SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

DECLARATION

I, AHAMAD ASHRAF Z.A., do hereby declare that this thesis "SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS" contains no material which has been accepted for the award of any degree or diploma of any other university or institution and, to the best of my knowledge and belief, contains no materials previously published by any other person, except where due reference is made in the text of the thesis.

Farook College
10-09-07

AHAMAD ASHRAF Z. A.

CERTIFICATE

This is to certify that the work reported in this thesis entitled "SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS", that is being submitted by Sri. AHAMAD ASHRAF Z.A., for the award of Doctor of Philosophy, to the University of Calicut, is based on the bonafide research work carried out by him under my supervision and guidance in the Department of Statistics, Farook College. The results embodied in this thesis have not been included in any other thesis submitted previously for the award of any degree or diploma of any other university or institution.

Farook College
10-09-07

T. P. MOHAMMED FAREED
Reader in Statistics,
Farook College, Kozhikode

ACKNOWLEDGMENTS

I am immensely grateful to my research supervisor Dr. T.P. Mohammed Fareed, Reader in Statistics, Farook College. He has been a source of strength and inspiration to me in all the phases of this study. Mere words are insufficient to express my profound gratitude to him.

I am greatly indebted to Dr. P. Anilkumar, the head of the department, and other faculty members of department of Statistics of Farook College for their wholehearted cooperation

I would like to express my sincere thanks to Prof. A Kuttialikutty, Principal of Farook College for providing necessary facilities to complete this work.

I am highly thankful to the heads, teachers and students of the schools who helped me to get reliable data and for the cooperation they extended to make this study fruitful.

The teacher fellowship received from the University Grants Commission during 2005-07 through Faculty Improvement Programme is gratefully acknowledged.

In addition, I am most thankful to my wife Fabi and my son Zain for their support throughout the period of my research.

Farook College
10-09-07

AHAMAD ASHRAF Z. A.

5

Contents

List of Figures

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

Chapter 1

Introduction

Almost every one is tested for their abilities, skills or talents empirically at least once in their life. For example in school, the achievement of students in mathematics or languages is tested by some tests. For the selection to jobs or higher courses people have to appear for some test or other. This indicates that testing or assessment plays a vital role in the day to day life of man.

The testing or assessment is normally carried out with some instruments, which are known as test tools or simply tests. A good test tool can yield good results. That is why the search for scientific methods for the preparation and standardisation of test tools has had a long history. Such enquiry helped reasonably in the emergence of a new area of study known as test theory.

Test theory is an interdisciplinary area of Statistics, Psychometrics and Education which discusses the methodology of test construction and measurement and analysis of psychological and educational variables. It includes the test construction methods, mathematical and statistical modelling, analysis and interpretation of test results.

By the early 1970s, the idea that measurement was fundamentally a statistical adventure seemed well accepted. This period was marked by the publication of a series of major works that established test theory as applied statistics (see Lohman and Ippel, 1992).

Test theory provides a general collection of techniques for evaluating the development and use, in assessment, of specific psychological tests. It has the same relation to the practice of testing, as statistical and experimental design principles have to actual programmes of experimental research in behavioural science. And it consists of the use of mathematical concepts that have been developed in order to refine questions into more precise forms and to provide answers to them.

The development of the test theory has generally been motivated by the need to solve problems in Psychology, including Educational Psychology and Educational Measurement. It is largely taking place at the hands of psychologists, who in many cases had to struggle to acquire the mathematics and, in particular, the statistical knowledge they needed to solve their problems (Macdonald, 1999).

There are mainly two frameworks in test theory viz. Classical Test Theory (CTT) and Item Response Theory (IRT). The classical and related models have served test development continuously over several decades. During the last two decades item response models and related methods became more popular among test developers. Within the last one decade item response models became mainstream as the theoretical basis for measurement and many standardised tests are developed on the basis of item response theory.

In spite of many advantages CTT has some limitations also (see Hambleton and Jones, 1993; Crocker and Algina, 1986). Most of the concepts in CTT are defined in a crude sense. In CTT the analysis of test items is done based on some pre-defined characteristics such as item difficulty or item discrimination and decisions will be based on these values.

In IRT the probability of responding correctly to an item as a function of the trait underlying of the items of the test is considered. IRT takes into account the probabilistic nature of answering an item by the subjects.

The basic problem in both CTT and IRT item analysis is that both selects the *best* test items from a set of items prepared to measure a particular trait individually or considering distribution marginally.

The present day literature on IRT reveals that almost all studies focus on item wise methods for elimination of *not good* items or selection of *best* items. For each item, the item parameters like item difficulty and item discrimination indices are computed based on pre-assumed model and the decision will be taken based on the estimated values. The basic assumption followed here is that of independence of each item responses. But in practice the independence between the item responses cannot be expected since the entire set of items have got the information about a particular trait. It is possible that the particular level of information of a trait may be inherent in two different items in such a way that under a given level of trait the response of an item may be statistically dependent on the response of other item. If there is high level of dependency among these two item responses there is no point in considering two items in the test tool, even when all their marginal parameters are significant.

The present study introduces an approach which will treat the items jointly to decide best item(s). The framework of the study is under IRT Model. The study extends its application of new method for the standardisation of some components of Differential Aptitude Tests (DAT), a test battery used to measure the vocational aptitude of school students.

The study has been designed in three parts. In the first part classical test theory analysis has been discussed and classical test theory statistics are computed for some components of DAT, which is developed under classical approach and based on a representative sample of size 1407 from 10^{th} standard students of Kerala. The relevance of items under classical approach in Kerala context is discussed here. It is found that either several items are inappropriate or the classical method is not a suitable approach. In the second part of the study, a statistical treatment of Item Response Theory has been carried out with two parameter logistic model. The parameters of the model are estimated using EM algorithm. The computation of the parameters was done with a programme written in MATLAB programme. The item parameters of different components of DAT were computed and the relevance of items has been discussed. In the third part of the study the concept of joint distribution of item responses has been introduced. By using conditional logistic model, the item parameters of DAT were computed. The consolidated discussion is presented in the last chapter.

Section 1.1 of this chapter discusses the basics of testing and assessment. Section 1.2 describes the procedure of item analysis in test theory. In Section 1.3, descriptions of the test tool used for standardisaion in the present study are presented. The data collection procedure adopted for the empirical validation of the findings of the study has been presented in section 1.4. Section 1.5 will give the scope and limitations of the present study and the organisation of topics in forthcoming chapters is presented in section 1.6.

1.1 Tests and Assessment

According to Kaplan an Saccuzzo (2001) a *test* is a measurement device or technique used to quantify behaviour or aid in the understanding and prediction of behaviour. The roots of contemporary psychological testing and assessment can be found in early twentieth-century France. In 1905 Alfred Binet and a colleague published a test designed to help Paris school children in appropriate classes (Cohen and Swerdlik, 2005).

A psychological or educational test is a set of items designed to measure characteristics of human beings that pertain to behaviour. Anastasi and Urbina (2004) define Psychological test as an objective and standardised measure of a sample of behaviour. Naturally these Psychological characteristics will be unobservable but can assume that those characteristics exist and vary from individual to individual. The quantification can be done only by observing a related behavior on properly designed and administered test. For example, one cannot directly observe the intelligence or aptitude of a student; but we believe it exists. These constructs will be then measured by observing some manifestation of behaviours assumed to be observed as influence of the construct.

Freeman (1965) defines the psychological test as a standardised instrument designed to measure objectively one or more aspects of a total personality by means of samples of verbal or non-verbal responses or by means of other behaviour. The term objectivity in this definition indicates how much the test is free from personal judgments regarding the trait to be measured.

Cohen and Swerdlik (2005) defines psychological assessment as the gathering and integration of psychology-related data for the purpose of making a psychological evaluation, accomplished through the use of tests and psychological testing as the process of measuring psychology-related variables by means of devices or procedures designed to obtain a sample of behaviour. The measuring device or procedure used for this can be simply defined as tests (Cohen and Swerdlik, 2005).

There will be varied tests in accordance with nature and situation of assessment. For example, in the context of medical diagnosis, blood tests or X-rays are the devices used as tests for diagnosis. In the context of Education and Psychology one of the primary uses of tests is the determination and analysis of individual differences in intelligence, aptitude , achievement etc. Stanford-Binet intelligence scale, Ravens Progressive Matrices and Wechler scales are examples of some very popular test tools to measure intelligence. Differential Aptitude Tests, Multidimensional Aptitude Battery, Minnesota Clerical Tests etc. are some aptitude tests used to check the vocational aptitude of the students. Two popular tests for measuring personality include Mayers-Briggs Type Indicator and Minnesota Multiphasic Personality Inventory.

For any type of tests, if it is used for the purpose of assessment, it is the responsibility of the test user to ensure that the test used for a particular measurement purpose is objective and reliable. Reliability is the extent to which a test is repeatable and yields consistent scores. In statistics, reliability is a term used to represent the consistency of a set of measurements or measuring instrument. An experiment is reliable if it yields consistent results of the same measure. In experimental sciences, reliability is the extent to which the measurements of a test remain consistent over repeated tests of the same subject under identical conditions. It is unreliable if repeated measurements give different results.

One of the serious complaints about testing pointed out by Ebel and Friesbie (1991) is that as most of the tests are not standardised ones, they give misinterpretation about the performance of the student. Of course, not all test scores are completely error free, but one can reduce the possibility of making error by standardising the test tool. The first phase of standardisation of the test tool is checking whether each item in a test tool holds some specific qualities. This process is known as item analysis.

1.2 Item Analysis

Many different facets of test development are involved in the process of test construction. One must go through a series of steps in order to create a test that suits best for assessing the trait to be measured. These steps include test conceptualization, test construction, test try-out, analysis and revision. All these come under the process of item analysis.

Item analysis is a process which examines the examinee's responses to individual test items (questions) in order to assess the characteristics of those items and of the test as a whole. Item analysis is especially valuable in improving items which will be used again in later tests, but it can also be used to eliminate ambiguous or misleading items in a single test administration.

French (2001) considers item analysis as a statistical procedure to analyse test items that combines methods used to evaluate the important characteristics of test items.

Within the item analysis all the possible test items are subjected to a stringent series of evaluation procedures, individually and within the context of the whole test. Then a sufficient sample of subjects are to be collected from the targeted population (for whom the test is made) for the process of item analysis.

In CTT framework, using this selected sample, some indices like item difficulty, item discrimination are calculated for each item. The quality of item will be decided on the basis of these values. The quality of the test as a whole will be determined on the basis of some coefficients for reliability and validity.

In IRT framework the item characteristics are decided based on values taken by the parameters of the model chosen for the item response. The parameters are estimated from the sample chosen for item analysis. Based on the values taken by the parameter for each item, the quality of the item will be decided.

Guilford (1982) emphasises the importance of item analysis as several properties of total score depend upon the properties of the items that compose it: the mean, variance, form of score distribution, reliability and validity. These features can be controlled, within the limits of the items available by selecting items of the right average difficulty level, the right spread of difficulty and the right degree of inter correlations, in accordance with the principles.

Item analysis can be a powerful method to instructors for the guidance and improvement of instruction. For this to be so, the items to be analyzed must be valid measures of instructional objectives. In addition, instructors who construct their own tests may greatly improve the effectiveness of test items and the validity of test scores if they select and rewrite their items on the basis of item performance data.

1.3 Test Tool Used in the Study

Since vocational aptitude is the primary variable considered for empirical analysis of the present study, Differential Aptitude Tests, a test tool for measuring aptitude was used in the study. By the term vocational aptitude we mean the inner capacity of an individual to perform any kind of work; which varies from person to person. In this section the meaning and definition of aptitude, different tools for measuring aptitude and differential aptitude tests as a measurement tool for aptitude are discussed.

1.3.1 Aptitude and Aptitude Tests

It is a fact that the individuals are different in their abilities, skills, capacities etc. This ability or potential of an individual to do something can be termed as Aptitude of that individual. Freeman (1965) defines *aptitude* as a combination of characteristics indicative of an individuals capacity to acquire some specific knowledge, skill, or set of organized responses such as the ability to speak a language, to become a musician, to do mechanical works etc. The terms intelligence, ability, and aptitude are often used interchangeably to refer to behaviour that is used to predict future learning or performance. However, subtle differences exist between the terms.

An aptitude test therefore is one designed to measure a persons potential ability in an activity of a specialized kind and within a restricted range. Aptitude tests are mainly used for two purposes viz. for the admissions to higher studies and for identifying the potential vocational area to be chosen. Scholastic Assessment Tests (SAT), Management Aptitude Test (MAT), Architectural Aptitude Tests are some examples of the first kind and Differential Aptitude Tests (DAT), General Aptitude Tests Battery (GATB) are some of the aptitude tests of the second type.

Like intelligence tests, aptitude tests measure a student's overall performance across a broad range of mental capabilities. But aptitude tests also often include items, which measure more specialized abilities that predict scholastic performance in educational programmes. A good aptitude test will be an excellent one in predicting the future scholastic achievement. It will provide ways of comparing an individual's performance with that of others in the same situation and will provide a profile of strengths and weaknesses. Aptitude tests are also used to uncover hidden talents of children, thus improving their educational opportunities.

In general, aptitude test results have several uses. One of the main uses is instructional. Teachers can use aptitude test results to adapt their curricula to match the level of their students, or to design assignments for students who differ widely. Aptitude test scores can also help teachers form realistic expectations of students. Knowing something about the aptitude level of students in a given class can help a teacher identify which students are not learning as much as could be predicted on the basis of aptitude scores. For instance, if a whole class were performing less well than would be predicted from aptitude test results, then curriculum, objectives, teaching methods, or student characteristics might be investigated.

Another use is for administrative purpose. Aptitude test scores can identify the general aptitude level of a high school, for example. This can be helpful in determining how much emphasis should be given to college preparatory programmes. Aptitude tests can be used to help identify students to be accelerated or given extra attention, for grouping, and in predicting job-training performance.

Aptitude tests scorers are widely used for career guidance. Guidance counsellors use aptitude tests to help parents develop realistic expectations for their child's school performance and to help students understand their own strengths and weaknesses.

Aptitude measurement has had significant influence on educational research and practice since Binet constructed the first intelligence test. Despite the long history of aptitude measurement, however, the nature of the individual differences that are measured by current aptitude tests remains a very controversial area in educational and psychological research (Whitely, 1981). Guilford (1982) states that it is more important to analyse aptitude tests than achievement tests.

1.3.2 Differential Aptitude Tests

There are different test tools for measuring the aptitude of students. In the present investigation, the test tool used to measure aptitude is Differential Aptitude Tests (DAT) developed by Binet, Seashore and Wesman. The Indian norms for this test tool were developed by Ojha (1989) as part of his doctoral work.

Differential Aptitude Tests, popularly known as DAT, is a multi-factor test battery of eight aptitude tests. They are (i) Verbal Reasoning, (ii) Numerical Ability, (iii) Abstract Reasoning, (iv) Space Relations, (v) Mechanical Reasoning, (vi)Clerical Speed and Accuracy, (vii) Language usage-Spelling and (viii) Language usage-sentences.

Ojha (1989) describes the components as follows:

(i) Verbal Reasoning (VR) :- This is the test of verbal comprehension and is a measure of ability to understand concepts framed in words . This test employs analogy type items in which two words, the first and the last, are to be filled in from the 8 pairs given as the alternate response. Verbal Reasoning Test is an assessment designed to measure the ability to understand concepts framed in words. It measures the ability to find commonalities among different concepts and to manipulate ideas on an abstract level the test tool administered there are 50 items and maximum time is 30 minutes. For each item there will be 16 alternatives.

(ii) Numerical Ability (NA) :- The ability for handling numbers is termed Numerical Ability. Numerical Ability test is an assessment designed to test an individual's understanding of numerical relationships and facility in handling numerical concepts. It measures the ability to understand and work with ideas related to numbers. There are 40 items with a time limit of 30 minutes. Four choices are given.

(iii) Abstract Reasoning (AR) :- This is a non-verbal measure of the reasoning ability and like verbal reasoning is fundamental to the ability of general intelligence. It involves the ability to think logically and to perceive relationships in abstract figure patterns. The student has to perceive relations and has to think in abstract symbols. There are 50 items each consisting of 4 alternatives and the time limit is 25 minutes.

(iv)Space Relations (SR) :- This is a test which assesses the ability for structural visualization which is an important requirement for occupations like architecture, mechanical drawing, interior decoration etc. The test employs two approaches to spatial visualization- ability to visualize from a given pattern and ability to imagine how it would appear. The test measures the ability to visualize a three-dimensional object from a two-dimensional pattern and to visualize how this object would look if rotated in space. It assesses the ability to 'think in three dimensions' from two dimensional perspective. There are 40 items with a time limit of 30 minutes.

(v) Mechanical Reasoning (MR) :- This test consists of picture depicting some situation or activity, where some mechanical and physical laws come into play. The examinee is asked to understand this and has to mark one of the three alternative responses. The test demands an understanding of simple physical laws and is a measure of the ability to perceive simple mechanical relationships which may regarded as an aspect of mechanical aptitude. The test measures the ability to understand basic mechanical principles of machinery, tools, and motion. There will be 68 items with 30 minutes of time to answer.

(vi) Clerical Speed and Accuracy (SA) :- This is purely a speed test which is an important factor in routine clerical work. It measures speed of perception, momentary retention and speed of responses. There will be 100 items to be answered within 3 minutes.

(vii) Language usage-Spelling part (S):- The ability needed to answer the items of this category is knowledge of using correct spelling in the use of English language. There will be 100 items and each item may be spelled correct or wrong. The examinee has to identify whether the spelling is right or wrong. The time limit is 10 minutes.

(viii) Language usage-Sentences part(St.):- This test is an assessment designed to measure the ability to detect errors in grammar, punctuation, and capitalization. There will be 50 sentences and in each sentence there may some kind of error, the examinee has to identify the mistake in each sentence and mark in which part it exists. The maximum time will be 25 minutes.

In DAT separate norms are given for male and female, since significant gender differences in performance exist on tests.

The Differential Aptitude Tests (DAT) are designed for use in educational and vocational guidance and are used by school counsellors, personnel officers, psychologists and all persons concerned with assessing the intellectual characteristics and educational or vocational aptitudes of adolescents. This battery of tests has been adapted for use in Irish schools. Testing time is approximately 3 hours and may be spread over several sessions. The tests are suitable for pre-Junior Certificate to Leaving Certificate pupils.

Rudner (1980) states that the fairness or appropriateness of measures of aptitude or achievement have long been of interest and theoretical concern, but more recently have surfaced as variables requiring empirical investigation.-

The rationale behind the development of the Differential Aptitude Tests is that since different kinds of abilities are useful in different jobs and in different school subjects, a battery giving measures of several abilities is likely to be more useful than a test giving a single general ability score.

1.4 Sample Selection Procedure

For the empirical validation of any study, a representative sample from the population is essential. Differential Aptitude Tests, which is validated through the present study, is widely used for vocational guidance of students. The tool is used in the process of career guidance. The students choose their choice of higher study based on the aptitude measured through the test tool. Since the study is mainly used for selecting subjects or combinations of subjects after high school education, the study has been validated over a sample of 10^{th} students of Kerala.

To get primary data from the students of Kerala as part of the study the test tool was administered over the selected sample. Sampling was done with proper care and according to sampling principles.

Since the sample has to be collected from students spread over different schools in different districts of Kerala, a two-stage sampling technique was planned. Two-stage sampling is a sampling technique which consists in selecting the clusters first and then selecting a specified number of elements from each selected cluster. It is also known as sub sampling or nested sampling. This type of sampling is very commonly used in large scale surveys and it is very useful in practice.

Besides this, as sampling is the process of taking any portion of a population or universe as representative of that population or universe, multi-stage sampling method has some advantage in using it in the present study. In multi-stage sampling the material is regarded as made up of a number of first-stage units each of which is made up of second-stage units, and so on. At the first stage of sampling, a number of first-stage units are selected; from each of the selected first-stage units, a number of second-stage units are then selected and so on. An example of multi-stage sampling is where, firstly, sub-divisions (clusters) are sampled from a city or state. Secondly, blocks of houses are selected from within the electoral sub-divisions and, thirdly, individual houses are selected from within the selected blocks of houses.

One advantage of multi-stage sampling is that it does not require a complete list of members in the target population, which greatly reduces sample preparation cost. It is more convenient, economic and efficient. Another advantage is that multi-stage sampling can involve more than one method or combined method of sampling, such as simple random, cluster or stratified sampling. It is like cluster sampling, but involves selecting a sample within each chosen cluster, rather than including all units in the cluster. It involves selecting a sample in at least two stages.

In the first stage, large groups or clusters are selected. These clusters are designed to contain more population units than are required for the final sample. In the second stage, population units are chosen from selected clusters to derive a final sample. If more than two stages are used, the process of choosing population units within clusters continues until the final sample is achieved. For example, a state may be considered as being divided into a number of districts; each district into a number of villages; each village into a number of farms. In multi-stage sampling a number of districts is selected in the first stage; within each such selected district a number of villages is selected in the second-stage, and from each selected village a number of farms is selected at the third-stage for enquiry. In the case of a crop-cutting investigation, the work may be carried further by the selection of fields from each selected farm and by plots within a field.

In the present study, the schools are treated as primary stage units and students from the schools are treated as second stage units. The primary units were selected from a total of 2, 585 schools of Kerala (See table 1.1) using stratified random sampling method. The strata like Districts, Type of management (Govt., Private aided, Private un-aided) were considered while taking the primary units. In this stage a total of 102 schools were selected randomly with due proportion to the factors Districts and Type of management. The number of schools selected as primary stage units in different districts are given in table 1.2.

TABLE 1.1

No. of Schools in Different Districts of Kerala

(Source: Department of Education, Govt. of Kerala, 1999)

District	Govt.	Private Aided	Private Un-aided	Total
Kasaragode	74	33	08	115
Kannur	81	77	10	168
Kozhikode	67	95	17	179
Wayanad	35	22	04	61
Malappuram	82	76	30	188
Palakkad	58	77	16	151

TABLE 1.1 (Cont.)

District	Govt.	Private Aided	Private Un-aided	Total
Trissur	79	147	20	246
Ernakulam	89	172	33	294
Kottayam	59	166	16	241
Idukki	52	72	10	134
Alappuzha	58	125	07	190
Pathanamthitta	47	113	07	167
Kollam	76	125	10	211
Thiruvananthapuram	119	94	27	240
Total	976	1394	215	2585

TABLE 1.2

No. of Schools Selected in the sample

District	Govt.	Private Aided	Private Un-aided	Total
Kasaragode	03	01	00	04
Kannur	04	03	00	07
Kozhikode	03	05	00	08
Wayanad	01	01	00	02
Malappuram	03	03	01	07

TABLE 1.2 (Cont.)

District	Govt.	Private Aided	Private Un-aided	Total
Palakkad	02	03	00	05
Trissur	04	06	01	11
Ernakulam	04	06	01	11
Kottayam	03	06	01	10
Idukki	00	05	00	05
Alappuzha	03	05	00	08
Pathanamthitta	02	05	00	07
Kollam	04	04	00	08
Thiruvananthapuram	04	03	02	09
Total	40	56	06	102

As the second stage of sampling, to select the students as second stage units, consent from the heads of 102 institutions chosen as primary units was collected for conducting the study in their institution. The nominal rolls of students of 10^{th} standard of selected schools were also collected. From this list, 1470 students of 10^{th} standard were selected by random proportional to the total number of students of each school. Due consideration was given for gender proportion while taking sample of students from each schools.

After fixing a convenient date after the discussion with heads of the institutions the tool Differential Aptitude tests was administered among these selected students during the academic year 2005-06. From this 1470 students who appeared for DAT, after eliminating incomplete forms, data of 1407 students were considered for analysis.

1.5 Scope and Limitations of the Study

Even though measurement methodologies are a very important part of any type of research, especially in social science, very few are using sufficiently sophisticated and powerful methods for test construction and data interpretation. Most of the researches are based on the traditional classical framework.

In spite of the easiness of the process of item analysis, CTT have many limitations also. The major weakness of classical test theory method is that it provides only a crude estimate for each item characteristics. It does not consider the probabilistic or population wise nature of responding to an item by the subject.

In IRT approach the criteria for selecting or eliminating items from a test tool is first to assume a probability model for the item responses and then estimate the parameters associated. Then decision of rejecting or accepting the item in to the final tool will be taken based on the values taken by the parameters in the model.

The present study approaches the problem with a more elaborate statistical treatment. One estimation procedure using EM algorithm was carried out in the study for the estimation of parameters in IRT model by considering two parameter IRT model. Bases on this item statistics, one can take the decision on rejecting or accepting items under the assumption that items are independent of one another.

In real situations the probability of answering an item correctly may depend on answering other items correctly. The present day IRT literature does not focus on this issue. The merit of the present study is that it considers inter- item dependency and proposes the need of considering the conditional probability while making the model by considering two items jointly. This method can be extended by considering all the items jointly.

The present study applies the method suggested in the study in the standardisation process of Differential Aptitude Tests, a well known test used to measure the aptitude of students.

The major limitation of the present study is that it has been limited to dichotomously scored tests only. In present study the focus is only on two-parameter IRT model, but one can easily extend it to higher parameter models.

