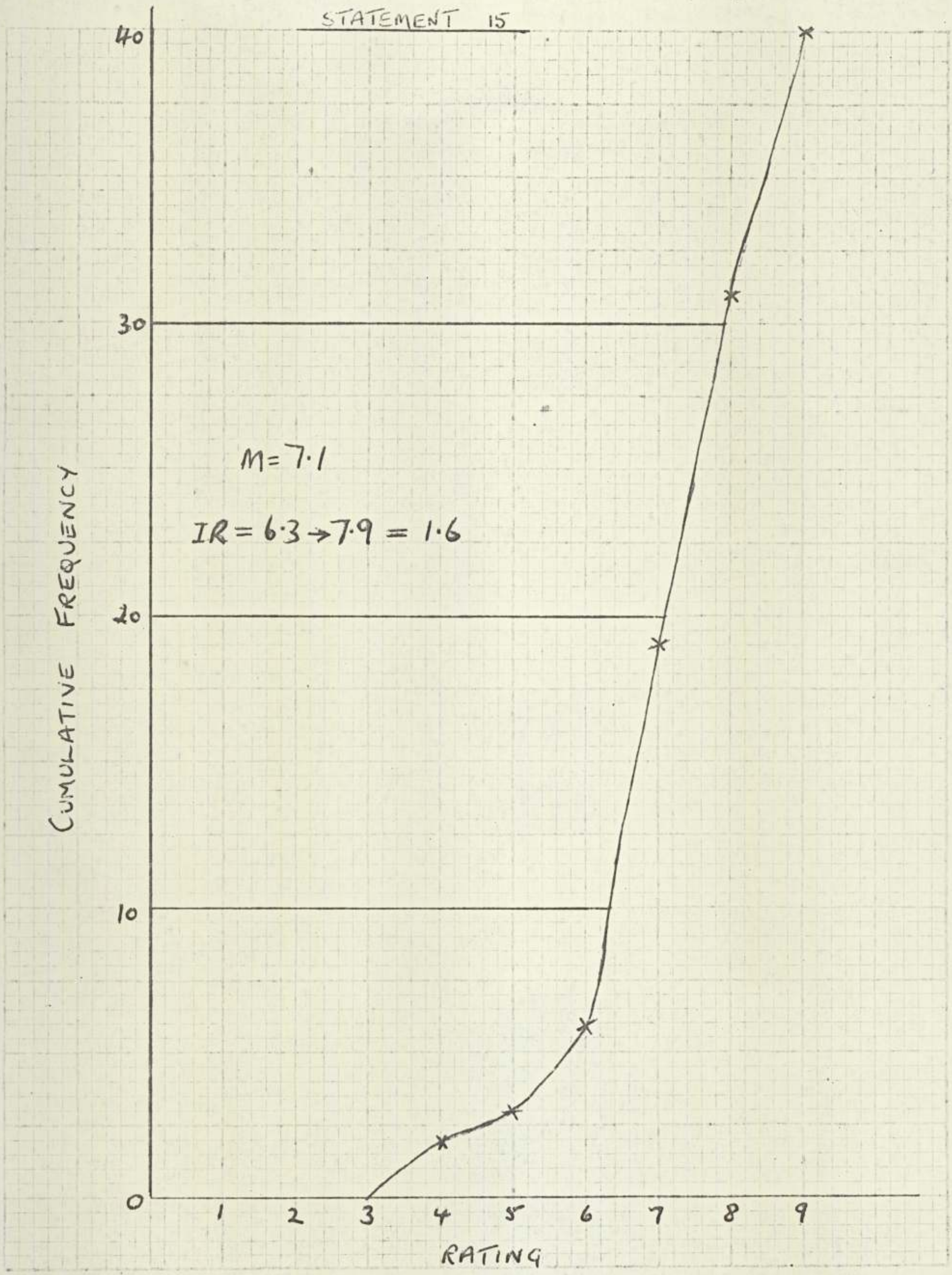

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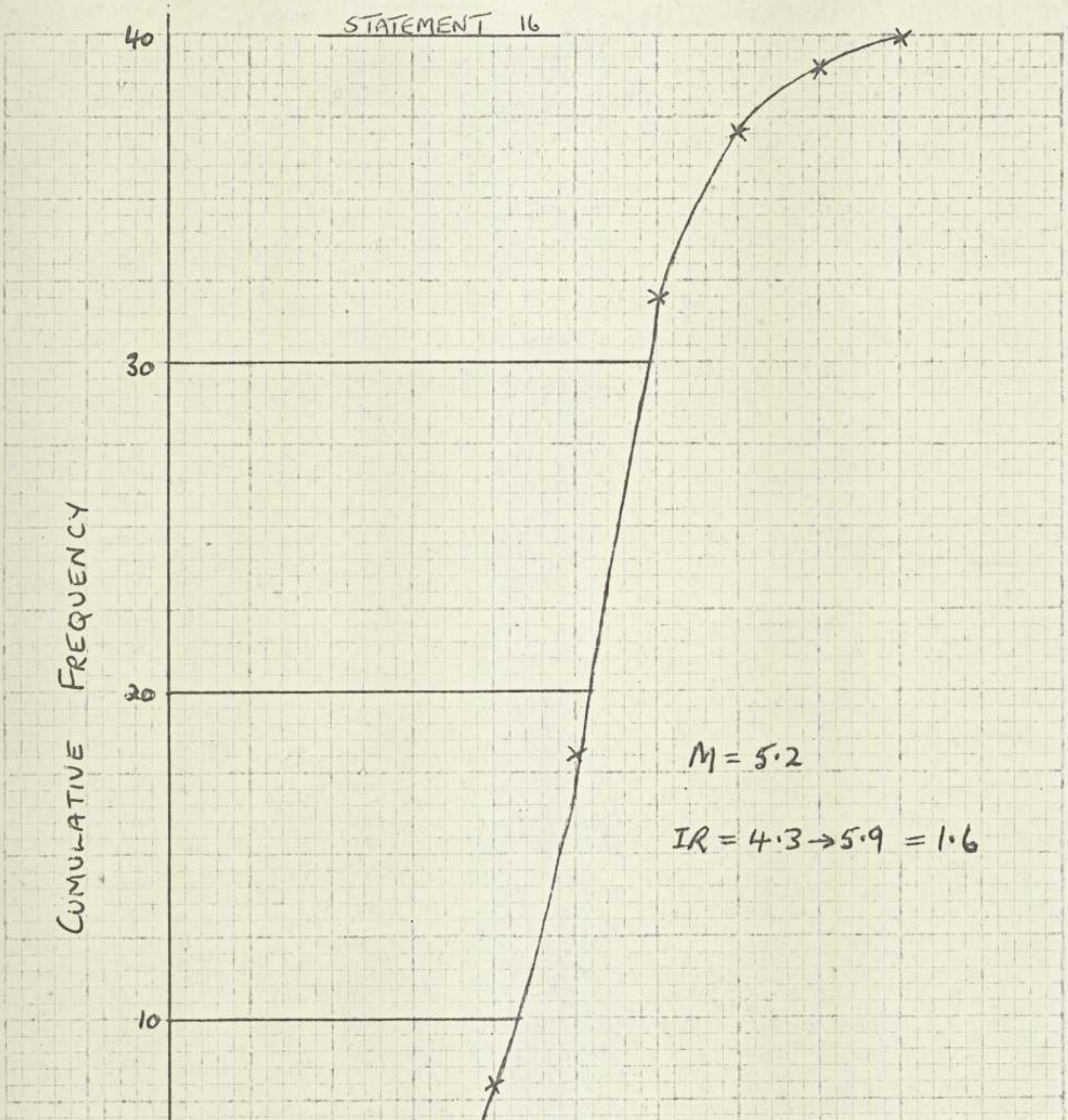

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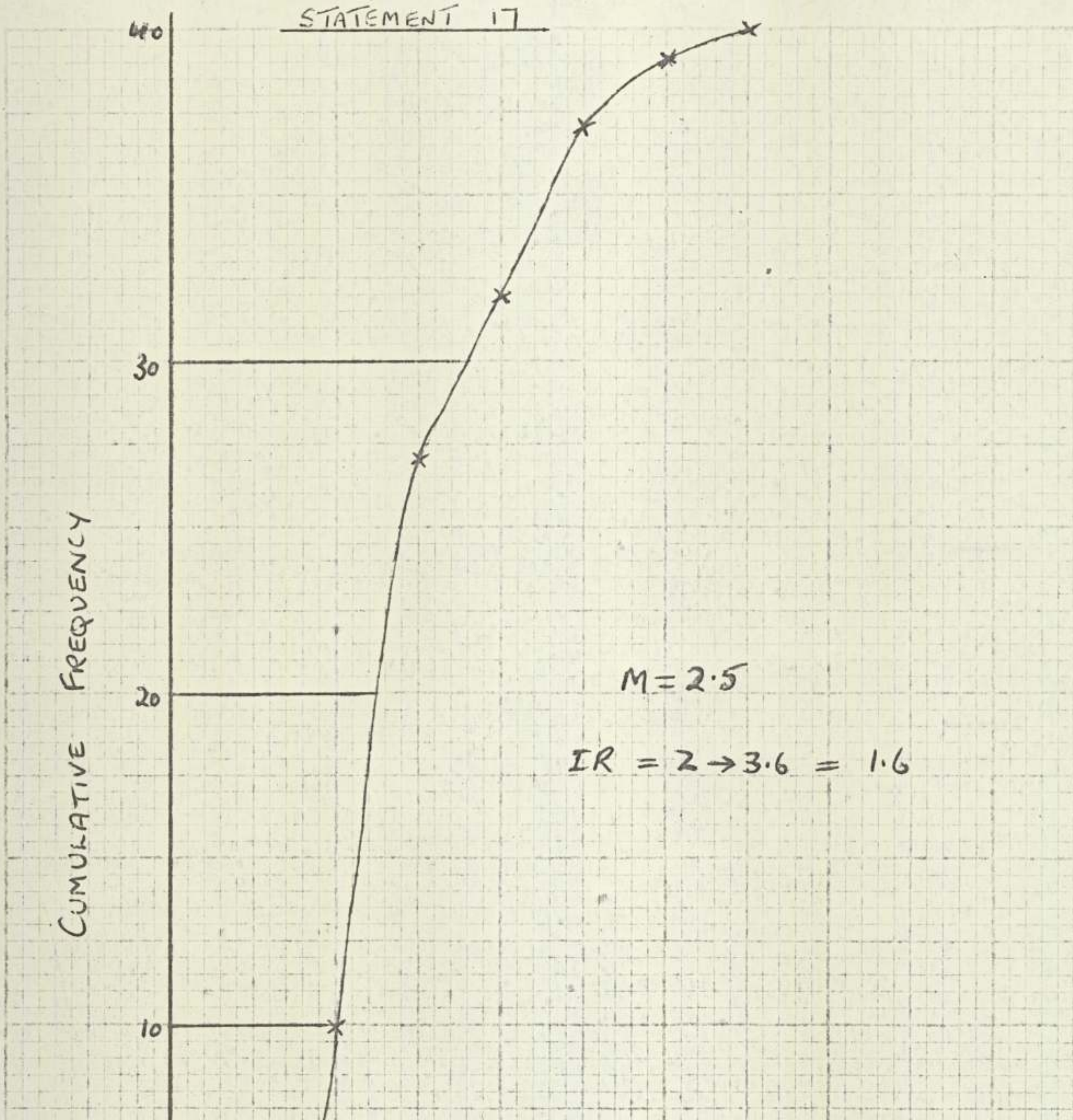

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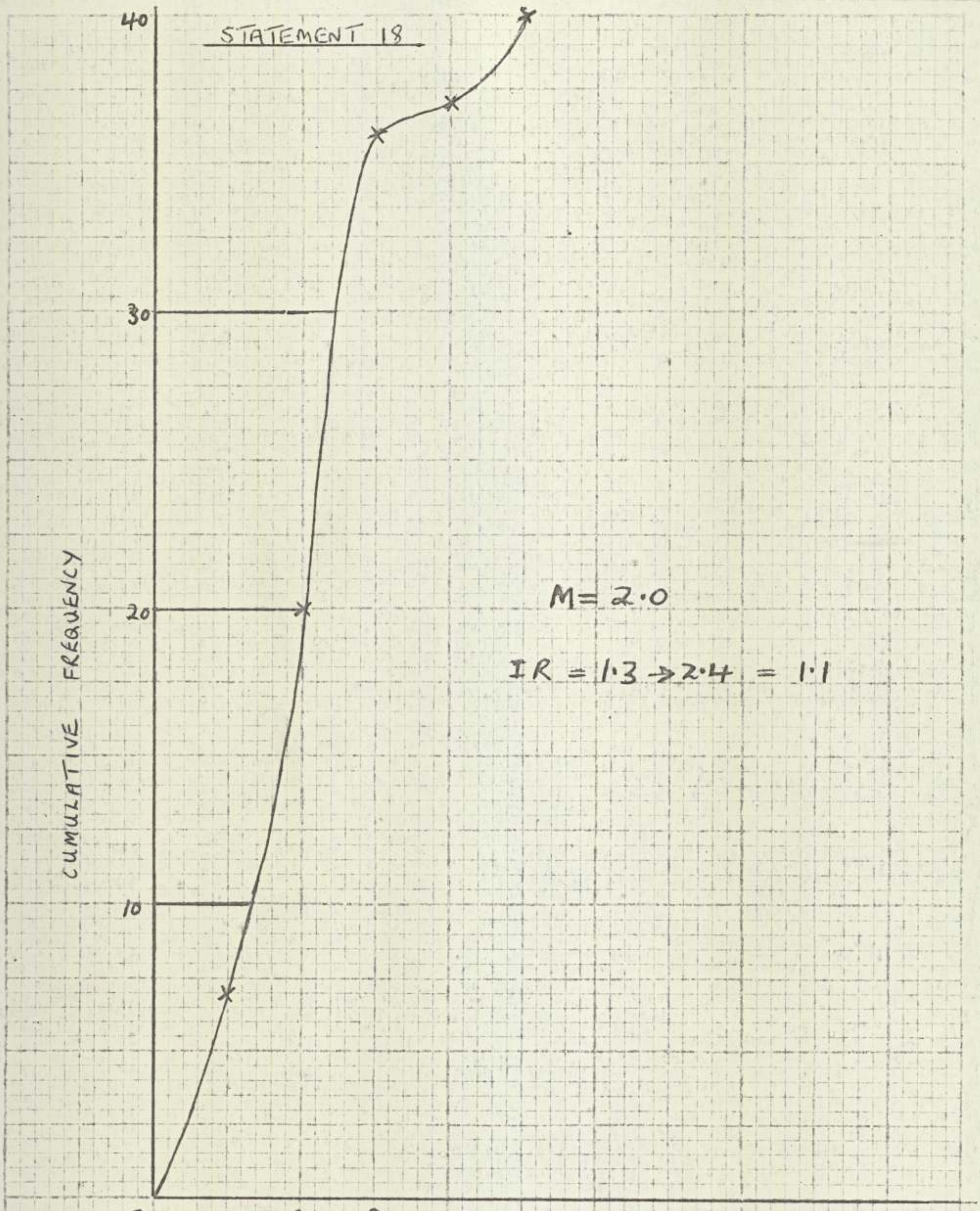

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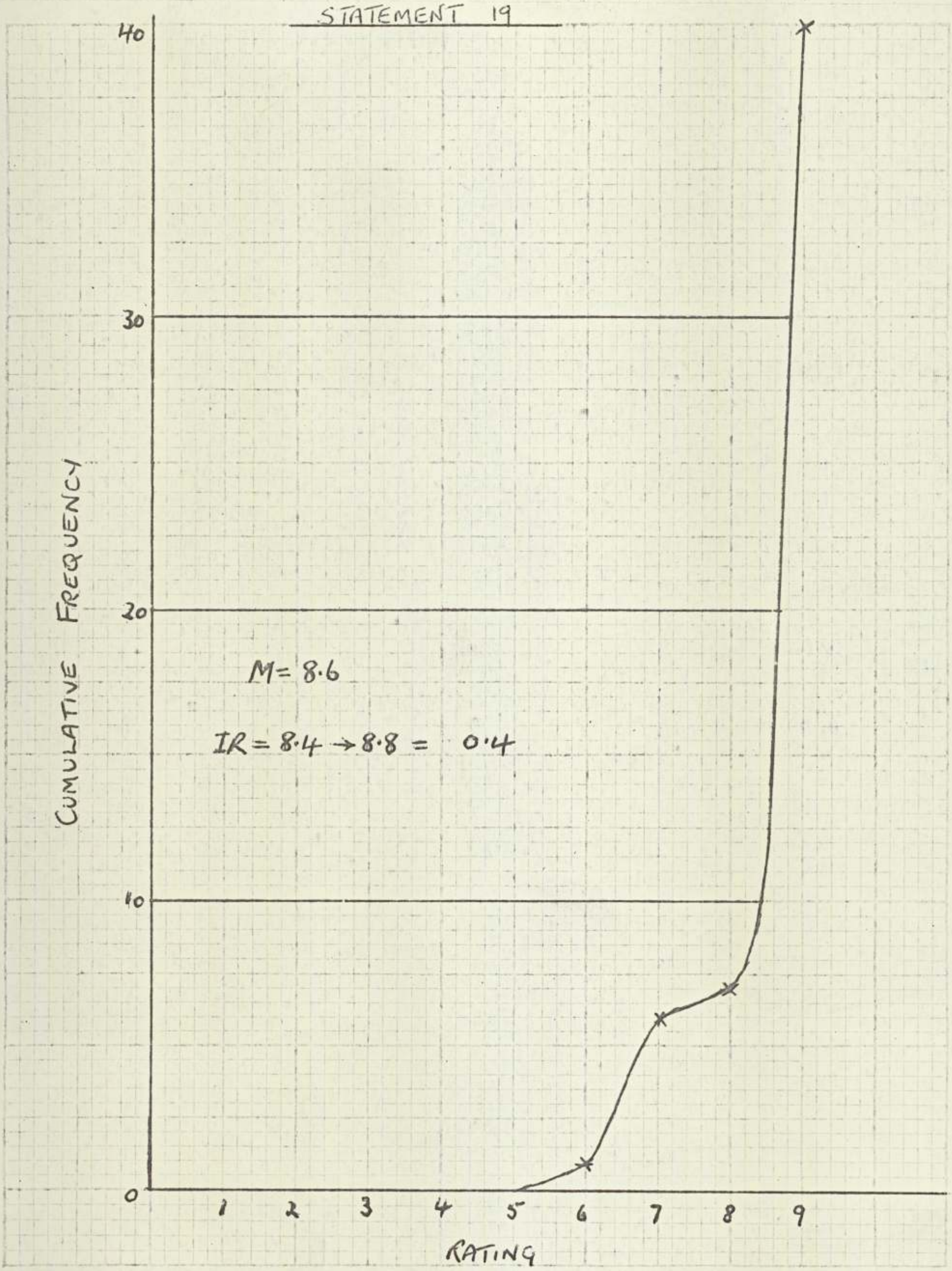

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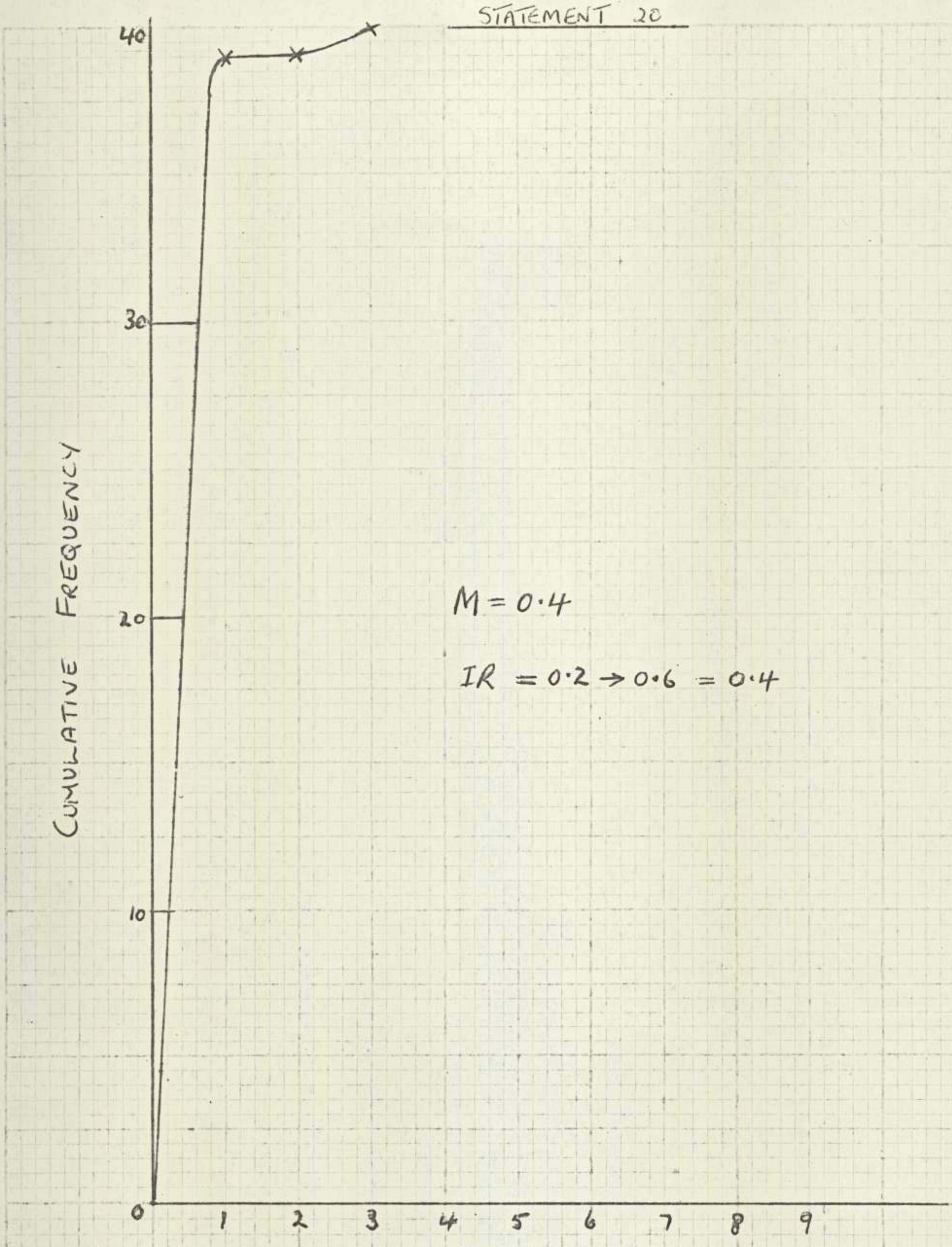

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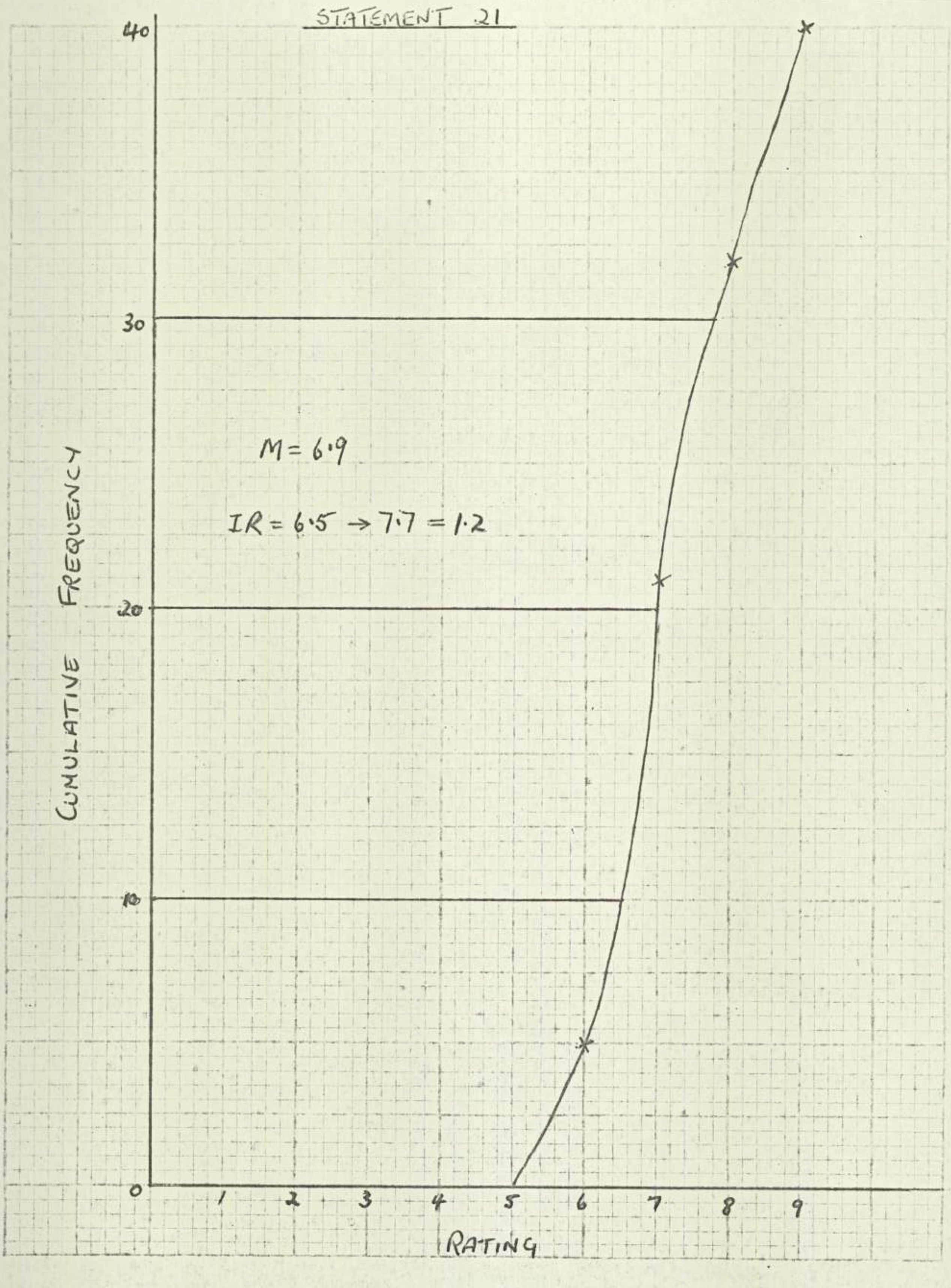
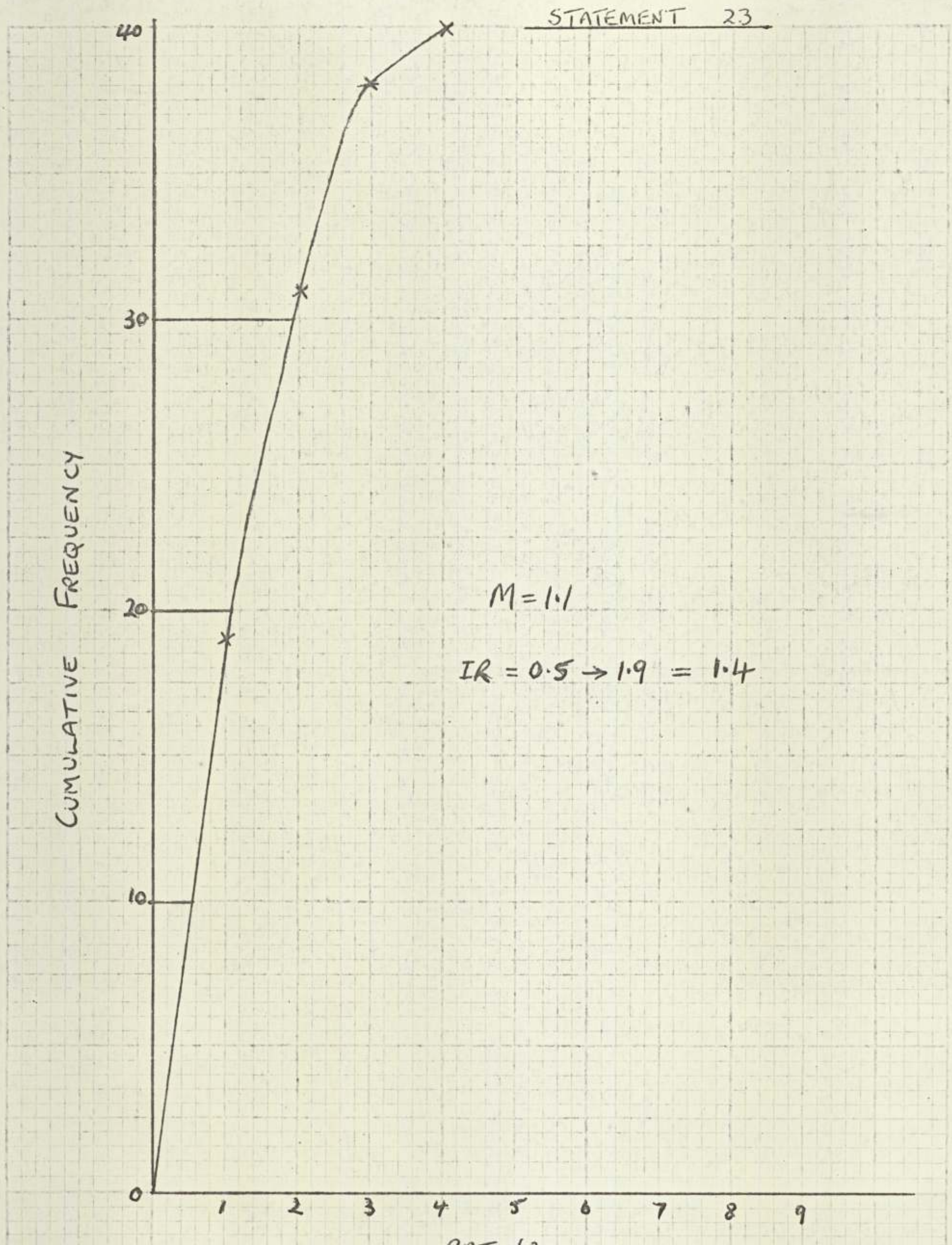


GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.

GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.



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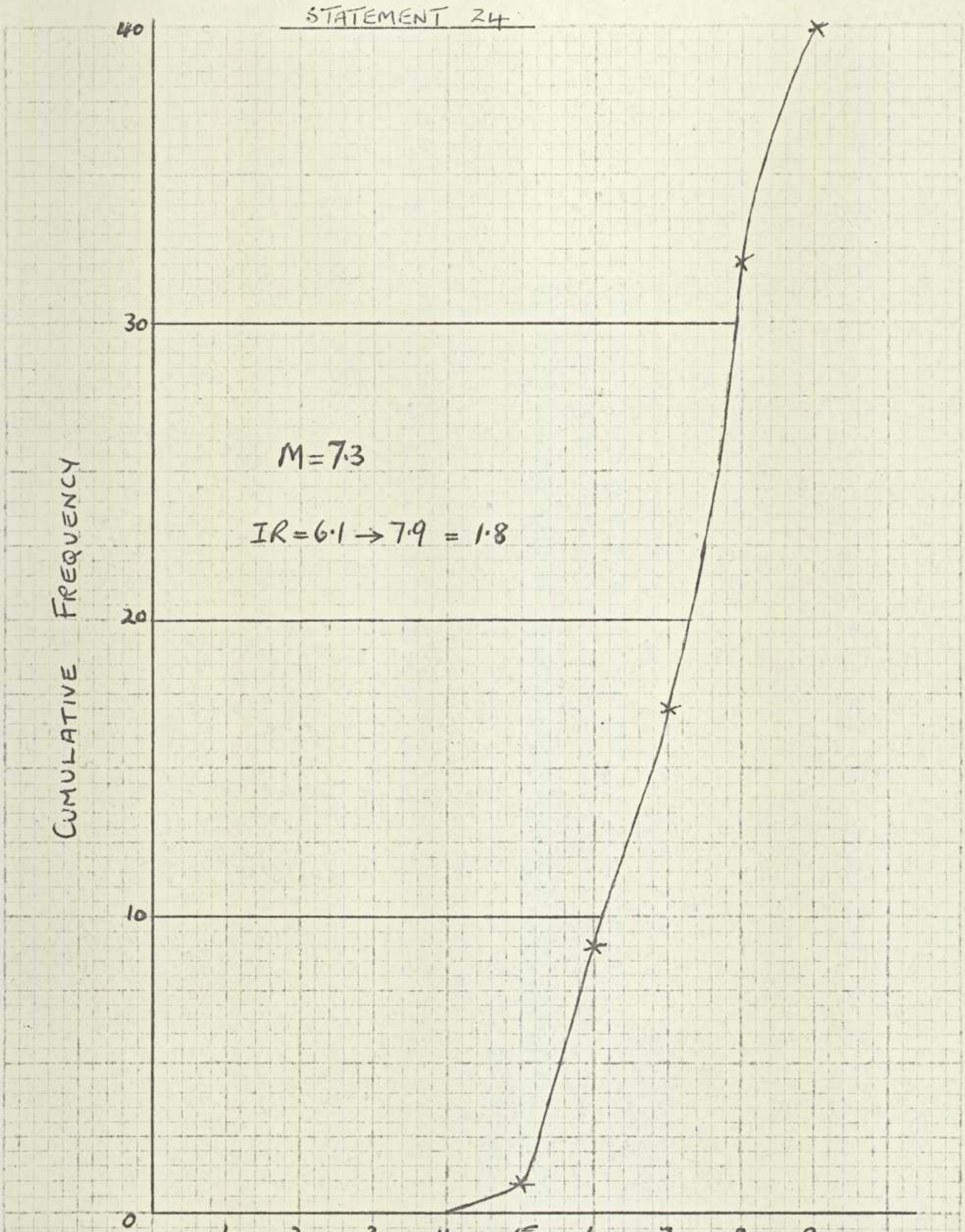

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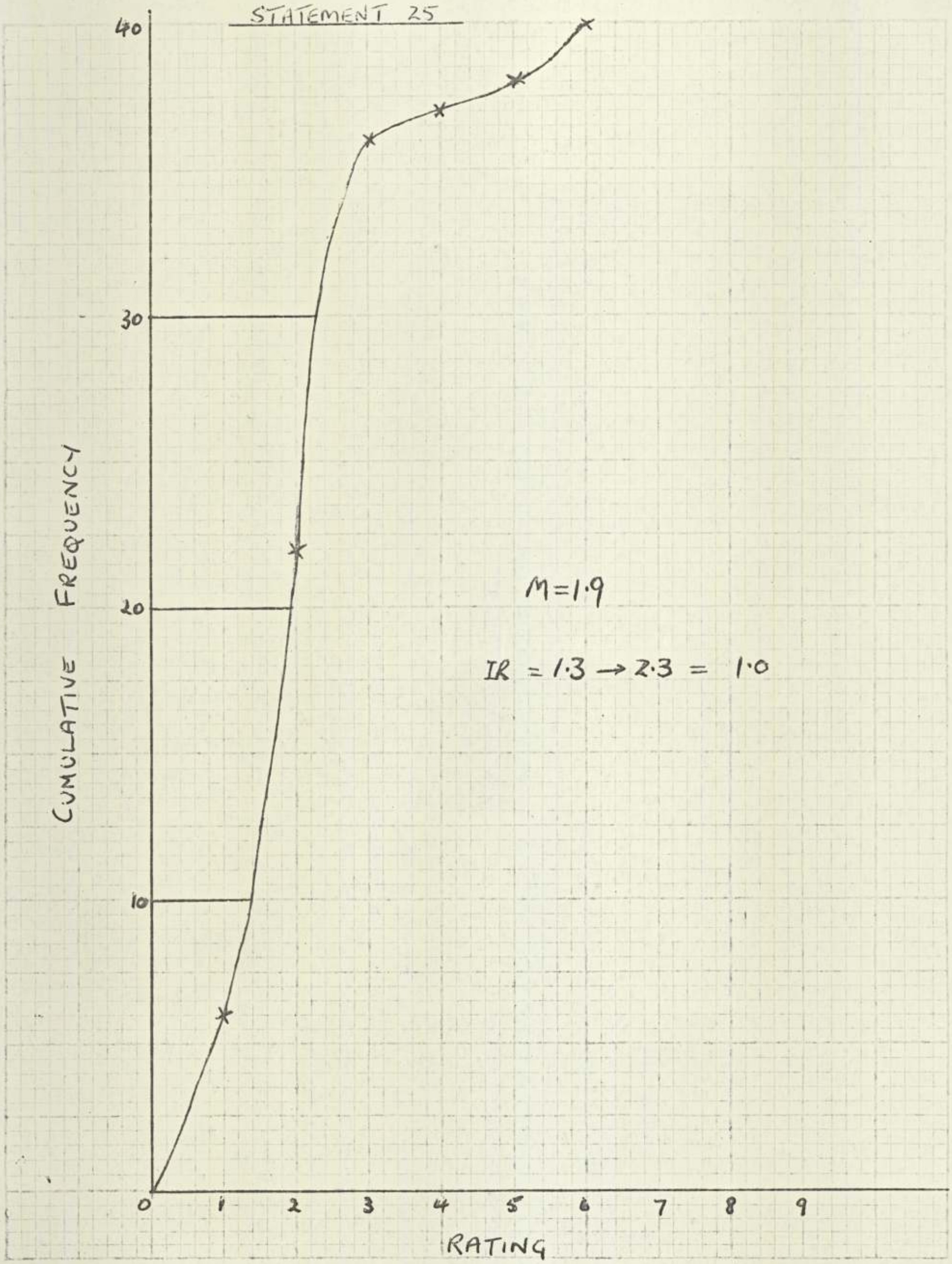

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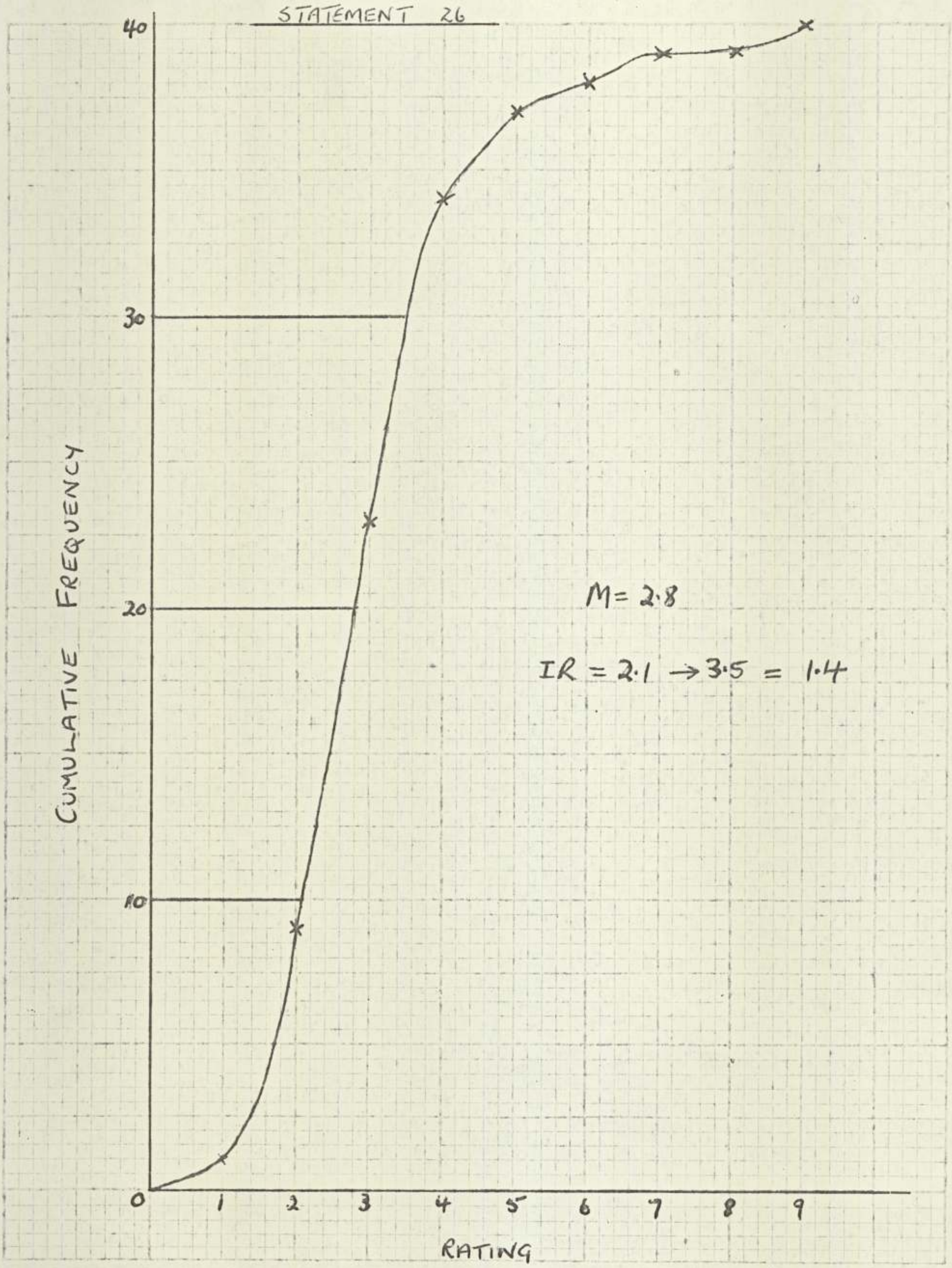

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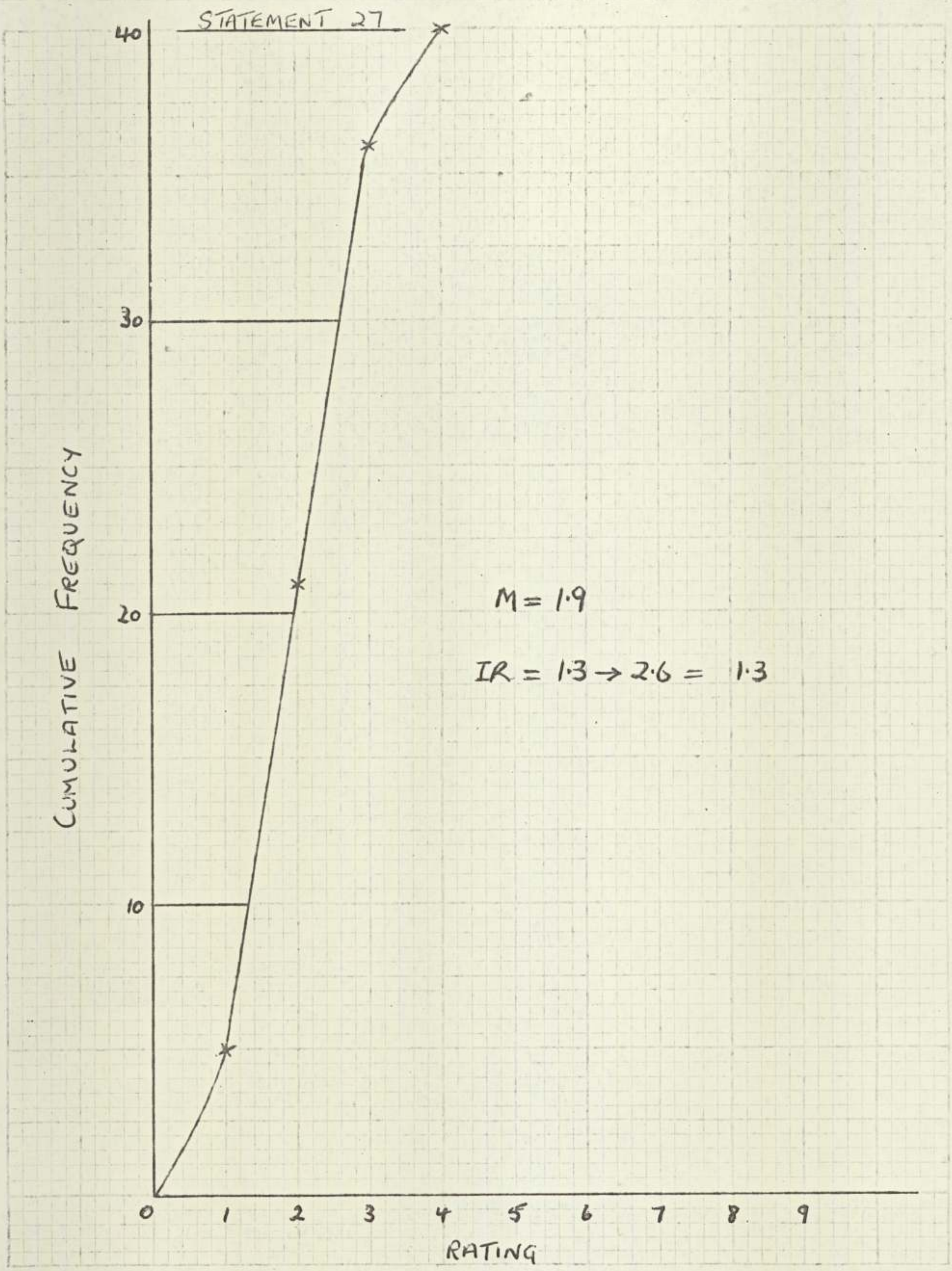

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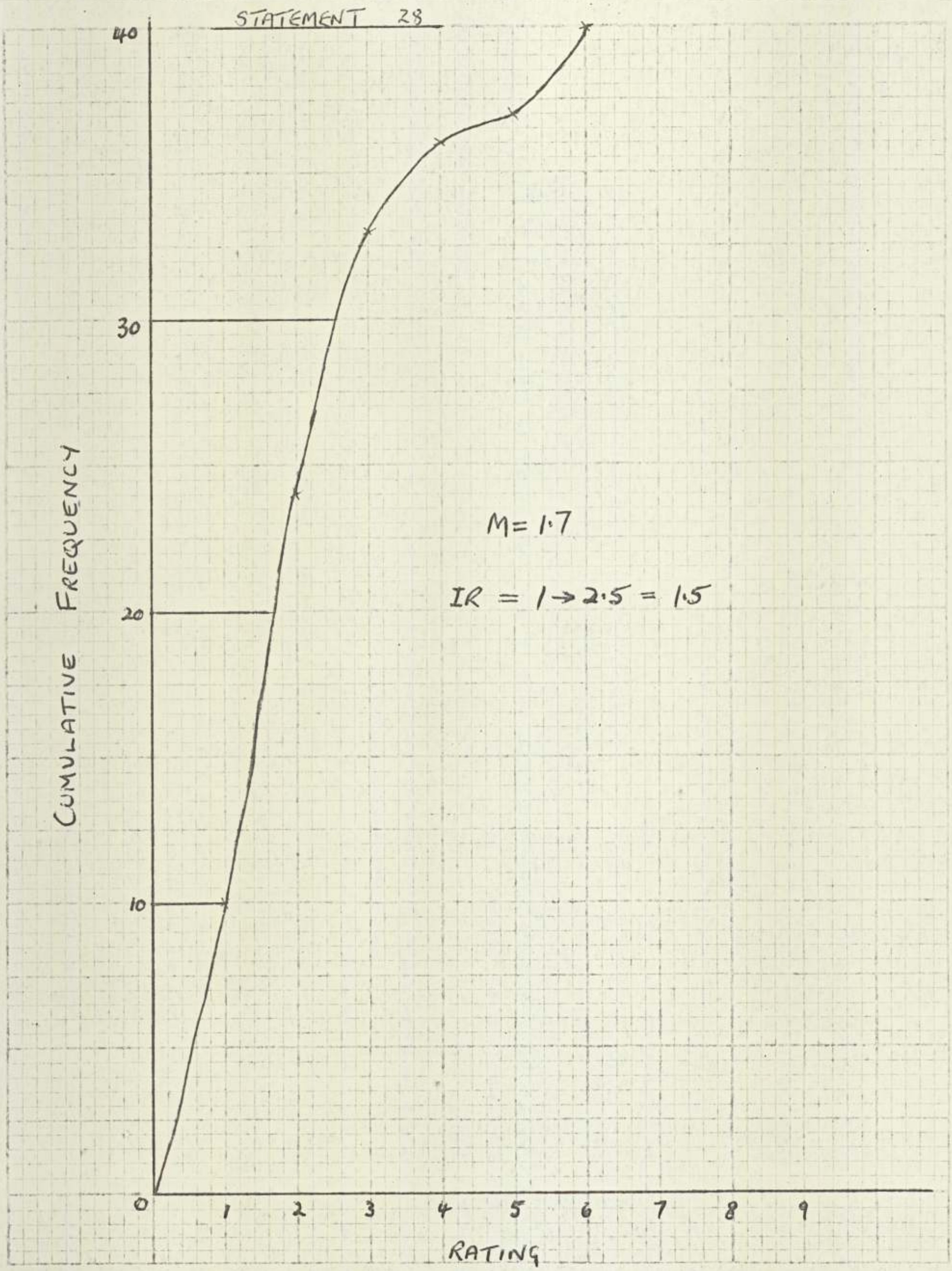

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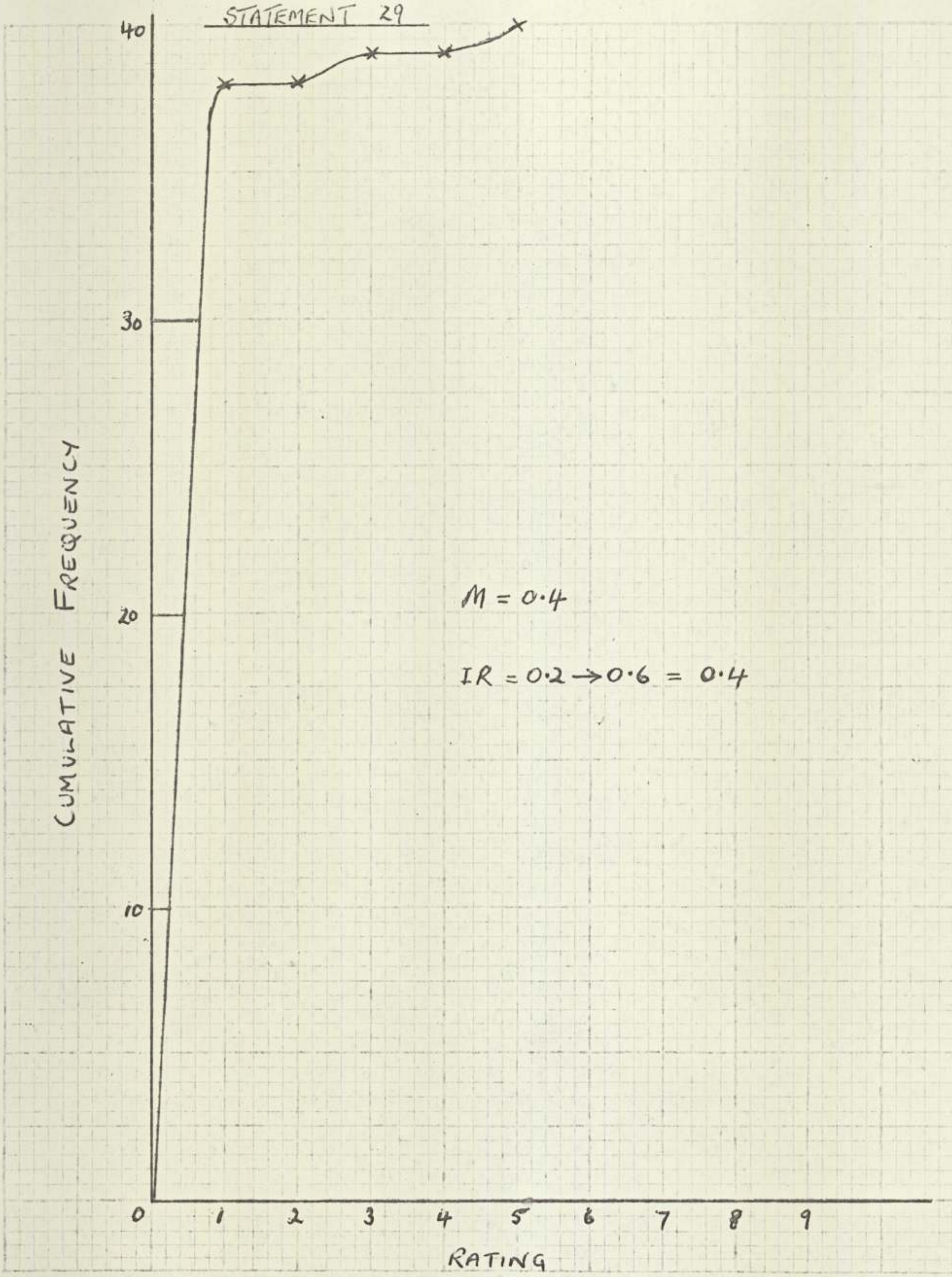

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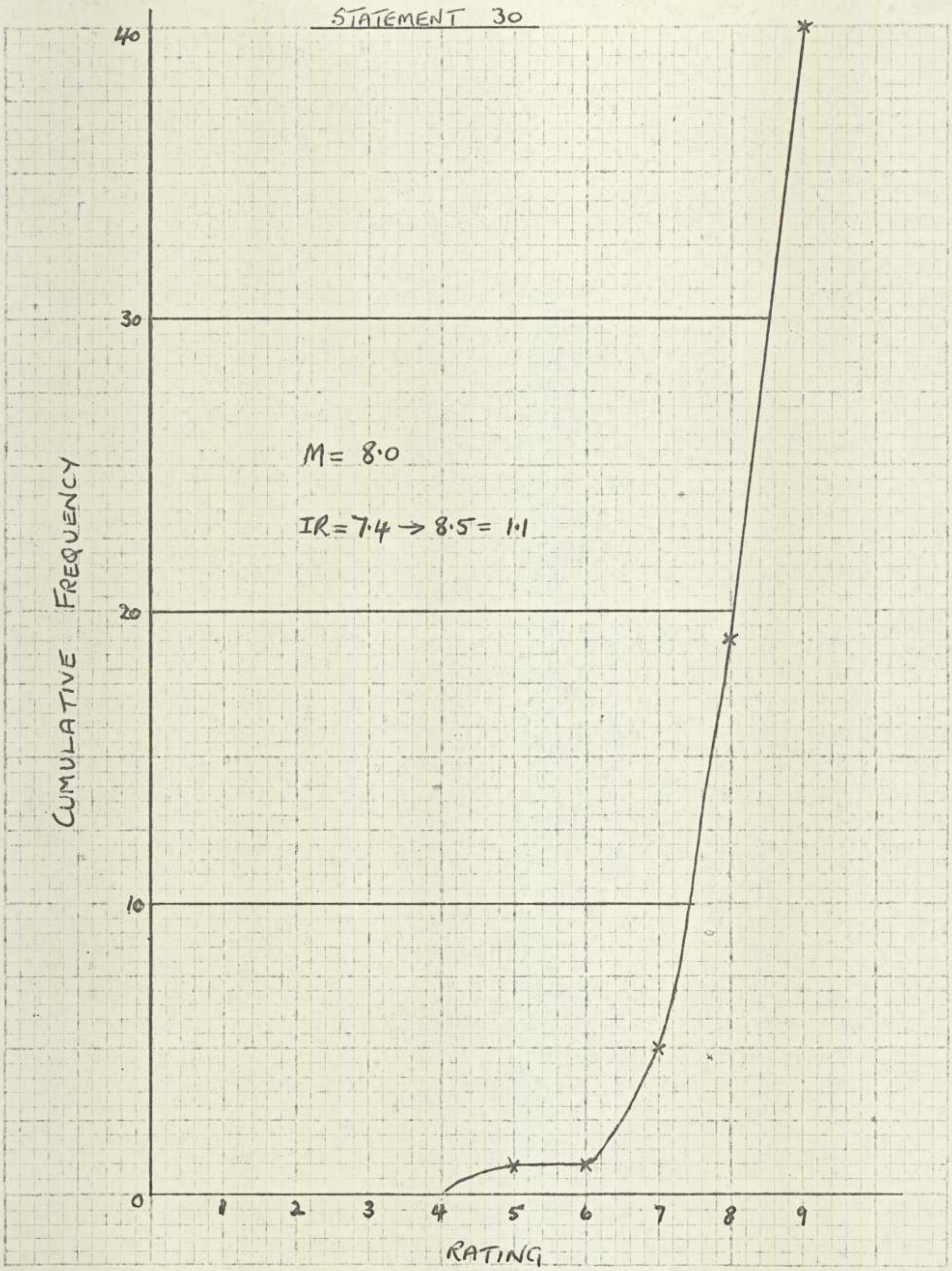