1.6 Organisation of the Study

The primary objective of the present study is to highlight the importance of considering inter item dependence in the item analysis process in an IRT framework. For this an estimation method for the item parameters of the IRT model was introduced by choosing two-parameter IRT model. Then the new approach has been applied in a real data consisting of measure of aptitude tests scores of 1407 students of Kerala. To give the discussion more systematic the presentation is made in the following sequence.

In chapter 2, Section 2.1 gives an introduction on Classical Tests Theory method. Section 2.2 is devoted to explain most commonly used concepts in Classical methods like item difficulty, item discrimination. In Section 2.3 The classical test theory statistics are computed for the data obtained from administering aptitude tests to the students of Kerala. The Section 2.4 is meant to give a brief discussion on the results presented in this chapter.

Chapter 3 starts with an introduction on item response theory. In Section 3.2 a brief history of item response theory has been presented. Section 3.3 intends to discuss the basic concepts from item response theory. Assumptions of Item response theory are described in Section 3.4. In Section 3.5 the parametric item response models are described. Section 3.6 provides the estimation procedure in the presence of missing or incomplete data and EM algorithm. The computation of item parameters of some components of DAT has been presented in Section 3.7. Some recent studies on the application of IRT has been presented in Section 3.8 followed by a comparison of classical methods with item response theory methods in Section 3.9.

Chapter 4 introduces the multi-item approach for item analysis in IRT. In Section 4.1 need of considering more than one item together in item analysis in emphasised. The method for determining interdependence for two items taking together is described in Section 4.2. In Section 4.3, the multi-item approach has been applied in some components of DAT followed by a discussion.

The last chapter gives an account on summary of the work and future research areas.

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

Chapter 2

Item Analysis of some components of DAT by CTT approach

2.1 Introduction

The conventional method of test construction and its interpretation is Classical Test Theory (CTT) methods. Classical test theory methods are widely used in almost all areas of social, behavioural, medical and many other fields of study. The conceptual foundations, assumptions, and extensions of the basic premises of CTT have allowed for the development of psychometrically sound scales over several decades.

In both classical and modern test theory, a general goal is to arrive at tests having minimum items that will yield necessary degree of reliability. The process applied to get a set of good items to measure a particular trait is known as item analysis.

The item analysis is an important phase in the development of a test. In this phase statistical methods are used to identify any test items that are not suitable to give exact picture about the ability of the examinee. If an item is too easy, too difficult, failing to show a difference between skilled and unskilled examinees, or even scored incorrectly, an item analysis will reveal it.

The item analysis techniques within the classical test theory approach is generally crude in nature. The common method is to determine the values of some pre-defined statistics and based on these values decision is taken to reject or accept an item, without considering the nature, form or characteristics of the population.

This chapter is devoted to reveal the item analysis technique in classical framework. As part of this an analysis of test items of some selected components of Differential Aptitude tests within the theoretical framework of CTT will be carried out. The Differential Aptitude Tests consists of eight different tests and each test is composed of a number of items. But in this study only four tests namely Numerical Ability, Abstract Reasoning, Mechanical Reasoning and Spelling are analysed.

There are some pieces of information like item difficulty and item discrimination that can be used to determine the quality of an item. These basic concepts are discussed in different sections of this chapter. Even though it is not advisable to use classical approach for item analysis in many situations, as it is not in a statistical framework, the method is adopted in this chapter because (i) the test was constructed under classical framework; hence it is necessary to see whether it satisfies the necessary pre-requesites under the classical approach and (ii) to discuss certain drawbacks of classical approach with the help of this practical example.

Section 2.2 of this chapter is devoted to discuss some of the very basic concepts of classical test theory. In Section 2.2.1 the meaning and definition of item difficulty and the different approaches in considering best item based on values of item difficulty are presented. Section 2.2.2 will give a brief outline on item discrimination and its range of value for choosing an item. In Section 2.3 the statistical computation of different item analysis statistics were done using the data obtained from the administration of Differential Aptitude Tests over a representative sample of students of Kerala. Section 2.4 is devoted to discuss the results obtained.

2.2 Basic concepts of Classical Item Analysis

The two most common statistics reported in an item analysis are the item difficulty, which is a measure of the proportion of examinees who responded to an item correctly, and the item discrimination, which is a measure of how well the item discriminates between examinees who are having different levels of trait (inherent capacity) and those who are not.

Both item difficulty and item discrimination are item statistics ;for each item one can find indices for item difficulty and item discrimination. There are some statistics such as reliability coefficient which are test statistics rather than item statistics. It means they will give some information on the test as a whole rather than item.

2.2.1 Item Difficulty

The item difficulty index is the proportion of number of examinees who get an item correct to total number of examinees (Anastasi and Urbina, 2004). It means item difficulty is a measure of the proportion of examinees that answered the item correctly. The item difficulty index, symbolized as p_i for an item i, can be computed simply by dividing the number of test takers who answered the item correctly by the total number of students who answered the item. Therefore easier the item larger the proportion will be. Hence a numerical problem correctly answered by 30 percentage of subjects ($p = 0.30$) will be considered harder than an item answered by 75 percentage of subjects ($p = 0.75$). The value of p_i ranges from 0 to 1. It takes 0 when no examinees answered the item correctly and 1 when all examinees answered the item correctly. However if p_i approaches either end of the spectrum less information about the group is revealed. The item difficulty index is also known as item endorsement index. In some literature $1 - p_i$ is called item facility.

For items with one correct alternative worth a single point, the item difficulty is simply the percentage of students who answer an item correctly. In this case, it is also equal to the item mean. When an alternative is worth other than a single point, or when there is more than one correct alternative per question, the item difficulty is the average score on that item divided by the highest number of points for any one alternative. In our discussion we will consider only items having one correct alternative.

In an achievement test, item difficulty is relevant for determining whether students have learned the concept being tested. It also plays an important role in the ability of an item to discriminate between students who know the tested material and those who do not. The item will have low discrimination if it is so difficult that almost everyone gets it wrong or guesses, or so easy that almost everyone gets it right. Hence all standardised tests have generally been designed to elicit maximum differentiation among individuals at all levels. For this the difficulty index of each items will be computed and items falls outside a desirable value of p_i will be rejected from the test tool.

When items are dichotomous, i.e. when items are scored either 0 or 1, simplest index of its difficulty is its mean item score. There are different criteria for fixing this desirable value. Different authors have suggested different criteria based on their arguments for determining an ideal value for p_i. Generally we can say that the optimum value of item difficulty is decided by the test developer based on the objectives of measurement.

Usually an item with difficulty index nearer to 0.5 is treated as a good item , as 0.5 is the value for item difficulty where 50% of subjects responded correctly. But there is no strict rule in deciding the admissible variation from 0.5. Kaplan and Saccuzzo (2001) states that, for most tests, items in the difficulty range of 0.30 to 0.70 tend to maximize information about the difference among individuals.

Chung (1985) states that a good item usually has a difficulty that lies between 40%and 70%. All these are only some thump rules.

Kaplan and Saccuzzo (2001) puts forward a set of ideal values for item difficulty by considering guessing factor. They suggests that optimum difficulty level for items is usually about halfway between 100% of respondents getting the item correct and the level of success expected by chance alone. Thus the optimum difficulty level of a four-choice item is 0.625. The optimum item difficulty index for an item with three-choice will be 0.666 and that of an item with only two choices will be 0.75. Guilforrd(1982) suggests some correction to proportion and presented a table to facilitate the correction for ideal item difficulty.

There is no strict criteria for deciding the allowed variation of item difficulty from this ideal value. It is decided by the the test developer with his personal judgment based on need and situation. But in the present study the the item difficulty index will be tested by proportion test using the test statistic

$$Z = \left[\frac{p_i - p_0}{\sqrt{p_0(1-p_0)/n}}\right] \tag{2.1}$$

where p_i is the item difficulty of the i^{th} item , p_0 is the optimum value of item difficulty and n is the sample size.

Besides the item difficulty of each item one can define the item difficulty of the whole test as the average test item difficulty of entire items (French, 2001). According to Cohen et al. (1996) the optimal average item difficulty is approximately 0.50.

2.2.2 Item discrimination

Item discrimination refers to the degree to which an item differentiates correctly among test takers in the behavior that the test is designed to measure (Anastasi and Urbina, 2004). It is an index that measures how well an item is able to distinguish between examinees who are knowledgeable and those who are not, or between masters and non-masters. Cohen and Swerdlik (2005) define it as a statistic designed to indicate how adequately a test item separates or discriminates between high and low scorers.

In test construction theory there are many indices to determine the property of item discrimination. Some of these assume normal distribution of the underlying trait. Despite of different procedures, most of the item discrimination indices provide closely similar results (Anastasi and Urbina, 2004). A common practice in computing item discrimination is to compare the proportion of cases that pass an item in contrasting criterion groups. This method compares people who have done very well with those who have done very poorly on a test (Kaplan and Saccuzzo, 2001). In this method there are three simple steps in calculating item discrimination index D_i. First, those who have the highest and lowest overall test scores are grouped into upper and lower groups. The upper group is made up of the 25% to 33% who are the best performers (have the highest overall test scores), and the lower group is made up of the bottom 25% to 33% who are the poorest performers (have the lowest overall test scores). Cureton (1957) suggested to use the top and bottom 27% of the distribution in creating these extreme groups, as this is the critical ratio that separates the tail from the mean of the standard normal distribution of response error. Step two is to examine each item and determine the p levels for the upper and lower groups, respectively. Step three is to subtract the p levels of the two groups; this provides the D_i.

Another way to find the discrimination index of items is to find the correlation between performance on the item and performance on the total test (Kaplan and Saccuzzo, 2001). One situation, which occurs frequently in item analysis, is when the test developer is interested in how closely performance on a test item scored 0 to 1 is related to performance on the total test score (Crocker and Algina, 1986). A simplified formula used in this situation is point biserial correlation denoted as $\rho_{\mathrm{p}bis}$, which is defined as the correlation between item score and total score.

This statistic looks at the relationship between examinees performance on the given item (correct or incorrect) and the examinees score on the overall test. For an item that is highly discriminating, in general the examinees who responded to the item correctly also did well on the test, while in general the examinees who responded to the item incorrectly also tended to do poorly on the overall test. Item discrimination indices must always be interpreted in the context of the type of test, which is being analyzed. Items with low discrimination indices are often ambiguously worded and should be examined. Items with negative indices should be examined to determine why a negative value was obtained. Tests with high internal consistency consist of items with mostly positive relationships with total test score.

Values of D_i may range from -1 to $+1$. For discrimination indices Crocker and Aligna (1986) prescribe a guideline as follows:

(i). If $D_i \geq 0.40$, the item is functioning quite satisfactorily.

(ii). If $0.30 \leq D_i \leq 0.39$, little or no revision is required.

(iii). If $0.20 \leq D_i \leq 0.29$, the item is marginal and needs revision.

(iv). If $D_i \leq 0.19$, the item should be eliminated or completely revised.

Chung (1985) states that a good item usually has a discriminating index that exceeds 0.40.

There are various other methods also for computation of discrimination index of test items. Obviously in some situations, because of the scoring of the variables one technique may be more appropriate than others (see Crocker and Algina, 1986).

In the present study items having discrimination index less than 0.30 are treated as items to be eliminated from the test tool.

2.3 Classical Item Analysis of DAT

In this section the classical item analysis is carried out for the selected four components of DAT. The components chosen for empirical study are Abstract Reasoning (AR), Numerical Ability (NA), Mechanical Reasoning (MR) and Spelling (S) tests. All these four components are having only one correct answer (i.e dichotomous). The following sections will give values computed for item statistics, item difficulty and item discrimination for all these components using CTT methods.

2.3.1 Item Analysis of the AR component of DAT

In Abstract Reasoning test there are 50 items; each item has four choices of answers. In this section the item difficulty index and item discrimination index for each item of Abstract Reasoning component has been computed. The item difficulty is computed as the proportion of correct response to each item and the item discrimination index is computed as the item-total correlation of scores for each item.

Item Difficulty

The following table (Table 2.1) gives the item difficulty indices of all items of Abstract Reasoning component of DAT. The Z-values obtained for the proportion test as in equation 2.1 is also presented here.

TABLE 2.1

Table showing the Item Difficulty Index of AR (N = 1407)

Item	P_i	Z	Item	P_i	Z
1	0.881	19.85	26	0.495	-10.09
2	0.538	-6.73	27	0.389	-18.30
3	0.770	11.21	28	0.699	5.70
4	0.675	3.88	29	0.515	-8.50
5	0.741	9.01	30	0.415	-16.26
6	0.554	-5.52	31	0.195	-33.28
7	0.568	-4.42	32	0.391	-18.13
8	0.645	1.57	33	0.176	-34.82

TABLE 2.1 (Cont.)

Item	P_i	Z	Item	P_i	Z
9	0.425	-15.54	34	0.479	-11.30
10	0.620	-0.35	35	0.314	-24.08
11	0.419	-15.93	36	0.265	-27.88
12	0.767	10.99	37	0.313	-24.14
13	0.580	-3.48	38	0.243	-29.59
14	0.549	-5.91	39	0.177	-34.71
15	0.475	-11.58	40	0.621	-0.29
16	0.706	6.31	41	0.184	-34.16
17	0.565	-4.64	42	0.343	-21.88
18	0.629	0.30	43	0.292	-25.79
19	0.527	-7.62	44	0.314	-24.08
20	0.613	-0.90	45	0.178	-34.60
21	0.335	-22.43	46	0.358	-20.67
22	0.311	-24.36	47	0.317	-23.86
23	0.610	-1.17	48	0.152	-36.64
24	0.449	-13.62	49	0.114	-39.61
25	0.502	-9.49	50	0.170	-35.26

Since the Abstract Reasoning test consists of four-choice items; as per the the criteria suggested in Kaplan and Saccuzzo (2001) the optimum value of item difficulty will be 0.625. The significance of difference of values from this optimum was tested using Z-test for significance of proportion as the sample size is large. The items with $|Z| \leq 2.58$ are treated as in admissible range of variation from optimum difficulty index.

The values obtained for Z indicates that only items with item number 8, 10, 18, 20, 23, and 40 can be considered good items with respect to their item difficulty indices (see table 2.1). The remaining items are to be eliminated from the test tool.

Item Discrimination

Item discrimination is also a very important concept in item analysis, which determines the power of the item to distinguish high achievers from low achievers. There are many different indices to indicate the item discrimination. Here in this section we will compute the item -total correlation as a measure of item discrimination of Abstract component of DAT.

The results of the item-total correlations of all items of Abstract Reasoning component has been presented in the Table 2.2.

TABLE 2.2

Table showing the item Discrimination Index of AR (N= 1407).

Item	D_i	Item	D_i	Item	D_i
1	0.325	18	0.442	35	0.245
2	0.570	19	0.547	36	0.314
3	0.548	20	0.453	37	0.452
4	0.551	21	0.355	38	0.405
5	0.510	22	0.343	39	0.187
6	0.562	23	0.542	40	0.433
7	0.571	24	0.399	41	0.311
8	0.636	25	0.296	42	0.305
9	0.547	26	0.508	43	0.165
10	0.548	27	0.429	44	0.237
11	0.460	28	0.348	45	0.244
12	0.499	29	0.506	46	0.458
13	0.455	30	0.364	47	0.275
14	0.505	31	0.258	48	0.264

TABLE 2.2(Cont.)

Item	D_i	Item	D_i	Item	D_i
15	0.482	32	0.390	49	0.146
16	0.582	33	0.273	50	0.224
17	0.574	34	0.439		

If we follow the criteria suggested by Crocker and Algina (1988) as to eliminate items having item- total correlation less than 0.3; the items 25, 31, 33, 35, 39, 43, 44, 45, 47, 48, 49 and 50 are to be eliminated from the test tool.

2.3.2 Item Analysis of the NA component of DAT

In this section the item difficulty index and item discrimination index for each item of Numerical Ability component has been computed. The item difficulty is computed as the proportion of correct response to each item and the item discrimination index is computed as the item-total correlation of scores for each item.

Item Difficulty

The item difficulty index computed for the numerical component of DAT is given in Table 2.3. The Z-values obtained for the proportion test by taking p_0 as 0.625 as in equation 2.1 is also presented here.

TABLE 2.3

Table showing the item Difficulty index of NA (N = 1407)

Item	P_i	Z	Item	P_i	Z
1	0.729	8.01	21	0.247	-29.31
2	0.733	8.40	22	0.205	-32.51
3	0.746	9.39	23	0.193	-33.50
4	0.489	-10.53	24	0.129	-38.45
5	0.718	7.19	25	0.212	-32.01
6	0.269	-27.55	26	0.157	-36.25
7	0.344	-21.77	27	0.149	-36.91
8	0.655	2.34	28	0.392	-18.02
9	0.284	-26.39	29	0.419	-15.99
10	0.370	-19.79	30	0.326	-23.20
11	0.265	-27.88	31	0.222	-31.24
12	0.126	-38.67	32	0.348	-21.44
13	0.318	-23.75	33	0.242	-29.64
14	0.444	-14.00	34	0.158	-36.20
15	0.174	-34.93	35	0.156	-36.36

TABLE 2.3 (Cont.)

Item	P_i	Z	Item	P_i	Z
16	0.116	-39.44	36	0.066	-43.30
17	0.043	-45.12	37	0.128	-38.51
18	0.036	-45.67	38	0.190	-33.72
19	0.762	10.66	39	0.149	-36.86
20	0.440	-14.33	40	0.147	-37.02

Since the Numerical Ability test consists of four-choice items; as per the the criteria suggested in Kaplan and Saccuzzo (2001) the optimum value of item difficulty will be 0.625. The significance of difference of values from this optimum was tested using Z-test for significance of proportion as the sample size is large. The items with $|Z| \leq 2.58$ are treated as in admissible range of variation from optimum difficulty index.

From the table one can see that, under this rule, all items except item no. 8 are to be eliminated from the test tool.

Item Discrimination

The item-total correlations of all items of Numerical Ability components of DAT has been presented in table 2.4.

TABLE 2.4

Table showing the item Discrimination Index of NA (N= 1407).

Item	D_i	Item	D_i	Item	D_i	Item	D_i
1	0.216	11	0.304	21	0.366	31	0.439
2	0.275	12	0.259	22	0.163	32	0.465
3	0.246	13	0.432	23	0.153	33	0.452
4	0.383	14	0.192	24	0.286	34	0.387
5	0.283	15	0.368	25	0.352	35	0.344
6	0.368	16	0.196	26	0.275	36	0.032
7	0.510	17	0.063	27	0.330	37	0.172
8	0.307	18	0.078	28	0.517	38	0.430
9	0.385	19	0.399	29	0.499	39	0.279
10	0.234	20	0.397	30	0.498	40	0.440

If the items having discrimination index ≤ 0.300 are considered as not good, the items 1, 2, 3, 5, 10, 12, 14, 16, 17, 18, 22, 23, 24, 26, 36, 37, and 39 are to be eliminated from the test tool.

2.3.3 Item Analysis of the MR component of DAT

Mechanical Reasoning component consists of 68 items with 3 alternatives of answers to each item. In this section the item difficulty index and item discrimination index for each item of Mechanical Reasoning component of DAT has been computed. The item difficulty is computed as the proportion of correct response to each item and the item discrimination index is computed as the item-total correlation of scores for each item.

Item Difficulty

The Table 2.5 gives the item difficulty indices of all items of Mechanical Reasoning component. The Z-values obtained for the proportion test as in equation 2.1 is also presented here. Since Mechanical Reasoning test consists of three choices for each items the ideal value for item difficulty will be 0.666.

TABLE 2.5

Table showing the item Difficulty index of MR (N = 1407)

Item	P_i	Z	Item	P_i	Z
1	0.700	2.65	35	0.395	-21.60
2	0.267	-31.78	36	0.457	-16.68
3	0.556	-8.82	37	0.466	-16.28
4	0.491	-13.96	38	0.439	-18.09
5	0.367	-23.80	39	0.416	-19.90

TABLE 2.5 (Cont.)

Item	P_i	Z	Item	P_i	Z
6	0.615	-4.07	40	0.466	-16.40
7	0.412	-20.30	41	0.237	-34.15
8	0.769	8.14	42	0.303	-28.89
9	0.414	-20.04	43	0.353	-24.94
10	0.437	-18.26	44	0.361	-24.31
11	0.559	-8.59	45	0.365	-23.97
12	0.548	-9.44	46	0.382	-22.67
13	0.459	-16.51	47	0.412	-20.24
14	0.475	-15.21	48	0.338	-26.12
15	0.338	-26.12	49	0.214	-36.02
16	0.392	-21.83	50	0.326	-27.14
17	0.497	-13.51	51	0.206	-36.64
18	0.343	-25.78	52	0.337	-26.24
19	0.328	-26.97	53	0.446	-17.58
20	0.429	-18.88	54	0.279	-30.82
21	0.424	-19.34	55	0.247	-33.42
22	0.394	-21.66	56	0.351	-25.11

TABLE 2.5 (Cont.)

Item	P_i	Z	Item	P_i	Z
23	0.240	-33.98	57	0.422	-19.45
24	0.409	-20.47	58	0.164	-39.98
25	0.389	-22.11	59	0.306	-28.72
26	0.338	-26.12	60	0.350	-25.22
27	0.188	-38.06	61	0.436	-18.32
28	0.287	-30.20	62	0.288	-30.14
29	0.490	-14.02	63	0.404	-20.86
30	0.228	-34.89	64	0.291	-29.86
31	0.328	-26.92	65	0.310	-28.39
32	0.304	-28.84	66	0.320	-27.59
33	0.300	-29.18	67	0.289	-30.08
34	0.401	-21.15	68	0.274	-31.27

Here one can see that there is not a single item that can be included into the final test tool as all are significantly different from the ideal item difficulty index of mechanical reasoning test.

Item Discrimination

The results of the item-total correlations of items of Mechanical Reasoning components of DAT has been presented in table 2.6.

TABLE 2.6

Table showing the item Discrimination Index of MR component(N= 1407).

Item	D_i	Item	D_i	Item	D_i
1	0.204	24	0.233	47	0.059
2	0.223	25	0.203	48	0.171
3	0.164	26	0.130	49	0.037
4	0.180	27	0.236	50	0.264
5	0.173	28	0.178	51	0.207
6	0.190	29	0.255	52	0.246
7	0.192	30	0.282	53	0.236
8	0.180	31	0.216	54	0.218
9	0.255	32	0.112	55	0.224
10	0.225	33	0.110	56	0.225
11	0.194	34	0.250	57	0.259
12	0.208	35	0.088	58	0.177

TABLE 2.6 (Cont.)

Item	D_i	Item	D_i	Item	D_i
13	0.229	36	0.224	59	0.198
14	0.163	37	0.233	60	0.303
15	0.164	38	0.197	61	0.259
16	0.265	39	0.244	62	0.187
17	0.180	40	0.199	63	0.256
18	0.214	41	0.141	64	0.239
19	0.165	42	0.106	65	0.262
20	0.202	43	0.230	66	0.269
21	0.190	44	0.190	67	0.222
22	0.298	45	0.224	68	0.255
23	0.190	46	0.227		

As per the criteria suggested in Crocker and Aligna(1986) as $d_i \leq 0.300$ are not good, only item number 60 can be considered as a good item.

2.3.4 Item Analysis of the S-component of DAT

Spelling component of DAT consists of 100 items with 2 alternatives of answers to each item. In this section the item difficulty index and item discrimination index for each item of Spelling component of DAT has been computed. The item difficulty is computed as the proportion of correct response to each item and the item discrimination index is computed as the item-total correlation of scores for each item.

Item Difficulty

The following table gives the item difficulty indices of all items of Spelling component of DAT. The Z-values obtained for the proportion test as in equation 2.1 is also presented here. Since Spelling has only two choices in answering for each item, the ideal item difficulty index will be 0.75.

TABLE 2.7

Table showing the item Difficulty index of Spelling (N = 1407)

Item	P_i	Z	Item	P_i	Z
1	0.512	-20.45	51	0.272	-41.38
2	0.587	-13.86	52	0.688	-5.18
3	0.798	4.47	53	0.343	-35.23
4	0.579	-14.60	54	0.815	5.95
5	0.578	-14.66	55	0.377	-32.21

TABLE 2.7(cont.)

Item	P_i	Z	Item	P_i	Z
6	0.425	-28.02	56	0.454	-25.56
7	0.696	-4.38	57	0.323	-36.83
8	0.459	-25.07	58	0.653	-8.14
9	0.601	-12.69	59	0.692	-4.75
10	0.808	5.21	60	0.310	-38.06
11	0.292	-39.54	61	0.224	-45.45
12	0.511	-20.51	62	0.460	-24.95
13	0.521	-19.65	63	0.248	-43.35
14	0.387	-31.69	64	0.216	-46.19
15	0.498	-21.68	65	0.457	-25.19
16	0.389	-31.16	66	0.328	-36.40
17	0.464	-24.64	67	0.357	-33.93
18	0.684	-5.49	68	0.314	-37.63
19	0.492	-22.24	69	0.255	-42.80
20	0.582	-14.42	70	0.301	-38.74
21	0.705	-3.64	71	0.304	-38.49
22	0.501	-21.44	72	0.474	-23.71

TABLE 2.7(cont.)

Item	P_i	Z	Item	P_i	Z
23	0.531	-18.85	73	0.590	-13.68
24	0.636	-9.61	74	0.480	-23.22
25	0.584	-14.23	75	0.505	-21.07
26	0.452	-25.62	76	0.192	-48.36
27	0.592	-13.56	77	0.539	-18.11
28	0.820	6.26	78	0.328	-36.40
29	0.616	-11.34	79	0.409	-29.44
30	0.671	-6.60	80	0.358	-33.87
31	0.352	-34.37	81	0.180	-49.39
32	0.448	-26.05	82	0.214	-46.43
33	0.281	-40.53	83	0.308	-38.18
34	0.410	-29.26	84	0.556	-16.57
35	0.709	-3.27	85	0.222	-45-69
36	0.519	-19.84	86	0.252	-43.05
37	0.426	-27.96	87	0.304	-38.55
38	0.515	-20.14	88	0.336	-35.78
39	0.289	-39.84	89	0.413	-29.01
40	0.347	-34.80	90	0.241	-43.97

TABLE 2.7(cont.)

Item	P_i	Z	Item	P_i	Z
41	0.603	-12.51	91	0.303	-38.61
42	0.238	-44.34	92	0.568	-15.53
43	0.546	-17.50	93	0.207	-47.05
44	0.475	-23.71	94	0.193	-48.22
45	0.580	-14.54	95	0.315	-37.57
46	0.381	-31.78	96	0.270	-41.51
47	0.241	-44.03	97	0.350	-35.61
48	0.473	-23.90	98	0.241	-44.03
49	0.565	-15.83	99	0.243	-43.79
50	0.804	4.97	100	0.100	-56.28

Here all items are significantly different from the ideal difficulty index 0.75 and hence as per classical approach all items are to be eliminated from the tool.

Item Discrimination index

The results of the item-total correlations of all items of Spelling components of is presented in table 2.8.

TABLE 2.8

Table showing the item Discrimination Index of Spelling(N= 1407).

Item	D_i	Item	D_i	Item	D_i	Item	D_i
1	0.297	26	0.178	51	0.228	76	0.241
2	0.253	27	0.216	52	0.398	77	0.356
3	0.060	28	0.227	53	0.076	78	0.246
4	0.271	29	0.210	54	0.317	79	0.376
5	0.277	30	0.274	55	0.172	80	0.342
6	0.233	31	0.192	56	0.292	81	0.251
7	0.250	32	0.127	57	0.252	82	0.262
8	0.185	33	0.197	58	0.313	83	0.196
9	0.247	34	0.275	59	0.370	84	0.439
10	0.180	35	0.258	60	0.197	85	0.285
11	0.173	36	0.234	61	0.256	86	0.172
12	0.219	37	0.164	62	0.248	87	0.383

TABLE 2.8 (Cont.)

Item	D_i	Item	D_i	Item	D_i	Item	D_i
13	0.207	38	0.254	63	0.290	88	0.375
14	0.088	39	0.143	64	0.246	89	0.288
15	0.321	40	0.253	65	0.287	90	0.233
16	0.203	41	0.305	66	0.278	91	0.284
17	0.260	42	0.140	67	0.269	92	0.478
18	0.262	43	0.251	68	0.224	93	0.171
19	0.290	44	0.366	69	0.278	94	0.297
20	0.278	45	0.104	70	0.254	95	0.233
21	0.267	46	0.220	71	0.162	96	0.245
22	0.329	47	0.235	72	0.421	97	0.344
23	0.255	48	0.342	73	0.424	98	0.160
24	0.231	49	0.306	74	0.392	99	0.219
25	0.153	50	0.287	75	0.431	100	0.147

As per the criteria suggested by Crocker and Algina(1988), only few items are having the quality of good item regarding item discrimination.

2.4 Discussion

The classical item analysis method carried out in the previous section for the four components can be summarised as in the following table (See Table 2.9).

TABLE 2.9

Table indicating the number of items eliminated through CTT item analysis

Test Component	Total Number of items	No. of items eliminated through item analysis	No. of remaining items
Abstract Reasoning	50	44	06
Numerical Ability	40	39	01
Mechanical Reasoning	68	68	00
Spelling	100	100	00

The table indicates that almost all items in each components are eliminated through the classical item analysis process. In the case of Abstract Reasoning test 44 items out of 50 items are eliminated. In the case of Numerical ability test only one item is found to satisfy the criteria for good item. In the case of Mechanical and Spelling tests no test item found to be good as per classical criteria.

The possible reason for this findings may be because of inadequacy of classical method for the item analysis of DAT or inadequacy of DAT in measuring aptitude of students. Here we feel that it may be because of inadequacy of classical item analysis method as it does not assume any parent population assumption and no efficiency type measure are used for developing the tool.

It must be noted that the DAT was developed under CTT framework, the methodology which does not assume any probabilistic model for the population and without the efficiency or optimality of decision of selection / elimination of items. That is why one can not give guarantee for the relevance of selected items for a longer period. Hence this study suggests a thorough revision of all the items of each component of DAT in a most efficient way. In the next chapter we review the characteristics of DAT using IRT under the assumption two parameter of logistic model, where the item difficulty and item discrimination parameters are estimated in a most efficient way.

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

Chapter 3

IRT framework for Item Analysis

3.1 Introduction

As discussed in the previous chapter, in spite of its easiness and other advantages of using classical test theory method, it has many limitations (see Crocker and Algina). The nature of the classical methodology has no room for test developer to apply any kind of probabilistic model to the item responding behaviour of the examinee. As the method will not allow to find any sort of efficiency factor and hence different statistics may give different decisions or interpretations. The experimenter cannot justify which statistics is best and which is not.

Item Response Theory (IRT) is an area of test theory which provides probabilistic approach to overcome some of the limitations of classical methods. IRT is a statistical technique involving models expressing the probability of a particular response to a scale item as a function of the ability (more precisely *trait*) of the subject. IRT models are widely used in the preparation and standardisation of test items. For more basic discussion on IRT see Chang and Reeve (2005) Cohen and Swerdlik (2005) and Baker(2001).

In IRT the *term* trait means the characteristic of the subject to be measured, which is latent or unobservable. This variable is often something intuitively understood like intelligence. When one says somebody is highly intelligent or is very poor in intelligence the listener has some idea as to what the speaker is conveying. Although this type of variables are easily understood and one can list its characteristics , they cannot be measured directly as one can measure height or weight.

Kaplan and Saccuzzo (2001) defines trait as relatively enduring dispositions (tendencies to act, think or feel in a certain manner in any given circumstance) that distinguish one individual from another.

Guilford(1959) defines trait as any distinguishable, relatively enduring way in which one individual varies from another.

Although item response theory (IRT) methods have been in existence for over three decades, only recently have they begun to achieve widespread popularity in

Psychological assessment. One very practical reason for this belated popularity is the fact that IRT techniques tend to be far more computationally demanding than methods of test construction and scoring that are based on classical test theory.

In the fields of Education and Psychology, now IRT methods are increasingly being applied to personality, attitude, aptitude and similar inventories containing items that are scored in a dichotomous fashion, such as checklists and inventory-type items. Recently, increased attention has also been devoted to IRT models that are capable of analyzing items that are rated using either ordered-category scales such as Likert-type or unordered, nominal scales. Nowadays in Medical research also IRT technique is widely used (see Hays et al.,2000; Chang,2005; Mungas and Reed,2000 etc).

IRT method has many advantages over CTT based methods of test development and scoring. Consistent with its origins in tests of educational achievement and aptitude, IRT methods are already well known among educational researchers. Item response theories have gained popularity due to their promise to provide greater precision and control in measurement involving both achievement and attitude instruments (Henson, 1999). IRT has also achieved wide use among industrial and organisational Psychologists, in part due to its ability to quantify the degree to which tests exhibit consistent bias with respect to race, sex, age, or other demographic factors.

The objective of this chapter is to provide an overview of the most popular IRT models, and then illustrate the practical application of IRT methods in standardising the popular aptitude measurement tool, Differential Aptitude Tests. The chapter has been divided into ten sections. In Section 3.2 a brief history of item response theory has been presented. Section 3.3 intends to discuss the basic concepts from item response theory. Assumptions of Item response theory are described in Section 3.4. In Section 3.5 the parametric item response models are described. The Section 3.6 aims to give the estimation procedure in the presence of missing or incomplete data and EM algorithm. The computation of item parameters of some components of DAT has been presented in Section 3.7. Some recent studies on the application of IRT has been presented in Section 3.8 followed by a comparison of classical methods with item response theory methods in Section 3.9.

3.2 Brief History of IRT

Traditional approaches to measurement scales are based on averages or simple summation of the multiple items. In contrast, Item Response Theory models are founded on the probability that a person will make a particular response according to their level of the underlying latent variable . The implications of IRT are profound. In fact, some people believe that IRT was the most important development in Psychological testing in the second half of the 20th century (Kaplan and Saccuzzo, 2001).

The first work in item analysis in this direction is considered as Lord and Novicks (1968) classic work "Statistical Theories of Mental Test Scores". Like CTT, IRT is concerned with the measurement of theoretical constructs (e.g., aptitude or intelligence) that have no concrete reality. Consequently, the theoretical constructs have to be measured by analogy with something that is directly measured.

Even though the first work in IRT is that of Lord and Novik, the conceptual basis was developed by L. L. Thurstone (1925) in his paper, entitled "A Method of Scaling Psychological and Educational Tests". In it, he provides a technique for placing the items of the Binet and Simon test of children's mental development on an age-graded scale. Plots of the proportions of children in successive age cross-sections succeeding on successive tasks and the effective location of each item on chronological age reflect many of the features suggestive of IRT. Thurstone dropped his work in measurement to pursue the development of multiple factor analysis, but his colleagues and students continued to refine the theoretical bases of IRT. Richardson (1936) and Ferguson (1943) introduced the normal ogive model as a means to display the proportions correct for individual items as a function of normalized scores. Lawley (1943) extended the statistical analysis of the properties of the normal ogive curve and described maximum-likelihood estimation procedures for the item parameters and linear approximations to those estimates.

Lord (1952) introduced the idea of a latent trait or ability and differentiated this construct from observed test score. Lazarsfeld (1950) described the unobserved variable as accounting for the observed interrelationships among the item responses. Considered a milestone in psychometrics (Embretson & Reise, 2000), Lord and Novicks (1968) textbook entitled Statistical Theories of Mental Test Scores provides a rigorous and unified statistical treatment of classical test theory. The remaining half of the book, written by Allen Birnbaum, provides an equally solid description of the IRT models. Bock, and several student collaborators at the University of Chicago, including David Thissen, Eiji Muraki, Richard Gibbons, and Robert Mislevy developed effective estimation methods and computer programs such as Bilog, Multilog, Parscale, and Testfact. Along with Aitken, Bock developed the algorithm of marginal maximum likelihood method to estimate the item parameters that are used in many of these IRT programs.

Nowadays IRT techniques are widely used by test developers , medical researchers, Psychologists and many others. Some statistical software are having the facility to compute the item parameters of IRT models.

3.3 Basics of Item Response Theory

While classical test theory was derived from the assumption that a persons score on an assessment is merely the empirical sum of its parts, proponents of IRT believe that assessments measure an underlying trait. Using IRT, conclusions can be drawn about the nature of this underlying trait and how well the items measure this trait. In other words, each set of items is only a sample of all possible items in the universe that could be used to assess the underlying trait that Psychologists seek to measure.

With item response theory the test developer assumes that the responses to the items on a test can be accounted for by latent traits. Indeed most applications of the theory assume that a single latent trait account for the response to items on a test (Crocker and Algina, 1986). Generally trait is a single entity or a multiple entity. But in practical situations it is considered as a single trait and is measured through a test.

A latent trait refers to a statistical construct; there is no implication that it is a

Psychological or Physiological entity with an independent existence. In cognitive tests, the latent trait is generally called the ability measured by the test (Anastasi and Urbina, 2004).

Let θ denote the latent trait to be measured based on a test which consists of a finite number of items. People at higher levels of θ have a higher probability of responding correctly to an item. Obviously, as θ is a latent construct, it cannot be directly observed or measured, and thus tests do not measure it in an absolute sense, like a ruler measures length. Instead, what can be determined is relative positions of individual test takers on the θ continuum.

Let Θ be the latent trait of a randomly selected examinee from the population. Note that Θ is a random variable, but not directly observable. Suppose we have a test tool consists of J items to measure the latent trait of individuals in the population. Let Y_j be the response to the j^{th} item of a randomly selected examinee, which is an observable random variable, that supposed to be contains information about his inherent trait θ. If the j^{th} item has L_j possible answers, coded as $0, 1, \ldots, L_{J-1}$, then the random variable take values $0, 1, \ldots, L_{J-1}$. Under the assumption that the examinee gets the answer mainly due to his inherent trait, the distribution Y_i is

$$P[Y_i = k \mid \Theta = \theta] \quad = \quad p_i(k;\theta), \quad k = 0, 1, \ldots L_{j-1},$$

$$i = 1, 2, \ldots, J$$

$$\text{where } p_i(k;\theta) \geq 0 \text{ and } \sum_{k=0}^{L_{j-1}} p_i(k;\theta) = 1 \qquad (3.1)$$

If $L_j = 2$, the item is called dichotomous item, otherwise they are called polytomous items.

In the case of dichotomous, we take $p_i(1;\theta) = p_i(\theta)$ and $p_i(0;\theta) = q_i(\theta)$.

, i.e.,

$$P[Y_i = 1 \mid \Theta = \theta] = p_i(\theta), \qquad (3.2)$$

$$P[Y_i = 0 \mid \Theta = \theta] = q_i(\theta), \qquad (3.3)$$

$$p_i(\theta) + q_i(\theta) = 1, i = 1, 2, \ldots J$$

The present study focuses only on dichotomous items and hence the above notation are used in entire discussion

3.3.1 Item Characteristics Curve (ICC)

In item response theory approach, for each item on test there will be a curve which characterises the nature of responding to an item, which is known as Item Characteristic Curve (ICC). It describes the probability of getting each particular item right given the ability level of each test taker. Baker (2001) treats the ICC as the basic building block of items response theory; all the other constructs of the

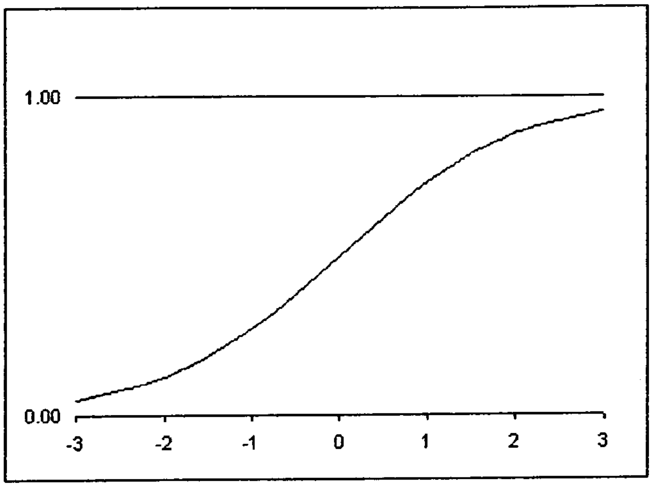

Figure 3.1: Item Characteristic Curve

theory depend upon this curve (Baker, 2001). Croker and Algina (1986) considers ICC as the central concept of IRT.

Let θ be the latent trait and $p_i(\theta)$ be the probability that an examinee with trait θ will give a correct answer to the items i, then $p_i(\theta)$ can be plotted as a function of θ and the resulting s-shaped curve will give Item Characteristic Curve. i. e. the ICC of i^{th} item is the graph of $p_i(\theta)$ versus θ. A typical ICC is given in figure 3.1. Here θ is represented on X- axis and $p_i(\theta)$ is represented on Y- axis.

Since $p_i(\theta)$ increases with θ and has values range from 0 to 1, $p_i(\theta)$ can be assumed to have the nature of cumulative distribution function (cdf) with asymptotic, in the sense that $p_i(\theta)$ never touches its lower and upper ends; i.e., no person has either no ability or complete ability to bring to bear on a given item (Henson, 1999). Baker(2001) point out the two technical properties of an ICC that are used to describe it as item difficulty and item discrimination.

3.3.2 Item difficulty parameter

In all IRT models it involves certain number of parameters. These parameters has its own physical importance for making decision on items. In IRT the difficulty of an item describes where the item functions along the ability scale. For example an easy item functions among the low ability examinees and a hard item functions among the high ability examinees. This means that difficulty can be considered as a location index. It analogous with the item difficulty index defined in classical approach, that indicates the proportion of numbers of examinees who get an item correct to the total number of examinees. Usually the item difficulty parameter is denoted as b_j for j^{th} item.

In an ICC, parameter b_j defines the location of the curve's inflection point along the x-axis. If a two parameter logistic model is considered for $p_i(\theta)$ as in equation 3.2 as

$$p_{ij}(\theta) = P[Y_{ij} = 1 \mid \Theta = \theta] = \left[\frac{1}{1 + e^{-a_j(\theta - b_j))}}\right]$$

the parameter b_j stands for item difficulty index of an item j. The figure 3.2 gives ICC of a 2PL model for different values of b_j. Lower the value of b_j will shifts the curve left and higher the value of b_j will shifts the curve right. The b_j does not effect the shape of the curve.

When $b_j = 0$, the probability of correct response to an item is 0.5 for those individual have their trait as 0. If b_j is greater than zero it indicates that the item is more easy and if b_j is less than zero it indicates the item is more harder. One has to choose items with a desirable level of item difficulty. The graph shows that items with difficulty index near to 0 will give more information on latent trait. Generally one can choose an item with difficulty index lies between -0.5 and 0.5.

3.3.3 Item discrimination parameter

The item discrimination indicates the extent to which success on an item corresponds to success on the whole test. It describes how well an item can differentiate between examinees having the trait below the item location and those having the trait above the item location. In ICC the item discrimination property essentially reflects the steepness of the curve in its middle section. The steeper the curve the

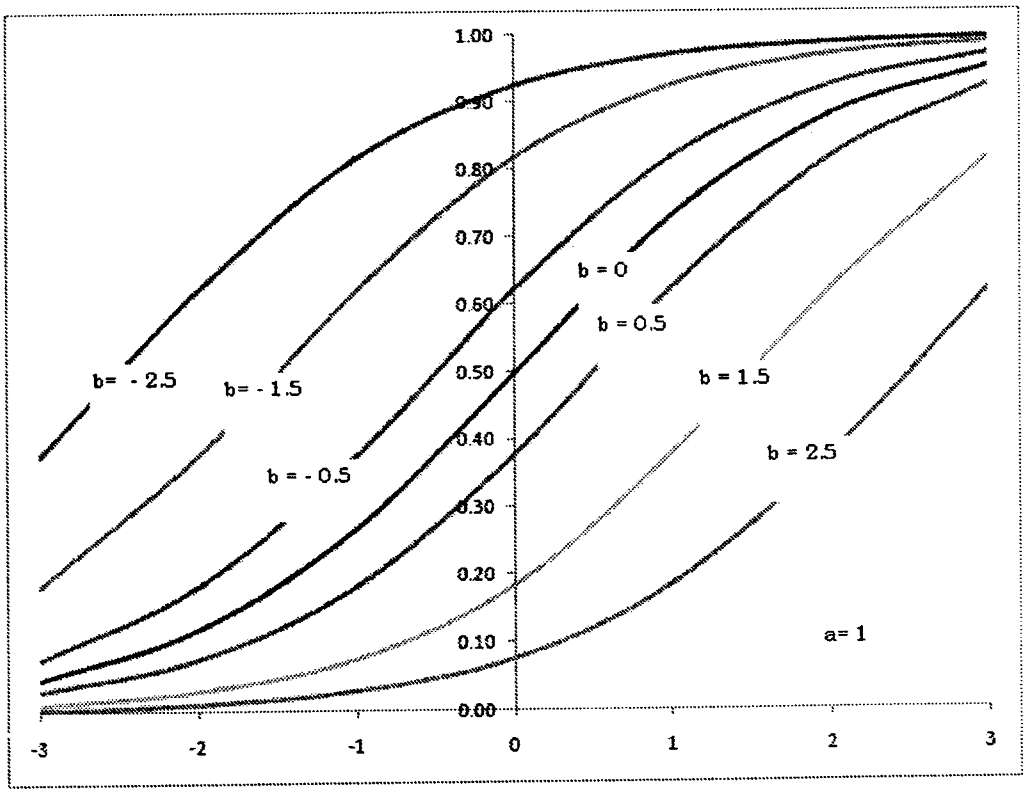

Figure 3.2: ICC for different b-values

better the item can discriminate.

In the case of two parameter logistic model is considered for $p_i(\theta)$ as in equation 3.2 as

$$\mathrm{p}_i(\theta) \quad = \quad P[Y_i = 1 \mid \Theta = \theta] \;=\; \left[\frac{1}{1 + \mathrm{e}^{-a_j(\theta - b_j))}}\right]$$

the parameter a_j stands for item discrimination index for an item j. The figure 3.3 gives ICC of a 2PL model for different values of a_j.

From the curve one can see that the change in the values of a_j changes the shape of the item response function and does not change its location. Also it is noted that higher values of a_j will give more information on item j that item .

Normally the value of a_j will be positive. If a_j is negative it results in a monotonically decreasing item response function (Rudner, 1998). It means that people having higher θ will have lower probability of correctly responding to item and people having lower θ will have higher probability to answer the item correctly.

Theoretically items with higher values of a is thought to be better items. But if the value of very high as Masters (1988) pointed out, it can be a symptom of a special kind of measurement disturbance introduced by that item that gives persons of high ability a special advantage over and above their higher abilities. Generally an item with the value of $0.75 \leq a_j \leq 1.75$ will be accepted to the final

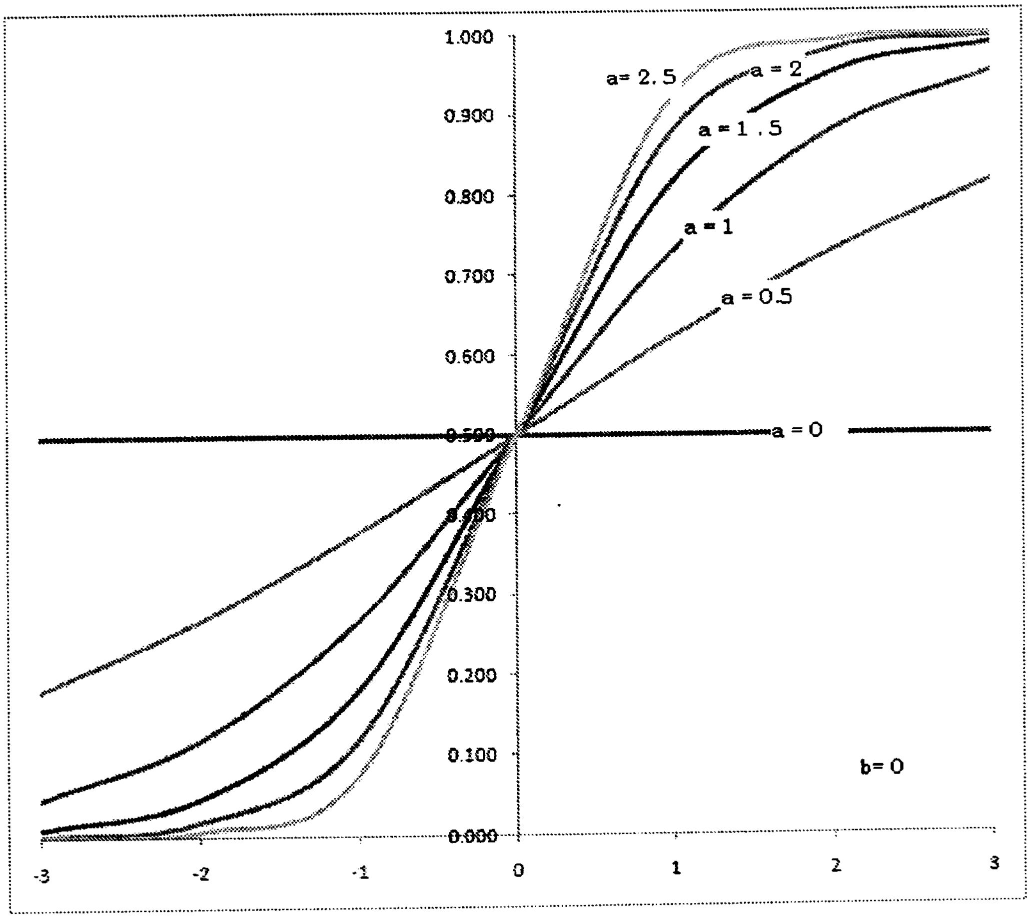

Figure 3.3: ICC for different a-values

test tool.

3.4 Assumptions of IRT

Like all probabilistic models, item response theory models are also based on some basic assumptions. The fundamental assumptions in IRT are (i) unidimensionality (ii) local independence and (iii) monotonicity . The assumption of unidimensionality says that only one single latent trait influences the response probabilities. Local independence means that the response probabilities of different items are independent of each other given a position on the latent trait. The assumption of monotonicity deals with the shape of the item response function. Monotonicity supposes that the item response function is non-decreasing in the latent trait. These three assumptions together ensure that the total score on a test can be used to rank order subjects in accordance with their positions on the latent trait. (Groningen, 2004).