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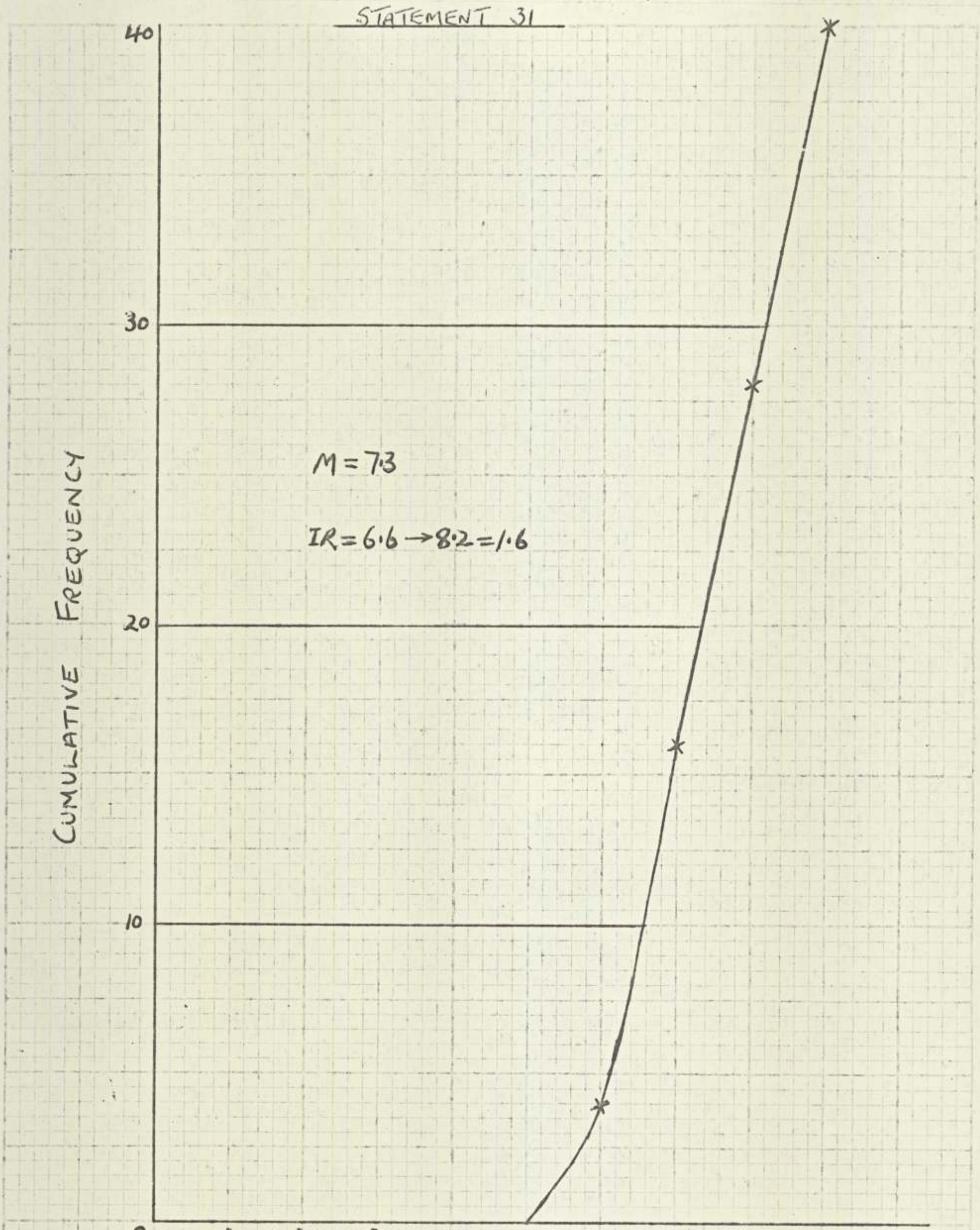

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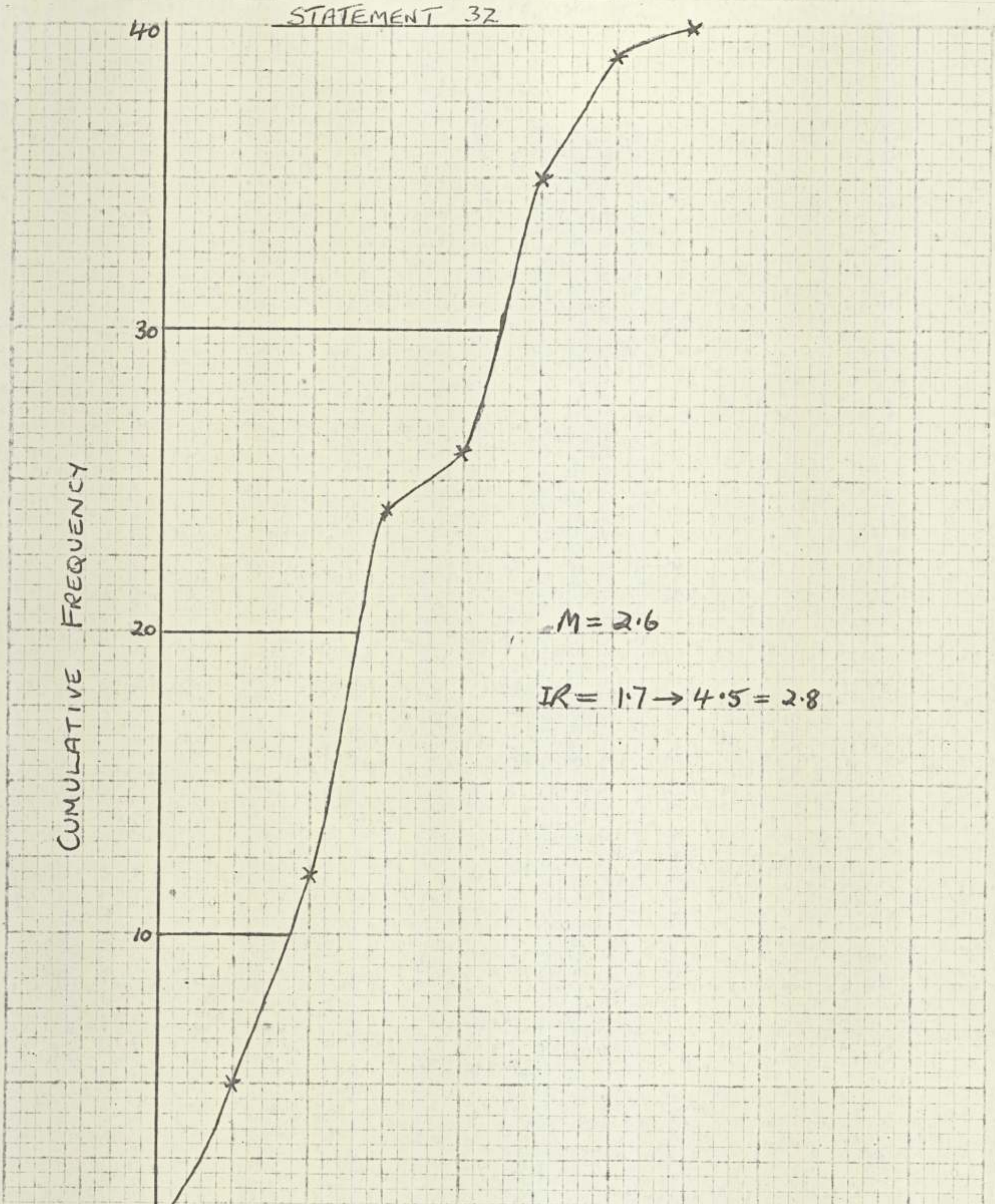

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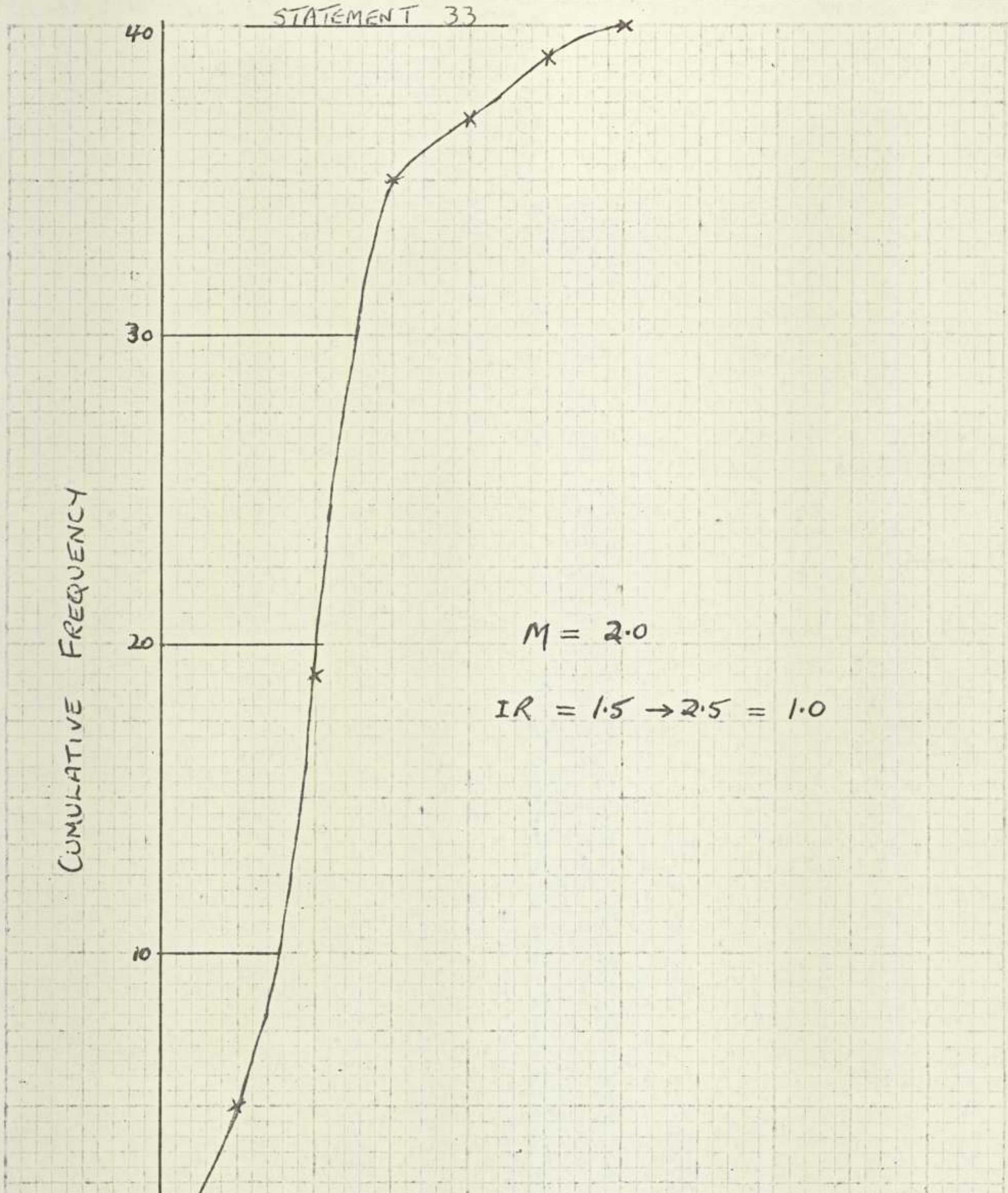

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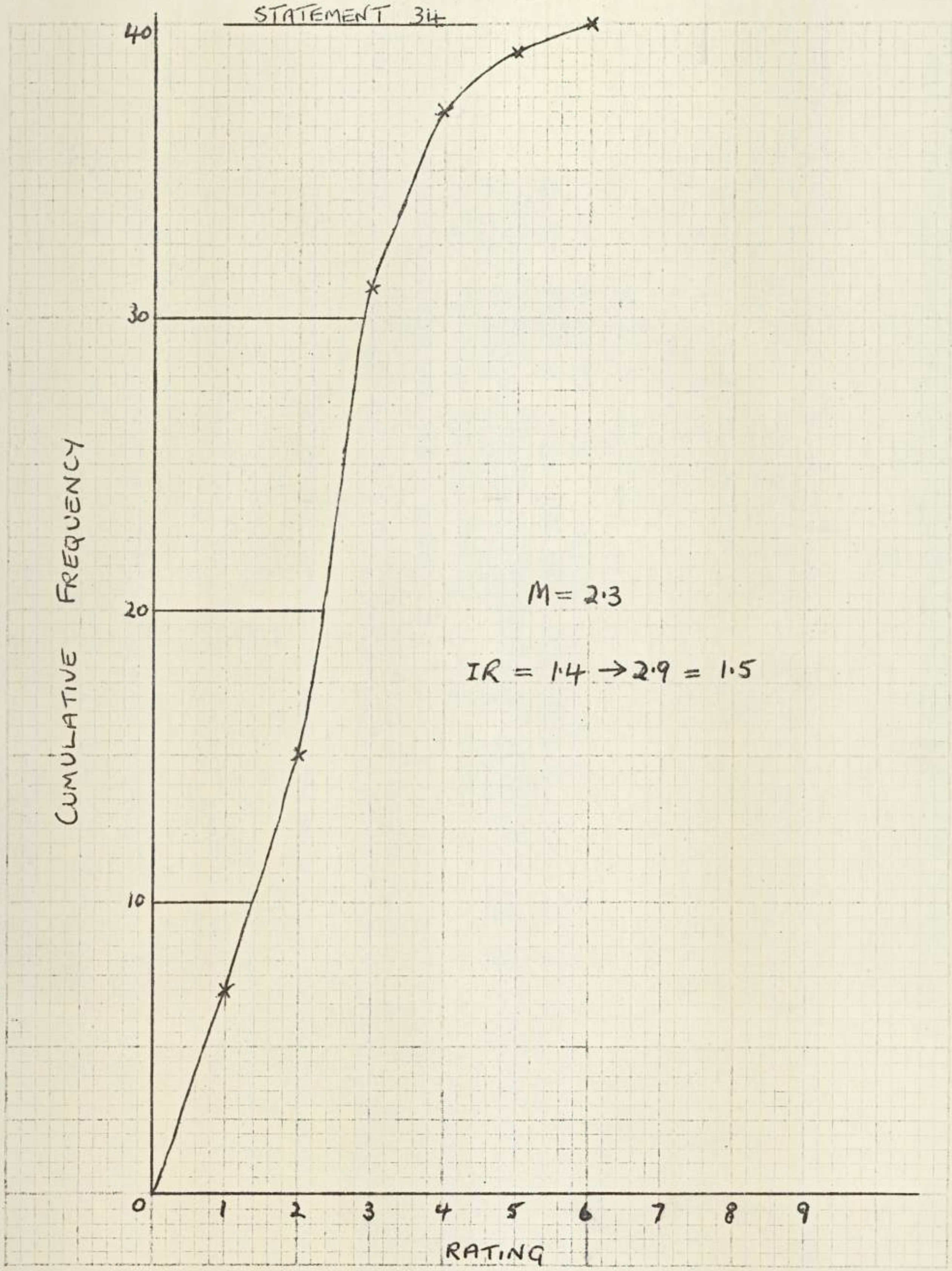

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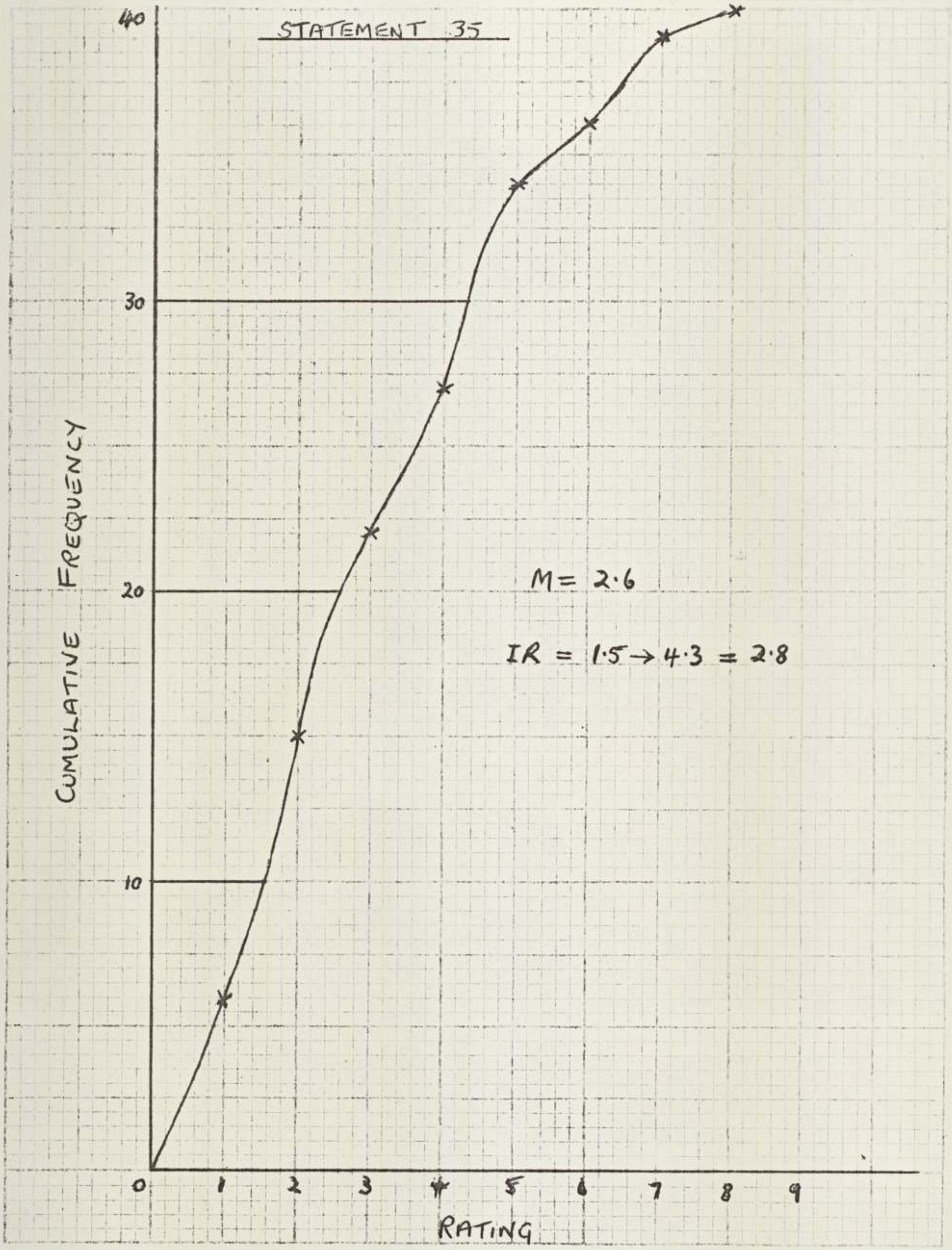

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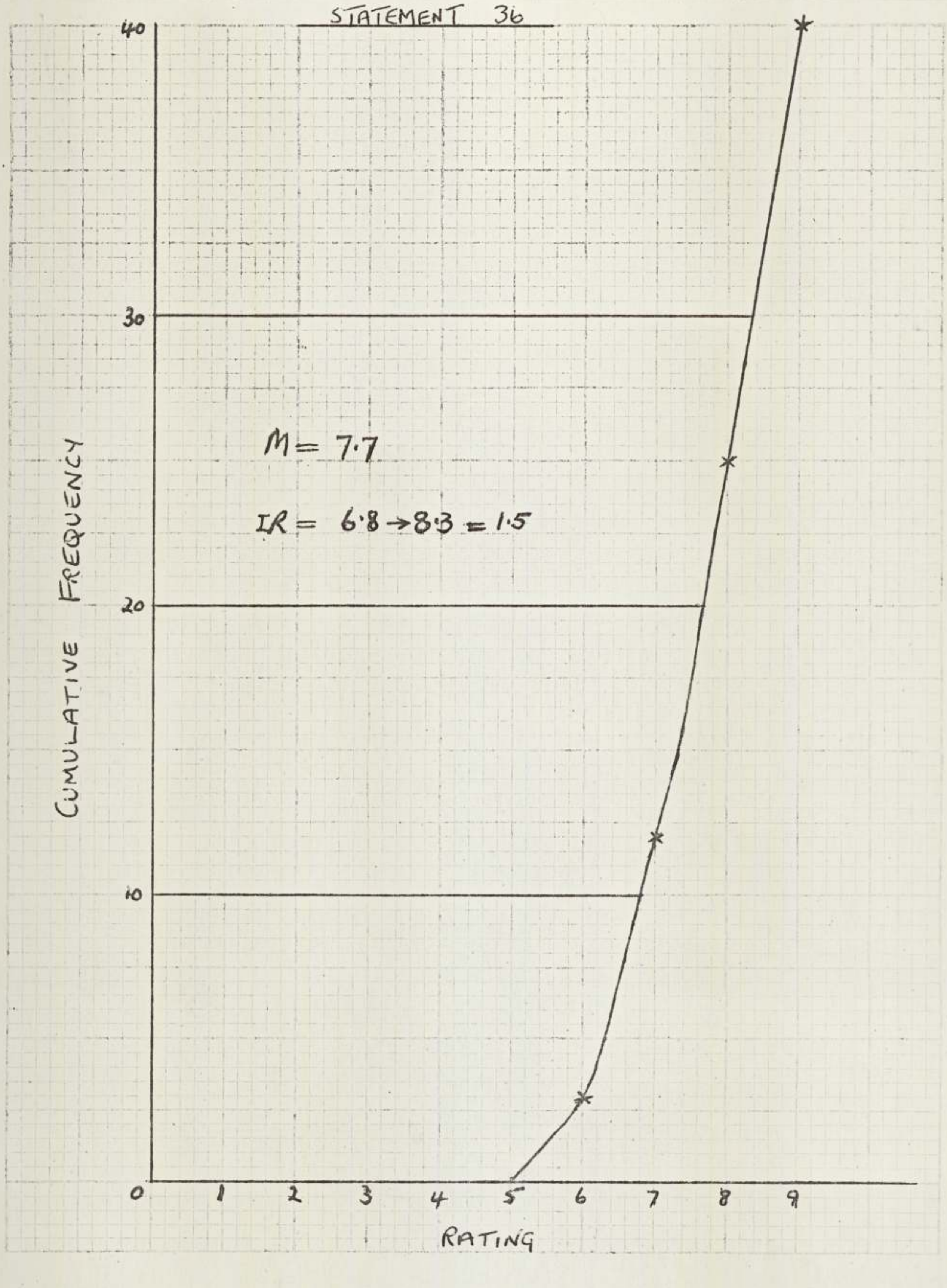

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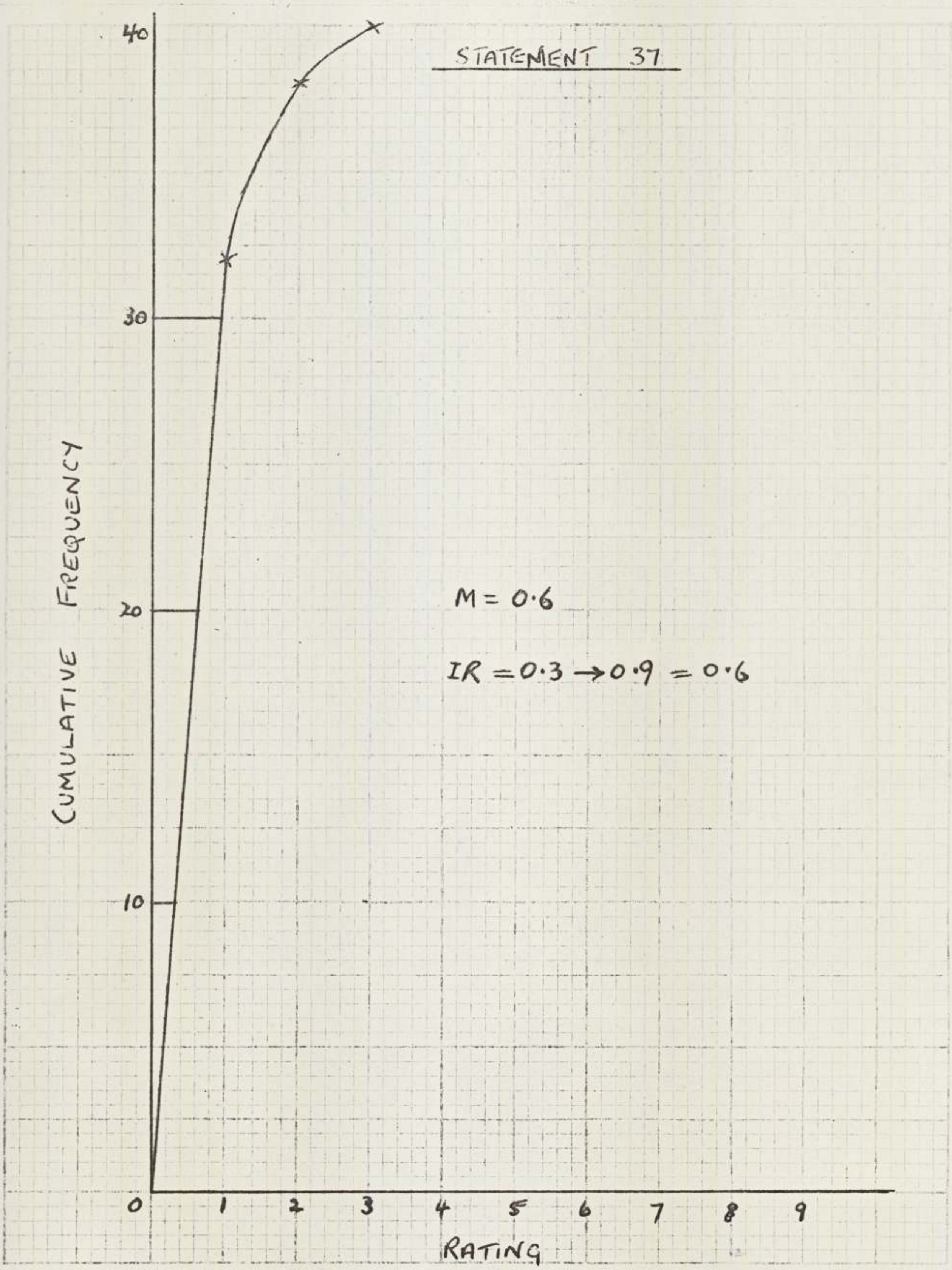

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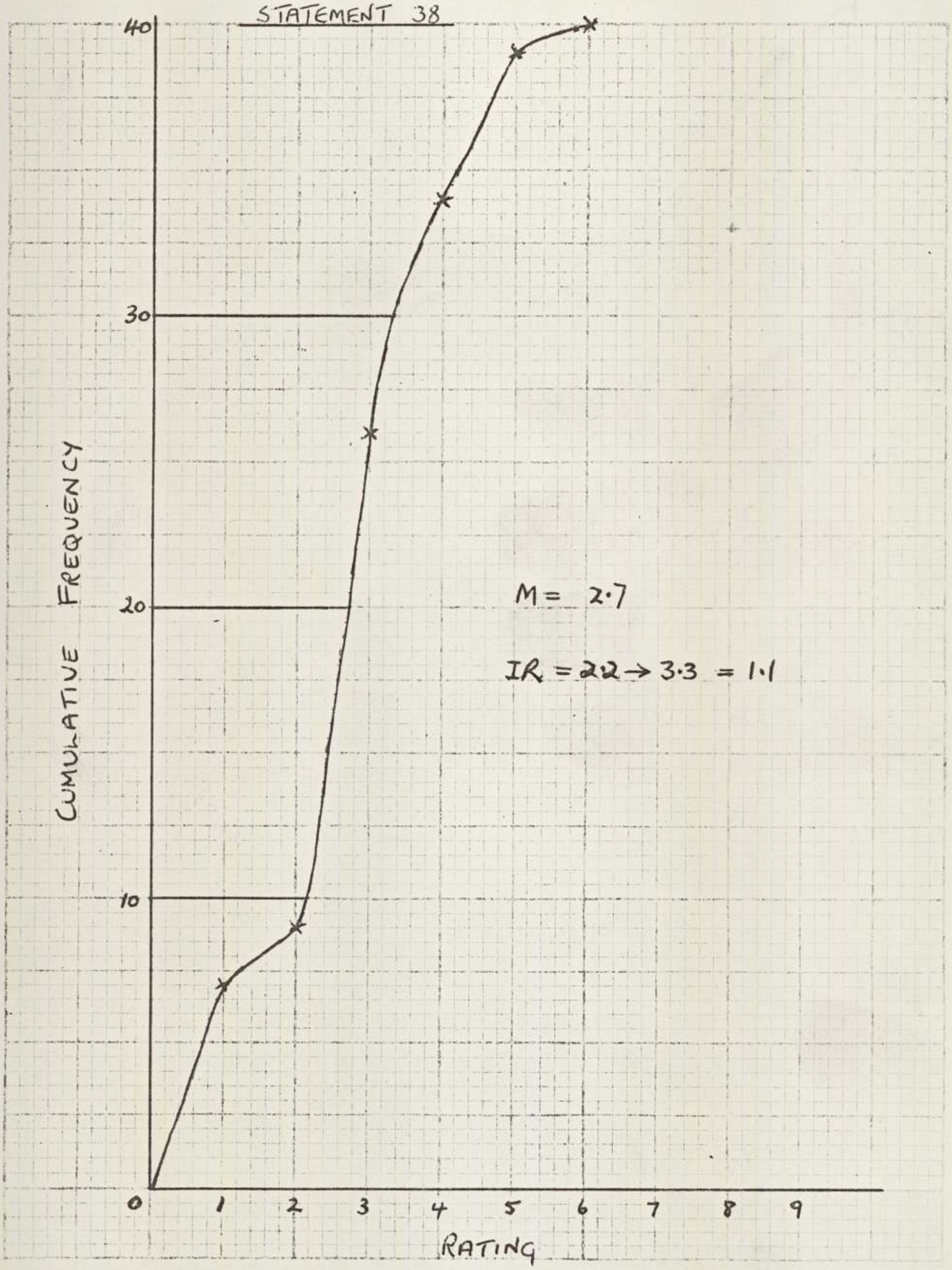