3.4.1 Assumption 1: Unidimensionality

One core assumption of IRT is the assumption of unidimensionality (UD). It states that only one latent dimension is needed to explain the item response probabilities.

Unidimensional IRT models have been developed for scales that are intends to measure a single domain or trait and multidimensional IRT models are developed to measure multiple correlated domain simultaneously (Chang and Reeve, 2005).

The unidimensionality question is a prime example of sound theory being a prerequisite for good Psychometric practice. Conceptualizing latent unidimensionality, as must be done, requires one to step back and ask the foundational question of how best to define latent unidimensionality (Stout, 2002).

A more general mathematical definition for unidimensionality is given by Stout (2002) as follows:

Definition : A test $U' = (U_1, U_2, U_3..........U_n)$ with specified manifest distribution $P(U = u)$ is said to be unidimensional if there exists a unidimensional random variable Θ with density denoted by $f(\theta)$ such that for all possible response patterns u

$$\mathrm{P}[U = u] = \int_{-\infty}^{+\infty} P[U = u \mid \Theta = \theta] f(\theta) d\theta \tag{3.4}$$

This indicates that for a given $\Theta = \theta$, distribution of U is completely known. In other words all the items measure the same construct θ.

3.4.2 Assumption 2: Local Independence

The second assumption of IRT is local independence. Assumption Local Independence requires that responses to several items are independent given the position of the subject on the latent trait. If items are to have statistics that are attributable to the item across samples, then each of the items must be answered independently from the other items (Hambleton and Swaminathan, 1985).This means that one item must not contain information that can contribute to the response of other items.

Stout(2002) defines locally independence as:

Definition : A test U is said to be locally independent with respect to latent variable Θ if for all u and θ

$$\mathrm{P}[U = u \mid \Theta = \theta] = \prod_{i=1}^{n} P[U_i = u_i \mid \Theta = \theta] \tag{3.5}$$

It indicates that the only relationship among the items is explained by the conditional relationship with the latent variable θ. In other words local independence means that if the trait level is held constant, there should be no association among the item responses.

3.4.3 Assumption 3: Monotonicity

Assumption Monotonicity states that the item response probabilities are non-decreasing in the latent trait. Trivially the concept of monotonicity is logical in the sense that higher the value of θ higher the chances of endorsing correctly. By this assumption one can model $p(\theta)$ using a distribution function. The characteristics of the distributions will reflect on the characteristics of item response. For example, if F is a known standard distribution function, then a suitable two parameter model is $F(a\,(\theta - b))$, which is well known location-scale family. In most of the cases a is the discriminating parameter and b is the difficulty index

By this assumption one can model the item response using a known distribution function of θ. The characteristics of the distributions will reflect on the characteristics of item responses.

3.5 Parametric Item Response Models

IRT models differ in the functional form of the item characteristic curves to handle different item response forms. A suitable function can be chosen from known distribution functions as

$$\mathrm{p}_i(\theta) \;=\; G[\theta; \Delta]$$

where G is a distribution function with known form in θ with asymptotes at 0 and 1. i.e the distribution function G is a completely known for known values of Δ and Δ is called item parametric vector. The characteristics of G is fully described by the nature of Δ.

For example if we denote Φ as the distribution function of a standard normal variate, then $p_i(\theta)$ can be model as

$$p_i(\theta) = \Phi\left(\frac{\theta - b}{a}\right)$$

where b and a are considered to as item parameters; b is the item difficulty and a is the item discrimination. In general if we model with a location-scale family distribution function, the parameters can be interpreted like this.

Table 3.1 presents seven common IRT models with potential application to Educational and health-related research. The table also indicates if the model is appropriate for dichotomous and polytomous responses, and some characteristics associated with each model.

TABLE 3.1

Frequently used IRT models

Model	Item Response Format	Model Characteristics
One Parameter Logistic	Dichotomous	Includes difficulty parameter only
Two Parameter Logistic	Dichotomous	includes discrimination and difficulty parameters
Three Parameter Logistic	Dichotomous	Includes pseudo-guessing parameter.
Graded Model	Polytomous	Ordered responses Discrimination varies
Partial Credit Model	Polytomous	Discrimination power constrained to be equal

3.5.1 The One-Parameter Logistic (1PL) Model

The one-parameter logistic model was the first one in these types of models. It is used when the responses are dichotomous in its nature. It is also referred to as the simple logistic model. As its name indicates, it presumes that only a single item parameter is necessary to represent the item response. The parameter involved here is termed as item difficulty and is denoted by b_j for j^{th} item. The model assumes that the items are all equal in discrimination and that guessing factor does not influence the response. The mathematical form of the model is

$$p_{ij}(\theta) \;=\; P[Y_{ij} = 1 \mid \Theta = \theta] = \left[\frac{1}{1 + e^{-(\theta - b_j))}}\right] \tag{3.6}$$

where θ is the latent variable and b_j is the parameter, known as item difficulty. The one-parameter Rasch model estimates the item difficulty parameter. The item difficulty parameter is the point on θ where 50 % of probability of answering the item correctly.

3.5.2 The Two Parameter Logistic (2PL) Model

The two-parameter logistic model (2PL) is also used in the situations where item responses are dichotomous. It allows the slope or discrimination parameter a to vary across items instead of being constrained to be equal as in the one-parameter logistic or Rasch model. The relative importance of the difference between a persons trait level and item threshold is determined by the magnitude of the discriminating power of the item (Embretson & Reise, 2000). The two-parameter logistic model trace line for the probability of a positive response to item j for a person with latent trait level θ is:

$$p_{ij}(\theta) = P[Y_{ij} = 1 \mid \Theta = \theta] = \left[\frac{1}{1 + e^{-a_j(\theta - b_j))}}\right] \tag{3.7}$$

The two-parameter Rasch model consists two parameters viz. the item difficulty parameter b_j and item discrimination parameter a_j.

3.5.3 The Three Parameter Logistic (3PL) Model

The three-parameter logistic model (3PL) was developed in Educational testing to extend the application of item response theory to multiple-choice items that may elicit guessing. It is also used when responses are dichotomous. For item i, the three-parameter logistic trace line is:

$$p_{ij}(\theta) = P[Y_{ij} = 1 \mid \Theta = \theta] = c_j + \left[\frac{1 - c_j}{1 + e^{-a_j(\theta - b_j))}}\right]$$

The guessing parameter c_j is the probability of a positive response to item j even if the person does not know the answer. When $c_j = 0$, the three-parameter model is equivalent to the 2-PL model.

3.5.4 The Graded Model

There are many situations where instead of two responses as right or wrong, responses are graded on a range of scores. For example,just like in Likert type scales, the response to a question like what you think about the statement 'Indians work hard when they are placed in abroad' may be 'I agree to the statement' , 'I am neutral to this statement' or 'I disagree with the statement' .Here one can grade the responses with values 0, 1, 2 or -1, 0, 1. In some other situations we may have to give grades from poor (=0) to excellent (=5).

For these types of graded or ordered response items Samejima (1969) proposed a model which is based on the logistic function giving the probability that an item response will be observed in category k or higher. For ordered responses $u = k$, $k = 1, 2, 3, ..., m$, where response m reflects the highest θ value, the graded model ICC is

$$p_i(\theta) \;=\; P[Y_i = k \mid \Theta = \theta] \;= \left[\frac{1}{1 + e^{-a_j(\theta - b_{jk})}}\right] - \left[\frac{1}{1 + e^{-a_j(\theta - b_{jk+1}))}}\right]$$

3.5.5 The Partial Credit Model

For items with two or more ordered responses, Masters (1982) created the partial credit model within the Rasch model framework. The partial credit model contains two sets of location parameters, one for persons and one for items, on an underlying unidimensional construct. The partial credit model is a simple adaptation of Rasch's model for dichotomies. The model follows that from the intended order $0 \leq 1 \leq 2 \leq .... \leq m$ of a set of categories, the conditional probability of scoring x rather than $x-1$ on an item should increase monotonically throughout the latent variable range. For the partial credit model, the expectation for person j scoring in category x over $4-1$ for item i is modeled:

$$\mathrm{p}_i(\theta) = P[Y_i = 1 \mid \Theta = \theta] = \left[\frac{\mathrm{e}^{\theta_j-\delta_{jx}}}{1+e^{\theta_j-\delta_{jx}}}\right]$$

Thus, the probability of a respondent j endorsing category x for item i is a function of the difference between their level on the underlying trait and the step difficulty. The Generalized Partial Credit Model is a generalization of the Partial Credit Model that allows the discrimination parameter to vary among the items.

3.6 Estimation of parameters in the presence of missing or incomplete data and EM Algorithm

In Statistics literature there are lots of situations where the complete data is not available. Several methods are available to tackle this situation. We can see that in our problem of estimating the item response parameters, the latent trait of an examinee is not observable. What observable is the response to each item.

Let Y_{ij} be the random response of i^{th} examinee for j^{th} item, $i = 1, 2, \ldots n$ and $j = 1, 2, \ldots J$.

If the j^{th} item is dichotamised, then Y_{ij} is binary and if it is polytomous with $L_j(\geq 3)$ values, then Y_{ij} takes the values $0, 1, \ldots, L_{j-1}$

$$\mathbf{Y} = \begin{pmatrix} \mathbf{Y}_1 \\ \mathbf{Y}_2 \\ \vdots \\ \mathbf{Y}_n \end{pmatrix}, \text{where } \mathbf{Y}_i = \begin{pmatrix} Y_{i1} & Y_{i2} & \cdots & Y_{iJ} \end{pmatrix} \tag{3.8}$$

Associated with the item j, suppose there are ν_j parameters represented by a vector $\delta_j = (\delta_1, \delta_2, \ldots, \delta_{\nu_j})$, $j = 1, 2, \ldots, J$ and let $\mathbf{\Delta} = [\delta_1, \delta_2, \ldots, \delta_J]$. Naturally if the number of item response categories is the same for every item, then we can assume that $\nu_j = \nu$, for all j.

For i^{th} examinee, let $\mathbf{y}_i$ be the observed value of $\mathbf{Y}_i$ and let θ_i be the corresponding latent trait. Then the vector realisation is $[\mathbf{Y}_{n\times j} \;\; \theta_{n\times 1}]_{n\times(J+1)}$; the first component $\mathbf{Y}_{n\times j}$ is observed but second component $\theta_{n\times 1}$ is unobserved. The joint likelihood of $[\mathbf{Y}_{n\times j} \;\; \theta_{n\times 1}]_{n\times(J+1)}$ at the point $(\mathbf{y}, \theta)$, assuming $(\mathbf{Y}_i, \Theta_i)$'s are independent, is

$$L_c((\mathbf{y}, \theta); (\mathbf{\Delta}, \pi)) = \prod_{i=1}^{n} f_{\mathbf{Y}_i, \theta_i}(\mathbf{y}_i, \theta_i; \mathbf{\Delta}), \tag{3.9}$$

where $f_{\mathbf{Y}_i, \theta_i}$ be the joint pdf of $(\mathbf{Y}_i, \theta_i)$, which naturally depend on the chosen distribution of Θ, π. Let $\pi(\theta)$ be the pdf of Θ. Then L_c is depend on the chosen values of $(\mathbf{\Delta}, \pi)$. The likelihood of observed response is

$$L_m(\mathbf{y}_i \mid \theta_i; \mathbf{\Delta}) = \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta_i}(\mathbf{y}_i \mid \theta_i, \mathbf{\Delta}), \tag{3.10}$$

where

$$f_{\mathbf{Y}_i|\theta_i}(\mathbf{y}_i \mid \theta_i, \mathbf{\Delta}) = \frac{f_{\mathbf{Y}_i,\theta_i}(\mathbf{y}_i, \theta_i \mid \mathbf{\Delta})}{\pi(\theta_i)} \tag{3.11}$$

and $\pi(\theta_i)$ is the pdf of Θ at θ_i. Now L_c can be written as

$$L_c((\mathbf{y}, \theta); (\mathbf{\Delta}, \pi)) = \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta_i}(\mathbf{y}_i \mid \theta_i, \mathbf{\Delta})\pi(\theta_i), \tag{3.12}$$

Taking marginal of L_c with respect to θ, we get the likelihood of the observed responses as

$$L_0((\mathbf{y}; (\mathbf{\Delta}, \pi)) = \begin{cases} \int_{-\infty}^{\infty} \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid \theta, \mathbf{\Delta})\pi(\theta)d\theta & \text{if } \theta \text{ is continuous} \\ \sum_{i=1}^{K} \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \mathbf{\Delta})\pi_k & \text{if } \theta \text{ is discrete with } K \text{ values, } q_1, q_2, \ldots, q_K \end{cases} \tag{3.13}$$

where $\pi_k = \mathrm{P}[\Theta = q_k]$.

Consider the complete likelihood given in (3.12)

$$L_c((\mathbf{y}_i, \theta_i); (\mathbf{\Delta}, \pi))) = \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta_i}(\mathbf{y}_i \mid \theta_i, \mathbf{\Delta})\pi(\theta_i), \tag{3.14}$$

Suppose Θ is discrete with probability distribution given by

$$\pi_k = \mathrm{P}[\Theta = q_k], \quad k = 1, 2, \ldots K, \text{ and } q_k\text{'s are real numbers} \tag{3.15}$$

Then L_c becomes

$$L_c(\mathbf{Y}_i, q_k) = \prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \mathbf{\Delta})\pi_k, \quad k = 1, 2, \ldots K. \tag{3.16}$$

The EM algorithm is a very general iterative algorithm for parameter estimation by maximum likelihood when some of the random variables involved are not observed i.e., considered missing or incomplete. The term EM was introduced in Dempster et al.(1977).

The EM algorithm formalizes an intuitive idea for obtaining parameter estimates when some of the data are missing. The steps involved in the algorithm are:

i. Replace missing values by estimated values,

ii. Estimate parameters.

iii. Repeat step (i) using estimated parameter values as true values, and step (ii) using estimated values as "observed" values, iterating until convergence.

The general EM algorithm generates a sequence of estimates $(\Delta^{(s)}, \pi^{(s)})$, for $s = 1, 2, \ldots,$ starting with initial values $(\Delta^{(0)}, \pi^{(0)})$ and which is usually arbitrarily assigned. There are two steps in each iteration

1. **The E-Step**: In this step the conditional expectation of the complete likelihood, L_c, with respect to the conditional distribution of Θ given $\mathbf{Y} = \mathbf{y}$

with the current value of $(\boldsymbol{\Delta}, \pi)$ as $(\boldsymbol{\Delta}^{(s)}, \pi^{(s)})$ the parameters. Using (3.16),

$$
\begin{aligned}
Q &= Q[(\boldsymbol{\Delta}, \pi) \mid (\boldsymbol{\Delta}^{(s)}, \pi^{(s)})] \\
&= E_{\boldsymbol{\Theta}|\mathbf{Y}=\mathbf{y}}[L_c((\mathbf{y}, \theta); (\boldsymbol{\Delta}, \pi))] \\
&= E_{\boldsymbol{\Theta}|\mathbf{Y}=\mathbf{y}}\left[\log\left\{\prod_{i=1}^{n} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid \Theta_i; \boldsymbol{\Delta})\pi(\Theta_i)\right\}\right] \\
&= E_{\boldsymbol{\Theta}|\mathbf{Y}=\mathbf{y}}\left[\sum_{i=1}^{n}\log\left\{f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid \Theta_i; \boldsymbol{\Delta})\pi(\Theta_i)\right\}\right] \\
&= \sum_{i=1}^{n} E_{\boldsymbol{\Theta}_i|\mathbf{Y}=\mathbf{y}}\left[\log\left\{f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid \Theta_i; \boldsymbol{\Delta})\pi(\Theta_i)\right\}\right] \\
&= \sum_{i=1}^{n}\sum_{k=1}^{K}\left[\log\left\{f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta})\pi(q_k)\right\}\right] \mathrm{P}_{(\boldsymbol{\Delta}^{(s)},\pi^{(s)})}[\Theta_i = q_k \mid \mathbf{Y} = \mathbf{y}] \\
&= \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}\log\left[f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta})\pi_k\right] f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}\right\} \\
&= \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}\left[\log f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}) + \log\pi_k\right] f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}\right\} \\
&= \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}\left[\log f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \boldsymbol{\Delta})\right] f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}\right\} \\
&\qquad + \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}[\log\pi_k]\, f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k, \boldsymbol{\Delta}^{(s)})\pi_k^{(s)}}\right\} \\
&= \phi[\boldsymbol{\Delta}; (\boldsymbol{\Delta}^{(s)}, \pi_k^{(s)})] + \psi[\pi; (\boldsymbol{\Delta}^{(s)}, \pi_k^{(s)})],
\end{aligned}
\tag{3.17}
$$

where

$$\phi[\Delta;(\Delta^{(s)},\pi_k^{(s)})] = \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}\left[\log f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k;\Delta)\right] f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k;\Delta^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k;\Delta^{(s)})\pi_k^{(s)}}\right\} \tag{3.18}$$

and

$$\psi[\pi;(\Delta^{(s)},\pi_k^{(s)})] = \sum_{i=1}^{n}\left\{\frac{\sum_{k=1}^{K}[\log \pi_k]\, f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k;\Delta^{(s)})\pi_k^{(s)}}{\sum_{k=1}^{K} f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k;\Delta^{(s)})\pi_k^{(s)}}\right\} \tag{3.19}$$

2. **The M-Step**

Now to maximize $Q[(\Delta,\pi) \mid (\Delta^{(s)},\pi^{(s)})]$ it is sufficient to maximize

$\phi[\Delta;(\Delta^{(s)},\pi_k^{(s)})]$ and $\psi[\pi;(\Delta^{(s)},\pi_k^{(s)})]$

Thus the M-step of E-M algorithm includes two parts (i) Find the value of Δ that maximize $\phi[\Delta]$ and (ii) Find the value of π which maximizes $\psi[\pi]$.

In the present study EM algorithm has been used to estimate the parameters in a two-parameter logistic IRT model.

3.6.1 Estimation of parameters in 2PL Model

Two parameter logist model is given by

$$\mathrm{p}_i(\theta) \;=\; P[Y_i = 1 \mid \Theta = \theta] = \left[\frac{1}{1 + \mathrm{e}^{-a_j(\theta - b_j))}}\right] \tag{3.20}$$

or

$$\mathrm{p}_i(\theta) \;=\; \left[\frac{\mathrm{e}^{a_j(q_k - b_j)}}{1 + \mathrm{e}^{a_j(q_k - b_j))}}\right] \tag{3.21}$$

Let Y_{ij} be the response of i^{th} examinee to j^{th} item. Then the probability mass function is given by

$$f_{Y_{ij}|\theta_j}(y_{ij} \mid q_k; (a_j, b_j)) = \left[\frac{\mathrm{e}^{a_j(q_k - b_j)}}{1 + \mathrm{e}^{a_j(q_k - b_j))}}\right]^{y_{ij}} \left[\frac{1}{1 + \mathrm{e}^{a_j(q_k - b_j))}}\right]^{1 - y_{ij}} \tag{3.22}$$

$$f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; (\mathbf{a}, \mathbf{b})) = \prod_{j=1}^{J} \left[\frac{\mathrm{e}^{a_j(q_k - b_j)}}{1 + \mathrm{e}^{a_j(q_k - b_j))}}\right]^{y_{ij}} \prod_{j=1}^{J} \left[\frac{1}{1 + \mathrm{e}^{a_j(q_k - b_j))}}\right]^{1 - y_{ij}} \tag{3.23}$$

$$\begin{aligned}
\log\left[f_{Y_{ij}|\theta_j}(y_{ij} \mid q_k, (a, b))\right] &= y_{ij} \log\left[\frac{\mathrm{e}^{a_j(q_k - b_j)}}{1 + \mathrm{e}^{a_j(q_k - b_j)}}\right] + (1 - y_{ij}) \log\left[\frac{1}{1 + \mathrm{e}^{a_j(q_k - b_j)}}\right] \\
&= y_{ij} \log\left[\mathrm{e}^{a_j(q_k - b_j)}\right] - \log\left[1 + \mathrm{e}^{a_j(q_k - b_j)}\right] \\
&= y_{ij}\left[a_j(q_k - b_j)\right] - \log\left[1 + \mathrm{e}^{a_j(q_k - b_j)}\right] \qquad (3.24)
\end{aligned}$$

$$\log f_{\mathbf{Y}_i|\theta}(\mathbf{y}_i \mid q_k; (\mathbf{a}, \mathbf{b})) = \sum_{j=1}^{J} y_{ij}\left[a_j(q_k - b_j)\right] - \sum_{j=1}^{J} \log\left[1 + \mathrm{e}^{a_j(q_k - b_j)}\right] \tag{3.25}$$

The expression as in equation 3.18 for $\phi = \phi[(a,b);(a^{(s)},b^{(s)}),\pi_k^{(s)})]$ function is

$$\phi = \sum_{i=1}^{n} \left\{ \frac{\sum_{k=1}^{K} \left\{ \sum_{j=1}^{J} y_{ij}\left[a_j(q_k - b_j)\right] - \sum_{j=1}^{J} \log\left[1 + \mathrm{e}^{a_j(q_k - b_j)}\right] \right\} \pi_k^{(s)} \prod_{j=1}^{J} A_{kj}^{(s)}(y_{ij})}{\sum_{k=1}^{K} \pi_k^{(s)} \prod_{j=1}^{J} A_{kj}^{(s)}(y_{ij})} \right\} \tag{3.26}$$

where

$$A_{kj}^{(s)}(y_{ij}) = \left[\frac{\mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)})}}{1 + \mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)}))}}\right]^{y_{ij}} \left[\frac{1}{1 + \mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)}))}}\right]^{1-y_{ij}} \tag{3.27}$$

i.e.,

$$A_{kj}^{(s)}(y_{ij}) = \begin{cases} \dfrac{\mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)})}}{1 + \mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)}))}} & \text{for } y_{ij} = 1 \\ \dfrac{1}{1 + \mathrm{e}^{a_j^{(s)}(q_k - b_j^{(s)}))}} & \text{for } y_{ij} = 0 \end{cases} \tag{3.28}$$

The expression of ϕ given in (3.26) can again be simplified in to

$$\phi[(a,b);(a^{(s)},b^{(s)}),\pi_k^{(s)})] = \sum_{k=1}^{K} \left\{ \sum_{j=1}^{J} \nu_{jk}^{(s)} \left[a_j(q_k - b_j)\right] - \rho_k^{(s)} \sum_{j=1}^{J} \log\left[1 + \mathrm{e}^{a_j(q_k - b_j)}\right] \right\} \tag{3.29}$$

where

$$\nu_{jk}^{(s)} = \sum_{i=1}^{n} y_{ij} P_{ki}^{(s)} \tag{3.30}$$

$$\rho_k^{(s)} = \sum_{i=1}^{n} P_{ki}^{(s)}, \tag{3.31}$$

and

$$P_{ki}^{(s)} = \frac{\pi_k^{(s)} \prod_{j=1}^{J} A_{kj}^{(s)}(y_{ij})}{\sum_{k=1}^{K} \pi_k^{(s)} \prod_{j=1}^{J} A_{kj}^{(s)}(y_{ij})} \tag{3.32}$$

With the above notations we directly get the ψ function as

$$\psi[\pi;(\boldsymbol{\Delta}^{(s)},\pi_k^{(s)})]=\sum_{k=1}^{K}\rho_k^{(s)}\log\pi_k \tag{3.33}$$

For maximisation of ϕ with respect to a_j, the normal equation is

$$\frac{\partial\phi}{\partial a_j}=0\Longrightarrow\sum_{i=1}^{n}y_{ij}Q^{(s)}(y_{ij})-b_jy_{\cdot j}=\sum_{k=1}^{K}\rho_k^{(s)}q_k\left\{\frac{e^{a_j(q_k-b_j)}}{1+e^{a_j(q_k-b_j)}}\right\} \tag{3.34}$$

For maximisation of ϕ with respect to b_j, the normal equation is

$$\frac{\partial\phi}{\partial b_j}=0\Longrightarrow a_jy_{\cdot j}=\sum_{k=1}^{K}\rho_k^{(s)}\left\{\frac{e^{a_j(q_k-b_j)}}{1+e^{a_j(q_k-b_j)}}\right\}, \tag{3.35}$$

where

$$\begin{aligned} Q^{(s)}(y_{ij}) &= \sum_{k=1}^{K}q_kP_{ki}^{(s)}\left(=E[\Theta\mid\mathbf{Y}_j=\mathbf{y}_j],\text{with }(a_j,b_j)=(a_j^{(s)},b_j^{(s)})\right)\\ \text{and}\qquad y_{\cdot j} &= \sum_{i=1}^{n}y_{ij}. \end{aligned} \tag{3.36}$$

The maximisation of ψ with respect to π_k such that $\sum_{k=1}^{K}\pi_k=1$ directly gives the solution

$$\pi_k=\lambda\rho_k^{(s)},\quad\text{where }\lambda=\left\{\sum_{k=1}^{K}\rho_k^{(s)}\right\}^{-1}. \tag{3.37}$$

Starting with initial values $(a_j^{(0)},b_j^{(0)})$, solve the simultaneous equations (3.34) and (3.35) for new solution $(a_j^{(s+1)},b_j^{(s+1)})$, using the current solution $(a_j^{(s)},b_j^{(s)})$; and starting $\pi_k^{(0)}$ get new solution $\pi_k^{(s+1)}$ from (3.37) using the current solution $\pi_k^{(s)}$, until the solutions converge.

3.7 Estimation of Item parameters of DAT

The next phase of the study is estimation of item parameters a and b of 2PL IRT model as described in the previous section. In this section the results of the computation made for estimation has been presented. The programme was written in MATLAB. The programme code has been presented in the appendix. The item parameters were computed for each of the components viz. Abstract Reasoning(AR), Numerical Ability (NA), Mechanical Reasoning (MR) and Spelling (S) components.

3.7.1 Item parameters of AR component of DAT

The Table 3.2 gives the estimated values for item parameters of abstract component of DAT. a_j stands for item discrimination parameter and b_j stands of item difficulty parameter.

TABLE 3.2

Table showing the item parameters a_j and b_j of AR (N= 1407).

Item	a_j	b_j	Item	a_j	b_j
1	0.7326	-0.1577	26	1.1227	0.1380
2	1.2238	0.0595	27	1.3234	-0.0287
3	0.8551	-0.1690	28	0.7636	-0.1081
4	0.9749	-0.1066	29	1.0605	-0.0613
5	0.8737	-0.1400	30	1.2083	0.1249
6	1.1641	0.0075	31	1.7284	0.6755
7	1.1348	-0.0267	32	1.2696	0.1169
8	1.0075	-0.1375	33	1.8215	0.6898
9	1.4116	0.1975	34	1.0816	-0.0063
10	1.0171	-0.0806	35	1.3720	0.3180
11	1.3780	0.2319	36	1.5565	0.3473
12	0.7987	-0.1464	37	1.5173	0.1091
13	1.0414	-0.0036	38	1.7091	0.2776
14	1.1034	-0.0116	39	1.7220	0.6424
15	1.2308	0.0879	40	0.8107	-0.0437

TABLE 3.2 (Cont.)

Item	a_j	b_j	Item	a_j	b_j
16	0.8579	-0.1615	41	1.8632	0.4484
17	1.0670	-0.0805	42	1.3024	0.1501
18	0.9253	-0.0477	43	1.3609	0.3110
19	1.1157	-0.0404	44	1.3393	0.2140
20	0.9357	-0.0471	45	1.8317	0.4385
21	1.4560	0.3561	46	1.3425	-0.0381
22	1.5095	0.4086	47	1.3568	0.1287
23	0.9442	0.1011	48	2.0128	0.4196
24	1.1930	0.1173	49	1.9983	0.6803
25	1.0449	-0.0290	50	1.8900	0.3695

If items with $0.75 \leq a_j \leq 1.75$ and $-0.50 \leq b_j \leq 0.50$ are selected for final test tool, the items 1, 31, 33, 39, 41, 45, 48, 49, and 50 are to be eliminated from the test tool.

3.7.2 Item parameters of NA component of DAT

The Table 3.3 gives the estimated values for item parameters of numerical component of DAT. a_j stands for item discrimination parameter and b_j stands of item difficulty parameter.

TABLE 3.3

Table showing the item parameters a_j and b_j of NA (N= 1407).

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
1	0.7110	-0.0091	15	2.1131	-0.0521	28	0.9013	-0.0303
2	0.6992	-0.0141	16	2.2456	0.2144	29	0.8355	0.0251
3	0.6750	0.0013	17	2.5061	0.7369	30	1.0677	-0.1390
4	1.0321	-0.0267	18	2.6313	0.7734	31	1.8798	-0.6136
5	0.6815	0.0200	19	0.5505	0.1689	32	0.9483	-0.0338
6	1.6673	0.0613	20	0.9134	0.0034	33	1.4981	-0.4314
7	1.4261	-0.0927	21	1.5778	-0.1624	34	2.0432	-0.4143
8	0.7104	0.0442	22	1.5694	0.0391	35	2.0035	-0.4018
9	1.5461	-0.0141	23	1.6292	0.0307	36	2.8093	-0.2372
10	1.1474	0.0715	24	2.6542	0.2442	37	2.0468	-0.3121
11	1.5294	0.0397	25	1.7986	-0.3053	38	1.7817	-0.4872
12	2.2697	0.2649	26	2.3194	-0.3740	39	1.9004	-0.3624
13	1.3679	0.0970	27	2.4795	-0.4537	40	1.9182	-0.3492
14	0.9120	0.1126						

If items with $0.75 \leq a_j \leq 1.75$ and $-0.50 \leq b_j \leq 0.50$ are selected for final test tool the items 1, 2, 3, 5, 8, 12, 15, 16, 17, 18, 19, 24, 25, 26, 27, 31, 34, 35, 36, 37, 38, 39, and 40, are to be eliminated from the test tool.

3.7.3 Item parameters of MR component of DAT

The Table 3.4 gives the estimated values for item parameters of mechanical component of DAT. a_j stands for item discrimination parameter and b_j stands of item difficulty parameter.

TABLE 3.4

Table showing the item parameters a_j and b_j of MR (N= 1407).

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
1	0.8611	-0.0301	24	1.2342	0.0293	47	1.1045	0.0420
2	1.7217	0.5737	25	1.2875	0.0353	48	1.3555	0.0023
3	1.0499	0.0901	26	1.4346	0.0693	49	1.9931	0.0425
4	1.1632	0.1448	27	2.4144	0.0891	50	1.4224	-0.0289
5	1.4295	0.3081	28	1.6711	0.0495	51	2.2013	-0.0376
6	0.9356	0.0217	29	1.0122	0.0037	52	1.3667	-0.0360
7	1.3178	0.2008	30	2.1046	0.0220	53	1.0295	-0.0070
8	0.7386	-0.0619	31	1.4656	0.0239	54	1.6096	-0.0316

TABLE 3.4 (Cont.)

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
9	1.3155	0.1447	32	1.5516	0.0231	55	1.8007	-0.0339
10	1.2500	0.1137	33	1.5839	0.0394	56	1.2804	-0.0241
11	0.9937	0.0244	34	1.2195	-0.0148	57	1.0627	-0.0017
12	1.0037	0.0317	35	1.2134	0.0116	58	2.5982	-0.0415
13	1.1749	0.0788	36	1.0606	-0.0062	59	1.4297	-0.0268
14	1.1160	0.0905	37	1.0478	-0.0085	60	1.2809	-0.0571
15	1.4502	0.2125	38	1.0944	-0.0032	61	1.0050	0.0102
16	1.3419	0.0807	39	1.1527	-0.0090	62	1.4805	-0.0245
17	1.0540	0.0599	40	1.0330	0.0092	63	1.0775	-0.0099
18	1.4719	0.1192	41	1.9352	0.0108	64	1.4507	-0.0285
19	1.4890	0.1493	42	1.5353	0.0032	65	1.3698	-0.0337
20	1.2010	0.0487	43	1.3317	-0.0070	66	1.3407	-0.0540
21	1.2047	0.0549	44	1.2892	0.0058	67	1.4444	-0.0385
22	1.3069	0.0276	45	1.2849	-0.0123	68	1.5213	-0.0569
23	1.9025	0.1558	46	1.2143	0.0069			

If items with $0.75 \leq a_j \leq 1.75$ and $-0.50 \leq b_j \leq 0.50$ are selected for final test tool the items 2, 8, 23, 27, 30, 41, 49, 51, 55 , and 58 are to be eliminated from the test tool.

3.7.4 Item parameters of S-component of DAT

The Table 3.5 gives the estimated values for item parameters of spelling component of DAT. a_j stands for item discrimination parameter and b_j stands of item difficulty parameter.

TABLE 3.5

Table showing the item parameters a_j and b_j of Spelling (N= 1407).

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
1	1.2606	0.2642	35	0.8434	-0.0525	68	1.4974	0.1337
2	1.1205	0.1396	36	1.1221	0.1170	69	1.8157	0.1283
3	0.8233	-0.0775	37	1.2950	0.2552	70	1.5701	0.1008
4	1.1334	0.1384	38	1.1243	0.1024	71	1.5104	0.1349
5	1.1335	0.1342	39	1.6028	0.5271	72	1.0791	-0.0377
6	1.4228	0.4218	40	1.4945	0.3392	73	0.8653	-0.0497
7	0.9448	-0.0086	41	0.9670	-0.0002	74	1.0558	-0.0296
8	1.3384	0.3516	42	1.7212	0.6425	75	1.0078	-0.0452
9	1.0827	0.0976	43	1.0433	0.0635	76	2.1513	0.1791
10	0.8054	-0.1081	44	1.2166	0.0562	77	0.9243	-0.0176

TABLE 3.5 (Cont.)

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
11	1.7095	0.7324	45	0.9543	0.0857	78	1.4465	0.0482
12	1.2230	0.2408	46	1.3757	0.2333	79	1.2123	-0.0176
13	1.2073	0.2110	47	1.7702	0.5000	80	1.3485	0.0186
14	1.4539	0.5000	48	1.1900	0.0553	81	2.3529	0.1146
15	1.2648	0.2135	49	0.9921	0.0090	82	2.0563	0.0875
16	1.4722	0.4559	50	0.6892	-0.0760	83	1.4928	0.0575
17	1.3198	0.2783	51	1.6691	0.3800	84	0.8894	-0.0500
18	0.9369	-0.0176	52	0.8124	0.0769	85	2.0525	0.0372
19	1.2589	0.2158	53	1.3722	0.3228	86	1.7728	0.0611
20	1.0873	0.0860	54	0.6668	-0.0733	87	1.6189	-0.0557
21	0.9001	-0.0425	55	0.3291	0.1934	88	1.4341	-0.0290
22	1.2336	0.1789	56	1.1725	0.0671	89	1.1527	-0.0089
23	1.1641	0.1453	57	1.4998	0.2145	90	1.8876	0.0175
24	0.9783	0.0308	58	0.8208	0.0305	91	1.5291	0.0056
25	1.0507	0.0989	59	0.7761	-0.0574	92	0.8567	-0.0544

TABLE 3.5 (Cont.)

Item	a_j	b_j	Item	a_j	b_j	Item	a_j	b_j
26	1.2918	0.2752	60	1.4994	0.2471	93	2.0883	0.0538
27	1.0371	0.0706	61	1.8620	0.3307	94	2.3962	-0.0222
28	0.7500	-0.1104	62	1.1122	0.0675	95	1.4857	-0.0267
29	0.9874	0.0414	63	1.8279	0.2136	96	1.7144	-0.0239
30	0.9124	-0.0252	64	1.9260	0.2892	97	1.3699	-0.0645
31	1.4916	0.4407	65	1.1080	0.0501	98	1.8597	-0.0020
32	1.2596	0.2709	66	1.4935	0.0939	99	1.8934	-0.0405
33	1.6627	0.5963	67	1.3890	0.0706	100	3.6755	0.0780
34	1.3731	0.2615						

If items with $0.75 \leq a_j \leq 1.75$ and $-0.50 \leq b_j \leq 0.50$ are selected for final test tool the items 11, 33, 39, 42, 50, 54, 55, 61, 63, 64, 69, 76, 81, 82, 85, 86, 90, 93, 94, 98, 99, and 100 are to be eliminated from the test tool.

3.7.5 Discussion

The number of items eliminated from each component as part of the IRT item analysis is presented in Table 3.6.

TABLE 3.6

Table indicating the number of items

eliminated through IRT item analysis

Test Component	Total Number of items	No. of items eliminated through item analysis	No. of remaining items
Abstract Reasoning	50	9	41
Numerical Ability	40	23	17
Mechanical Reasoning	68	10	58
Spelling	100	22	78

The table reveals that only few items are eliminated from the test as part of the item analysis carried out with IRT method. In the case of Abstract Reasoning test only 9 items out of 50 are eliminated. In Numerical Ability test it is 23 out of 40 , in the case of Mechanical Reasoning test it is 10 out of 68 and in Spelling test it is only 22 out of 100. This indicate that IRT is more suitable than CTT method in item analysis of Differential Aptitude Tests. In the case of Numerical Ability test more items are eliminated and it indicates the need of revision of items of the test.

Since IRT is theoretically sound, we can conclude that the status of DAT is not worst as we could see through CTT method. The result suggests a thorough revision of Numerical. Simple modifications may standardise the other tests.

3.8 Some Recent Studies on Application of IRT

Item Response Theory and its applications in various fields is a very fast growing research area. During the last two decades, a large number of works has been emerged in this area (see Stout, 2002; Stage, 2003; Chang and Reeve, 2005; Hays et al., 2000; Thornton, 2002). The IRT literature of last one decade is rich with many studies on applications of the theory in different fields ranging from Education to Medicine. Since modern psychometric methods based upon IRT framework provide more effective methods for item analysis, the use of IRT is increasing very fast. This leads to a large number of research papers in this feiled. In this section some recent studies on applications of IRT are reviewed.

Fraley et al. (2000) made an Item Response Theory analysis of Self-Report Measures of Adult Attachment to determine whether existing attachment scales suffer from scaling problems. The authors conducted an IRT analysis of 4 commonly used self-report inventories. Data from 1,085 individuals were analyzed using Samejima's graded response model. The author's findings indicate that commonly used attachment scales can be improved in a number of important ways. Accordingly, the authors show how IRT techniques can be used to develop new attachment scales with desirable psychometric properties.

Karabatsos (2001) in his study describes some of the similarities and differences between additive conjoint measurement and the Rasch model. It seems that there are many similarities between the two frameworks, however, their differences are nontrivial. For instance, while conjoint measurement specifies measurement scales using a data-free, non-numerical axiomatic frame of reference, the Rasch model specifies measurement scales using a numerical frame of reference that is, by definition, data dependent. In order to circumvent difficulties that can be realistically imposed by this data dependence, this research formalizes new non-parametric item response models. These models are probabilistic measurement theory models in the sense that they explicitly integrate the axiomatic ideas of measurement theory with the statistical ideas of order restricted inference and Markov Chain Monte Carlo.

Ghosh et al.(2000) presented a unified Bayesian approach for the analysis of one-parameter item response models. They have given a necessary and sufficient condition for the propriety of posterior under improper priors with non-identifiable likelihoods. When the item parameters have a flat prior but the item totals do not fall at a boundary value, they give the propriety of the Bayesian joint posterior under some sufficient conditions on the joint (proper) distribution of the subject parameters. The methods are implemented using Markov chain Monte Carlo and illustrated with an example from a cross-over study comparing three medical treatments.

Mungas and Reed (2000) conducted a study to apply item response theory methods in evaluating and developing global functioning scales. Subjects were 1207 patients who had received comprehensive dementia evaluations. Items were selected from two measures of cognitive functioning (Mini Mental State Examination, MMS; Blessed Information Memory Concentration Test, BIMCT) and one measure of independent functioning (Blessed -Roth Dementia Rating Scale, BR-DRS). The MMS and BIMCT showed significant non-linearity of measurement, especially at low and high ability levels. A brief composite measure was created by selecting from the three instrument's items that fit a uniform distribution of item difficulty across the entire range of ability measured by the three instruments. This composite measure and the BRDRS showed better linearity of measurement than the other two instruments. Results have implications for development of a psychometrically sophisticated, brief measure of global functioning for clinical and research use in dementia.

Hahn et al. (2005) evaluated the measurement properties of the Functional Assessment of Cancer Therapy - Breast (FACT-B) in 111 Austrian and 144 U.S. patients with breast cancer using IRT methods. A small number of items were identified as displaying statistically significant differential item functioning (DIF), suggesting possible measurement bias. The majority of the items functioned similarity between the two cultural groups. US patients reported lower (worse) physical function and well-being compared with Austrian patients, higher (better) social/family well-being and similar emotional well-being, before and after adjustment for DIF. IRT and related measurement models provide useful methods for assessing cross-cultural equivalence and determining which items can be pooled across languages before analyzing HRQOL data.

Wiberg (2004) evaluated the IRT model among the 1PL, 2PL and 3PL IRT models in the Swedish driving-license test and compared the chosen IRT model with the indices in CTT. The theory test has 65 multiple-choice items and is criterion-referenced. The evaluation of the models were made by verifying the assumptions that IRT models rely on, examining the expected model features and evaluating how well the models predict actual test results. The overall conclusion from this evaluation is that 3PL model is preferable to use when evaluating the theory test. By comparing the indices from CTT and IRT it was concluded that both give valuable information and should be included in an analysis of the theory test in the Swedish driving-license test.

Chang and Reeve (2005) found that the integration of modern test theory and advanced computer technology makes it possible to facilitate better patient reported outcome measurement to provide high-quality outcomes assessment and patient care without added burden to the patients.

In a study Kostin (2004) explored the relationship between a set of item characteristics and the difficulty of TOEFL dialogue items. The study employed 365 TOEFL dialogue items, which were coded on 49 variables. It was found that 3 variables correlated significantly with item difficulty in this study. Another 11 met a critical probability criterion. These 11 included representatives from three broad categories of variables: 2 in the category of word-level factors, 1 in the category of discourse-level factors, and 8 in the category of task-processing factors. Multiple regression analyses indicate that the variables in this study account for about 40% of the variance in item difficulty.

Garcia-Perez (1999) illustrates how mechanical adoption of off-the shelf logistic functions as IRFs for IRT models can result in off-the-shelf parameter estimates and fits to data. The results of a simulation study are presented, which show that logistic IRT models can fit a set of data generated by IRFs other than logistic functions just as well as they fit logistic data, even though the response processes and parameter spaces involved in each case are substantially different. An explanation of why logistic functions work as they do is offered, the theoretical and practical consequences of their behavior are also discussed in his work.

Bolt et al. (2001) proposed a mixture item response model for investigating individual differences in the selection of response categories in multiple-choice items. The model accounts for local dependence among response categories by assuming that examinees belong to discrete latent classes that have different propensities towards those responses. Varying response category propensities are captured by allowing the category intercept parameters in a nominal response model to assume different values across classes. A Markov Chain Monte Carlo algorithm for the estimation of model parameters and classification of examinees is also described by them. A real data example illustrates how the model can be used to distinguish examinees that are disproportionately attracted to different types of distracters in a test of English usage. A simulation study evaluates item parameter recovery and classification accuracy in a hypothetical multiple-choice test designed to be diagnostic. Implications for test construction and the use of multiple-choice tests to perform cognitive diagnosis of item response patterns are also discussed.

In their study Sung and Kang (2006) compared four model selection methods based on Bayesian estimation process in terms of their relative performances in choosing the best IRT model to analyze Likert-type data. Among lots of polytomous IRT models already suggested, the rating scale model , the partial credit model , the generalized partial credit model and the graded response model are used to compare the utility of the four model selection methods. Results indicate that model selection was dependent to some extent on the particular conditions simulated.

Kacmar et. al (2006) introduce a scale to measure meta-perspectives, my view of your view of me, about one's performance in an organizational setting. Applied to the performance appraisal process, this perspective allows the authors to investigate how employees think their supervisors view their performance. Meta-perspectives thereby enrich our understanding of the relationship effects inherent in the performance appraisal process. Due to the desirable properties of item response theory (non-sample specific item parameter estimates), a multidimensional item response theory model was applied to the data. This allowed for the simultaneous estimation of dimensionality and item threshold values. Data collected from 1,255 full-time workers in two different organizations reveal that the items did not lie along a unidimensional continuum, but that three dimensions underlie the proposed scale: employee perceptions of the supervisors view of employee work ethic, work product, and self-regulation.

Veerkamp and Berger (1999) in their paper derives discrimination parameter values, as functions of the guessing parameter and distances between person parameters and item difficulty, that yield maximum information for the three-parameter logistic item response theory model. An upper bound for information as a function of these parameters is also derived. An algorithm is suggested for the maximum information item selection criterion for adaptive testing and is compared with a full bank search algorithm.

Veerkamp (2000) states that Taylor approximation can be used to generate a linear approximation to alogistic ICC and a linear ability estimator. For a specific situation it will be shown to result in a special case of a Robbins-Monro item selection procedure for adaptive testing. The linear estimator can be used for the situation of zero and perfect scores when maximum likelihood estimation fails to come up with a finite estimate. It is also possible to use this estimator to generate starting values for maximum likelihood and weighted likelihood estimation. Approximations to the expectation and variance of the linear estimator for a sequence of Robbins-Monro item selections can be determined analytically.

Orlando (2000) introduced a new goodness of fit indices for dichotomous item response theory models., These indices are based on the likelihoods of number correct scores derived from the IRT model, and they provide a direct comparison of the modeled and observed frequencies for correct and incorrect responses for each number correct score. The behavior of Pearsons χ^2 and the likelihood ratio G^2 was assessed in a simulation study and compared with two fit indices similar to those currently in use.

Wagner and Harvey (2003) developed a test namely Wagner Assessment Test (WAT) to assess critical thinking ability via the conceptual approach taken by the Watson-Glaser Critical Thinking Assessment (WGCTA), using a less easily faked response format. Item response theory (IRT) analyses showed that the WAT produced higher test information functions and higher internal consistency reliability.

Noortgate et. al (2003) conducted a study on IRT models and combination of a multilevel model with random person effects and one with random item effects leads to a cross-classification multilevel model, which can be of interest for IRT applications. The use of cross-classification multilevel logistic models were illustrated with an Educational measurement application.

Baker et al (2000) compared category item response theory models are using a data set of 52 mood terms with 713 subjects.. Principle components analysis and item parameter tests supported the uni-dimensionality assumption. Comparative model data fit for the Samejima's logistic model for graded responses and the Masters partial credit model favored the former model for this particular data set. Theoretical and practical aspects of the comparative application of multiple category models in the measurement of .subjective well-being or mood are discussed.

Ogasawara (2001) The asymptotic standard errors of the estimates of the equated scores by several types of IRT true score equating are provided. The first group of equating do not use IRT equating coefficients. The second group of equating use the IRT equating coefficients given by the moment or characteristic curve methods. The equating designs considered in this article cover those with internal or external common items and the methods with separate or simultaneous estimation of item parameters of associated tests. For the estimates of the asymptotic standard errors of the equated true scores, the method of marginal maximum likelihood estimation is employed for estimation of item parameters.

Janssen et al (2000) proposed a hierarchical IRT model for mastery classification in criterion referenced measurement. In this model, items measuring the same criterion are grouped, and a difficulty and discrimination parameter of the criterion is estimated on the same scale as the person and item parameters. The level of proficiency of a student with respect to the criterion is determined by the probability of success on the criterion. Cutoff points on the probability scale can be used to classify respondents into masters and non- masters. The hierarchical IRT model is estimated using the Gibbs sampler and tested using posterior predictive checks. The model is illustrated with a test measuring the attainment targets of reading comprehension (in Dutch) at the end of primary education.

Rossi et al (2002) used methods of functional data analysis to estimate item response functions (IRFs) non parametrically. The EM algorithm is used to maximize the penalized marginal likelihood of the data. The penalty controls the smoothness of the estimated IRFs, and is chosen so that, as the penalty is increased, the estimates converge to shapes closely represented by the three-parameter logistic family. The one-dimensional latent trait model is recast as a problem of estimating a space curve or manifold, and, expressed in this way, the model no longer involves any latent constructs, and is invariant with respect to choice of latent variable. Some results from differential geometry are used to develop a data-anchored measure of ability and a new technique for assessing item discriminability. Functional data analytic techniques are used to explore the functional variation in the estimated IRFs. Applications involving simulated and actual data are included.

3.9 Comparison of CTT with IRT

Even though there is an exponential growth of Item Response Theory during last two decades, Classical Test Theory is the most popular and widely used method among most of the researchers. The major reason for this is the easiness of applying classical test theory methods in developing test tools compared to item response approach.

Classical test theory methods have relatively weak theoretical assumptions, which make it easy to apply in many testing situations (Hambleton & Jones, 1993). Hence it is very easy to compute major focus of CTT analysis item statistics viz. item difficulty and item discrimination and reliability. In this section we will discuss some of the similarities of these item statistics of CTT and IRT.

CTT does not invoke a complex theoretical model to relate an examinees ability to success on a particular item. Instead, CTT collectively considers a pool of examinees and empirically examines their success rate on an item. This success rate of a particular pool of examinees on an item is used as the index for the item difficulty. Actually, it is an inverse indicator of item difficulty, with higher value indicating an easier item. In IRT the parameter b_j is used to indicate the index for the item difficulty of item$j$..

In CTT, The ability of an item to discriminate between higher ability examinees and lower ability examinees is known as item discrimination, which is often expressed statistically as the Pearson product-moment correlation coefficient between the scores on the item and the scores on the total test. When an item is dichotomously scored, this estimate is often computed as a point-biserial correlation coefficient. Similar to this the parameter a_j represents the item discrimination index of item j in the context of IRT.

It is fair to say that, to a great extent, although there are some issues that may not have been addressed theoretically within the CTT framework, many have been addressed through ad hoc empirical procedures. IRT, on the other hand, is more theory grounded and models the probabilistic distribution of examinees success at the item level.

Classical test theory and item response theory are widely perceived as representing two very different measurement frameworks. However, few studies have empirically examined the similarities and differences in the parameters estimated using the two frameworks. Some of the studies on comparison of IRT with CTT are given below.