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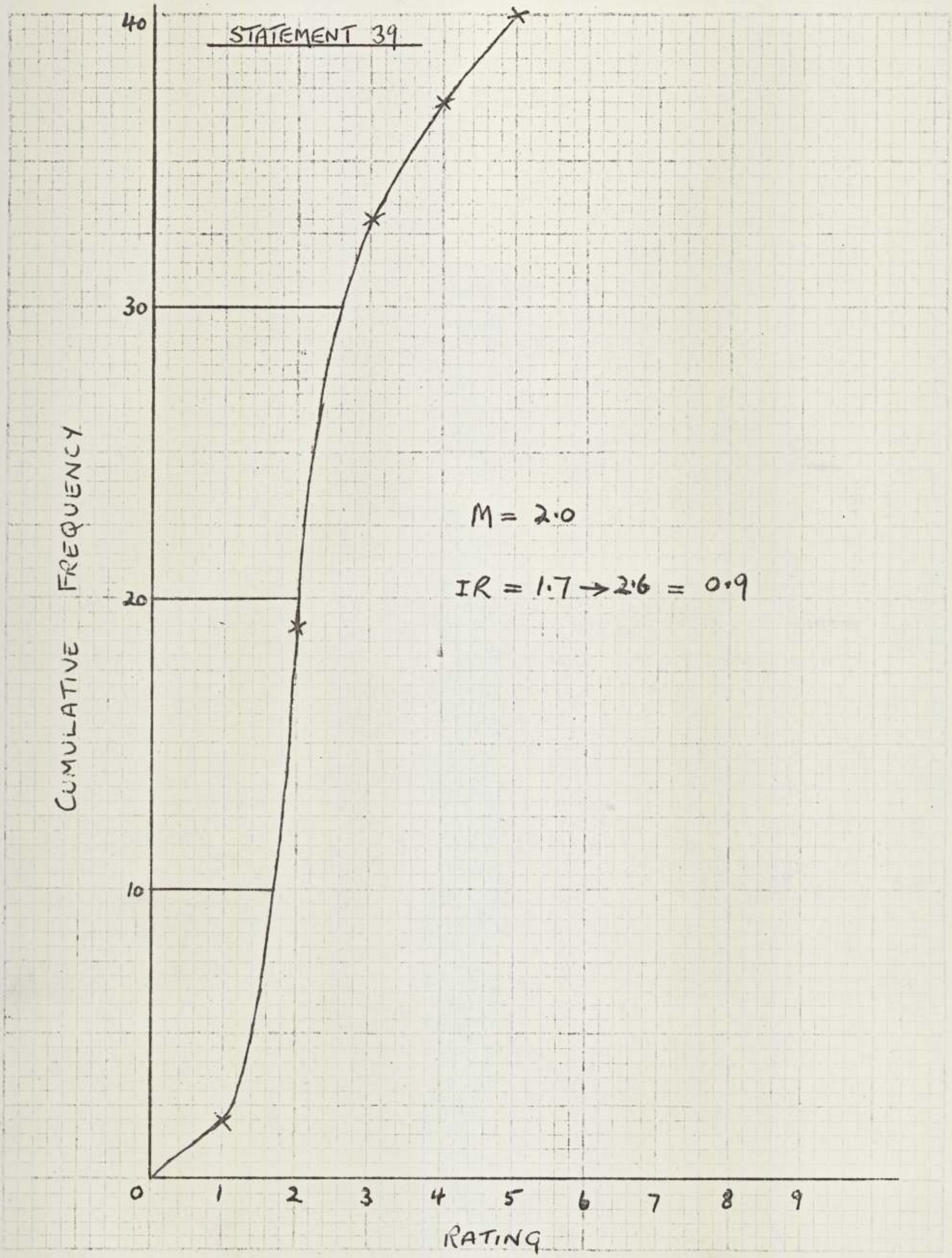

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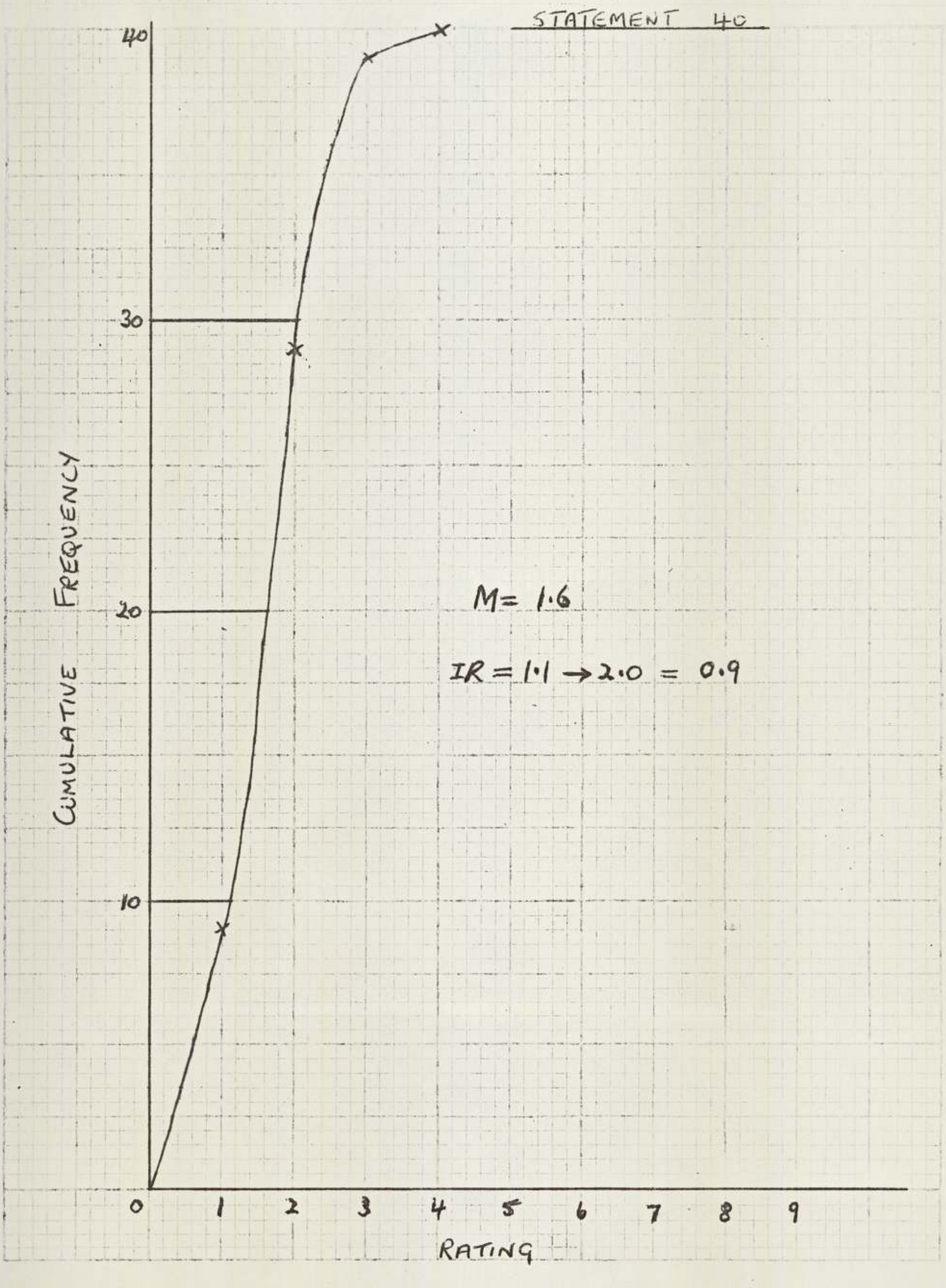

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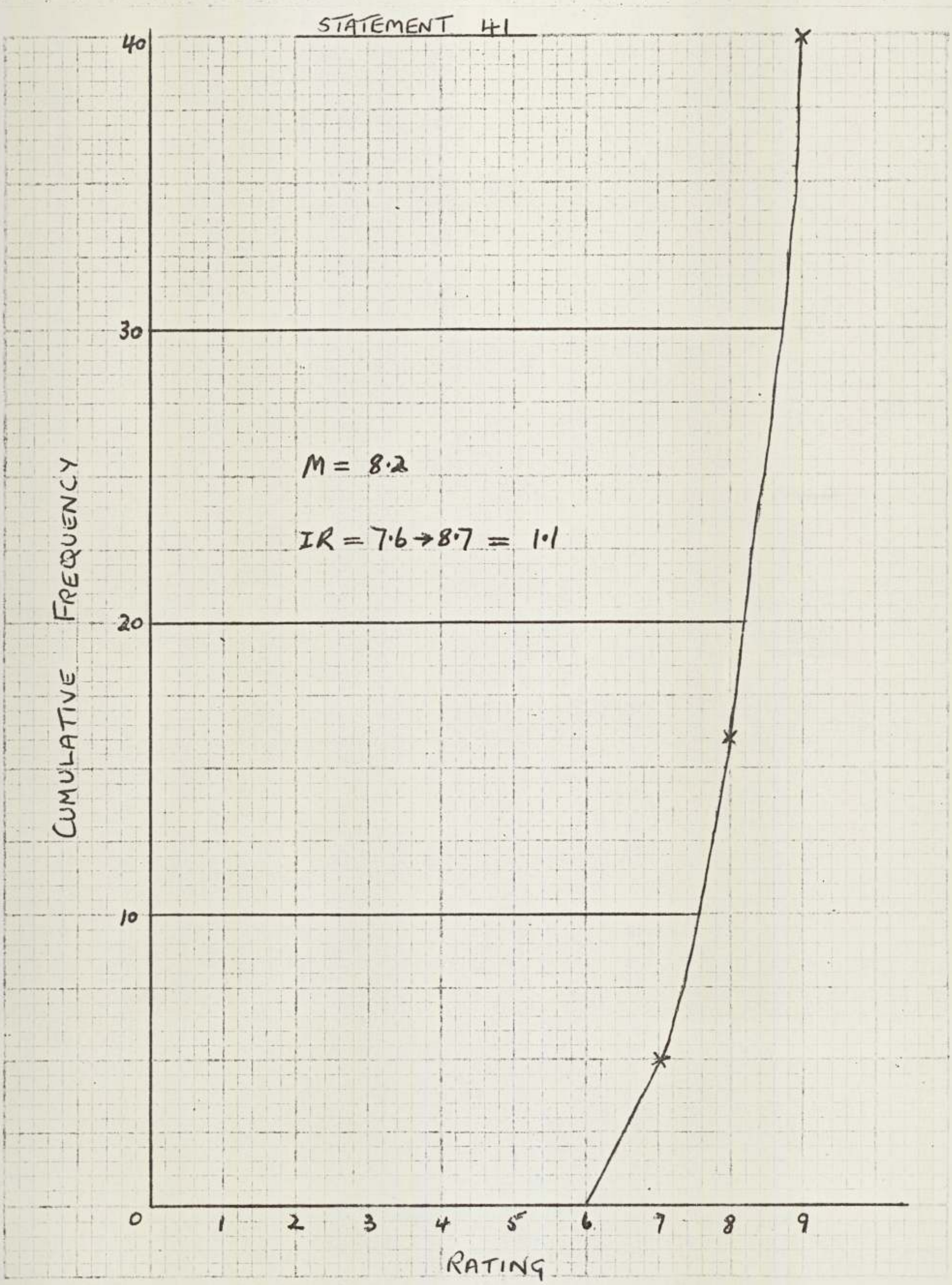

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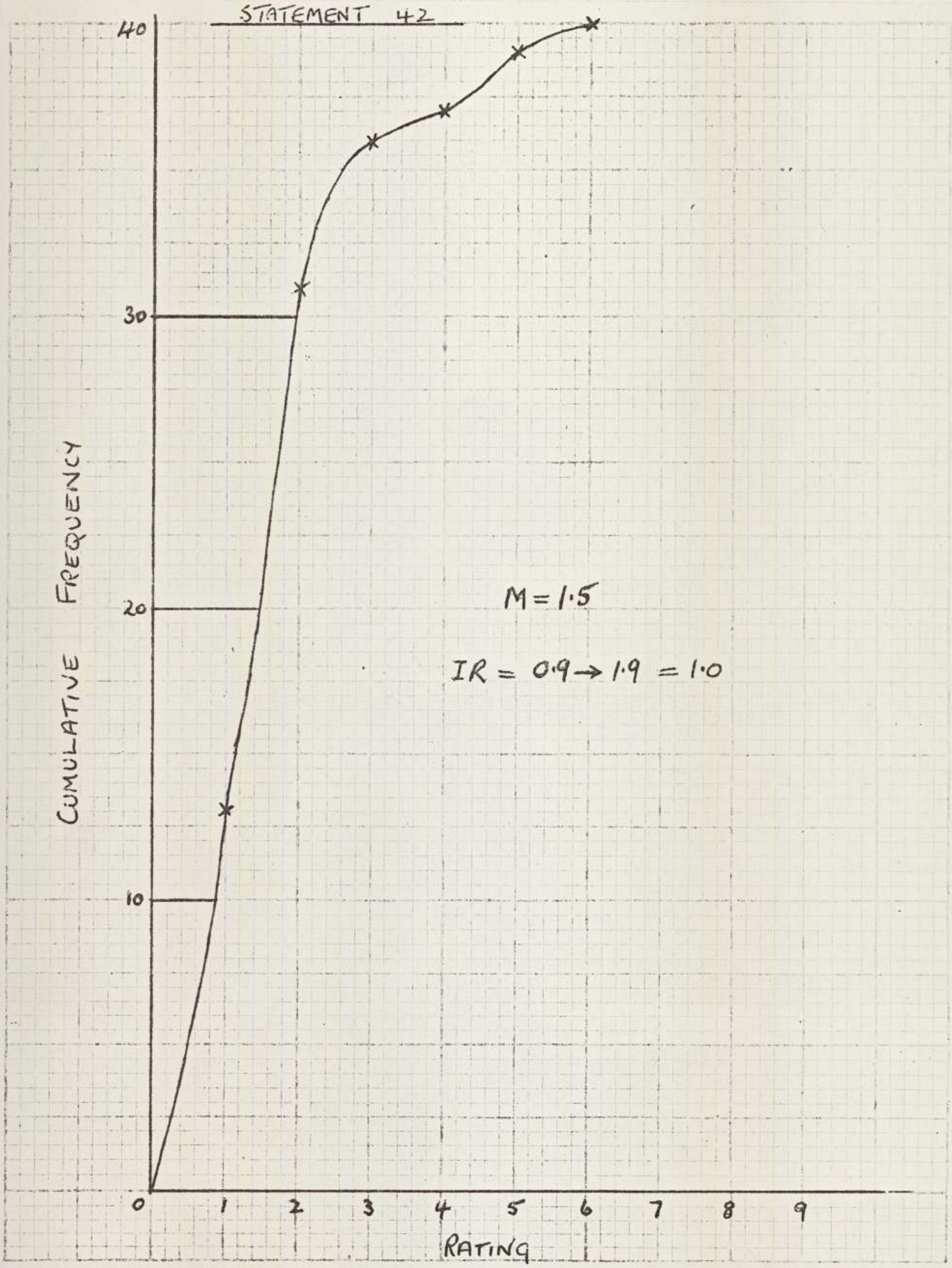

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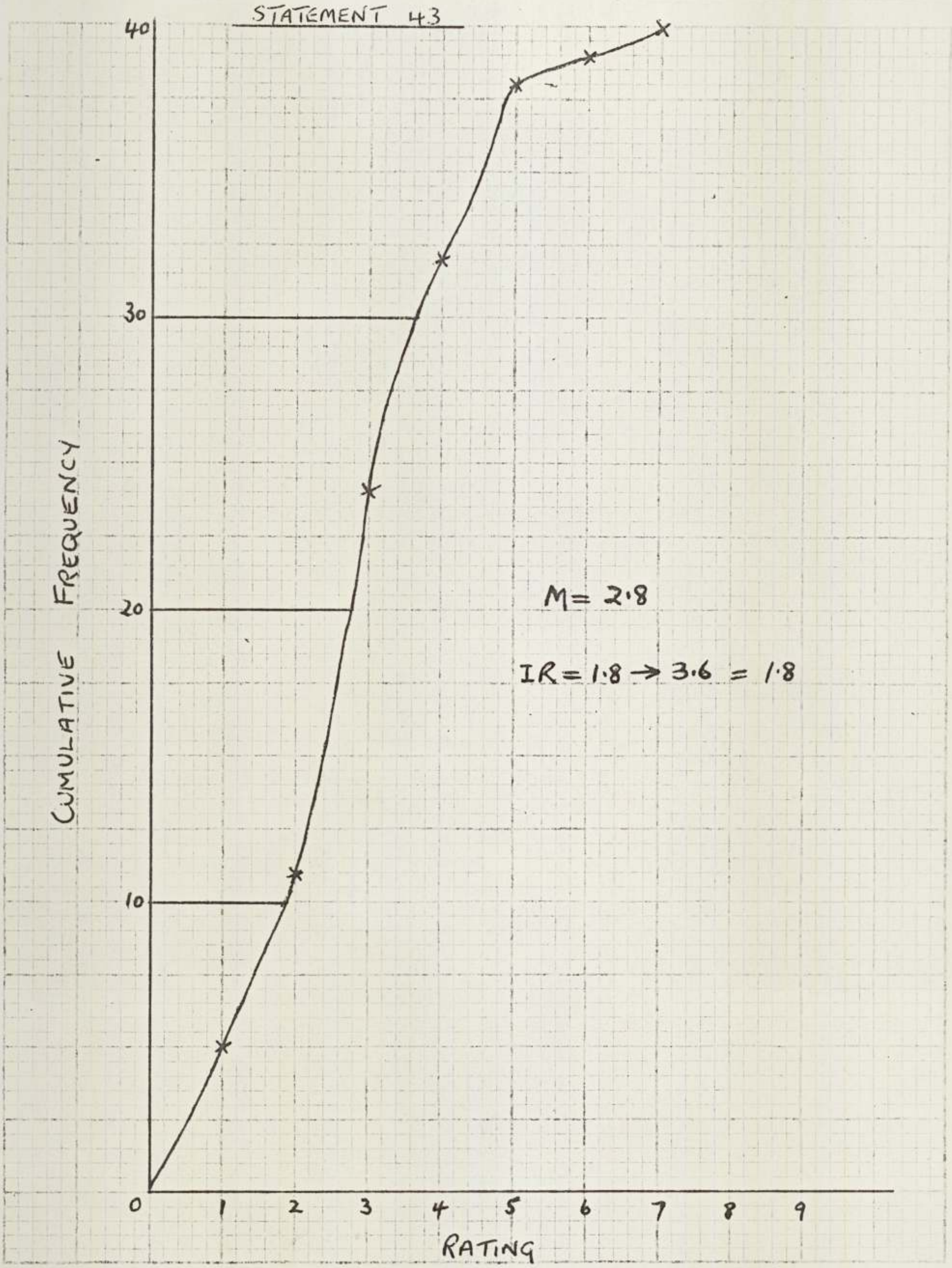

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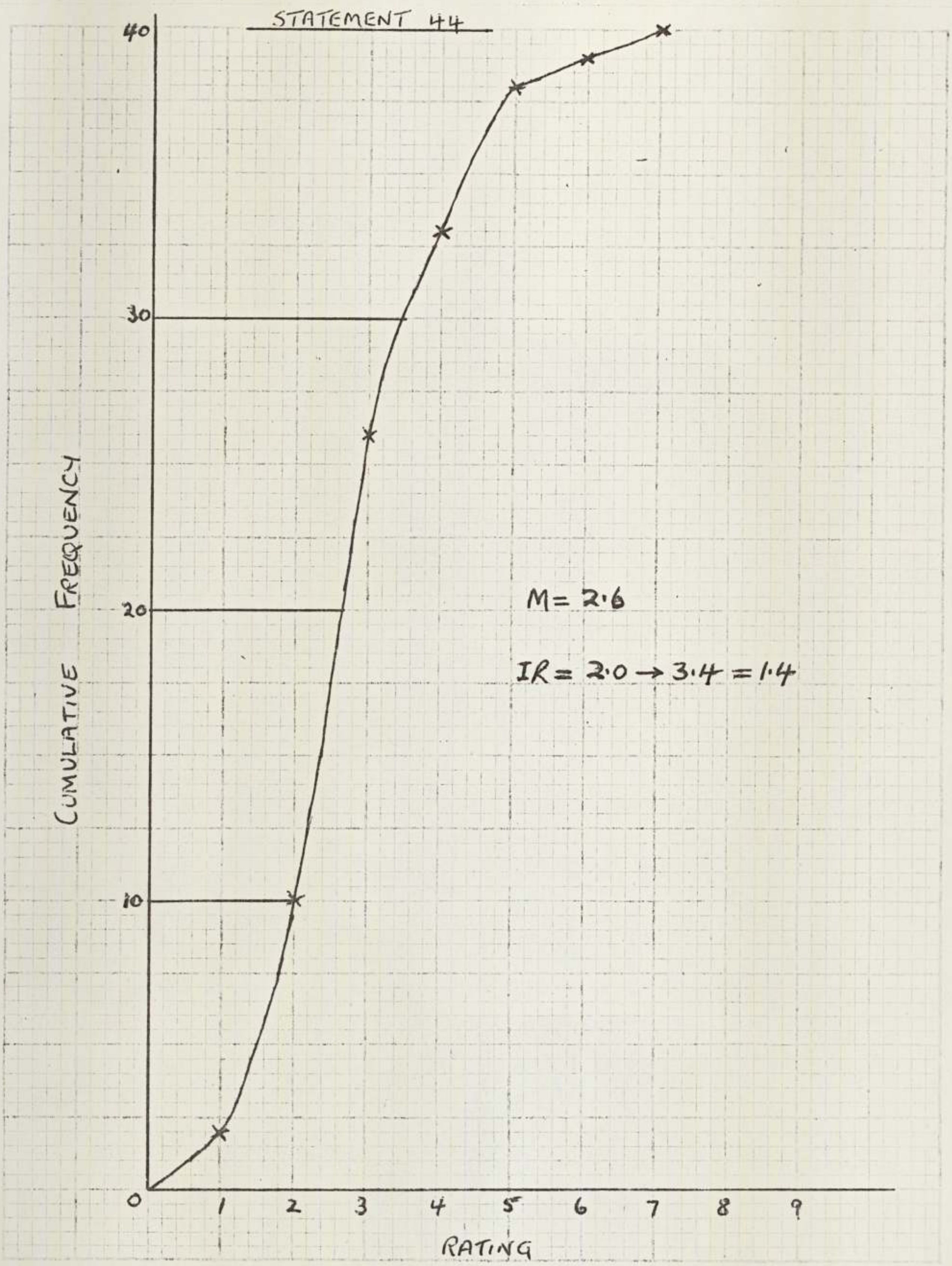

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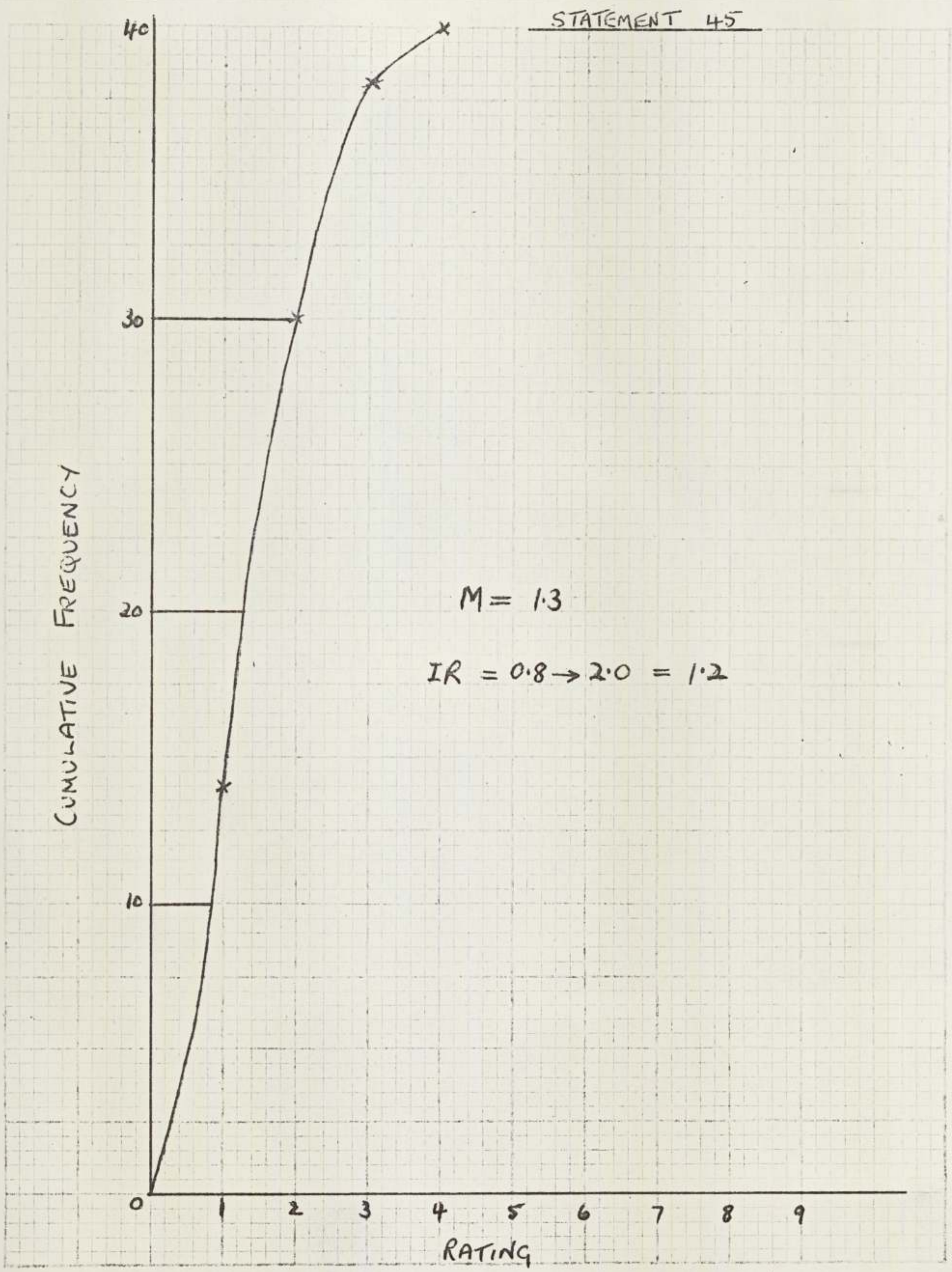

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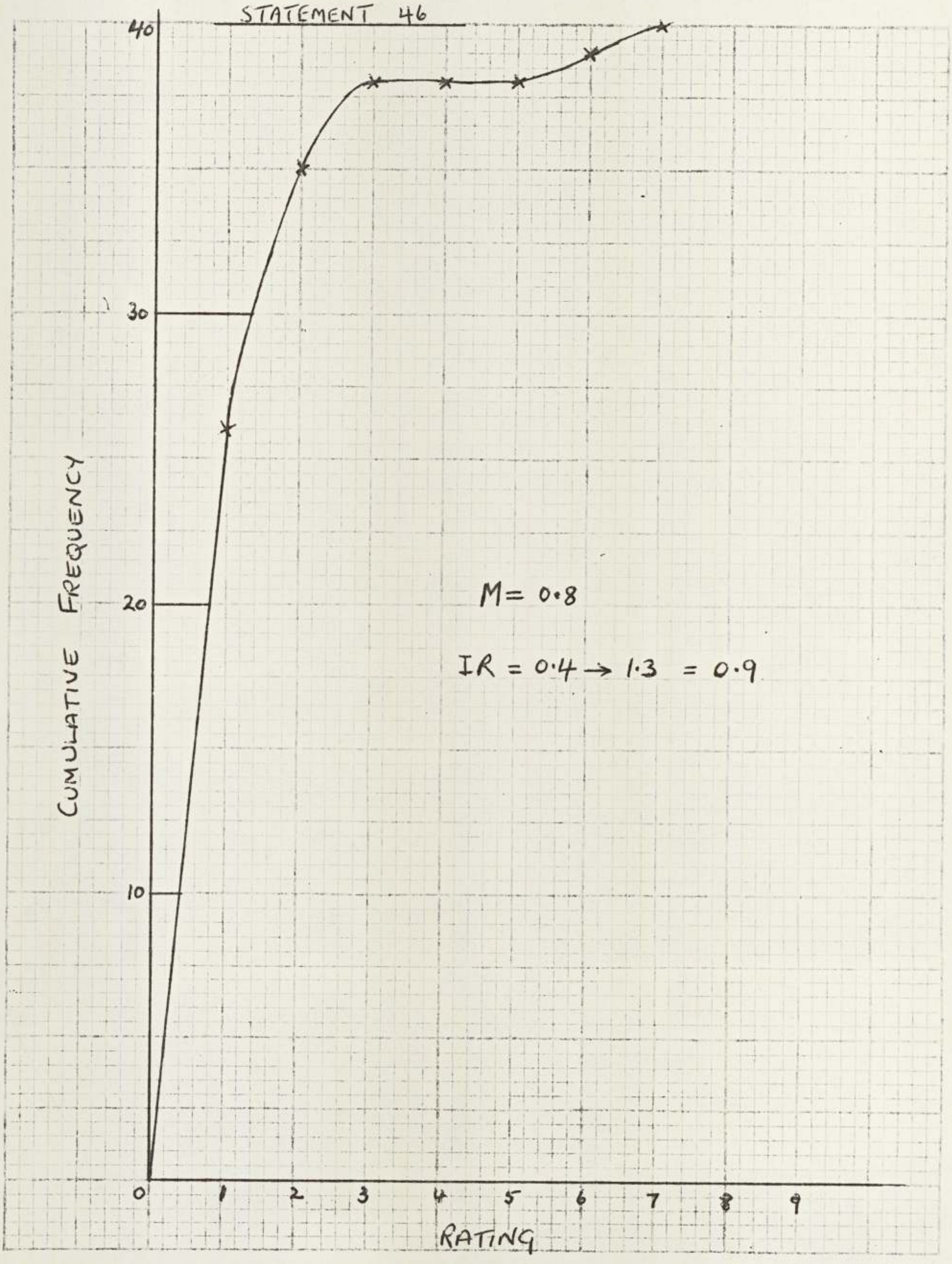