Xitao (1998) in his study empirically examines the behaviors of the item and person statistics derived from these two measurement frameworks. The study focused on two issues: (a) what are the empirical relationships between IRT-and CTT-based item and person statistics and (b) To what extent are the item statistics from IRT and those from CTT invariant across different participant samples. A large-scale statewide assessment database was used in the study. The findings indicate that the person and item statistics derived from the two measurement frameworks are quite comparable.

Bechger et. al (2003) examines the relations between classical test theory and item response theory. It is shown that CTT is based upon the assumption that measures are exchangeable while IRT is based upon conditional independence. Thus, IRT is presented as an extension of CTT and concepts from both theories are related to one another. Furthermore, in their study it is demonstrated that IRT can be used to provide CTT statistics in situations where CTT fails. Reliability, for instance, can be determined even though a test was not administered to the intended population.

Cantrell (1997) points out one peculiarity of estimates obtained through IRT than that of CTT as IRT estimates are item free and person free. Item free means that the person ability estimates are theoretically independent of the item used on the measurement. Person free means that the item difficulty calibrations are theoretically independent of the persons generating the calibrations.

Stage (2003) made an effort to investigate whether item response theory would be applicable to the Swedish Scholastic Aptitude Test (SweSAT). The aim has been to examine whether a switch from classical test theory to item response theory, in the process of item development, test design, scoring or equating, would improve the quality of the test. The conclusion was that since the model data fit was somewhat dubious, especially for the total test, there was nothing to be gained by switching from CTT to IRT.

Verstralen et al. (2001) studied a number of relations between concepts of models from classical test theory, such as reliability, and item response theory. It is demonstrated that the use of IRT models allows us to extend the range of applications of CTT, and investigate relations among concepts that are central in CTT such as reliability and item-test correlation.

In short, one can see that, all studies emphasises that IRT is is better than CTT in general.

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

Chapter 4

Multi-item approach in IRT for the item analysis

4.1 Introduction

The assumption of independence between item responses is practically not valid in the sense that it is not possible to collect a set of items in such a way that each item independently contains a unique component of information of the trait. For example, in an intelligence test with 25 items, one cannot make sure that the 25 items will measure the 25 independent unique components of intelligence.

In this chapter, we test the validity of this assumption for different components of DAT by approaching each item conditioning on the response of other items. It is possible that two or more items jointly discriminate the examinees with regard to the trait, even if they are not marginally discriminating. In fact, if this happened in an item analysis, the two informative items will be eliminated through marginal approach. The joint difficulty index is completely different from that of the marginal index in the sense that an item which is marginally difficult may not be difficult when conditioning on some items. For example, suppose i and j are two items having difficult index greater than 0.5. In some cases we can observe, the difficulty index is less than 0.5 for those who are correctly respondent for item j. This means the item is not that much difficult for those who are correctly answered for the item j. Clearly this useful information is not explained in marginal approach. To quote another example, two items are not marginally difficult but one item may be difficult for those examinees who responded wrongly to the other item. This type of several combination of information can be available using the conditional approach.

In all the similar situations the marginal approach may lead to wrong conclusion about the item. Modelling the item responses using a suitable multivariate distribution is appropriate in this situation. As a first attempt, we consider the problem conditionally and explain how far is the problem relevant in item analysis of DAT.

In this discussion the traditional approach of considering items individually or marginally will be treated as Single Item IRT (SIIRT) approach and the approach that we are introducing, which considers more than one item for the estimation of item parameters, will be termed as Multi-item IRT (MIIRT) approach. The estimate obtained through SIIRT is termed as SIIRT estimate and that through MIIRT is termed as MIIRT estimate.

In this chapter we look in to the conditional distribution of items responses conditioning on one of the responses of the remaining items. We assume that the item responses are conditionally logistically distributed and the location scale parameters are estimated based on the conditional likelihood of each response conditional on one of the other responses.

4.2 Method

Let Y_j and Y_l are responses of two items j and l respectively. The conditional distribution of Y_j given Y_l is

$$\mathrm{P}[Y_j = 1 \mid Y_l = 0] = \left[\frac{1}{1 + \mathrm{e}^{-a^0_{jl}(\theta - b^0_{jl}))}}\right] \tag{4.1}$$

and

$$\mathrm{P}[Y_j = 1 \mid Y_l = 1] = \left[\frac{1}{1 + \mathrm{e}^{-a^1_{jl}(\theta - b^1_{jl}))}}\right] \tag{4.2}$$

Then by using the EM algorithm as described in chapter 3, the parameters a^0_{jl} , a^1_{jl} , b^0_{jl} and b^1_{jl} are estimated. The same algorithm was used to test the hypothesis $a_{jl} = a_j$ and $b_{jl} = b_j$ using the likelihood ratio test by approximating it as a χ^2 - test.

4.2.1 Notation

For convenience we will use the following notations for the estimates obtained through multi-item approach. The estimate of a obtained for item j by conditioning item $l = z$ will be denoted as $a^z_{j,l}$. Since the items are dichotomous z will take the values of either 0 or 1.

Similarly $b^z_{j,l}$ will denote the estimate of b obtained for j^{th} item by conditioning item $l = z$.

4.3 Item analysis of AR components of DAT by MIIRT approach

In this section we will compute the item parameters of two parameter logistic model by considering the conditional probability of each item. The obtained values will be compared with the desirable range of values of a and b chosen in previous chapter as $0.75 \leq a^z_{jl} \leq 1.75$ and $-0.50 \leq b^z_{jl} \leq 0.50$.

The tables representing the values of a and b of abstract reasoning component obtained by conditioning on each item are presented in appendix A.

Analysis of Item 1 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate (estimate when item is marginally considered) of a_1 is out side the desirable range.

The table A.1 given in appendix A, reveals that, when the significance of association of responses of item 1 with the remaining 49 items are tested, 37 items show high association between their responses and the response of item 1.

Among these significant items, when MIIRT estimates of a are computed conditional on other items, one can see (refer appendix A) that

$a^0_{1,16}$ $a^0_{1,32}$ $a^1_{1,2}$ $a^1_{1,4}$ $a^1_{1,7}$ $a^1_{1,8}$ $a^1_{1,9}$, $a^1_{1,10}$ $a^1_{1,11}$ $a^1_{1,12}$

$a^1_{1,13}$ $a^1_{1,14}$ $a^1_{1,15}$ $a^1_{1,16}$ $a^1_{1,17}$ $a^1_{1,19}$ $a^1_{1,20}$ $a^1_{1,21}$ $a^1_{1,22}$ $a^1_{1,23}$

$a^1_{1,24}$ $a^1_{1,25}$ $a^1_{1,26}$ $a^1_{1,27}$ $a^1_{1,28}$ $a^1_{1,29}$ $a^1_{1,30}$ $a^1_{1,32}$ $a^1_{1,33}$ $a^1_{1,34}$

$a^1_{1,37}$ $a^1_{1,40}$ $a^1_{1,41}$ $a^1_{1,42}$ $a^1_{1,46}$ $a^1_{1,47}$

are *not* lying outside the desirable range.

This indicates that one cannot take the decision to eliminate the item 1 from the test tool based on item discrimination, as the joint information contained in the item 1 with that of many other items are significant. In other words the item no. 1 gets discriminating power when it is combined with the other items.

Regarding the item difficulty, in SIIRT, b_1 lies in the desirable range of a good item. While considering conditional estimates, all b's fall in desirable region. It means for item no. 1, item difficulty-estimate through SIIRT and MIIRT gives same results.

Analysis of Item 2 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_2 and b_2 are within the admissible range.

The table A.2 given in appendix A, reveals that, when the significance of association of responses of item 2 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 2.

Among these significant items, when item parameters of a and b are computed conditional on other items, (refer appendix A) one can see that $a^0_{2,3}$ is higher than the desirable value. It means that when item no. 2 is conditioned on item 3 , it gets high discrimination power. Hence we can conclude that there is nothing wrong in selecting the item to final test tool.

The MIIRT estimates for b is also within the desirable range for item 2 conditioned on others. This means that the item difficulty of item no. 2 is same for all sub group conditioned on other items.

Hence item no. 2 can be selected to the final test tool.

Analysis of Item 3 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_3 and b_3 are inside the admissible range.

The table A.3 given in appendix A, reveals that, when the significance of association of responses of item 3 with the remaining 49 items are tested, 42 items show high association between their responses and the response of item 3.

Among these significant items, when item parameters of a and b are computed conditional on other items (as in appendix A), it is seen that all estimates of the parameters are inside the admissible range. i.e. item no. 3 satisfies the condition for good test in both SIIRT and MIIRT analysis.

Therefore the item should be selected into the final test tool.

Analysis of Item 4 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_4 and b_4 are inside the admissible range.

The table A.4 given in appendix A, reveals that, when the significance of association of responses of item 4 with the remaining 49 items are tested, 42 items show high association between their responses and the response of item 4.

Among these significant items, when item parameters of a and b are computed conditional on other items (as in appendix A), we found that all estimates of the parameters are inside the admissible range.Hence item no. 4 satisfies the condition for good test in both SIIRT and MIIRT analysis.

Therefore the item should be selected into the final test tool.

Analysis of Item 5 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_5 and b_5 are inside the admissible range.

The table A.5 given in appendix A, reveals that, when the significance of association of responses of item 5 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 5.

Among these significant items, when item parameters of a and b are computed conditional on other items (see appendix A), we found that all estimates of the parameters are inside the admissible range.Hence item no. 5 satisfies the condition for good test in both SIIRT and MIIRT analysis.

Therefore the item should be selected into the final test tool.

Analysis of Item 6 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_6 and b_6 are inside the admissible range.

The table A.6 given in appendix A, reveals that, when the significance of association of responses of item 6 with the remaining 49 items are tested, 45 items show high association between their responses and the response of item 6.

Among these significant items, when item parameters of a and b are computed conditional on other items , we found that all estimates of the parameters are inside the admissible range.Hence item no. 6 satisfies the condition for good test in both SIIRT and MIIRT analysis.

Therefore the item should be selected into the final test tool.

Analysis of Item 7 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_7 and b_7 are inside the admissible range.

The table A.7 given in appendix A, reveals that, when the significance of association of responses of item 7 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 7.

Among these significant items, when item parameters of a and b are computed conditional on other items, i. e. MIIRT estimates, one can see that that the value of the parameter $a^0_{7,8}$ is higher than that of the desirable value. It means that when item no. 7 is conditioned on item 8 , it gets high discrimination power. So the conclusion is that there is nothing wrong in selecting the item to final test tool

The MIIRT estimates for b is also within the desirable range for item 7 conditioned on others. This means that the item difficulty of item no. 7 is same for all sub group conditioned on other items.

Hence item no. 7 can be selected for the final test tool.

Analysis of Item 8 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_8 and b_8 are inside the admissible range.

The table A.8 given in appendix A, reveals that, when the significance of association of responses of item 8 with the remaining 49 items are tested, 46 items show high association between their responses and the response of item 8.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all estimates except $a^0_{8,2}$ and $b^0_{8,2}$ are within the admissible range. It indicate the item 8 behaves as good except conditioned on item 2.

As it is admissible in all other points, the item 8 can be included into the final test tool.

Analysis of Item 9 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_9 and b_9 when marginally considered are inside the admissible range.

The table A.9 given in appendix A, reveals that, when the significance of association of responses of item 9 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 9.

Among these significant items, when item parameters of a and b are computed conditional on other items , we found that values of the parameters $a^0_{9,3}$ $a^0_{9,4}$ $a^0_{9,6}$ $a^0_{9,7}$ $a^0_{9,8}$ $a^0_{9,17}$ and $a^0_{9,19}$ are outside the desirable range and MIIRT estimates of b is in admissible range for all cases conditioned on other items.

It indicates that the item 9 contains some information contained in item 3, item 4, item 6, item 7, item 8, item 17 and item 19. Hence one must make necessary investigation before including this item in the final tool.

In short the item 9 cannot be taken in to the final test tool, as suggested by SIIRT method.

Analysis of Item 10 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{10} and b_{10} are inside the admissible range.

The table A.10 given in appendix A, reveals that, when the significance of association of responses of item 10 with the remaining 49 items are tested, 44 items show high association between their responses and the response of item 10.

Among these significant items, when item parameters of a and b are computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 10 should be selected into the final test tool.

Analysis of Item 11 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{11} and b_{11} are inside the admissible range.

The table A.11 given in appendix A, reveals that, when the significance of association of responses of item 11 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 11.

Among these significant items,when item parameters of a and b were computed conditional on other items , we found that all value of the parameter $a^0_{11,8}$ is higher than the desirable value. It means that when item no. 11 is conditioned on item 8 , it gets high discrimination power. We can conclude that there is nothing wrong in selecting the item to final test tool.

Hence item no. 11 can be selected to the final test tool.

Analysis of Item 12 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{12} and b_{12} are inside the admissible range.

The table A.12 given in appendix A, reveals that, when the significance of association of responses of item 12 with the remaining 49 items are tested, 42 items show high association between their responses and the response of item 12.

Among these significant items when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 12 should be selected into the final test tool.

Analysis of Item 13 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{13} and b_{13} are inside the admissible range.

The table A.13 given in appendix A, reveals that, when the significance of association of responses of item 13 with the remaining 49 items are tested, 44 items show high association between their responses and the response of item 13.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 13 should be selected into the final test tool.

Analysis of Item 14:-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{14} and b_{14} are inside the admissible range.

The table A.14 given in appendix A, reveals that, when the significance of association of responses of item 14 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 14.

Among these significant items, when item parameters of a and b were computed conditional on other items, we found that all values of the parameters are inside the admissible range.

Hence item no. 14 should be selected into the final test tool.

Analysis of Item 15 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{15} and b_{15} are inside the admissible range.

The table A.15 given in appendix A, reveals that, when the significance of association of responses of item 15 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 15.

Among these significant items,when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 15 should be selected into the final test tool.

Analysis of Item 16 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{16} and b_{16} are inside the admissible range.

The table A.16 given in appendix A, reveals that, when the significance of association of responses of item 16 with the remaining 49 items are tested, 45 items show high association between their responses and the response of item 16.

Among these significant items,when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 16 should be selected into the final test tool.

Analysis of Item 17:-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{17} and b_{17} are inside the admissible range.

The table A.17 given in appendix A, reveals that, when the significance of association of responses of item 17 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 17.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 17 should be selected into the final test tool.

Analysis of Item 18:-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{18} and b_{18} are inside the admissible range.

The table A.18 given in appendix A, reveals that, when the significance of association of responses of item 18 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 18.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 18 should be selected into the final test tool.

Analysis of Item 19 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{19} and b_{19} are inside the admissible range.

The table A.19 given in appendix A, reveals that, when the significance of association of responses of item 19 with the remaining 49 items are tested, 42 items show high association between their responses and the response of item 19.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 19 should be selected into the final test tool.

Analysis of Item 20 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{20} and b_{20} are inside the admissible range.

The table A.20 given in appendix A, reveals that, when the significance of association of responses of item 20 with the remaining 49 items are tested, 40 items show high association between their responses and the response of item 20.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 20 should be selected into the final test tool.

Analysis of Item 21 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{21} and b_{21} are inside the admissible range.

The table A.21 given in appendix A, reveals that, when the significance of association of responses of item 21 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 21.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters except $a^0_{21,8}$ and $b^1_{21,38}$ are outside the desirable range.It indicate the item behaves as good except two cases conditioned on item 8 and 38.

As it is in admissible in all other points, the item 21 can be included into the final test tool.

Analysis of Item 22 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{22} and b_{22} are inside the admissible range.

The table A.22 given in appendix A, reveals that, when the significance of association of responses of item 22 with the remaining 49 items are tested, 37 items show high association between their responses and the response of item 22.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters except $a^0_{22,6}$, $a^0_{22,8}$, $b^1_{22,28}$, $b^1_{22,36}$ are outside the desirable range. It indicate the item behaves as good except for two items in discrimination and two items in difficulty.

Since the value of item parameters within the admissible range for all other cases, there is nothing wrong in selecting the item 22 to the final test tool.

Analysis of Item 23 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{23} and b_{23} when marginally considered are inside the admissible range.

The table A.23 given in appendix A, reveals that, when the significance of association of responses of item 23 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 23.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 23 should be selected into the final test tool.

Analysis of Item 24 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{24} and b_{24} when marginally considered are inside the admissible range.

The table A.24 given in appendix A, reveals that, when the significance of association of responses of item 24 with the remaining 49 items are tested, 40 items show high association between their responses and the response of item 24.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 24 should be selected into the final test tool.

Analysis of Item 25 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{25} and b_{25} when marginally considered are inside the admissible range.

The table A.25 given in appendix A, reveals that, when the significance of association of responses of item 25 with the remaining 49 items are tested, 39 items show high association between their responses and the response of item 25.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 25 should be selected into the final test tool.

Analysis of Item 26 :–

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{26} and b_{26} when marginally considered are inside the admissible range.

The table A.26 given in appendix A, reveals that, when the significance of association of responses of item 26 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 26.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 26 should be selected into the final test tool.

Analysis of Item 27 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{27} and b_{27} when marginally considered are inside the admissible range.

The table A.27 given in appendix A, reveals that, when the significance of association of responses of item 27 with the remaining 49 items are tested, 41 items show high association between their responses and the response of item 27.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 27 should be selected into the final test tool.

Analysis of Item 28 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of $a_2 8$ and $b_2 8$ when marginally considered are inside the admissible range.

The table A.28 given in appendix A, reveals that, when the significance of association of responses of item 28 with the remaining 49 items are tested, 40 items show high association between their responses and the response of item 28.

Among these significant items,

When item parameters of a and b were computed conditional on other items , we found that the MIIRT estimates

$$a^0_{28,3} \quad a^0_{28,4} \quad a^0_{28,5} \quad a^0_{28,6} \quad a^0_{28,7} \quad a^0_{28,8} \quad a^0_{28,10} \quad a^0_{28,13}$$

$$a^0_{28,17} \quad a^0_{28,18} \quad a^0_{28,18} \quad a^0_{28,20} \quad a^0_{28,22} \quad a^0_{28,23} \quad a^0_{28,24} \quad a^0_{28,26}$$

$$a^0_{28,29} \quad a^0_{28,34} \quad a^0_{28,37} \quad a^0_{28,38} \quad a^0_{28,46}$$

are outside the desirable range. i.e. the results obtained through MIIRT is contradictory to that of SIIRT estimates .

Hence it is not advisable to include item no, 28 into the final test tool.

Analysis of Item 29 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{29} and b_{29} when marginally considered are inside the admissible range.

The table A.29 given in appendix A, reveals that, when the significance of association of responses of item 29 with the remaining 49 items are tested,43 items show high association between their responses and the response of item 29.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 29 should be selected into the final test tool.

Analysis of Item 30 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimates of a_{30} and b_{30} when marginally considered are inside the admissible range.

The table A.30 given in appendix A, reveals that, when the significance of association of responses of item 30 with the remaining 49 items are tested, 39 items show high association between their responses and the response of item 30.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 30 should be selected into the final test tool.

Analysis of Item 31 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{31} is within the admissible range

The table A.31 given in appendix A, reveals that, when the significance of association of responses of item 31 with the remaining 49 items are tested, 36 items show high association between their responses and the response of item 31.

Among these significant items, when MIIRT of a are computed conditional on other items ,

$$
\begin{array}{cccccccccc}
a^0_{31,2} & a^1_{31,2} & a^0_{31,3} & a^1_{31,3} & a^0_{31,4} & a^1_{31,4} & a^0_{31,5} & a^0_{31,6} & a^0_{31,7} & a^0_{31,8} \\
a^0_{31,9} & a^1_{31,9} & a^0_{31,10} & a^1_{31,10} & b^1_{31,10} & a^0_{31,13} & a^0_{31,14} & a^0_{31,17} & a^1_{31,17} & a^0_{31,19} \\
a^1_{31,19} & a^0_{31,21} & a^0_{31,23} & a^1_{31,23} & a^0_{31,26} & a^1_{31,26} & a^0_{31,27} & a^0_{31,29} & a^1_{29,29} & a^0_{31,30} \\
a^0_{31,32} & a^0_{31,34} & a^1_{31,34} & a^0_{31,35} & a^0_{31,36} & a^0_{31,37} & a^1_{31,37} & a^0_{31,38} & b^0_{31,38} & a^0_{31,39} \\
a^0_{31,46} & a^1_{31,46}
\end{array}
$$

are *not* within the desirable range. It indicates highly contradictory results for SIIRT and MIIRT approach.

When considering the SIIRT estimate b_{31} , it is outside the admissible range while the MIIRT estimates of b ,

$$
\begin{array}{cccccccc}
b^0_{31,2} & b^0_{31,3} & b^0_{31,4} & b^0_{31,5} & b^0_{31,6} & b^0_{31,7} & b^0_{31,8} & b^0_{31,9} \\
b^0_{31,10} & b^0_{31,12} & b^0_{31,13} & b^0_{31,17} & b^0_{31,19} & b^1_{31,20} & b^0_{31,23} & b^0_{31,26} \\
b^0_{31,29} & b^0_{31,34} & b^0_{31,46}
\end{array}
$$

are within the desirable range. Hence the MIIRT results shows contradictory results with its SIIRT counter parts.

Analysis of Item 32 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{32} and b_{32} when marginally considered are inside the admissible range.

The table A.32 given in appendix A, reveals that, when the significance of association of responses of item 32 with the remaining 49 items are tested, 44 items show high association between their responses and the response of item 32.

Among these significant items when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 32 should be selected into the final test tool.

Analysis of Item 33 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{33} and b_{33} are *outside* the admissible range.

The table A.33 given in appendix A, reveals that, when the significance of association of responses of item 33 with the remaining 49 items are tested, 29 items show high association between their responses and the response of item 33.

Among these significant items, when item parameters of a are computed conditional on other items , we can see that MIIRT estimates

$$a^1_{33,9} \quad a^1_{33,11} \quad a^1_{33,22} \quad a^1_{33,27} \quad a^1_{33,30} \quad a^1_{33,31} \quad a^1_{33,37}$$

and

$$b^0_{33,2} \quad b^0_{33,3} \quad b^0_{33,4} \quad b^0_{33,5} \quad b^0_{33,6} \quad b^0_{33,7} \quad b^0_{33,8} \quad b^0_{33,9}$$

$$b^0_{33,10} \quad b^0_{33,13} \quad b^0_{33,17} \quad b^0_{33,19} \quad b^0_{33,23} \quad b^0_{33,26} \quad b^0_{33,29} \quad b^0_{33,46}$$

are *within* the desirable range.

i. e. the MIIRT results shows highly contradictory results with its SIIRT counter parts.

Analysis of Item 34 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_34 and b_34 are inside the admissible range.

The table A.34 reveals that, when the significance of association of responses of item 34 with the remaining 49 items are tested, 48 items show high association between their responses and the response of item 34.

Among these significant items,when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 34 should be selected into the final test tool.

Analysis of Item 35 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{35} and b_{35} when marginally considered are inside the admissible range.

The table A.35 given in appendix A, reveals that, when the significance of association of responses of item 35 with the remaining 49 items are tested, 28 items show high association between their responses and the response of item 35.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 35 should be selected into the final test tool.

Analysis of Item 36 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{36} and b_{36} when marginally considered are inside the admissible range.

The table A.36 given in appendix A, reveals that, when the significance of association of responses of item 36 with the remaining 49 items are tested, 43 items show high association between their responses and the response of item 36.

Among these significant items, when item parameters of a were computed conditional on other items , we found that MIIRT estimates $a^0_{36,3}$, $a^0_{36,8}$ and $b^1_{36,48}$

are outside the desirable range. It indicate the item 8 behaves as good except conditioned on items 3, 8 and 48.

As it is in admissible in all other points, the item 36 can be included into the final test tool.

Analysis of Item 37 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{37} and b_{37} when marginally considered are inside the admissible range.

The table A.37 given in appendix A, reveals that, when the significance of association of responses of item 37 with the remaining 49 items are tested, 47 items show high association between their responses and the response of item 37.

Among these significant items, when item parameters of a and b were computed conditional on other items , we get

$$a^0_{37,1} \quad a^0_{37,2} \quad a^0_{37,3} \quad a^0_{37,4} \quad a^0_{37,5} \quad b^0_{37,5} \quad a^0_{37,7} \quad a^0_{37,8} \quad a^0_{37,9}$$

$$a^0_{37,10} \quad a^0_{37,12} \quad a^0_{37,15} \quad a^0_{37,17} \quad a^0_{37,19} \quad a^0_{37,23} \quad a^0_{37,40} \quad a^0_{37,46} \quad b^0_{37,5}$$

are outside the desirable range. i. e. the MIIRT analysis shows contradictory results with its SIIRT counter parts.

Analysis of Item 38 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{38} and b_{38} when marginally considered are inside the admissible range.

The table A.38 given in appendix A, reveals that, when the significance of association of responses of item 38 with the remaining 49 items are tested, 47 items show high association between their responses and the response of item 38.