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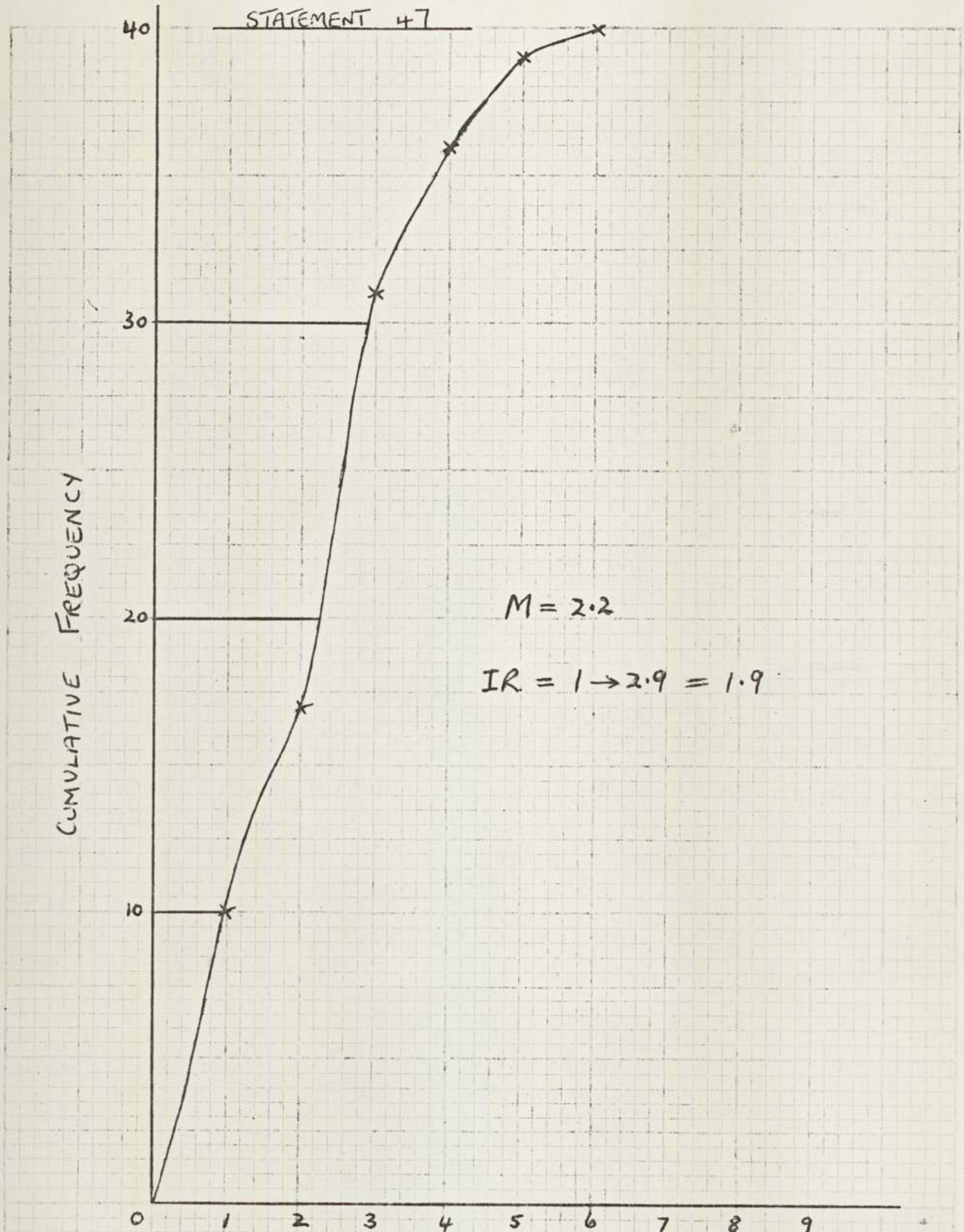

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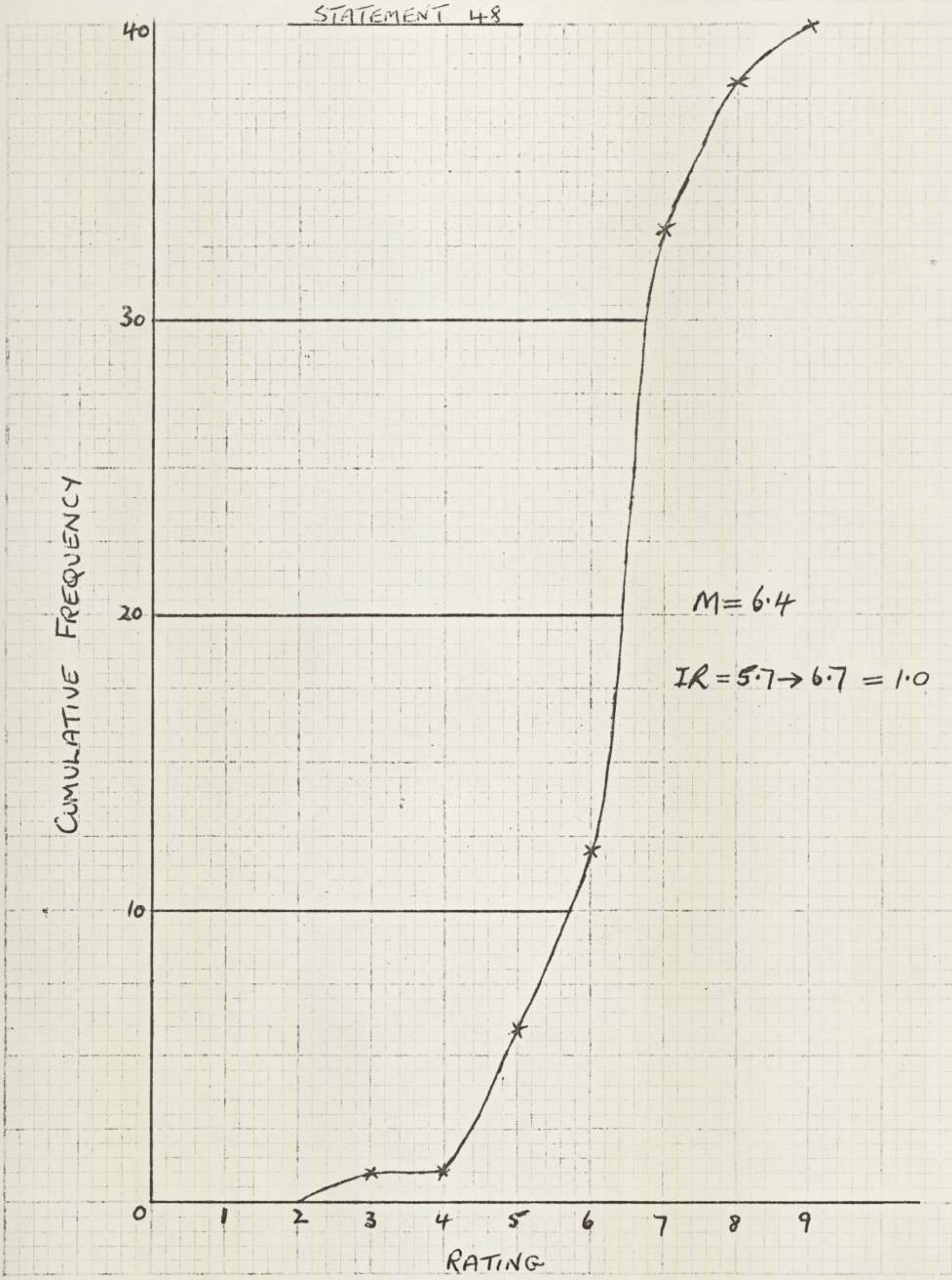

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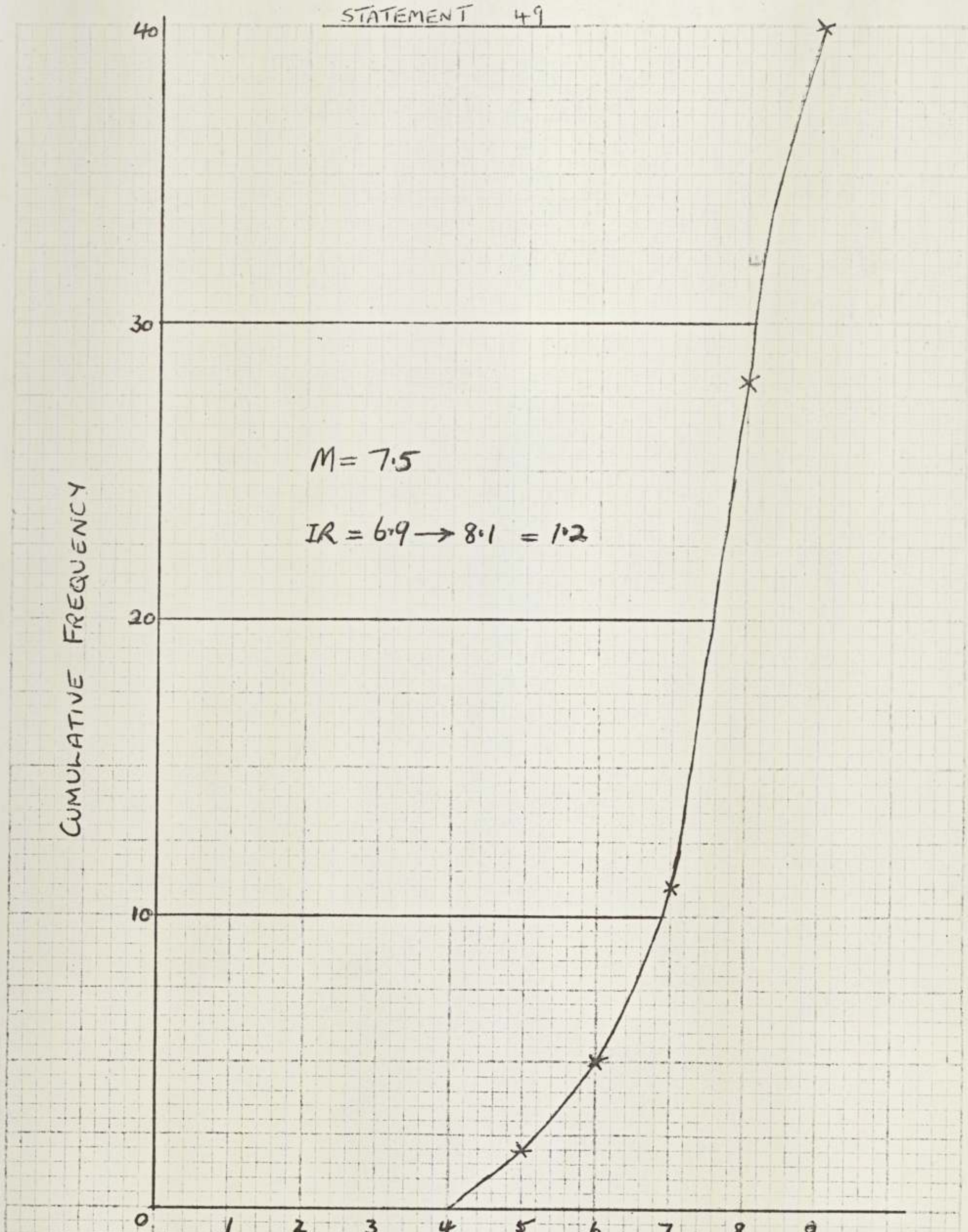

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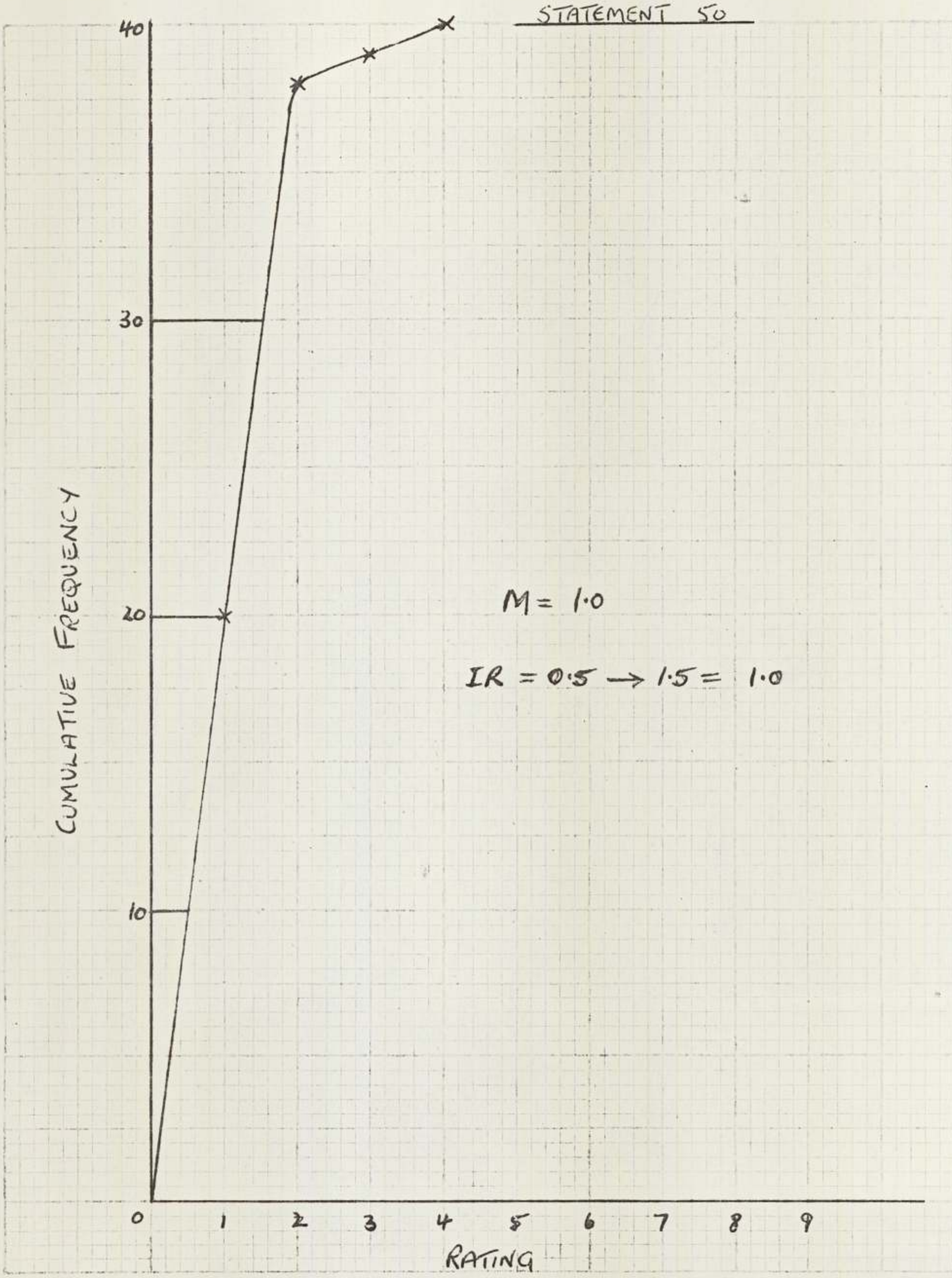

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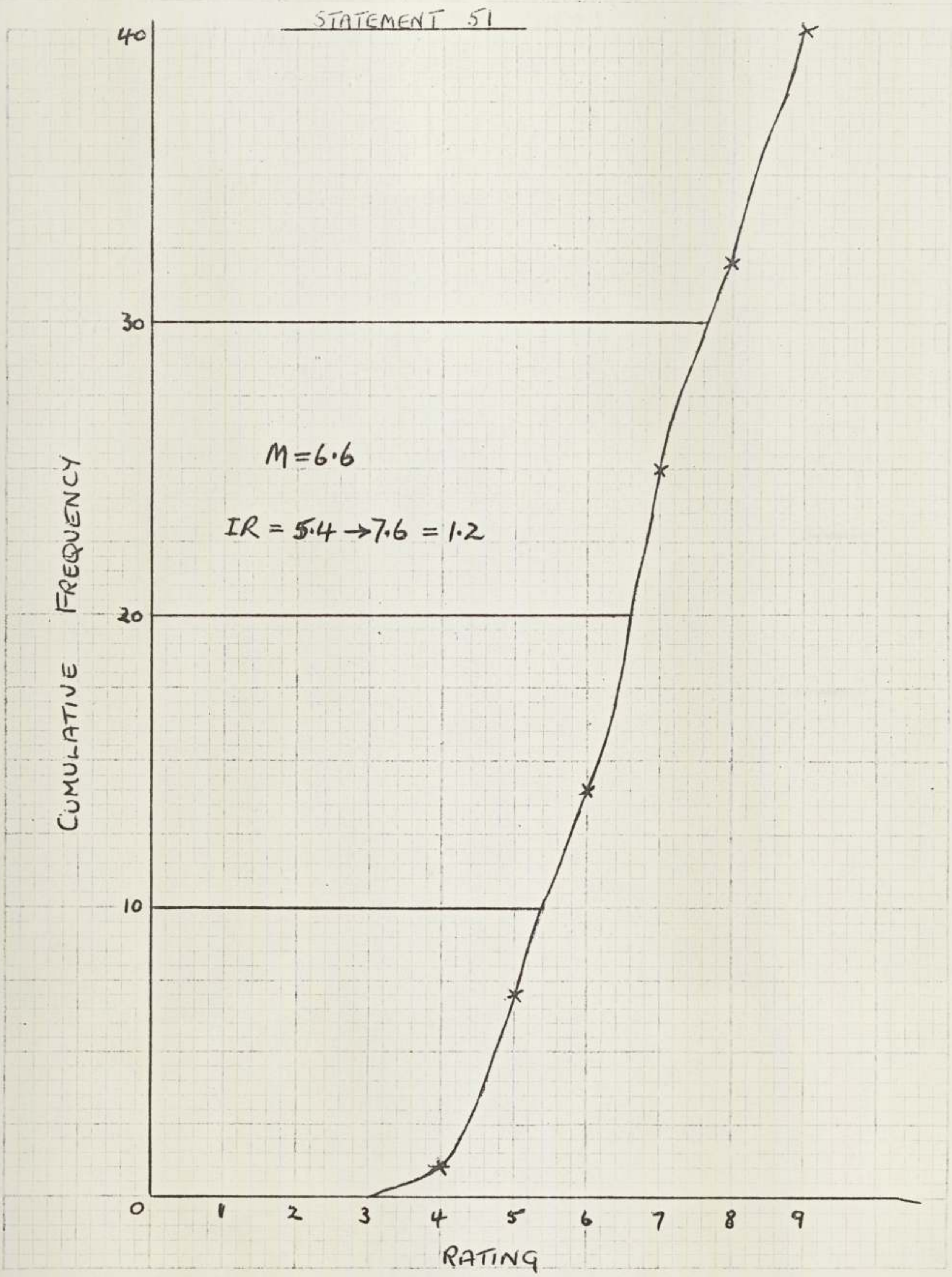

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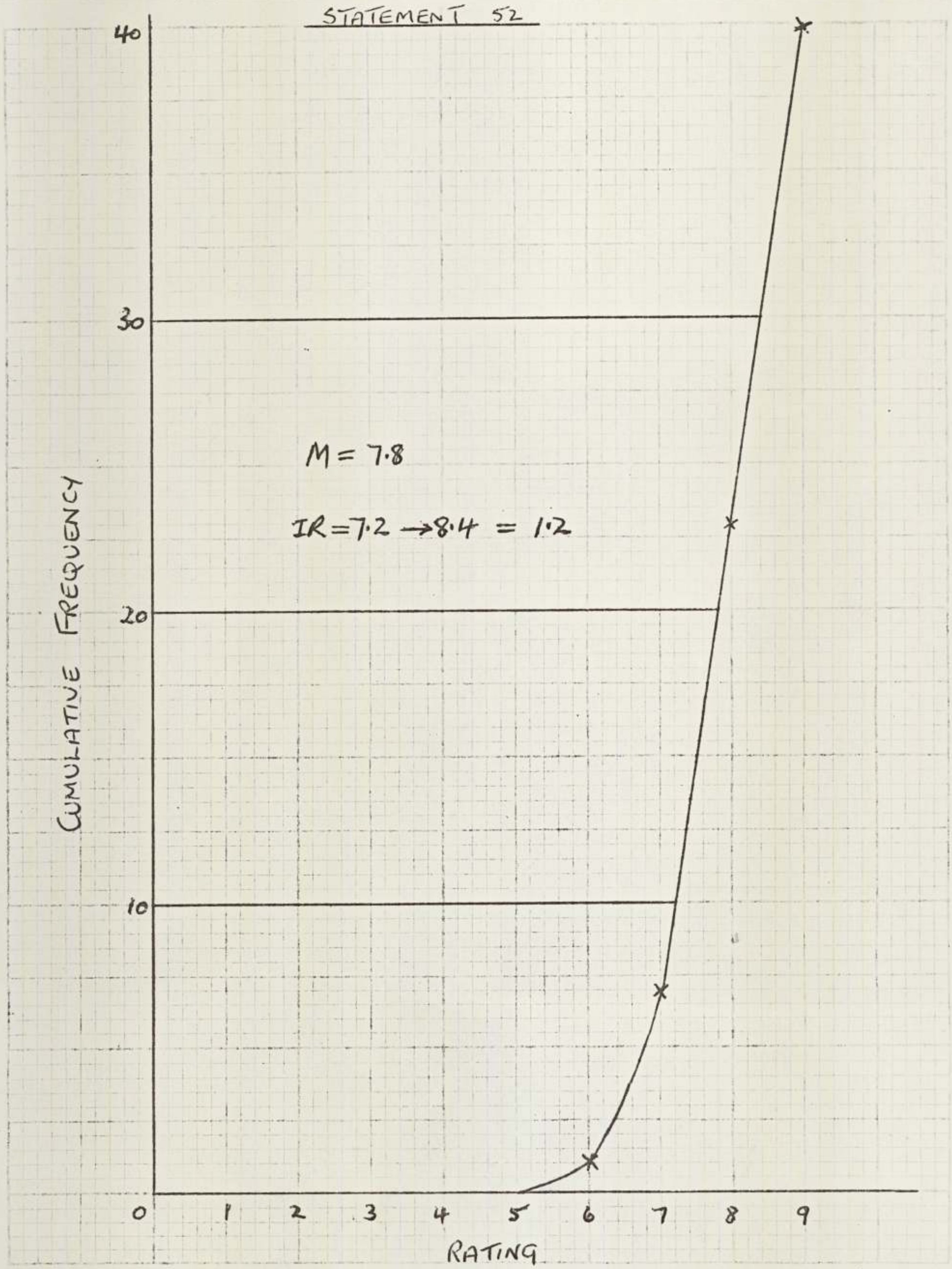
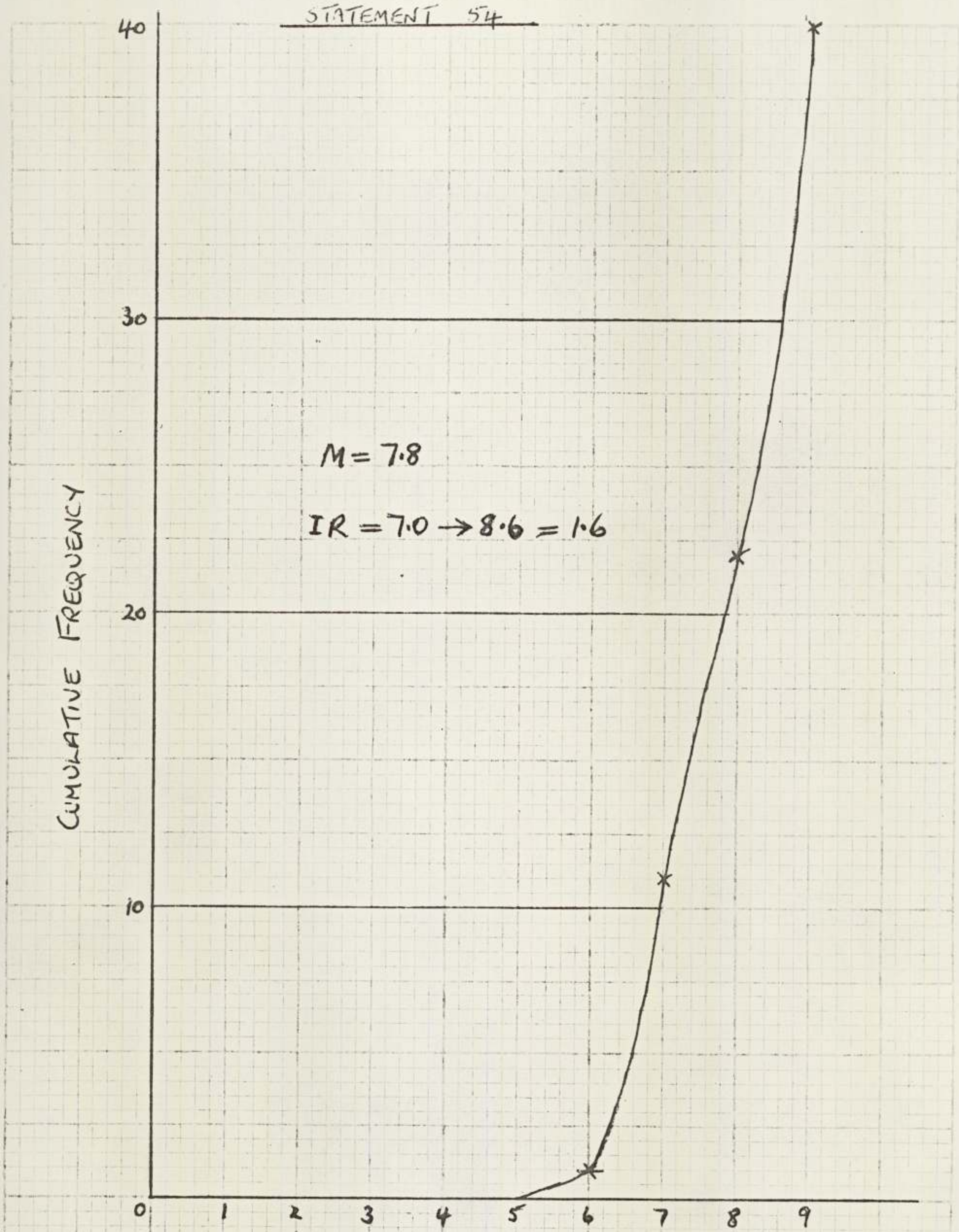


GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.

GRAPH OF CUMULATIVE FREQUENCIES OF RATINGS.



APPENDIX IX

MEDIANS AND INTERQUARTILE RANGES FOR ATTITUDE STATEMENTS

NO. OF STATEMENT	MEDIAN	INTERQUARTILE RANGE
1	2.8	2.5
2	7.1	1.3
3	7.0	1.5
4	1.9	1.0
5	8.1	1.0
6	2.1	3.4
7	0.7	0.8
8	1.3	1.4
9	0.9	1.1
10	7.2	1.2
11	7.1	0.9
12	5.9	2.5
13	1.6	1.6
14	7.6	1.5
15	7.1	1.6
16	5.2	1.6
17	2.5	1.6
18	2.0	1.1
19	8.6	0.4
20	0.4	0.4
21	6.9	1.2
22	6.8	1.2
23	1.1	1.4
24	7.3	1.8
25	1.9	1.0
26	2.8	1.4
27	1.9	1.3
28	1.7	1.5
29	0.4	0.4
30	8.0	1.1

NO. OF STATEMENT	MEDIAN	INTERQUARTILE RANGE
31	7.3	1.6
32	2.6	2.8
33	2.0	1.0
34	2.3	1.5
35	2.6	2.8
36	7.7	1.5
37	0.6	0.6
38	2.7	1.1
39	2.0	0.9
40	1.6	0.9
41	8.2	1.1
42	1.5	1.0
43	2.8	1.8
44	2.6	1.4
45	1.3	1.2
46	0.8	0.9
47	2.2	1.1
48	6.4	1.0
49	7.5	1.2
50	1.0	1.0
51	6.6	1.2
52	7.8	1.2
53	1.5	1.8
54	7.8	1.6

APPENDIX X

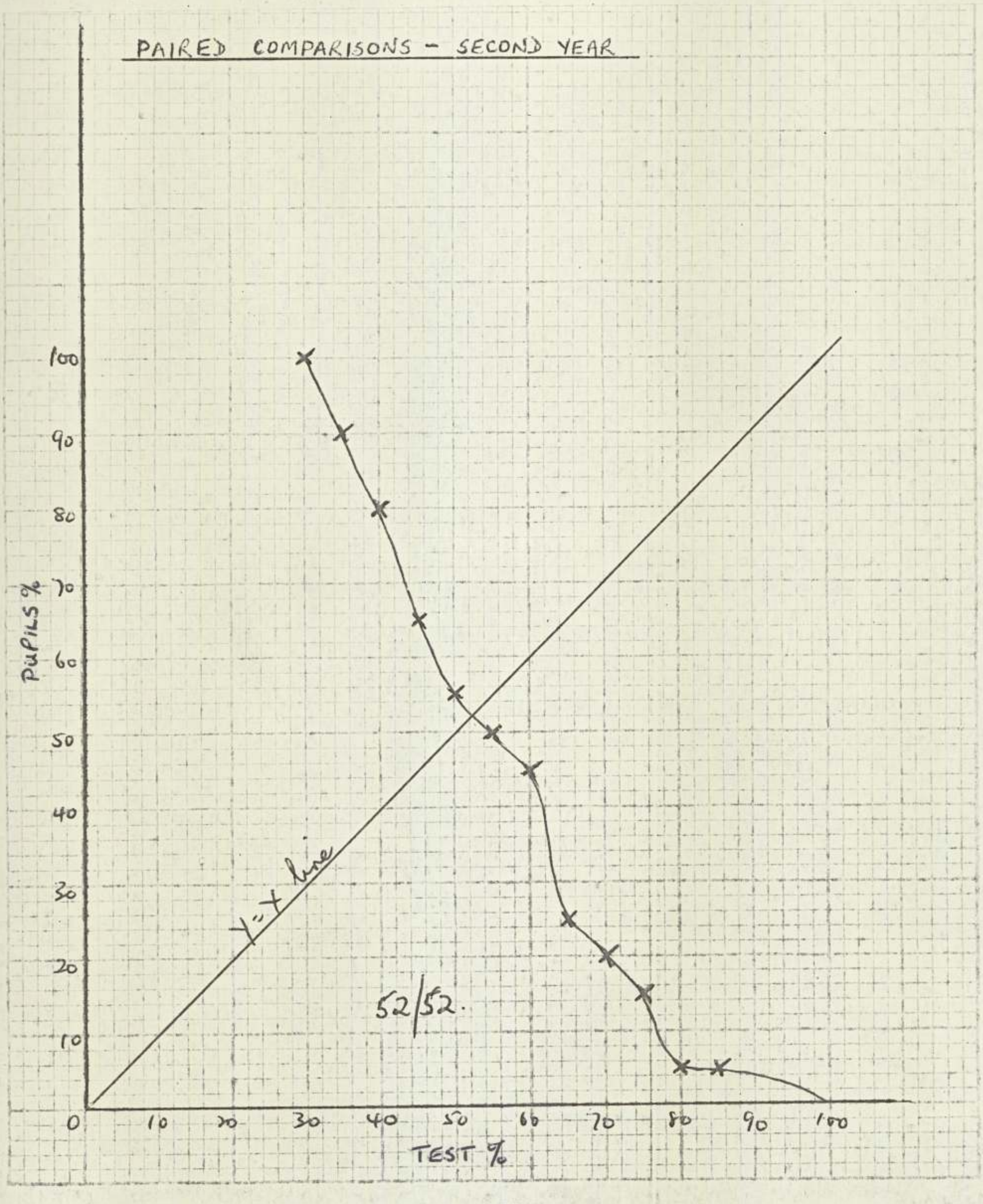
Facility Index for Original Test Items

	All Pupils (N=74)		Groups 2 and 3 (N=54)	
Item No.	No. of correct answers	% correct answers	No. of correct answers	% correct answers
1	60	81	46	85
2	61	82	43	80
3	41	55	36	67
4	49	66	37	69
5	60	81	46	85
6	48	65	38	70
7	65	88	51	94
8*	33	43	29	54
9	61	82	47	87
10	54	73	36	67
11	52	70	45	83
12	66	89	50	93
13	52	70	45	83
14	45	61	38	70
15	62	84	45	83
16*	46	62	34	63
17*	29	39	27	50
18	53	72	42	78
19	49	66	40	74
20	42	57	39	72

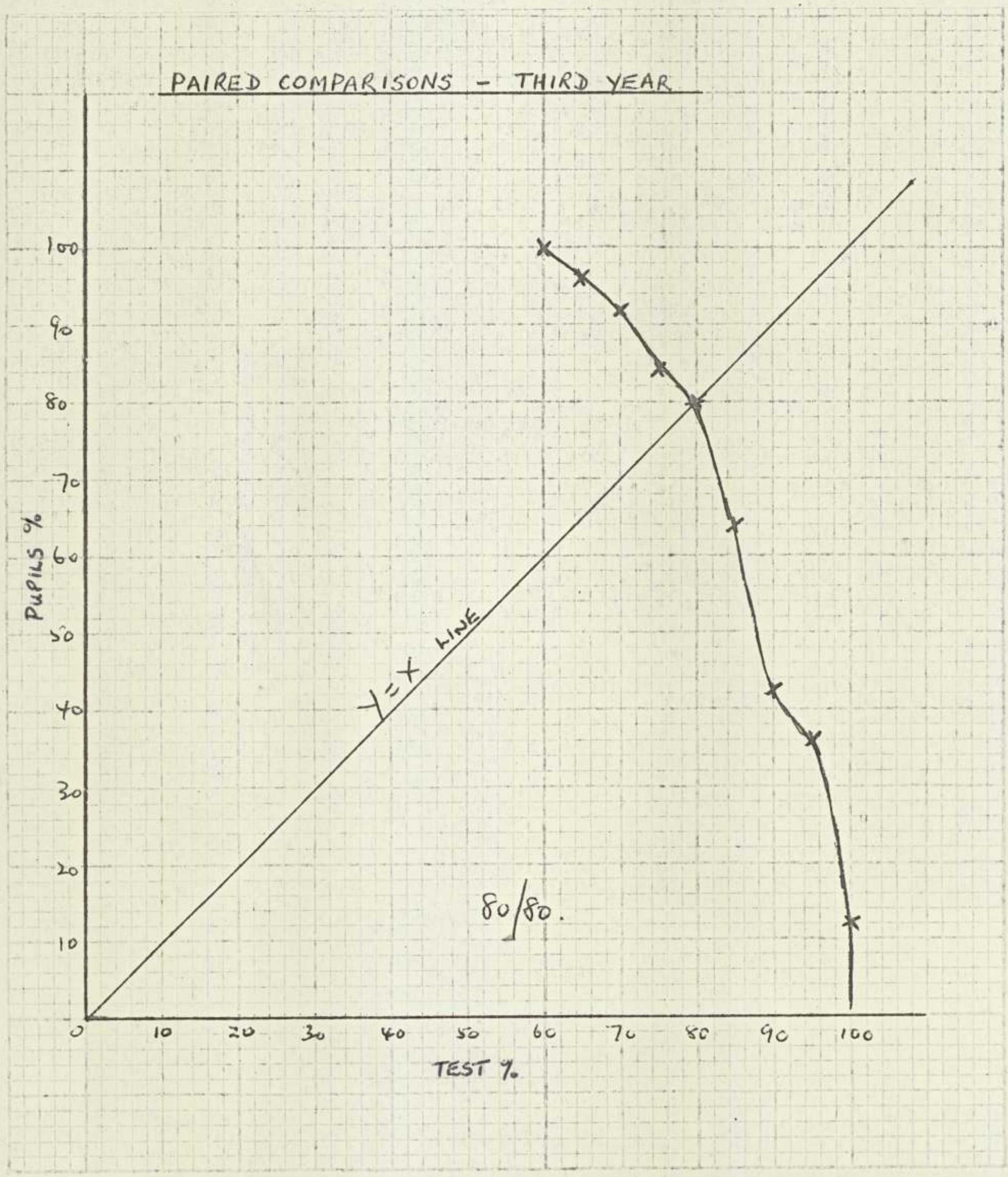
* Items which required modification.

APPENDIX XI.

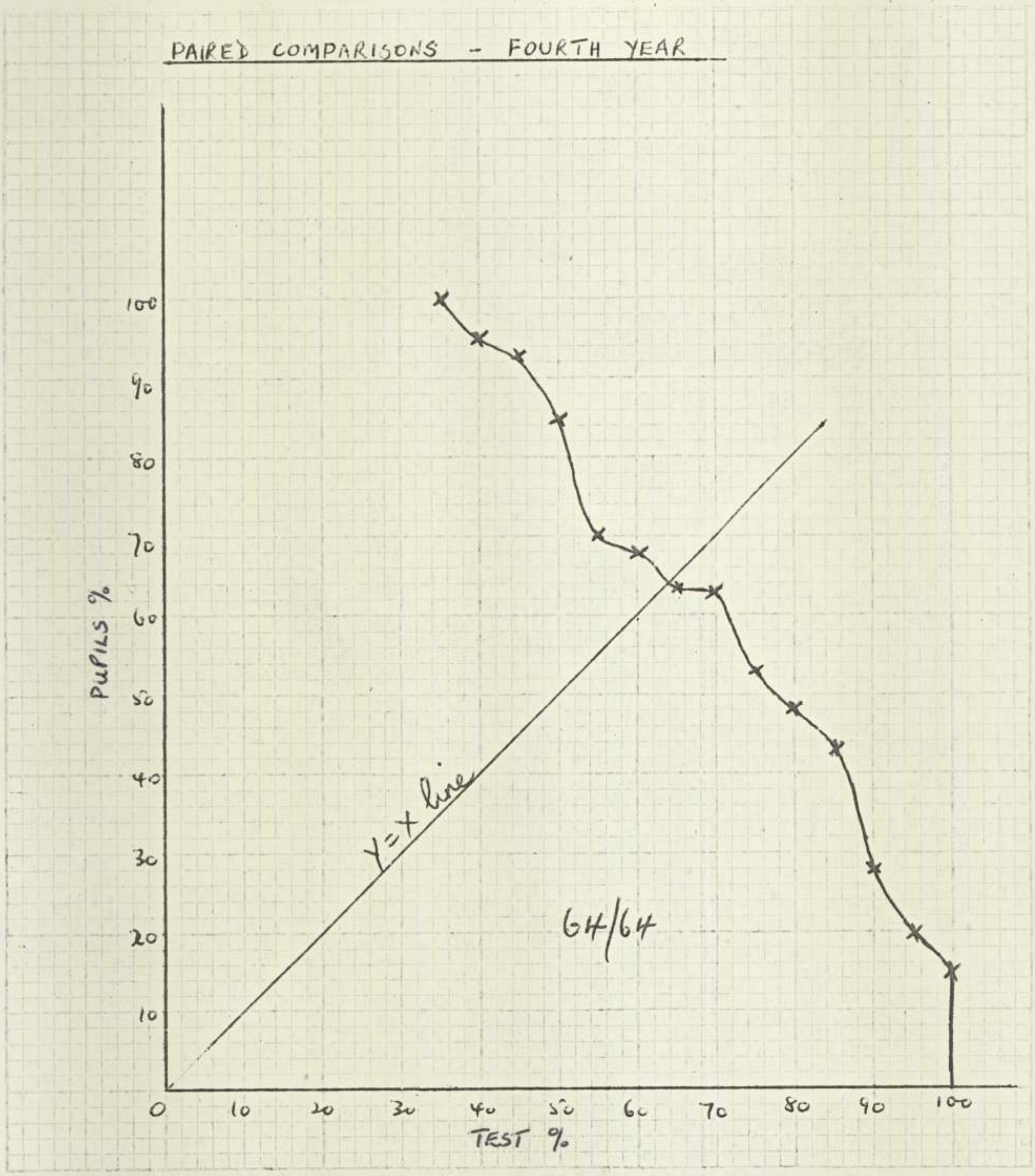
CUMULATIVE FREQUENCY GRAPH.



CUMULATIVE FREQUENCY GRAPH.



CUMULATIVE FREQUENCY GRAPH.

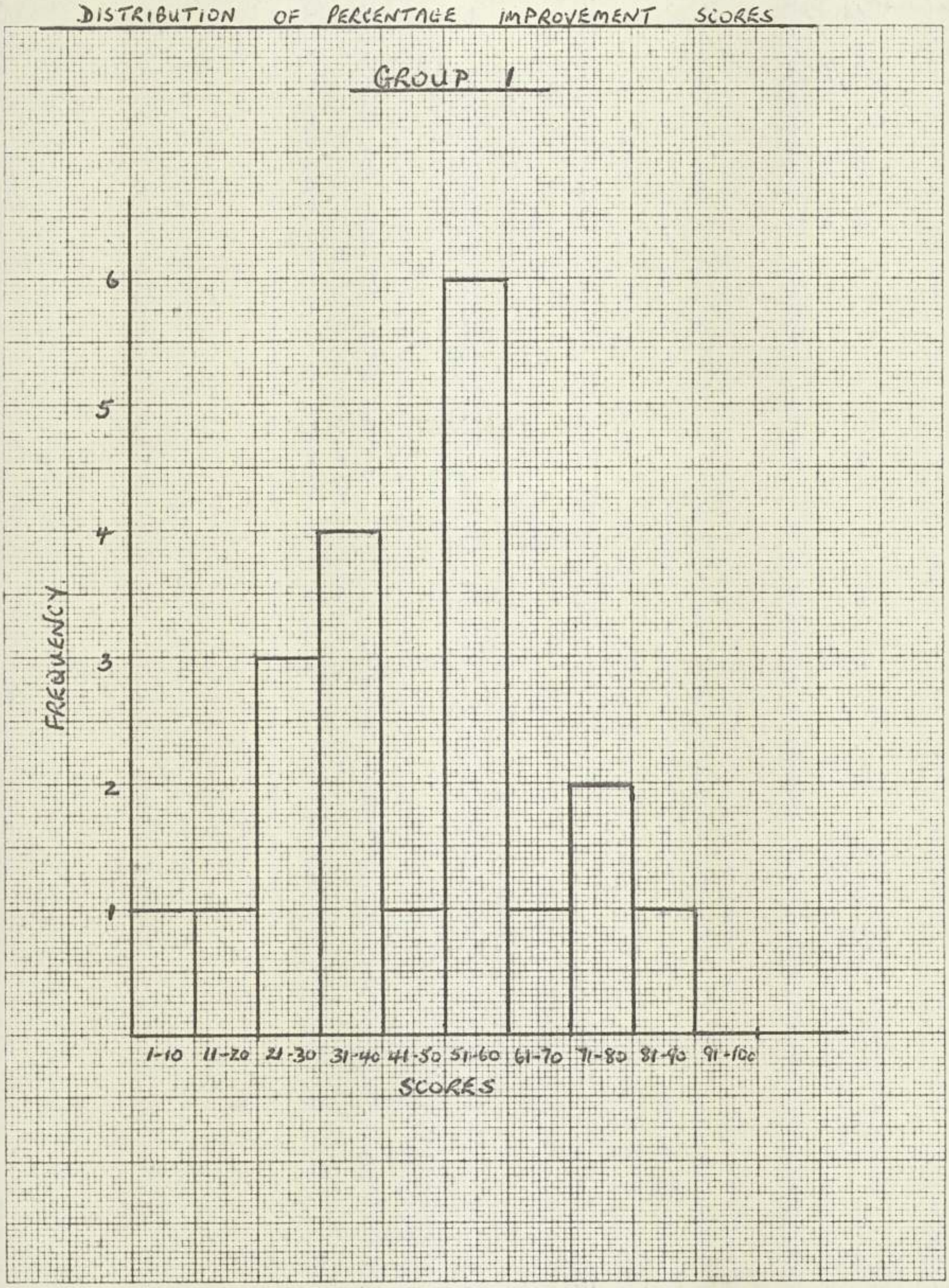


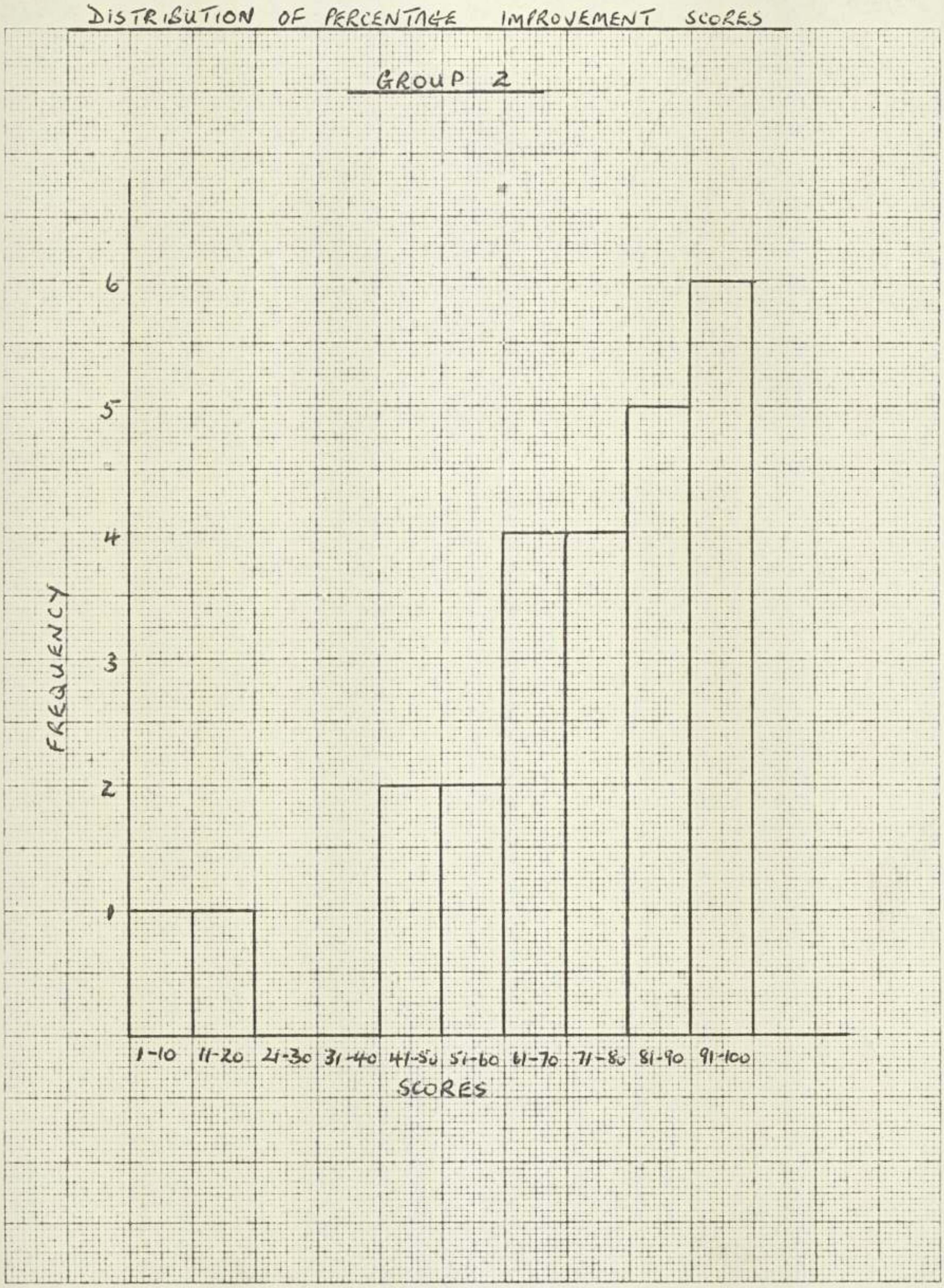
APPENDIX XII(a)

Table of frequency distributions for Percentage Improvement scores.

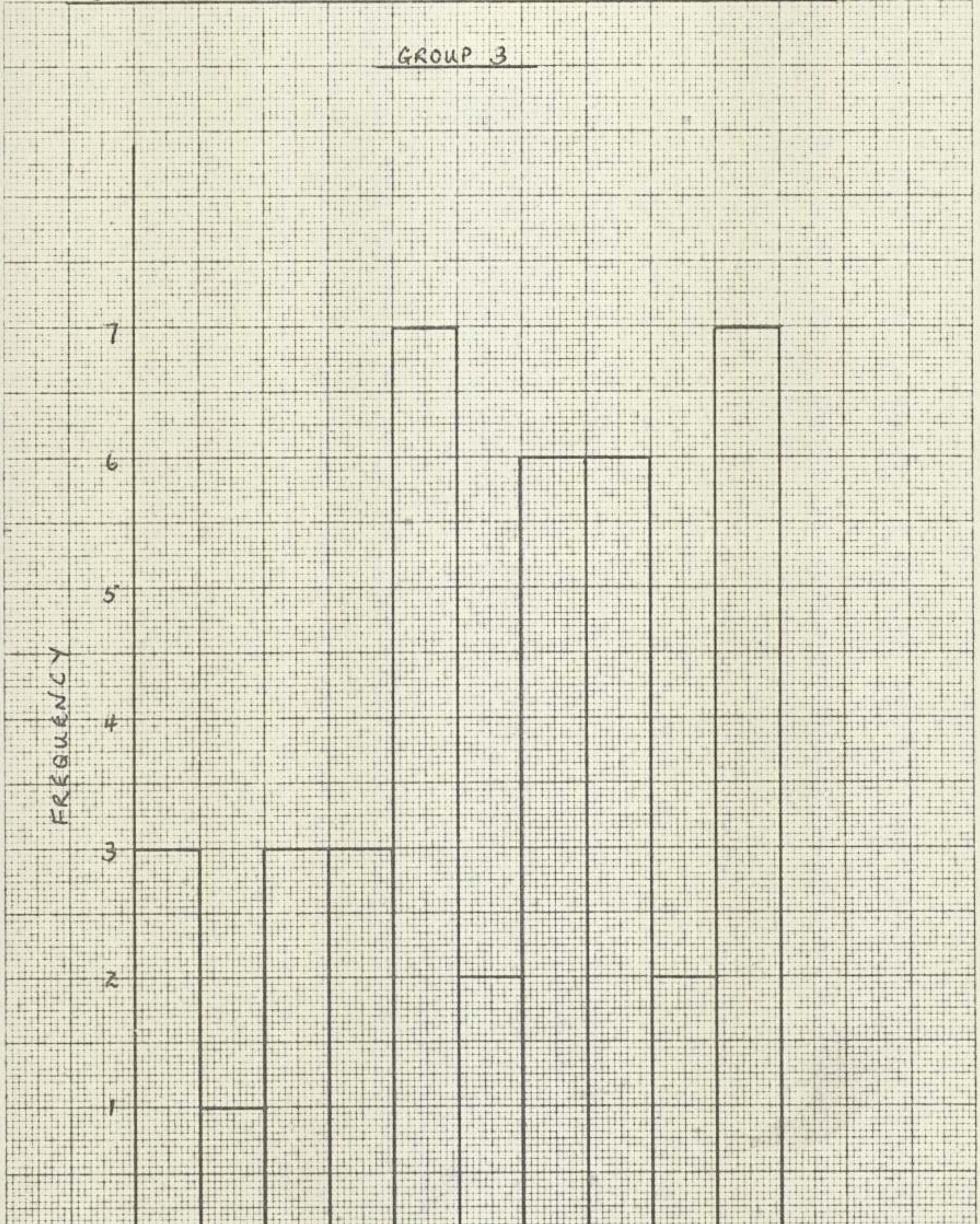
Score	Frequency			
	2nd yr. (N=20)	3rd yr. (N=25)	4th yr. (N=40)	All (N=85)
1- 10	1	1	3	5
11- 20	1	1	1	3
21- 30	3	0	3	6
31- 40	4	0	3	7
41- 50	1	2	7	10
51- 60	6	2	2	10
61- 70	1	4	6	11
71- 80	2	4	6	12
81- 90	1	5	2	8
91-100	0	6	7	13
Total	20	25	40	85

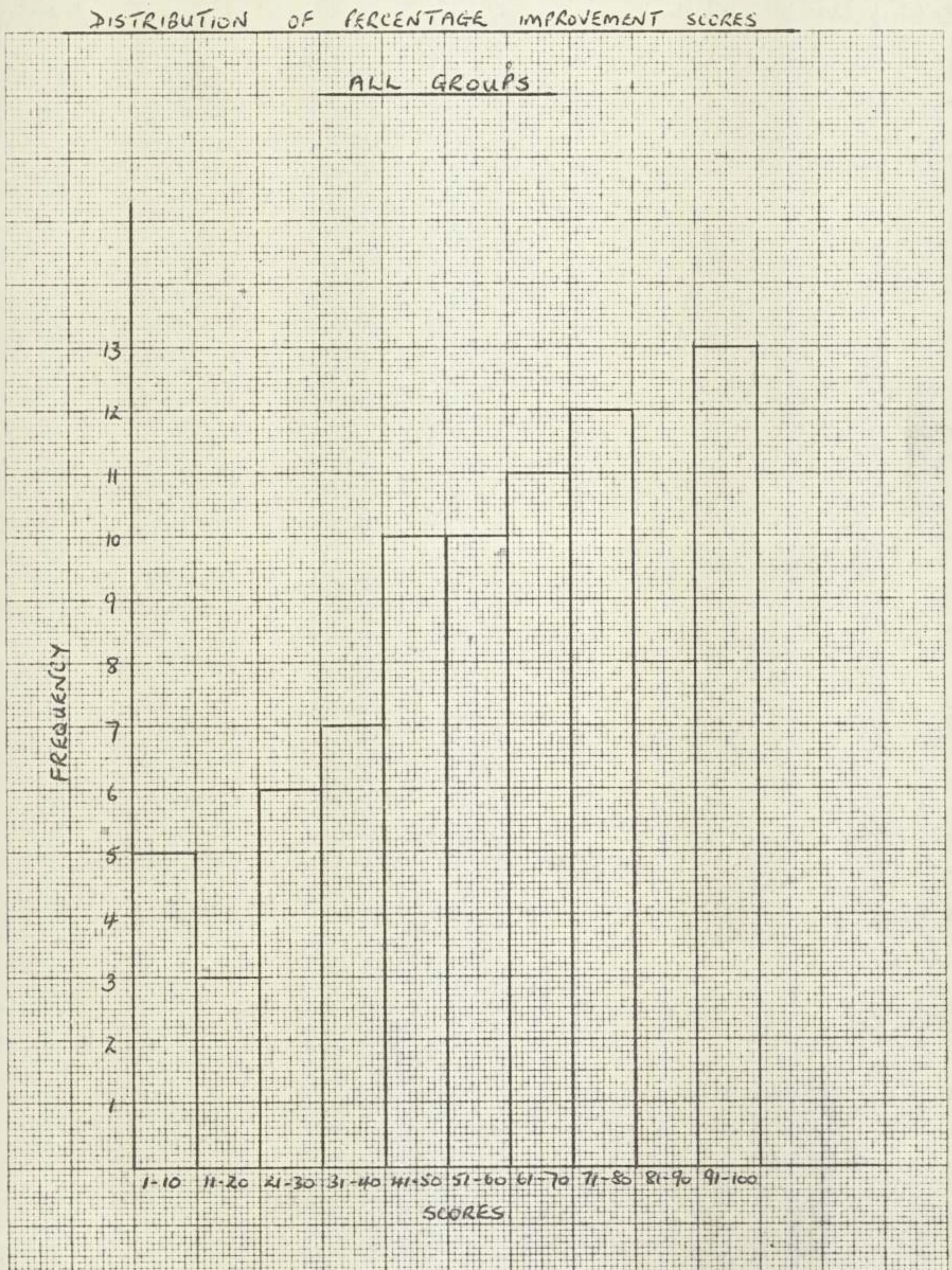
APPENDIX XII(b)


DISTRIBUTION OF PERCENTAGE IMPROVEMENT SCORES
GROUP 1
FREQUENCY
1
2
3
4
5
6
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
SCORES


DISTRIBUTION OF PERCENTAGE IMPROVEMENT SCORES
GROUP 2
FREQUENCY
1
2
3
4
5
6
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
SCORES