Among these significant items, when item parameters of a and b were computed conditional on other items, we found that all values of the parameters

$a^0_{38,2}$ $a^0_{38,3}$ $a^0_{38,4}$ $a^0_{38,5}$ $a^0_{38,6}$ $a^0_{38,7}$ $a^0_{38,8}$ $a^0_{37,9}$

$a^0_{38,10}$ $a^0_{38,12}$ $a^0_{38,13}$ $a^0_{38,14}$ $a^0_{38,15}$ $a^0_{38,17}$ $a^0_{38,18}$ $a^0_{38,19}$

$a^0_{38,20}$ $a^0_{38,21}$ $a^0_{38,23}$ $a^0_{38,24}$ $a^0_{38,25}$ $a^0_{38,26}$ $a^0_{38,27}$ $a^0_{38,29}$

$a^0_{38,30}$ $a^0_{38,31}$ $a^0_{38,32}$ $a^0_{38,34}$ $a^0_{38,35}$ $a^0_{38,36}$ $a^0_{38,37}$ $a^0_{38,39}$

$a^0_{38,40}$ $a^0_{38,41}$ $a^0_{38,42}$ $a^0_{38,44}$ $a^0_{38,45}$ $a^0_{38,46}$ $a^0_{38,47}$ $a^0_{38,48}$

$a^0_{38,49}$ are outside the desirable range.

Hence item no. 38 cannot be included into the final test tool.

Analysis of Item 39 :–

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{39} is inside the desirable range and b_{39} is outside the desirable range when marginally considered.

The table A.39 given in appendix A, reveals that, when the significance of association of responses of item 39 with the remaining 49 items are tested, 20 items show high association between their responses and the response of item 39.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters

$$a^1_{39,5} \quad a^0_{39,8} \quad a^1_{39,8} \quad a^0_{39,16} \quad a^1_{39,16} \quad a^0_{39,31} \quad a^0_{39,32} \quad a^0_{39,34} \quad a^0_{39,36}$$

$$a^0_{39,37} \quad a^1_{39,37} \quad a^0_{39,38} \quad a^0_{39,40} \quad a^0_{39,44} \quad a^0_{39,46} \quad a^0_{39,47} \quad a^0_{39,48} \quad a^0_{39,50}$$

are outside the desirable range. And

$$b^0_{39,5} \quad b^0_{39,8} \quad b^0_{39,34} \quad b^0_{39,37} \quad b^0_{39,46}$$

are within the desirable range. i. e. the MIIRT analysis shows contradictory results with its SIIRT counter parts.

Analysis of Item 40 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{40} and b_{40} when marginally considered are inside the admissible range.

The table A.40 given in appendix A, reveals that, when the significance of association of responses of item 40 with the remaining 49 items are tested, 44 items show high association between their responses and the response of item 40.

Among these significant items, when item parameters of a and b were computed conditional on other items , we can see that MIIRT estimates

$$a^0_{40,1} \quad a^0_{40,4} \quad a^0_{40,6} \quad a^0_{40,7} \quad a^0_{40,8} \quad a^0_{40,12} \quad a^0_{40,13}$$

$$a^0_{40,15} \quad a^0_{40,17} \quad a^0_{40,19} \quad a^1_{40,38} \quad a^1_{40,39} \quad a^1_{40,42} \quad a^1_{40,43}$$

$$a^1_{40,44} \quad a^1_{40,45} \quad a^1_{40,46} \quad a^1_{40,47} \quad a^1_{40,48} \quad a^1_{40,50}$$

are outside the desirable range.

Hence further investigation has to be carried out before taking a decision to include the item into the final test tool.

Analysis of Item 41 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{41} when marginally considered is outside the admissible range. And b_{41} when marginally considered is inside the admissible range.

The table A.41 given in appendix A, reveals that, when the significance of association of responses of item 41 with the remaining 49 items are tested, 45 items show high association between their responses and the response of item 41.

Among these significant items, the MIIRT estimates

$$a^1_{41,21} \quad a^1_{41,32} \quad a^1_{41,35} \quad a^1_{41,36} \quad a^1_{41,38} \quad a^1_{41,39} \quad a^1_{41,42}$$

$$a^1_{41,43} \quad a^1_{41,44} \quad a^1_{41,45} \quad a^1_{41,46} \quad a^1_{41,47} \quad a^1_{41,49} \quad a^1_{41,50}$$

are within the desirable range.

$b^1_{41,2}$ $b^1_{41,4}$ $b^1_{41,7}$ $b^1_{41,8}$ $b^1_{41,9}$ $b^1_{41,10}$ $b^1_{41,13}$ $b^1_{41,14}$

$b^1_{41,15}$ $b^1_{41,17}$ $b^1_{41,18}$ $b^1_{41,19}$ $b^1_{41,21}$ $b^1_{41,22}$ $b^1_{41,23}$ $b^1_{41,26}$

$b^1_{41,28}$ $b^1_{41,29}$ $b^1_{41,30}$ $b^1_{41,34}$ $b^0_{41,35}$ $b^1_{41,36}$ $b^1_{41,37}$ $b^1_{41,38}$

$b^0_{41,39}$ $b^0_{41,43}$ $b^0_{41,44}$ $b^0_{41,49}$ $b^0_{41,50}$

are outside the desirable region.

i .e the results of SIIRT is contradictory with that of MIIRT

Analysis of Item 42 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{42} and b_{42} are inside the admissible range.

The table A.42 given in appendix A, reveals that, when the significance of association of responses of item 42 with the remaining 49 items are tested, 42 items show high association between their responses and the response of item 42.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 42 should be selected into the final test tool.

Analysis of Item 43 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{43} and b_{43} are inside the admissible range.

The table A.43 given in appendix A, reveals that, when the significance of association of responses of item 43 with the remaining 49 items are tested, 16 items show high association between their responses and the response of item 43.

Among these significant items,when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 43 should be selected into the final test tool.

Analysis of Item 44 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{44} and b_{44} inside the admissible range.

The table A.44 given in appendix A, reveals that, when the significance of association of responses of item 43 with the remaining 49 items are tested, 20 items show high association between their responses and the response of item 43.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 44 should be selected into the final test tool.

Analysis of Item 45 :–

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{45} when was outside the admissible range.

The table A.45 given in appendix A, reveals that, when the significance of association of responses of item 45 with the remaining 49 items are tested, 37 items show high association between their responses and the response of item 45.

Among these significant items,

When item parameters of a and b were computed conditional on other items, we found that

$$a^1_{45,25} \quad a^1_{45,34} \quad a^1_{45,35} \quad a^1_{45,36} \quad a^1_{45,38} \quad a^1_{45,39} \quad a^1_{45,40} \quad a^1_{45,41}$$

$$a^1_{45.42} \quad a^1_{45,43} \quad a^1_{45,44} \quad a^1_{45,46} \quad a^1_{45,47} \quad a^1_{45,48} \quad a^1_{45,49} \quad a^1_{45,50}$$

are within the desirable range. and

$$b^1_{45,2} \quad b^1_{45,8} \quad b^1_{45,9} \quad b^1_{45,10} \quad b^1_{45,11} \quad b^1_{45,13} \quad b^1_{45,15} \quad b^1_{45,17}$$

$$b^1_{45,18} \quad b^1_{45,19} \quad b^1_{45,25} \quad b^1_{45,26} \quad b^1_{45,29} \quad b^1_{45,30} \quad b^1_{45,34} \quad b^1_{45,35}$$

$$b^1_{45,36} \quad b^1_{45,37} \quad b^1_{45,38} \quad b^1_{45,39} \quad b^1_{45,41} \quad b^1_{45,42} \quad b^1_{45,43} \quad b^1_{45,48} \quad b^0_{45,50}$$

are outside the desirable range.

Analysis of Item 46 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{46} and b_{46} are inside the admissible range.

The table A.46 given in appendix A, reveals that, when the significance of association of responses of item 46 with the remaining 49 items are tested, 49 items show high association between their responses and the response of item 46.

Among these significant items, when item parameters of a and b are computed conditional on other items , we found that $a^0_{46,3}$, $a^0_{46,8}$, $a^1_{46,22}$, $a^0_{46,40}$, are outside the desirable range. When item difficulty is considered, $b^0_{46,3}$ $b^0_{46,5}$ and $b^0_{46,8}$ are outside the desirable range.

Since the IIRT estates are outside the desirable range for very few items, we can include the item into the final test tool.

Analysis of Item 47 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{47} and b_{47} when marginally considered are inside the admissible range.

The table A.47 given in appendix A, reveals that, when the significance of association of responses of item 47 with the remaining 49 items are tested, 30 items show high association between their responses and the response of item 47.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all values of the parameters are inside the admissible range.

Hence item no. 47 should be selected into the final test tool.

Analysis of Item 48 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{48} was outside the admissible range. The table A.48 given in appendix A, reveals that, when the significance of association of responses of item 48 with the remaining 49 items are tested, 33 items show high association between their responses and the response of item 48.

Among these significant items, when item parameters of a and b were computed conditional on other items , we can see that the MIIRT estimates

$$a^1_{48,38} \quad a^1_{48,39} \quad a^1_{48,41} \quad a^1_{48,44} \quad a^1_{48,45} \quad a^1_{48,46} \quad a^1_{48,47} \quad a^1_{48,49} \quad a^1_{48,50}$$

are inside the desirable range. and

$$b^1_{48.2} \quad b^1_{48,9} \quad b^1_{48,11} \quad b^1_{48,15} \quad b^1_{48,17} \quad b^1_{48,19} \quad b^1_{48,21} \quad b^1_{48,24} \quad b^1_{48,26} \quad b^1_{48,27} \quad b^1_{48,28} \quad b^1_{48,29}$$
$$b^1_{48,32} \quad b^1_{48,34} \quad b^1_{48,36} \quad b^1_{48,37} \quad b^1_{48,38} \quad b^1_{48,39} \quad b^1_{48,41} \quad b^1_{48,42} \quad b^0_{48,43} \quad b^1_{48,46} \quad b^0_{48,50}$$

are outside the desirable range.

Hence item no. 48 cannot be deleted.

On Item No. 49 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{49} and b_{49} are outside the admissible range. The table A.49, given in appendix A reveals that, when the significance of association of responses of item 49 with the remaining 49 items are tested, 13 items show high association between their responses and the response of item 49.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that all a are outside the desirable range and

$b^0_{49,34}$ $b^0_{49,37}$ $b^0_{49,40}$ $b^0_{49,42}$ $b^0_{49,46}$ $b^0_{49,49}$ $b^1_{49,49}$ are within the desirable range.

i. e the results SIIRT and MIIRT are almost same except for some points of b. Hence the item should be eliminated fro the test tool.

On Item No. 50 :-

From table 3.2 in Section 3.7.1, one can see that the SIIRT estimate of a_{50} when marginally considered is outside the admissible range. The table A.50 given in appendix A, reveals that, when the significance of association of responses of item 50 with the remaining 49 items are tested, 21 items show high association between their responses and the response of item 50.

Among these significant items, when item parameters of a and b were computed conditional on other items , we found that

$$a^1_{50,35} \quad a^1_{50,39} \quad a^1_{50,41} \quad a^1_{50,42} \quad a^1_{50,43} \quad a^1_{50,44} \quad a^1_{50,45} \quad a^1_{50,47} \quad a^1_{50,48} \quad a^1_{50,49}$$

are within the desirable range

$$b^1_{50,11} \quad b^1_{50,13} \quad b^1_{50,25} \quad b^1_{50,34} \quad b^1_{50,38} \quad b^1_{50,42}$$

are outside the desirable range.

Hence item no. 50 cannot be eliminated.

Discussion

When IRT is applied without considering the joint nature (i.e. in SIIRT) we found that 41 items are selected into the final test tool and remaining 9 items are to be eliminated from the tool. But MIIRT results give a different report on the items to be eliminated.

The table 4.1 summarises the actions taken on items in both SIIRT and MIIRT approaches.

TABLE 4.1

Table indicating the number of items eliminated through

MIIRT item analysis of AR Component

	Selected by SIIRT	Eliminated by SIIRT	Total
Selected by MIIRT	37	–	37
Eliminated by MIIRT	4	1	5
Cannot be decided	–	8	8
Total	41	9	50

When multi-item approach is administered it can be seen that from the 41 items selected through SIIRT, item no. 9, item no. 28 , item no. 37 and item no. 38 cannot be selected to the final test tool as they do not possess the quality of good item in MIIRT analysis. Hence from these 41 items only 37 items can be selected for the final test tool.

In the 9 items eliminated through marginal analysis one can make the definite conclusion only on item 49, which is outside the desirable range for almost all points. For the remaining 8 items one cannot make definite conclusion as they possess the quality at least in some points.

In short, the MIIRT analysis suggests the revision / elimination of thirteen items from the collection of 50 items of AR component of DAT.

4.4 Item analysis of NA, MR, S- components of DAT in MIIRT approach

When similar MIIRT analysis was carried out for NA, MR, S- components of DAT in some of the items eliminated through SIIRT are found in satisfactory region for both a and b in some points. Similarly some of the items selected through SIIRT are found to be not in the desirable region of item difficulty and item discrimination in some points in MIIRT.

4.5 Conclusion

In CTT we found that almost all items in all the four components of DAT are eliminated through the item analysis process. The reason can be the inadequacy of classical method for the item analysis of DAT and the crude nature in defining the item characteristics. Hence classical method is not an efficient method for item analysis of DAT.

The IRT analysis reveals that only few items are eliminated from the test as part of the item analysis carried out with this method. It demands elimination of very few items or revision of some items. As IRT is based on probability models it gives more powerful results than CTT. This theoretical strength of IRT leads to better results in the item analysis of DAT.

The drawback of existing IRT approach is that it neglects the possibility of joint nature of items in reflecting a particular trait. This drawback can be overcome with the method suggested as MIIRT. One can find the estimates of item parameters conditionally and the interpretation based on these estimates will be more powerful. The test tool consisting items selected through this method will measure the latent trait more effectively. The results obatined through MIIRT provides more informative results on item as well as on the test.

In short, one can conclude that MIIRT approach is more advisable for item analysis as it gives more informative results than the others.

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

Chapter 5

Summary and Future Research

In this chapter a brief summary of the work has been presented. An outline of the future research is also added.

5.1 Summary

Item analysis is the most important part of test construction. Test theory, the area of Psychometrics which discusses the methodology of test construction and standardisation deals with the procedure of item analysis for making a test tool better. It includes the test construction methods, mathematical and statistical modeling, analysis and interpretation of test results.

Even though test theory has been existing for many decades, most of the treatments in present day literature remains in its classical framework. In spite of the easiness of the process of item analysis, classical approach has many limitations. The major weakness of classical test theory method is that it provides only a crude estimate for each item characteristics. It does not consider the probabilistic or population wise nature of responding to an item by the subject.

The present study is an attempt to point out some of the weaknesses of classical approach in the context of item analysis and to present a more statistical treatment for item analysis. Item Response Theory (IRT) is the framework adopted for this.

One of the crucial assumptions of IRT is the assumption of independence between item responses. This assumption means that each item in the given set of items independently contains a unique component of information of the trait, which is not practically valid. It is logical to assume that the items will have joint information about the trait in the sense that the characteristics like joint discrimination and joint difficulty indices are more informative for taking decisions than the corresponding marginal indices. Once the joint discrimination and joint difficulty indices are defined, the same can be used for item analysis in a more efficient and informative way. As the first step we define the conditional indices, which gives whether the two items are jointly informative for the trait. The result of the study has been empirically validated with a real data consisting of a sample of size 1407 collected from students of Kerala using the psychometric tool, Differential Aptitude Tests (DAT), a well known test for the measurement of aptitude of the students.

The study has three parts. As an introduction the basics of testing and assessment, the procedure of item analysis, the descriptions on the test tool used for standardisaion, the data collection procedure adopted for the empirical validation of the findings of the study are presented in the introductory chapter of this thesis.

As the first part of the study, which is presented in the second chapter of the thesis, the Classical Test Theory(CTT) analysis has been discussed and CTT statistics are computed for four components of DAT viz. Abstract Reasoning, Numerical Ability, Mechanical Reasoning and Spelling. The statistics item difficulty and item discrimination index were computed based on a representative sample of size 1407 from 10^{th} standard students of Kerala. The relevance of items under classical approach in Kerala context is discussed here. The major finding of this part of the study is that either several items are inappropriate or the classical method is not a suitable one. It was found that almost all items in each components are eliminated through the classical item analysis process. In the case of Abstract Reasoning test 44 items out of 50 items are eliminated. In the case of Numerical ability test only one item is found to satisfy the criteria for good item.

In the case of Mechanical and Spelling tests no test item was found to be good as per classical criteria. It can be concluded that the possible reason for this findings may be because of the inadequacy of classical method for item analysis of DAT or inadequacy of DAT in measuring aptitude of the students. Here we feel that it may be because of the inadequacy of classical item analysis method as it does not assume any parent population assumption and no efficiency type measure is used for developing the tool.

To overcome these limitations, as the second part of the study, item analysis using the Item Response Theory was carried out. Item Response Theory (IRT) is an area of test theory which provides probabilistic approach to overcome some of the limitations of classical methods. IRT is a statistical technique involving models expressing the probability of a particular response to a scale item as a function of the trait of the subject. An overview of the most popular IRT models, a brief history of item response theory, the basic concepts from item response theory, assumptions of Item response theory and some recent studies on the application of IRT are described in Chapter 3. An estimation procedure in the presence of missing or incomplete data using EM algorithm has been presented here. The item parameters of the four components of DAT was computed using the algorithm prepared for that. From the estimates of the item parameters, we can see that only few items are eliminated from the test as part of the item analysis carried out with IRT method. In the case of Abstract Reasoning test only 9 items out of 50 are eliminated. In Numerical Ability test it is 23 out of 40 , in the case of Mechanical Reasoning test it is 10 out of 68 and in Spelling test it is only 22 out of 100.

This indicates that DAT measures the aptitude of the students in an effective way, after the revision of some of the items. Here we can also conclude that the CTT method is not appropriate for item analysis, even though CTT was the basis for the construction of DAT. A strong basis to DAT could be formed if the IRT would have been applied for the construction for DAT at the time. It may be the effect of time (generation difference as it was standardised in India in 1970s), IRT suggests for modifying certain items of all the DAT components.

This indicate that IRT is more suitable than CTT method in item analysis of Differential Aptitude Tests. In the case of Numerical Ability test more items are eliminated and it indicates the need for revision of items of the test. In short we got the result that IRT item analysis is more statistically efficient than its Classical counterpart.

The third part of the study introduces an approach which will treat the items jointly to decide the best item(s) under Item Response Theory framework. In this part the attempt is to suggest a method for choosing best item(s) by taking the interdependency of items in to consideration. This multi-item approach introduced in chapter 4 emphasises the need for considering the responses of more than one item together in item analysis. The results of applying the multi-item approach in four components of DAT have been presented in this chapter.

When we apply multi-item approach to different components of DAT, we could observe both the cases (i) some of the items selected in single-item approach are not informative and (ii) some of the items eliminated through single-item approach are informative. The study strongly recommends the use of multi-item approach for the item analysis of test tools. The study also points out the need for timely revision of DAT.

5.2 Future Research

Even though Item Response Theory is a fast growing research area for the last decade, a plenty of works has been left unfinished.

The results of the present study recommends the following as some of the research works to be carried out:

(i) The test tool, Differential Aptitude should be revised in an IRT framework. The present study focussed only on four test tools, which can be scored dichotomously. The remaining three tests are polytomous in its nature. They should be standardised with polytomous IRT models.

(ii) It also necessitates to consider more than two item simultaneously while selecting best items from a set of items. This study is limited to the case of two items at a time. The same can be done based on a set of k items together.

(iii) The study is confined to the logistic model for item response. There can be better multivariate models which should be investigated as a model for joint responses of all items together.

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the
University of Calicut

For the award of the Degree of
DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS
FAROOK COLLEGE, KOZHIKODE
KERALA- INDIA -673632

2007

REFERENCES

1. Anastasi, A., & Urbina, S. (2004). Psychological Testing, 7th Edition, Pearson Education, New Delhi.
2. Baker, J.G., Rounds J.B., & Zevon, M. A. (2000). A Comparison of Graded Response and Rasch Partial Credit Models with Subjective Well-Being. Journal of Educational and Behavioral Statistics, fall 2000, Vol. 25, No. 3, pp. 253-270.
3. Bechger, T. M., Maris, G., Verstralen & Beguin, A. A. (2003). Using Classical Test Theory in Combination with Item Response Theory. Applied Psychological Measurement, 27(5), 319-334.
4. Bielinski, J., & Davison, M., L. (1998). Gender Differences by Item Difficulty Interactions in Multiple-Choice Mathematics Items. American Educational Research Journal, Vol. 35, No. 3, pp. 455-476.
5. Bock, R. D. (1972). Estimating item parameters and latent ability when the responses are scored in two or more nominal categories. Psychometrika, 37, 29-51.
6. Bolt, D. M., Cohen, A., S., & Wollack, J., A. (2001). A Mixture Item Response Model for Multiple-Choice Data. Journal of Educational and Behavioral Statistics, Vol. 26, No. 4, pp. 381-409.

7. Cantrell, C.E., (1997). Item Response Theory: Understanding the one-parameter Rasch Model. Paper presented at the Annual Meeting of the southwest Education Research Association Austin, 1997.

8. Chang, C. H., & Reeve, B. B. (2005). Item Response theory and its applications to Patient reported outcome measurement. Evaluation & the Health professions Vol. 28 No. 3 264-282.

9. Cohen, R. J., & Swerdlik, M. E. (2005). Psychological Testing and Assessment: An introduction to tests and measurement. McGraw Hill-New York.

10. Cohen, R. J., Swerdlick, M. E., & Philips, S. M. (1996). Test development in Psychological testing and Assessment: an Introduction to tests and Measurement, 3rd Edition, Mountain view, CA, Mayfield.

11. Crocker, L., & Algina, J. (1986). Introduction to classical and modern test theory. Toronto: Holt, Rine Hart, and Winston, Inc.

12. Cureton, E. E., (1957). The upper and lower twenty seven percent rule. Psychometrika 22, 293-296

13. Dempster, A. P., Laird, N.M., & Rubin, D. B (1977). Maximum likelihood estimation from incomplete data via the EM algorithm. Journal of the Royal Statistical Society B, 39, 1-38.

14. Department of Education (1999). List of high schools, special schools, Anglo Indian schools and teachers training institutes, The Statistical Unit, Office of Public Instruction, Govt. of Kerala.

15. Ebel R., T., and Frisbie D., A., (1991) Essentials of Educational Measurement, Prentice-Hall of India, New Delhi.

16. Embretson, S. E., & Reise, S. P. (2000). Item Response Theory for Psychologists. Mahwah, New Jersey: Lawrence Erlbaum Associates.

17. Ferguson, G. A. (1943). Item selection by the constant process. Psychometrika, 7, 19-29.

18. Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An Item Response Theory Analysis of Self-Report Measures of Adult Attachment. Journal of Personality and Social Psychology Vol. 78, No. 2, 350-365.

19. Freeman .F.S, (1965) Theory and practice of Psychological Testing, Oxford and IBH publishing co., New Delhi.

20. French, C.L. (2001). A review of classical methods of Item Analysis. Paper presented in annual meeting of the Southwest Educational Research Association, New Orleans, February 1-3, 2001. ERIC.

21. Garcia-Perz, M.A (1999). Fitting logistic IRT Models: Small wonder. The Spanish Journal of Psychology Vol 2 No. 1 74-94.

22. Ghosh, M., Ghosh, A., Chen, M. H., & Agresti, A. (2000). Bayesian Estimation for Item Response Models. Journal of Statistical Planning and Inference, 88, 99-115, 2000.

23. Groningen, R. (2004). Ordered latent class models in nonparametric item responses theory. Doctoral thesis.

24. Guilford, J. P. (1982). Psychometric Methods. Mc Graw Hill , New York

25. Hahn, E. A., Holzner, B., Kemmler, G., Spermerumterweger, B., Hudgens, S. A., & Cella, D., (2005) Cross- Cultural Evaluation of Health Status Using Item Response Theory, Evaluation & the Health Professions, Vol. 28 No. 2, 233-259.

26. Hambleton, R. K., & Swaminathan, H., (1985). Item Response Theory: Principles and applications. Boston: Kluwer.

27. Hambleton, R. K., & Jones, R. W. (1993). Comparison of classical test theory and item response theory and their applications to test development. Educational Measurement: Issues and Practice, 12(3), 38-47

28. Hays, R. D., Morales, S. L., & Reise, P. S. (2000). Item Response Theory and Health Outcomes Measurement in the 21st Century. Medical Care, 38 pp II-28–II-42.

29. Helms, L. S. (1999). Basic Concepts in Classical Test theory: Tests aren't Reliable, the Nature of Alpha and Reliability Generalization as Meta-analytic Method. , Paper presented at the annual meeting of Southwest Educational Research Association, San Antonio, Jamuary21, 1999.

30. Henson, R. K., (1999). Understanding the one parameter Rasch Model of Item Response Theory. ERIC.

31. Hulin CL, Drasgow F, and Parsons CK: Item response theory: Applications to psychological measurement. Homewood, IL: Irwin.

32. Janssen, R., Tuerlinckx, F., Meulders, M., & Boeck P. D. (2000). A Hierarchical IRT Model for Criterion-Referenced Measurement, Journal of Educational and Behavioral Statistics, Vol. 25, No. 3, pp. 285-306.