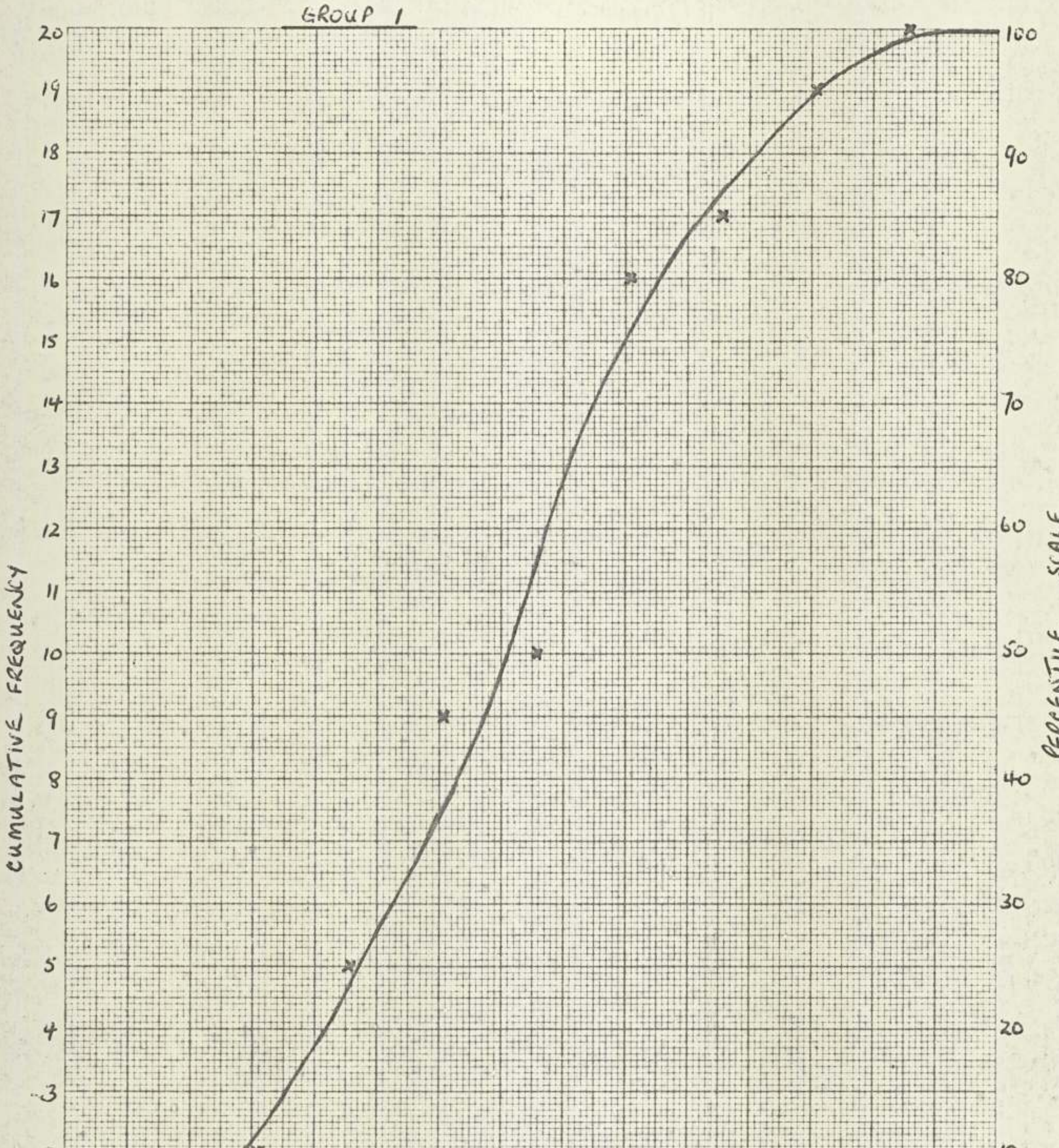
DISTRIBUTION OF PERCENTAGE IMPROVEMENT SCORES



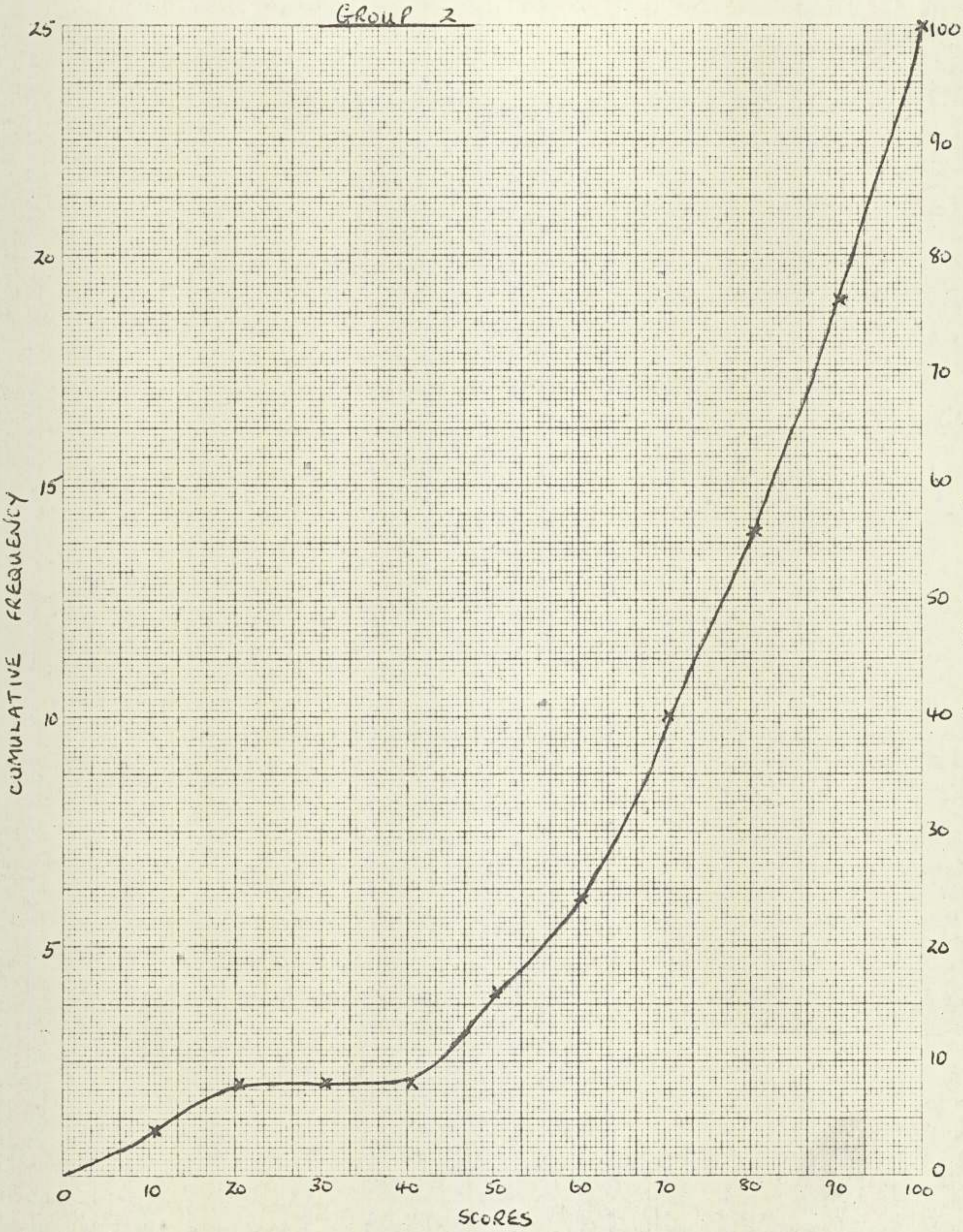

DISTRIBUTION OF PERCENTAGE IMPROVEMENT SCORES
ALL GROUPS
FREQUENCY
1
2
3
4
5
6
7
8
9
10
11
12
13
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
SCORES

APPENDIX XIII.

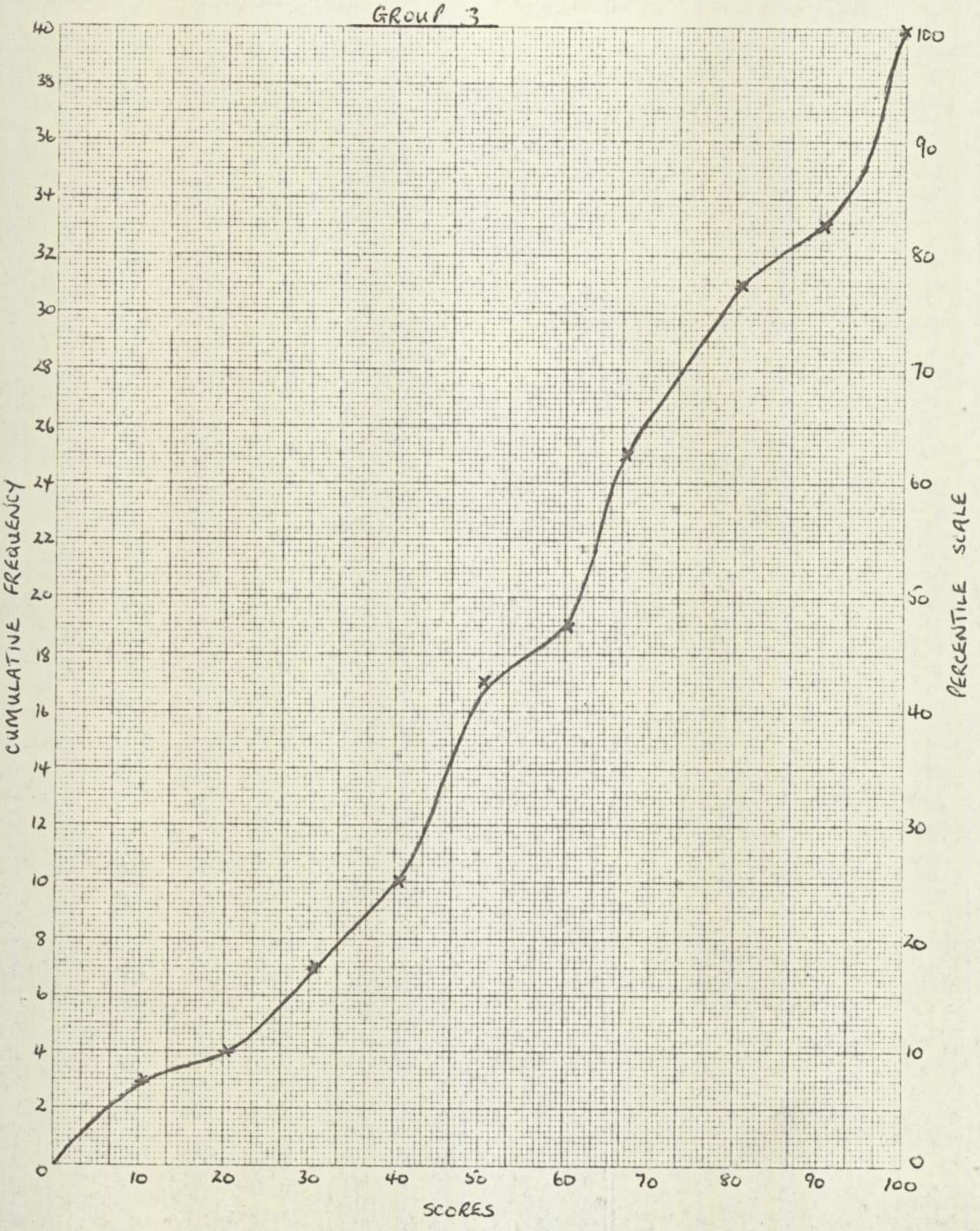
GRAPH TO CONVERT PERCENTAGE IMPROVEMENT SCORES INTO PERCENTILE SCORES.



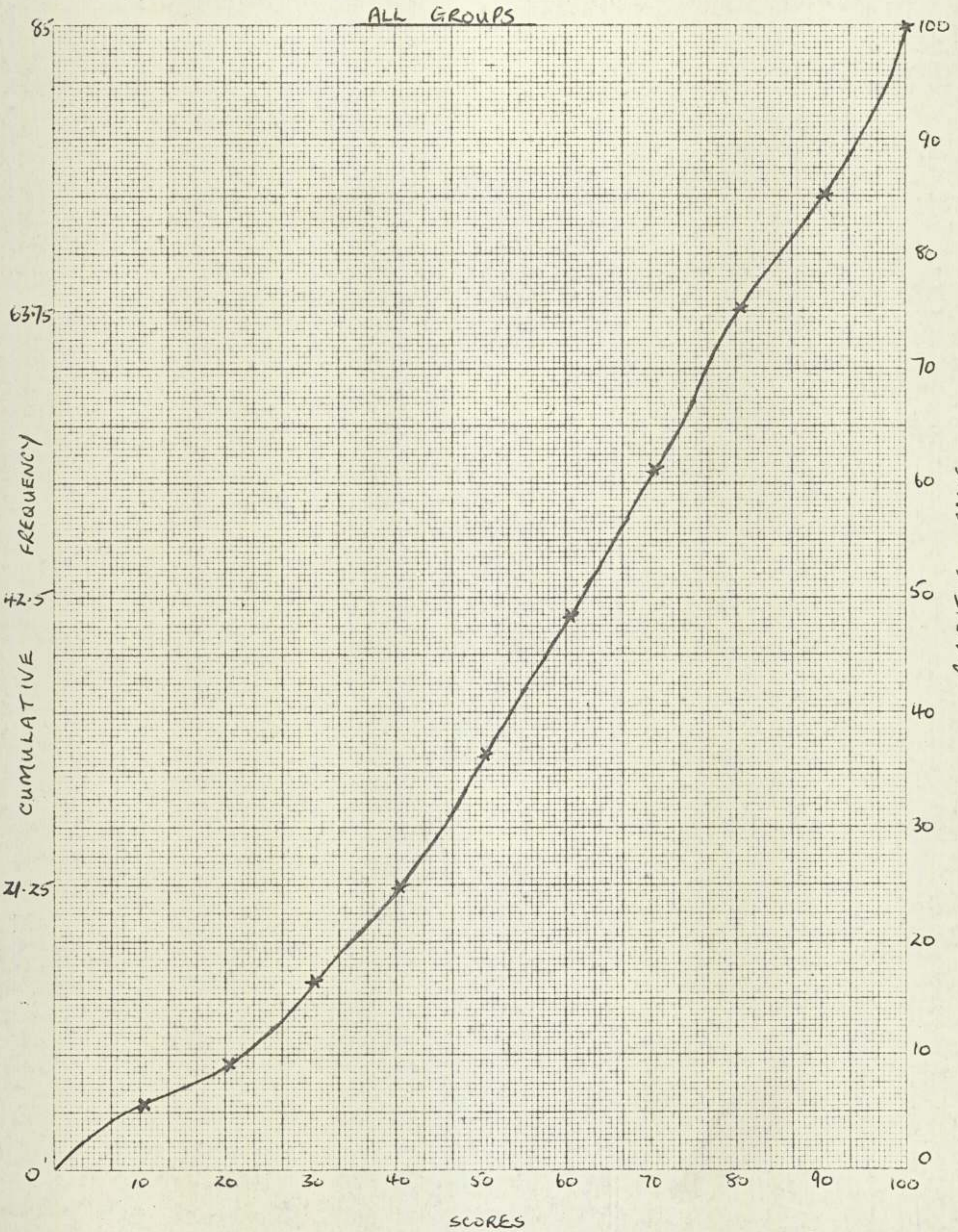
GRAPH TO CONVERT PERCENTAGE IMPROVEMENT SCORES INTO PERCENTILE SCORES.



GRAPH TO CONVERT PERCENTAGE IMPROVEMENT SCORES INTO PERCENTILE SCORES.



GRAPH TO CONVERT PERCENTAGE IMPROVEMENT SCORES INTO PERCENTILE SCORES.



APPENDIX XIV

MEANS AND STANDARD DEVIATIONS OF STENS FOR PERSONALITY FACTORS

FACTOR	GROUP 1 MEAN	GROUP 1 S.D.	GROUP 2 MEAN	GROUP 2 S.D.	GROUP 3 MEAN	GROUP 3 S.D.
A	4.6	1.7	4.9	1.3	5.2	2.0
B	4.4	1.2	5.2	1.9	4.9	1.7
C	5.2	1.4	5.9	1.6	5.5	1.5
D	5.9	1.1	5.8	1.3	5.7	1.5
E	6.0	1.4	4.8	1.5	6.1	1.4
F	5.4	1.4	6.3	1.9	6.0	2.1
G	5.0	1.9	5.5	1.2	5.7	2.0
H	5.0	1.1	5.7	1.7	5.0	2.2
I	5.3	1.2	4.9	1.8	4.8	2.0
J	5.8	1.3	6.0	1.7	6.0	1.7
O	5.4	1.9	5.4	2.2	5.8	1.5
Q2	6.1	1.9	7.6	1.5	7.0	1.7
Q3	5.2	1.1	6.2	2.0	5.3	1.6
Q4	5.6	1.3	5.3	1.7	5.7	1.9

APPENDIX XV

Computer Code Names for Variables.

PRTEST	Pre-test scores from achievement test.
POTEST	Post-test scores from achievement test.
PERIMP	Percentage improvement scores.
INTELL	Intelligence quotient.
ATTITI	Attitude towards programmed instruction.
ATTITS	Self attitude from graphic rating scale.
RVOCAB	Reading vocabulary.
RCOMPR	Reading comprehension.
RSPEED	Reading speed.
SCHSCI	Stanine score from school science records.
MONTHS	Age in months over twelve years.
PUPOP1	Science interest.
PUPOP2	Social implications of science.
PUPOP3	Theoretical/practical approach to science.
PUPOP4	Attitude towards science teachers.
PUPOP5	Attitude towards school.

Cattell's H.S.P.Q. yielded fourteen personality traits and these are listed according to their alphabetically designated factors. The verbal interpretation of these factors was given in Chapter 3 and a detailed analysis of the factors may be found in Cattell and Cattell (1969).

PERS01	Factor A
PERS02	Factor B
PERS03	Factor C
PERS04	Factor D
PERS05	Factor E
PERS06	Factor F
PERS07	Factor G
PERS08	Factor H
PERS09	Factor I
PERS10	Factor J
PERS11	Factor O
PERS12	Factor Q_2
PERS13	Factor Q_3
PERS14	Factor Q_4

APPENDIX XVI

Means and Standard Deviations for all variables.

Third year (N = 115).

Variables	Mean	S.D.
PRTEST	5.66	4.43
POTEST	10.83	4.37
PERIMP	40.40	24.40
INTELL	99.17	9.28
ERRORS	19.00	10.17
TIMESS	77.06	14.75
ATTIT1	64.24	12.88
ATTITS	4.40	2.11
RVOCAB	100.32	8.91
RCOMPR	97.14	8.40
RSPEED	102.02	10.46
SCHSCI	4.85	2.06
MONTHS	24.66	3.67
PUPOP1	62.32	13.57
PUPOP2	44.29	7.23
PUPOP3	27.48	3.15
PUPOP4	29.43	5.29
PUPOP5	34.50	5.86
PERSO1	3.12	1.24
PERSO2	4.54	1.53
PERSO3	4.04	1.25
PERSO4	4.37	1.00
PERSO5	4.07	1.15
PERSO6	3.55	1.15
PERSO7	3.43	1.33
PERSO8	3.70	1.33
PERSO9	3.10	1.53
PERS10	4.42	1.36
PERS11	3.44	1.21
PERS12	4.18	1.26
PERS13	3.39	1.24
PERS14	4.00	1.07

Means and Standard Deviations for all variables.

Fourth year (N = 77).

Variable	Mean	S.D.
PRTEST	5.71	4.50
POTEST	12.12	5.14
PERIMP	49.14	27.86
INTELL	98.20	8.40
ERRORS	16.99	10.43
TIMESS	68.18	11.82
ATTITI	62.07	12.52
ATTITS	4.33	1.86
RVOCAB	103.05	9.82
RCOMPR	100.10	10.79
RSPEED	99.73	9.46
SCHSCI	4.83	2.27
MONTHS	36.14	3.21
PUPOP1	58.18	12.92
PUPOP2	42.90	5.87
PUPOP3	26.08	3.18
PUPOP4	27.12	5.99
PUPOP5	31.86	6.22
PERSO1	4.96	1.67
PERSO2	4.31	1.45
PERSO3	5.66	1.30
PERSO4	5.95	1.33
PERSO5	5.92	1.46
PERSO6	5.48	1.54
PERSO7	4.91	1.49
PERSO8	5.17	1.46
PERSO9	4.56	1.80
PERS10	5.99	1.46
PERS11	5.39	1.78
PERS12	6.46	1.77
PERS13	5.18	1.50
PERS14	5.55	1.61

Means and Standard Deviations for all variables.

All pupils. (N = 192).

Variable	Mean	S.D.
PRTEST	5.68	4.45
POTEST	11.34	4.73
PERIMP	43.91	26.13
INTELL	98.78	8.93
ERRORS	18.19	10.30
TIMESS	73.50	14.30
ATTITI	63.37	12.75
ATTITS	4.37	2.01
RVOCAB	101.42	9.52
RCOMPR	98.33	11.53
RSPEED	101.10	10.11
SCHSCI	4.84	2.14
MONTHS	29.27	6.63
PUPOP1	60.66	13.44
PUPOP2	43.73	6.74
PUPOP3	26.92	3.23
PUPOP4	28.50	5.68
PUPOP5	33.44	6.13
PERSO1	3.86	1.69
PERSO2	4.45	1.50
PERSO3	4.69	1.50
PERSO4	5.00	1.38
PERSO5	4.81	1.57
PERSO6	4.32	1.62
PERSO7	4.02	1.57
PERSO8	4.29	1.56
PERSO9	3.68	1.79
PERS10	5.05	1.60
PERS11	4.22	1.75
PERS12	5.09	1.85
PERS13	4.11	1.61
PERS14	4.62	1.51

Means and Standard Deviations for all variables.

Girls (N = 70).

Variable	Mean	S.D.
PRTEST	5.13	4.08
POTEST	11.01	4.44
PERIMP	43.43	22.29
INTELL	101.29	8.84
ERRORS	16.93	9.40
TIMESS	73.59	15.76
ATTIT1	62.57	12.26
ATTITS	4.23	1.94
RVOCAB	102.01	9.97
RCOMPR	100.46	10.23
RSPEED	101.74	10.74
SCHSCI	4.66	2.03
MONTHS	28.90	6.68
PUPOP1	56.06	10.56
PUPOP2	44.77	6.79
PUPOP3	26.33	3.04
PUPOP4	28.49	4.95
PUPOP5	33.63	5.88
PERSO1	3.21	1.56
PERSO2	4.54	1.59
PERSO3	4.44	1.41
PERSO4	4.90	.42
PERSO5	4.87	1.46
PERSO6	4.33	1.46
PERSO7	3.97	1.45
PERSO8	4.16	1.64
PERSO9	2.97	1.79
PERS10	4.86	1.64
PERS11	4.06	1.51
PERS12	4.83	1.77
PERS13	3.99	1.86
PERS14	4.67	1.57

Means and Standard Deviations for all variables.

Boys (N = 122).

Variable	Mean	S.D.
PRTEST	6.00	4.63
POTEST	11.53	4.89
PERIMP	44.18	28.18
INTELL	97.34	8.69
ERRORS	18.92	10.75
TIMESS	73.45	13.46
ATTIT1	63.83	13.06
ATTITS	4.45	2.05
RVOCAB	101.07	9.00
RCOMPR	97.11	8.90
RSPEED	100.73	9.76
SCHSCI	4.95	2.20
MONTHS	29.48	6.62
PUPOP1	63.30	14.22
PUPOP2	43.71	6.74
PUPOP3	27.25	3.29
PUPOP4	28.51	6.08
PUPOP5	33.33	6.29
PERSO1	4.23	1.65
PERSO2	4.39	1.45
PERSO3	4.84	1.53
PERSO4	5.06	1.36
PERSO5	4.78	1.63
PERSO6	4.32	1.71
PERSO7	4.05	1.64
PERSO8	4.36	1.51
PERSO9	4.09	1.66
PERS10	5.16	1.56
PERS11	4.32	1.86
PERS12	5.25	1.89
PERS13	4.18	1.45
PERS14	4.59	1.49

APPENDIX XVII(a)

Percentage scores and percentage cumulative frequencies for paired - comparisons. (Third year)

Score	% Score	Frequency	Cumulative Frequency	% Cumulative Frequency
20	100	6	6	5.2
19	95	3	9	7.8
18	90	4	13	11.3
17	85	1	14	12.2
16	80	4	18	15.7
15	75	5	23	20.0
14	70	8	31	27.0
13	65	8	39	33.9
12	60	7	46	40.0
11	55	7	53	46.1
10	50	10	63	54.8
9	45	17	80	69.6
8	40	11	91	79.1
7	35	8	99	86.1
6	30	6	105	91.3
5	25	6	111	96.6
4	20	1	112	97.4
3	15	2	114	99.1
2	10	0	114	99.1
1	5	1	115	100

Percentage scores and percentage cumulative frequencies for paired - comparisons. (Fourth year)

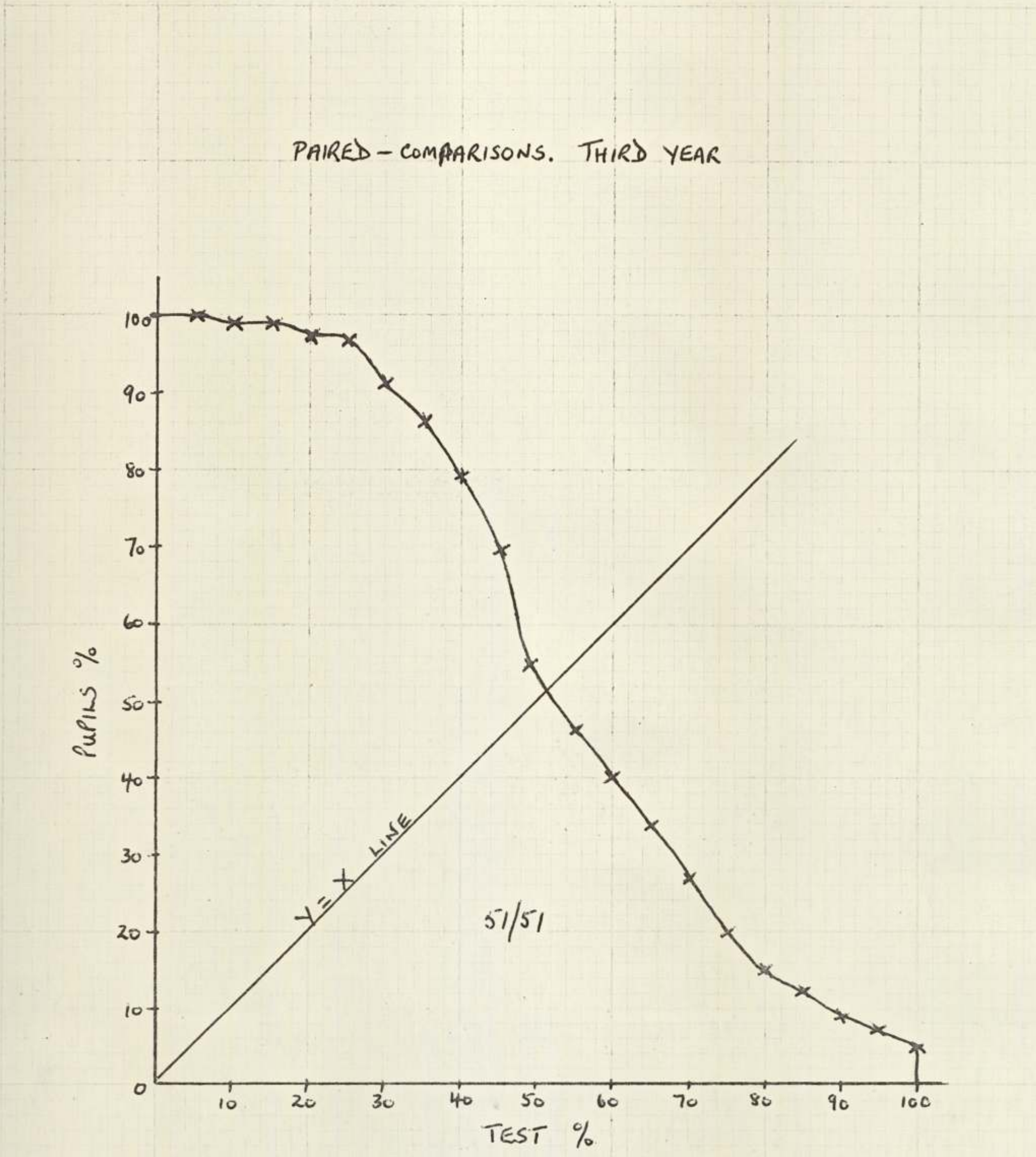
Score	% Score	Frequency	Cumulative Frequency	% Cumulative Frequency
20	100	7	7	9.1
19	95	5	12	15.6
18	90	4	16	20.8
17	85	3	19	24.7
16	80	6	25	32.5
15	75	4	29	37.7
14	70	3	32	41.6
13	65	3	35	45.5
12	60	5	40	52.0
11	55	3	43	55.9
10	50	4	47	61.0
9	45	8	55	71.4
8	40	4	59	76.6
7	35	10	69	89.6
6	30	1	70	90.9
5	25	2	72	93.5
4	20	2	74	96.1
3	15	2	76	98.7
2	10	0	76	98.7
1	5	1	77	100

Percentage scores and percentage cumulative frequencies for paired - comparisons. (All pupils)

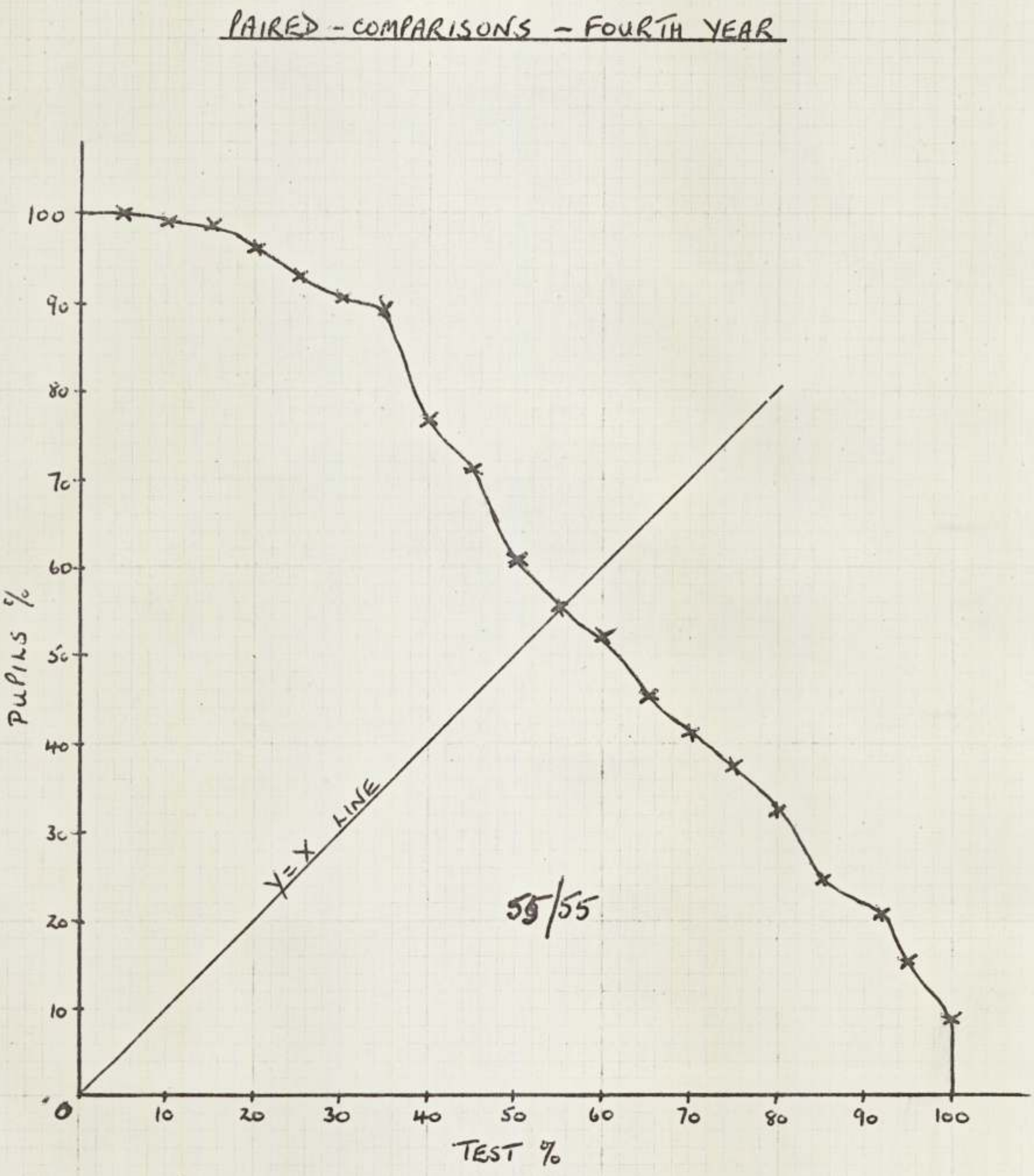
Score	% Score	Frequency	Cumulative Frequency	% Cumulative Frequency
20	100	13	13	6.8
19	95	8	21	10.9
18	90	8	29	15.1
17	85	4	33	17.2
16	80	10	43	22.4
15	75	9	52	27.1
14	70	11	63	32.8
13	65	11	74	38.5
12	60	12	86	44.8
11	55	10	96	50.0
10	50	14	110	57.3
9	45	25	135	70.3
8	40	15	150	78.1
7	35	18	168	87.5
6	30	7	175	91.2
5	25	8	183	95.3
4	20	3	186	96.9
3	15	4	190	99.0
2	10	0	190	99.0
1	5	2	192	100

APPENDIX XVII(b)

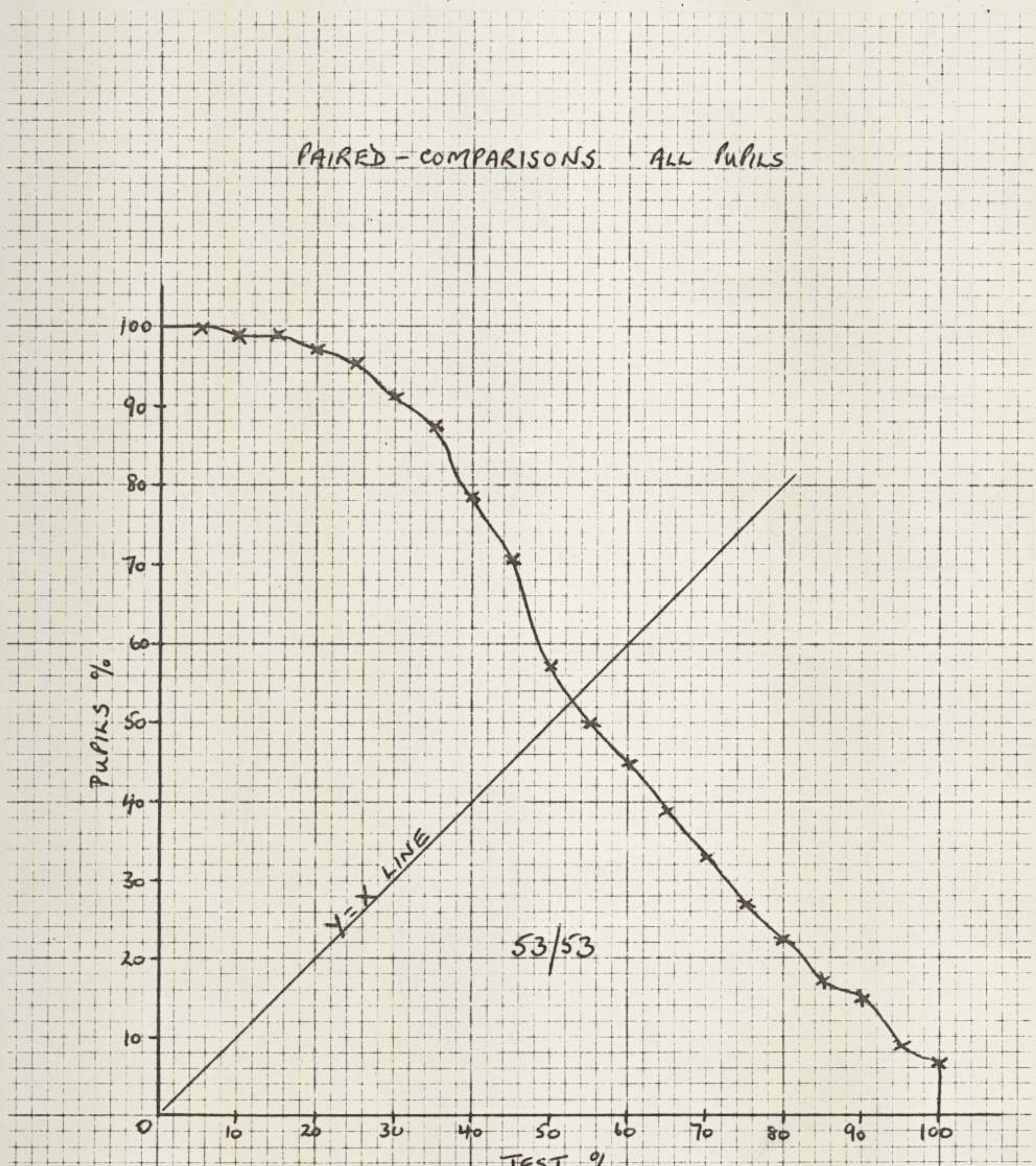
CUMULATIVE FREQUENCY GRAPH.



CUMULATIVE FREQUENCY GRAPH.



CUMULATIVE FREQUENCY GRAPH.



APPENDIX XVIII.

CORRELATION MATRIX.

	PRTEST	POTEST	PERIMP	INTELL	ERRORS
PRTEST	1.000	0.753	0.381	0.336	-0.345
POTEST	0.753	1.000	0.821	0.579	-0.590
PERIMP	0.381	0.821	1.000	0.525	-0.595
INTELL	0.336	0.579	0.525	1.000	-0.416
ERRORS	-0.345	-0.590	-0.595	-0.416	1.000
TIMESS	-0.119	-0.165	-0.121	-0.322	0.225
ATTIT1	0.221	0.171	0.117	0.106	-0.122
ATTITS	0.274	0.270	0.109	0.164	-0.145
RVOCAB	0.463	0.686	0.588	0.722	-0.481
RCOMPR	0.457	0.694	0.636	0.708	-0.552
RSPEED	0.054	0.102	0.070	0.285	-0.024
SCHSCI	-0.473	-0.807	-0.773	-0.649	0.572
MONTHS	0.001	0.145	0.176	-0.050	-0.139
PUPOP1	0.452	0.353	0.189	0.076	-0.158
PUPOP2	0.270	0.200	0.093	0.121	-0.125
PUPOP3	0.018	-0.026	-0.034	-0.088	0.018
PUPOP4	0.273	0.290	0.138	0.126	-0.120
PUPOP5	0.306	0.300	0.163	0.208	-0.219
PERSO1	-0.046	0.064	0.070	-0.077	-0.060
PERSO2	0.265	0.311	0.214	0.363	-0.136
PERSO3	-0.038	0.005	0.011	-0.079	-0.003
PERSO4	-0.172	-0.058	0.032	-0.100	-0.004
PERSO5	-0.193	-0.035	0.057	-0.008	0.000
PERSO6	-0.154	0.012	0.076	-0.110	-0.005
PERSO7	-0.004	0.104	0.071	-0.019	-0.047
PERSO8	-0.039	0.041	0.082	-0.053	0.027
PERSO9	0.058	0.096	0.066	-0.082	-0.080
PERS10	-0.030	0.007	0.014	-0.076	0.059
PERS11	-0.187	-0.073	0.004	-0.135	0.098
PERS12	-0.012	0.002	-0.004	-0.199	0.063
PERS13	0.121	0.173	0.163	-0.031	-0.069
PERS14	-0.070	0.080	0.147	-0.073	0.000

CORRELATION MATRIX (CONT.)

	TIMESS	ATTIT1	ATTITS	RVOCAB	RCOMPR	RSPEED
PRTEST	-0.119	0.221	0.274	0.463	0.457	0.054
POTEST	-0.165	0.171	0.270	0.686	0.694	0.102
PERIMP	-0.121	0.117	0.199	0.588	0.636	0.070
INTELL	-0.322	0.106	0.164	0.722	0.708	0.285
ERRORS	0.225	-0.122	-0.145	-0.481	-0.552	-0.024
TIMESS	1.000	-0.015	-0.074	-0.339	-0.317	-0.372
ATTIT1	-0.015	1.000	0.758	0.121	0.103	0.038
ATTITS	-0.074	0.758	1.000	0.235	0.213	0.145
RVOCAB	-0.339	0.121	0.235	1.000	0.781	0.290
RCOMPR	-0.317	0.103	0.213	0.781	1.000	0.200
RSPEED	-0.372	0.038	0.145	0.290	0.200	1.000
SCHSCI	0.139	-0.121	-0.265	-0.693	-0.688	-0.154
MONTHS	-0.282	-0.052	-0.038	0.144	0.194	-0.123
PUPOP1	-0.022	0.273	0.274	0.174	0.154	0.104
PUPOP2	-0.009	0.187	0.172	0.061	0.157	0.021
PUPOP3	0.152	0.075	0.096	-0.121	-0.091	0.063
PUPOP4	0.072	0.219	0.221	0.091	0.151	0.032
PUPOP5	-0.113	0.188	0.245	0.196	0.214	0.160
PERS01	-0.164	-0.168	-0.071	0.116	0.097	-0.098
PERS02	-0.063	0.075	0.047	0.336	0.323	0.085
PERS03	-0.223	-0.035	-0.021	0.021	0.032	-0.069
PERS04	-0.125	-0.152	-0.091	0.036	0.086	0.024
PERS05	-0.131	-0.143	-0.088	0.032	0.079	-0.034
PERS06	-0.185	-0.113	-0.045	0.041	0.018	0.022
PERS07	-0.151	-0.041	-0.056	0.060	0.077	-0.066
PERS08	-0.231	-0.043	-0.019	0.010	0.100	0.041
PERS09	-0.110	-0.076	-0.075	0.035	0.002	-0.120
PERS10	-0.085	-0.129	-0.051	0.031	0.023	-0.079
PERS11	-0.033	-0.178	-0.085	0.007	-0.045	-0.078
PERS12	-0.153	-0.032	-0.004	0.011	-0.026	-0.153
PERS13	-0.160	-0.066	-0.071	0.151	0.159	-0.231
PERS14	-0.075	-0.215	-0.176	-0.029	0.062	-0.095

CORRELATION MATRIX (CONT.)

	SCHSCI	MONTHS	PUPOP1	PUPOP2	PUPOP3
PRTEST	-0.473	0.001	0.452	0.270	0.018
POTEST	-0.807	0.145	0.353	0.200	-0.026
PERIMP	-0.773	0.176	0.189	0.093	-0.034
INTELL	-0.649	-0.050	0.076	0.121	-0.088
ERRORS	0.572	-0.139	-0.158	-0.125	0.018
TIMESS	0.139	-0.282	-0.022	-0.009	0.152
ATTIT1	-0.121	-0.052	0.273	0.187	0.075
ATTITS	-0.265	-0.038	0.274	0.172	0.096
RVOCAB	-0.693	0.144	0.174	0.061	-0.121
RCOMPR	-0.688	0.194	0.154	0.157	-0.091
RSPEED	-0.154	-0.123	0.104	0.021	0.063
SCHSCI	1.000	-0.019	-0.291	-0.178	0.017
MONTHS	-0.019	1.000	-0.173	-0.115	-0.216
PUPOP1	-0.291	-0.173	1.000	0.599	0.388
PUPOP2	-0.178	-0.115	0.599	1.000	0.301
PUPOP3	0.017	-0.216	0.388	0.301	1.000
PUPOP4	-0.285	-0.189	0.619	0.502	0.301
PUPOP5	-0.292	-0.173	0.456	0.399	0.092
PERS01	0.010	0.464	-0.077	-0.120	-0.029
PERS02	-0.249	-0.098	0.110	0.041	-0.006
PERS03	0.117	0.411	-0.068	0.015	-0.090
PERS04	0.092	0.491	-0.201	-0.167	-0.029
PERS05	0.074	0.503	-0.294	-0.163	-0.126
PERS06	0.031	0.505	-0.129	-0.093	-0.010
PERS07	-0.016	0.435	-0.015	0.115	-0.042
PERS08	0.003	0.324	-0.011	0.059	-0.013
PERS09	0.002	0.287	0.033	0.016	-0.035
PERS10	0.036	0.366	-0.131	-0.123	-0.109
PERS11	0.136	0.415	-0.193	-0.202	-0.143
PERS12	0.100	0.463	-0.111	-0.101	-0.135
PERS13	-0.092	0.456	-0.017	0.031	-0.127
PERS14	0.071	0.447	-0.264	-0.212	-0.175

CORRELATION MATRIX (CONT.)

	PUPOP4	PUPOP5	PERSO1	PERSO2	PERSO3	PERSO4
PRTEST	0.273	0.306	-0.046	0.265	-0.038	-0.172
POTEST	0.290	0.300	0.064	0.311	0.005	-0.058
PERIMP	0.138	0.163	0.070	0.214	0.011	0.032
INTELL	0.126	0.208	-0.077	0.363	-0.079	-0.100
ERRORS	-0.120	-0.219	-0.060	-0.136	-0.003	-0.004
TIMESS	0.072	-0.113	-0.164	-0.063	-0.223	-0.125
ATTIT1	0.219	0.188	-0.168	0.075	-0.035	-0.152
ATTITS	0.221	0.245	-0.071	0.047	-0.021	-0.091
RVOCAB	0.091	0.196	0.116	0.336	0.021	0.036
RCOMPR	0.151	0.214	0.097	0.323	0.032	0.086
RSPEED	0.032	0.160	-0.098	0.085	-0.069	0.024
SCHSCI	-0.285	-0.292	0.010	-0.249	0.117	0.092
MONTHS	-0.189	-0.173	0.464	-0.098	0.411	0.491
PUPOP1	0.619	0.456	-0.077	0.110	-0.068	-0.201
PUPOP2	0.502	0.399	-0.120	0.041	0.015	-0.167
PUPOP3	0.301	0.092	-0.029	-0.006	-0.090	-0.029
PUPOP4	1.000	0.515	-0.183	0.015	-0.052	-0.251
PUPOP5	0.515	1.000	-0.173	0.105	0.001	-0.171
PERSO1	-0.183	-0.173	1.000	0.069	0.509	0.306
PERSO2	0.015	0.105	0.069	1.000	-0.018	-0.119
PERSO3	-0.052	0.001	0.509	-0.018	1.000	0.304
PERSO4	-0.251	-0.171	0.306	-0.119	0.304	1.000
PERSO5	-0.242	-0.267	0.476	-0.198	0.354	0.403
PERSO6	-0.101	-0.134	0.501	-0.081	0.416	0.419
PERSO7	-0.025	0.066	0.355	0.023	0.482	0.348
PERSO8	-0.044	-0.033	0.476	0.041	0.594	0.248
PERSO9	-0.067	-0.009	0.285	-0.075	0.303	0.299
PERS10	-0.219	-0.235	0.220	-0.107	0.242	0.385
PERS11	-0.224	-0.321	0.333	-0.107	0.171	0.474
PERS12	-0.199	-0.277	0.271	-0.111	0.350	0.374
PERS13	-0.106	0.048	0.349	0.051	0.455	0.342
PERS14	-0.206	-0.298	0.291	-0.146	0.195	0.486

CORRELATION MATRIX (CONT.)

	PERSO5	PERSO6	PERSO7	PERSO8	PERSO9
PRTEST	-0.193	-0.154	-0.004	-0.039	0.058
PUTEST	-0.035	0.012	0.104	0.041	0.096
PERIMP	0.057	0.076	0.071	0.082	0.066
INTELL	-0.008	-0.110	-0.019	-0.053	-0.082
ERRORS	0.000	-0.005	-0.047	0.027	-0.080
TIMESS	-0.131	-0.185	-0.151	-0.231	-0.110
ATTIT1	-0.143	-0.113	-0.041	-0.043	-0.076
ATTITS	-0.088	-0.045	-0.056	-0.019	-0.075
RVOCAB	0.032	0.041	0.060	0.010	0.035
RCOMPR	0.079	0.018	0.077	0.100	0.002
RSPEED	-0.034	0.022	-0.066	0.041	-0.120
SCHSCI	0.074	0.031	-0.016	0.003	0.002
MONTHS	0.503	0.505	0.435	0.324	0.287
PUPOP1	-0.294	-0.129	-0.015	-0.011	0.033
PUPOP2	-0.163	-0.093	0.115	0.059	0.016
PUPOP3	-0.126	-0.010	-0.042	-0.013	-0.035
PUPOP4	-0.242	-0.101	-0.025	-0.044	-0.067
PUPOP5	-0.267	-0.134	0.066	-0.033	-0.009
PERSO1	0.476	0.501	0.355	0.476	0.285
PERSO2	-0.198	-0.081	0.023	0.041	-0.075
PERSO3	0.354	0.416	0.482	0.594	0.303
PERSO4	0.403	0.419	0.348	0.248	0.299
PERSO5	1.000	0.626	0.208	0.354	0.048
PERSO6	0.626	1.000	0.341	0.444	0.216
PERSO7	0.208	0.341	1.000	0.448	0.247
PERSO8	0.354	0.444	0.448	1.000	0.157
PERSO9	0.048	0.216	0.247	0.157	1.000
PERS10	0.283	0.304	0.292	0.157	0.335
PERS11	0.403	0.452	0.195	0.163	0.313
PERS12	0.261	0.323	0.363	0.257	0.385
PERS13	0.263	0.295	0.511	0.462	0.430
PERS14	0.331	0.311	0.292	0.189	0.207

CORRELATION MATRIX (CONT.)

	PERS10	PERS11	PERS12	PERS13	PERS14	DUMMY1
PRTEST	-0.030	-0.187	-0.012	0.121	-0.070	0.095
POTEST	0.007	-0.073	0.002	0.173	0.080	0.053
PERIMP	0.014	0.004	-0.004	0.163	0.147	0.014
INTELL	-0.076	-0.135	-0.199	-0.031	-0.073	-0.214
ERRORS	0.059	0.098	0.063	-0.069	0.000	0.093
TIMESS	-0.085	-0.033	-0.153	-0.160	-0.075	-0.005
ATTIT1	-0.129	-0.178	-0.032	-0.066	-0.215	0.048
ATTITS	-0.051	-0.085	-0.004	-0.071	-0.176	0.053
RVOCAB	0.031	0.007	0.011	0.151	-0.029	-0.049
RCOMPR	0.023	-0.045	-0.026	0.159	0.062	-0.170
RSPEED	-0.079	-0.078	-0.153	-0.231	-0.095	-0.048
SCHSCI	0.036	0.136	0.100	-0.092	0.071	0.066
MONTHS	0.366	0.415	0.463	0.456	0.447	0.042
PUPOP1	-0.131	-0.193	-0.111	-0.017	-0.264	0.260
PUPOP2	-0.123	-0.202	-0.101	0.031	-0.212	-0.005
PUPOP3	-0.109	-0.143	-0.135	-0.127	-0.175	0.138
PUPOP4	-0.219	-0.224	-0.199	-0.106	-0.206	0.002
PUPOP5	-0.235	-0.321	-0.277	0.048	-0.298	-0.024
PERS01	0.220	0.333	0.271	0.349	0.291	0.291
PERS02	-0.107	-0.107	-0.111	0.051	-0.146	-0.048
PERS03	0.242	0.171	0.350	0.455	0.195	0.127
PERS04	0.385	0.474	0.374	0.342	0.486	0.055
PERS05	0.283	0.403	0.261	0.263	0.331	-0.028
PERS06	0.304	0.452	0.323	0.295	0.311	-0.003
PERS07	0.292	0.195	0.363	0.511	0.292	0.024
PERS08	0.157	0.163	0.257	0.462	0.189	0.063
PERS09	0.335	0.313	0.385	0.430	0.207	0.302
PERS10	1.000	0.417	0.554	0.377	0.415	0.090
PERS11	0.417	1.000	0.478	0.241	0.502	0.073
PERS12	0.554	0.478	1.000	0.477	0.373	0.109
PERS13	0.377	0.241	0.477	1.000	0.346	0.058
PERS14	0.415	0.502	0.373	0.346	1.000	-0.026

CORRELATION COEFFICIENTS (PRELIMINARY EXPERIMENT)

	PRTEST	POTEST	PERIMP	NORMAT
PRTEST	1.00000	0.55669	0.23547	0.27785
POTEST	0.55669	1.00000	0.89551	0.85822
PERIMP	0.23547	0.89551	1.00000	0.95939
NORMAT	0.27785	0.85822	0.95939	1.00000
ERRORS	-0.48556	-0.56611	-0.49393	-0.50085
TIMESS	-0.27685	-0.14435	-0.06822	-0.08985
ATTIT1	-0.16043	-0.11454	-0.09712	-0.04172
ATTITS	-0.01588	0.04742	0.01182	0.03793
RSPEED	0.10177	-0.02751	-0.07103	-0.07609
RVOCAB	0.29045	0.21374	0.16847	0.19135
RCOMPR	0.34918	0.30227	0.18077	0.22159
SCHSCI	0.52318	0.51090	0.36110	0.31667
INTELL	0.02914	0.32702	0.37383	0.36542
PERS01	0.02669	0.01113	-0.04578	-0.05728
PERS02	0.04231	0.25453	0.24474	0.24581
PERS03	0.16136	0.02746	-0.06348	-0.10901
PERS04	0.07667	0.16640	0.18433	0.22665
PERS05	-0.15068	-0.11442	-0.07717	-0.07136
PERS06	0.05830	0.03341	0.00369	-0.02566
PERS07	0.24205	0.08475	-0.00452	-0.01436
PERS08	0.03117	0.00876	-0.07098	-0.12230
PERS09	-0.12491	-0.15368	-0.20611	-0.25004
PERS10	0.22036	0.19592	0.15606	0.16969
PERS11	-0.15489	-0.10304	-0.07869	-0.04980
PERS12	0.19484	0.14517	0.10480	0.08810
PERS13	0.16889	0.06050	-0.03075	-0.10099
PERS14	-0.20528	-0.19322	-0.17003	-0.20101
PUPOP1	0.37126	0.32465	0.24957	0.25567
PUPOP2	0.36031	0.26087	0.17299	0.21960
PUPOP3	-0.09067	-0.18555	-0.16208	-0.15533
PUPOP4	-0.00767	-0.00659	-0.00294	0.02250
PUPOP5	0.05934	0.09878	0.09602	0.10132
MONTHS	0.41231	0.31690	0.18510	0.20883
DUMMY1	0.02163	-0.06481	-0.11378	-0.16522
DUMMY2	0.33252	0.43855	0.29410	0.22877
DUMMY3	0.16161	0.02112	-0.01645	0.03743

CORRELATION COEFFICIENTS (PRELIMINARY EXPERIMENT)

	ERRORS	TIMESS	ATTIT1	ATTITS	RSPEED
PRTEST	-0.48556	-0.27685	-0.16043	-0.01588	0.10177
POTEST	-0.56611	-0.14435	-0.11454	0.04742	-0.02751
PERIMP	-0.49393	-0.06822	-0.09712	0.01182	-0.07103
NORMAT	-0.50085	-0.08985	-0.04172	0.03793	-0.07609
ERRORS	1.00000	0.33975	0.08348	0.01617	-0.02123
TIMESS	0.33975	1.00000	0.10887	0.06547	-0.38213
ATTIT1	0.08348	0.10887	1.00000	0.72309	0.00871
ATTITS	0.01617	0.06547	0.72309	1.00000	0.06378
RSPEED	-0.02123	-0.38213	0.00871	0.06378	1.00000
RVOCAB	-0.12133	-0.05742	-0.08351	0.08402	0.24304
RCOMPR	-0.28771	-0.05872	-0.04777	0.03142	0.03887
SCHSCI	-0.40710	-0.05910	-0.17874	-0.08601	-0.20063
INTELL	-0.11880	-0.05166	0.05573	0.06066	0.16549
PERS01	0.04124	0.19126	0.11807	0.06120	-0.13346
PERS02	-0.17223	0.02977	0.05232	0.14558	0.12505
PERS03	0.07466	0.11400	-0.03240	-0.04447	-0.08018
PERS04	-0.20257	-0.20920	-0.04038	-0.00259	0.04822
PERS05	0.04228	0.09056	0.06861	0.14550	-0.03988
PERS06	0.06305	-0.07247	0.01419	0.03540	0.10138
PERS07	-0.10252	0.11349	-0.07969	-0.12425	-0.05115
PERS08	0.06014	0.28800	0.06551	0.04952	-0.25862
PERS09	0.01387	0.14592	-0.02138	-0.06720	0.14609
PERS10	-0.21214	0.03953	-0.03744	0.00736	0.00657
PERS11	0.01295	-0.14525	-0.01551	-0.09525	0.07164
PERS12	-0.15048	-0.08721	-0.23351	-0.13010	-0.06868
PERS13	0.01884	0.07897	-0.21071	-0.16705	-0.28383
PERS14	0.02130	-0.31177	-0.08510	-0.11858	0.19094
PUPOP1	-0.37220	-0.01929	0.22443	0.19465	-0.19521
PUPOP2	-0.22932	-0.09451	0.16805	0.21627	-0.05904
PUPOP3	-0.04407	-0.12734	0.32200	0.09442	0.08442
PUPOP4	-0.04656	-0.05119	0.20443	0.23403	-0.16767
PUPOP5	0.01689	-0.01500	0.24000	0.21540	-0.04025
MONTHS	-0.33401	-0.20573	-0.22621	-0.10202	0.14362
DUMMY1	-0.12213	0.08248	-0.00232	-0.02041	-0.13690
DUMMY2	-0.21101	-0.00793	-0.13826	0.00542	-0.13642
DUMMY3	-0.19475	-0.19434	-0.12102	-0.12677	0.19684