33. Kacmar, K. M., Farmer, W. L., Zivnuska, S. & Witt, L. A. (2006). Applying Multidimensional Item Response Theory Analysis to a Measure of Meta-Perspective Performance. The Electronic Journal of Business Research Methods. Volume 4 Issue 1, pp 23 -30, available online at www.ejbrm.com

34. Kaplan, R. M., & Saccuzoo, D.P. (2001). Psychological Testing – Principles, Applications and Issues -5th Edition, Wadsworth, Stanford.

35. Karabatsos, G. (2001). The Rasch Model, Additive Conjoint Measurement, and New Models of Probabilistic Measurement Theory. Journal of Applied Measurement 2(4), 389–423.

36. Kostin, I. (2004). Exploring Item Characteristics- That Are Related to the Difficulty of TOEFL Dialogue Items, Educational Testing Service.

37. Lawley, D. N. (1943). On problems connected with item selection and test construction. Proceedings of the Royal Society of Edinburgh, 74-82.

38. Lazarsfeld, P. F. (1950). The logical and mathematical foundation of latent structure analysis. Measurement and Prediction. Wiley, New York.

39. Lohman, D.F., Ippel, M.J. (1992). Cognitive Diagnosis: From Statistically based assessment towards theory based assessment: Test theory for new generation of tests. Edited by Norman Frederiksen, Robert J. Mislevy, Isaac I. Bejar, Lawrence Erlbaum Associates.

40. Lord F. M., & Novick, M. R (1968). Statistical Theories of mental test scores. Addison-Wesley.

41. Lord, F. M. (1952). A theory of test scores. Psychometric Monographs, Whole No. 7.

42. Lord, F.M. (1977). Practical Applications of Item Characteristic Curve Theory. Journal of Educational Measurement, Vol. 14, No. 2, pp. 117-138.

43. Macdonald, R.P. (1999). Test Theory – A unified treatment, Lawrence Erlbaum Associates.

44. Macklem, G. L. (1990). Measuring aptitude. Practical Assessment, Research and Evaluation, 2(5). Retrieved from http://PAREonline.net/getvn.asp.

45. Masters, G., N. (1988). Item Discrimination: When more is Worse, Journal of Educational Measurement, 25, 1,15,1988.

46. Mungas, D., & Reed, B. R. (2000). Application of item response theory for development of a global functioning measure of dementia with linear measurement properties. Statistics in Medicine, 19:1631-1644

47. Noortgate, W. V., Boeck, P. D., Meulders, M. (2003). Cross-Classification Multilevel Logistic Models in Psychometrics. Journal of Educational and Behavioral Statistics, Vol. 28, No. 4, pp. 369-386.

48. Ogasawara, H. (2001). Item Response Theory True Score Equating and Their Standard Errors, Journal of Educational and Behavioral Statistics, Vol. 26, No. I, pp. 31-50

49. Ojha, J.M. (1989). Revision of Differential Aptitude Tests for higher secondary schools, Manasayan, New Delhi.

50. Orlando, M. (2000). Likelihood-Based Item-Fit Indices for Dichotomous Item Response Theory Models. Applied Psychological Measurement, Vol. 24 No. 1, 50–64

51. Richardson, M. W. (1936). The relationship between difficulty and the differential validity of a test. Psychometrika, 1, 33-49.

52. Rossi, N., Wang, X., & Ramsay, J. (2002). Nonparametric Item Response Function Estimates with the EM Algorithm , Journal of Educational and Behavioral Statistics , Vol. 27, No. 3, pp. 291-317

53. Rudner L., M. (1980). Getson P., R., & Knight D., L., A. Monte Carlo Comparison of seven Biased item detection techniques, Journal of Educational Measurement 17, 1.

54. Rudner, L., M., (1998). An on-line interactive computer adaptive testing mini-tutorial, http://edresearch.org/scripts/cat.

55. Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. Psychometrika Monographs, 34.

56. Stage, C. (2003). Classical test theory or Item Response theory: The Swedish Experience. UMEA Univerisitet. www.cepchile.cl.

57. Stout, W. (2002). Psychometrics: From practice to theory and back, Psychometrika- 67, 485–518.

58. Sung, H. J. & Kang, T. (2006). Choosing a Polytomous IRT Model using Bayesian Model Selection Methods, paper presented at the National Council on Measurement in Education annual meeting in San Francisco, April, 2006.

59. Thornton, A., (2002). A Primer on the 2- and 3- parameter Item Response Theory Models, Paper presented at the annual meeting of the Educational Research Exchange, University of North Texas, and February, 2002.

60. Thurstone, L. L. (1925). A method of scaling psychological and educational tests. Journal of Educational Psychology, 16, 433-451.

61. Veerkamp, W. J. J. (2000). Taylor Approximations to Logistic IRT Models and Their Use in Adaptive Testing. Journal of Educational and Behavioral Statistics. Vol. 25, No. 3, pp. 307-343

62. Veerkamp, W. J. J., & Berger, M. P. F. (1999). Optimal Item Discrimination and Maximum Information for Logistic IRT Models , Applied Psychological Measurement, Vol. 23, No. 1, 31-40

63. Verstral, H., Bechger, T., & Maris G. (2001). The combined use of classical test theory and item response theory. http: www.cito.nl/pok/poc

64. Wagner, T. A., & Harvey, R. J. (2003). Developing A New Critical Thinking Test Using Item Response Theory Paper presented at the Annual Conference of the Society for Industrial and Organizational Psychology, Orlando.

65. Whitely, S. E. (1981). Measuring Aptitude Processes with Multicomponent Latent Trait Models. Journal of Educational Measurement, Vol. 18, No. 2. pp. 67-84.

66. Wiberg, M (2004) Classical test theory Vs Item Response theory- An evaluation of the theory test in Swedish driving license test. UMEA Universitet.

67. Xitao, F. (1998). Item response theory and classical test theory: an empirical comparison of their item/person statistics, Educational and Psychological Measurement, 58, 357- (25).

SOME CONTRIBUTIONS TO MULTI-ITEM APPROACH FOR ITEM RESPONSE MODELS

Thesis submitted to the

University of Calicut

For the award of the Degree of

DOCTOR OF PHILOSOPHY

AHAMAD ASHRAF Z. A.

DEPARTMENT OF STATISTICS

FAROOK COLLEGE, KOZHIKODE

KERALA- INDIA -673632

2007

APPENDIX A

TABLE A.1

The Table showing the values of item parameters a and b of all items conditioned on item no. 1

Item	Item 1= 0	Item 1= 1	χ^2	p	Significance
2	a= 1.2717	a= 0.8162			
	b= -0.1454	b= -0.1731	82.241	0.000	Significant
3	a= 1.2542	a= 0.9404			
	b= -0.0266	b= -0.1156	145.190	0.000	Significant
4	a= 1.0435	a= 0.8489			
	b= -0.0715	b= -0.1471	76.705	0.000	Significant
5	a= 1.3441	a= 1.1376			
	b= 0.0374	b= -0.0011	77.584	0.000	Significant
6	a= 1.4648	a= 1.0966			
	b= 0.0169	b= -0.0349	38.584	0.000	Significant
7	a= 1.1693	a= 0.9831			
	b= -0.0966	b= -0.1445	55.658	0.000	Significant
8	a= 1.6596	a= 1.3868			
	b= 0.0994	b= 0.1955	49.350	0.000	Significant
9	a= 1.2799	a= 0.988			
	b= -0.1738	b= -0.0798	26.488	0.000	Significant
10	a= 1.4015	a= 1.3627			
	b= 0.31	b= 0.2192	49.975	0.000	Significant
11	a= 0.8562	a= 0.7858			
	b= -0.0942	b= -0.1498	23.513	0.000	Significant
12	a= 1.0859	a= 1.0284			
	b= -0.0379	b= -0.0037	55.079	0.000	Significant
13	a= 1.1945	a= 1.0901			
	b= -0.1439	b= -0.0068	24.856	0.000	Significant
14	a= 1.3751	a= 1.2127			
	b= -0.0386	b= 0.0895	22.491	0.000	Significant
15	a= 0.9854	a= 0.8379			
	b= -0.1686	b= -0.1611	23.556	0.000	Significant
16	a= 1.378	a= 1.0288			
	b= -0.0554	b= -0.0857	55.024	0.000	Significant
17	a= 1.1589	a= 0.8969			
	b= -0.109	b= -0.0453	56.882	0.000	Significant
18	a= 1.1194	a= 1.1069			
	b= -0.0856	b= -0.043	49.350	0.000	Significant

Item	Item 1= 0	Item 1= 1	χ^2	p	Significance
19	a= 0.9001 b= -0.0878	a= 0.9334 b= -0.045	18.355	0.000	Significant
20	a= 1.4693 b= 0.1157	a= 1.4529 b= 0.3607	15.730	0.000	Significant
21	a= 1.366 b= 0.4551	a= 1.5124 b= 0.3941	9.899	0.002	Significant
22	a= 1.1874 b= -0.2681	a= 0.9164 b= -0.1001	12.526	0.000	Significant
23	a= 1.2807 b= 0.0179	a= 1.1769 b= 0.0991	45.318	0.000	Significant
24	a= 1.0118 b= 0.0375	a= 1.0413 b= 0.1202	21.550	0.000	Significant
25	a= 1.2995 b= -0.1993	a= 1.0985 b= -0.024	13.053	0.000	Significant
27	a= 1.2793 b= 0.0306	a= 1.3201 b= 0.1351	25.467	0.000	Significant
28	a= 0.7891 b= -0.0074	a= 0.7516 b= -0.0245	11.351	0.000	Significant
29	a= 1.2143 b= -0.215	a= 1.0362 b= -0.0547	26.230	0.000	Significant
30	a= 1.084 b= 0.2172	a= 1.2109 b= 0.1101	12.716	0.000	Significant
31	a= 1.4497 b= 0.2869	a= 1.7847 b= 0.6721	0.572	0.449	Not Significant
32	a= 1.3379 b= -0.0723	a= 1.2566 b= 0.116	14.166	0.000	Significant
33	a= 1.9645 b= 0.5043	a= 1.8093 b= 0.6749	12.498	0.000	Significant
34	a= 1.08 b= 0.0187	a= 1.0661 b= -0.0115	19.845	0.000	Significant
35	a= 1.2325 b= 0.0109	a= 1.391 b= 0.3217	2.258	0.132	Not Significant
36	a= 1.593 b= -0.1229	a= 1.5659 b= 0.3538	3.679	0.055	Not Significant
37	a= 2.0035 b= -0.3036	a= 1.49 b= 0.1053	17.204	0.000	Significant
38	a= 1.7662 b= -0.1551	a= 1.7247 b= 0.2712	4.962	0.025	Not Significant

Item	Item 1= 0	Item 1= 1	χ^2	p	Significance
39	a= 1.6909 b= 0.0355	a= 1.7539 b= 0.645	0.967	0.325	Not Significant
40	a= 0.7217 b= 0.0577	a= 0.8086 b= -0.0454	11.247	0.000	Significant
41	a= 3.2936 b= -0.4181	a= 1.847 b= 0.4417	9.830	0.002	Significant
42	a= 1.2515 b= -0.1028	a= 1.2988 b= 0.1511	6.979	0.008	Significant
43	a= 1.3736 b= -0.0894	a= 1.3581 b= 0.3161	5.368	0.020	Not Significant
44	a= 1.0538 b= -0.078	a= 1.3771 b= 0.2208	0.0067	0.934	Not Significant
45	a= 1.934 b= -0.2472	a= 1.8585 b= 0.4428	1.064	0.302	Not Significant
46	a= 1.7134 b= -0.4348	a= 1.3122 b= -0.0357	18.209	0.000	Significant
47	a= 1.2433 b= -0.0799	a= 1.3569 b= 0.1296	5.252	0.021	Not Significant
48	a= 2.2823 b= -0.1674	a= 2.0357 b= 0.4082	3.717	0.053	Not Significant
49	a= 2.934 b= -0.2052	a= 2.0022 b= 0.6784	3.294	0.069	Not Significant
50	a= 2.642 b= -0.3969	a= 1.8813 b= 0.3716	5.179	0.022	Not Significant

TABLE A.2

The Table showing the values of item parameters a and b of all items conditioned on item no. 2

Item	Item 2= 0	Item 2= 1	χ^2	p	Significance
1	a= 0.6826	a= 0.765			
	b= -0.0509	b= -0.2221	82.241	0.000	Significant
3	a= 1.1262	a= 0.8812			
	b= -0.0177	b= -0.1554	196.339	0.000	Significant
4	a= 0.9093	a= 0.8533			
	b= -0.1136	b= -0.1575	196.86	0.000	Significant
5	a= 1.5279	a= 0.9552			
	b= 0.2691	b= -0.098	109.86	0.000	Significant
6	a= 1.5016	a= 0.9516			
	b= 0.0817	b= -0.076	310.75	0.000	Significant
7	a= 1.2612	a= 0.8749			
	b= -0.084	b= -0.1698	259.112	0.000	Significant
8	a= 1.9744	a= 1.1104			
	b= 0.577	b= 0.0807	243.038	0.000	Significant
9	a= 1.1435	a= 0.9489			
	b= -0.0591	b= -0.092	325.689	0.000	Significant
10	a= 1.6131	a= 1.2538			
	b= 0.2942	b= 0.2083	132.107	0.000	Significant
11	a= 0.7834	a= 0.8178			
	b= -0.0915	b= -0.1762	125.960	0.000	Significant
12	a= 1.1111	a= 1.0043			
	b= 0.0398	b= -0.025	77.196	0.000	Significant
13	a= 1.2218	a= 1.0566			
	b= -0.0817	b= 0.0276	99.290	0.000	Significant
14	a= 1.4968	a= 1.0666			
	b= 0.278	b= 0.0227	82.734	0.000	Significant
15	a= 0.9119	a= 0.8288			
	b= -0.1312	b= -0.1783	206.06	0.000	Significant
16	a= 1.3072	a= 0.9455			
	b= -0.0462	b= -0.0936	124.98	0.000	Significant
17	a= 0.9278	a= 0.9362			
	b= -0.02	b= -0.0593	185.507	0.000	Significant
18	a= 1.3194	a= 1.0087			
	b= 0.0116	b= -0.0654	66.825	0.000	Significant

Item	Item 2= 0	Item 2= 1	χ^2	p	Significance
19	a= 0.9348 b= -0.0194	a= 0.9499 b= -0.0598	157.89	0.000	Significant
20	a= 1.6531 b= 0.1119	a= 1.4348 b= 0.4465	63.702	0.000	Significant
21	a= 1.6104 b= 0.1457	a= 1.5500 b= 0.5000	44.729	0.000	Significant
22	a= 1.008 b= -0.1115	a= 0.9092 b= -0.1084	26.902	0.000	Significant
23	a= 1.23 b= 0.0036	a= 1.2013 b= 0.1445	100.339	0.000	Significant
24	a= 0.9804 b= 0.117	a= 1.1158 b= 0.1162	45.825	0.000	Significant
25	a= 1.2321 b= -0.1173	a= 1.079 b= 0.0054	29.305	0.000	Significant
27	a= 1.5252 b= 0.0567	a= 1.2373 b= 0.1633	76.047	0.000	Significant
28	a= 0.704 b= 0.0355	a= 0.8204 b= -0.0672	90.455	0.000	Significant
29	a= 1.1685 b= -0.1232	a= 1.0072 b= -0.036	31.451	0.000	Significant
30	a= 1.2393 b= 0.1815	a= 1.185 b= 0.0927	90.546	0.000	Significant
31	a= 1.8887 b= 0.2716	a= 1.8067 b= 0.7832	16.413	0.000	Significant
32	a= 1.2945 b= -0.0408	a= 1.3013 b= 0.1735	32.582	0.000	Significant
33	a= 2.3419 b= 0.3053	a= 1.7527 b= 0.7594	47.645	0.000	Significant
34	a= 1.0798 b= -0.0207	a= 1.0902 b= -0.0062	53.562	0.000	Significant
35	a= 1.3124 b= 0.0253	a= 1.5158 b= 0.4298	5.4117	0.020	Not Significant
36	a= 1.707 b= 0.048	a= 1.5881 b= 0.42	30.141	0.000	Significant
37	a= 2.0029 b= -0.1817	a= 1.3845 b= 0.1754	80.287	0.000	Significant
38	a= 1.9537 b= -0.0069	a= 1.6904 b= 0.3395	40.417	0.000	Significant

Item	Item 2= 0	Item 2= 1	χ^2	p	Significance
39	a= 1.8518 b= -0.0275	a= 1.9333 b= 0.8494	0.00002	0.996	Not Significant
40	a= 0.7500 b= 0.0355	a= 0.854 b= -0.0731	32.564	0.000	Significant
41	a= 2.4435 b= -0.1361	a= 1.8762 b= 0.5717	20.297	0.000	Significant
42	a= 1.2734 b= -0.0304	a= 1.3611 b= 0.1982	23.119	0.000	Significant
43	a= 1.1994 b= 0.0862	a= 1.5483 b= 0.4008	1.9490	0.162	Not Significant
44	a= 1.1752 b= 0.0171	a= 1.5299 b= 0.2848	2.3101	0.128	Not Significant
45	a= 2.1467 b= -0.1209	a= 1.9131 b= 0.5803	8.5675	0.003	Significant
46	a= 1.4601 b= -0.2557	a= 1.3048 b= 0.0205	44.532	0.000	Significant
47	a= 1.1496 b= 0.0653	a= 1.5398 b= 0.15	5.8473	0.015	Not Significant
48	a= 2.5248 b= -0.0976	a= 2.0407 b= 0.516	17.213	0.000	Significant
49	a= 2.2382 b= 0.0154	a= 2.2317 b= 0.8319	0.241	0.623	Not Significant
50	a= 2.2733 b= -0.1071	a= 1.8807 b= 0.4817	18.755	0.000	Significant

TABLE A.3

The Table showing the values of item parameters a and b
of all items conditioned on item no. 3

Item	Item 3= 0	Item 3= 1	χ^2	p	Significance
1	a= 0.6698 b= 0.0719	a= 0.7351 b= -0.1972	145.190	0.000	Significant
2	a= 1.8319 b= 0.2201	a= 1.1067 b= 0.0265	196.339 +	0.000	Significant
4	a= 1.3265 b= 0.0142	a= 1.5252 b= 0.0027	224.316	0.000	Significant
5	a= 1.1162 b= -0.0342	a= 0.8176 b= -0.1581	224.316	0.000	Significant
6	a= 1.5252 b= 0.0027	a= 1.0963 b= 0.0000	253.818	0.000	Significant
7	a= 1.6992 b= -0.0891	a= 1.0477 b= -0.0278	135.510	0.000	Significant
8	a= 1.4569 b= -0.119	a= 0.9272 b= -0.1453	173.325	0.000	Significant
9	a= 1.8508 b= -0.026	a= 1.3592 b= 0.2081	224.070	0.000	Significant
10	a= 1.3968 b= -0.1458	a= 0.9487 b= -0.081	83.8617	0.000	Significant
11	a= 1.6861 b= 0.0867	a= 1.3297 b= 0.2343	180.758	0.000	Significant
12	a= 0.8785 b= -0.0403	a= 0.7707 b= -0.1629	85.0456	0.000	Significant
13	a= 1.1004 b= 0.0413	a= 1.0161 b= -0.0117	200.167	0.000	Significant
14	a= 1.4758 b= -0.0504	a= 1.0334 b= -0.0123	97.3540	0.000	Significant
15	a= 1.3211 b= -0.0267	a= 1.2161 b= 0.091	154.798	0.000	Significant
16	a= 1.1224 b= -0.2197	a= 0.8041 b= -0.1574	68.044	0.000	Significant
17	a= 1.4118 b= -0.2251	a= 1.0062 b= -0.0714	225.102	0.000	Significant
18	a= 0.9189 b= 0.0094	a= 0.9172 b= -0.0546	138.302	0.000	Significant

Item	Item 3= 0	Item 3= 1	χ^2	p	Significance
19	a= 1.2157 b= -0.0836	a= 1.0883 b= -0.0415	86.1200	0.000	Significant
20	a= 1.083 b= -0.0938	a= 0.8999 b= -0.0434	87.2147	0.000	Significant
21	a= 1.6845 b= -0.0307	a= 1.4491 b= 0.3744	127.183	0.000	Significant
22	a= 1.6354 b= 0.0536	a= 1.5217 b= 0.4184	46.2183	0.000	Significant
23	a= 1.3578 b= -0.2317	a= 0.874 b= -0.102	38.992	0.000	Significant
24	a= 1.2023 b= -0.1148	a= 1.2035 b= 0.1163	198.670	0.000	Significant
25	a= 0.9177 b= 0.1203	a= 1.0772 b= 0.1108	41.3883	0.000	Significant
26	a= 1.5613 b= -0.2699	a= 1.058 b= -0.0178	32.2005	0.000	Significant
27	a= 1.3667 b= -0.176	a= 1.3374 b= 0.1584	119.393	0.000	Significant
28	a= 0.6907 b= 0.1401	a= 0.7745 b= -0.0527	62.6679	0.000	Significant
29	a= 1.482 b= -0.3727	a= 1.0001 b= -0.0374	113.146	0.000	Significant
30	a= 1.0201 b= 0.1345	a= 1.2638 b= 0.1067	24.4573	0.000	Significant
31	a= 2.1455 b= -0.1059	a= 1.7751 b= 0.6896	17.6729	0.000	Significant
32	a= 1.465 b= -0.2153	a= 1.2525 b= 0.131	50.3019	0.000	Significant
33	a= 2.6977 b= -0.3887	a= 1.8717 b= 0.7199	12.0768	0.000	Significant
34	a= 1.0566 b= -0.0223	a= 1.0732 b= -0.0089	54.4368	0.000	Significant
35	a= 1.2243 b= -0.1157	a= 1.4559 b= 0.3397	6.56548	0.000	Significant
36	a= 1.8866 b= -0.5016	a= 1.6242 b= 0.3713	10.7870	0.000	Significant
37	a= 2.2614 b= -0.4396	a= 1.461 b= 0.1333	55.4521	0.000	Significant
38	a= 2.2229 b= -0.4293	a= 1.7299 b= 0.2942	23.3821	0.000	Significant

Item	Item 3= 0	Item 3= 1	χ^2	p	Significance
39	a= 2.1467	a= 1.8256			
	b= -0.4344	b= 0.6723	2.9427	0.086	Not Significant
40	a= 0.8048	a= 0.79			
	b= 0.0593	b= -0.0453	86.534	0.000	Significant
41	a= 2.3751	a= 1.9059			
	b= -0.3458	b= 0.4633	14.9220	0.000	Significant
42	a= 1.0609	a= 1.3697			
	b= -0.0145	b= 0.1534	9.4131	0.002	Significant
43	a= 0.99	a= 1.5055			
	b= 0.0403	b= 0.3215	0.0080	0.928	Not Significant
44	a= 0.9668	a= 1.4819			
	b= 0.0571	b= 0.2033	0.6222	0.430	Not Significant
45	a= 2.1838	a= 1.9065			
	b= -0.3647	b= 0.4433	8.6675	0.003	Significant
46	a= 1.7999	a= 1.3054			
	b= -0.5938	b= -0.0194	45.472	0.000	Significant
47	a= 1.0238	a= 1.4579			
	b= 0.0402	b= 0.1108	5.1674	0.023	Not Significant
48	a= 2.2143	a= 2.1137			
	b= -0.3163	b= 0.4212	6.3397	0.011	Not Significant
49	a= 2.0256	a= 2.2401			
	b= -0.3598	b= 0.6897	0.687	0.407	Not Significant
50	a= 1.9943	a= 1.9767			
	b= -0.3709	b= 0.3905	4.1195	0.042	Not Significant

TABLE A.4

The Table showing the values of item parameters a and b of all items conditioned on item no. 4

Item	Item 4= 0	Item 4= 1	χ^2	p	Significance
1	a=0.6549	a=0.7568			
	b=0.0049	b=-0.2076	76.705	0.000	Significant
2	a=1.6329	a=1.0860			
	b=0.2078	b=0.0095	196.868	0.000	Significant
3	a=0.9792	a=0.7983			
	b=-0.0858	b=-0.1979	224.316	0.000	Significant
5	a=0.9701	a=0.8318			
	b=-0.0405	b=-0.1707	178.484	0.000	Significant
6	a=1.5429	a=1.0440			
	b=0.1517	b=-0.0310	201.720	0.000	Significant
7	a=1.7252	a=0.9810			
	b=0.1249	b=-0.0646	279.660	0.000	Significant
8	a=1.5617	a=0.8660			
	b=-0.0140	b=-0.1706	353.138	0.000	Significant
9	a=1.9051	a=1.2912			
	b=0.1792	b=0.1861	135.094	0.000	Significant
10	a=1.1867	a=0.9620			
	b=-0.0992	b=-0.0808	130.973	0.000	Significant
11	a=1.7233	a=1.2690			
	b=0.3258	b=0.2032	140.203	0.000	Significant
12	a=0.7849	a=0.7997			
	b=-0.0413	b=-0.1760	105.989	0.000	Significant
13	a=1.0472	a=1.0413			
	b=-0.0021	b=-0.0045	63.4122	0.000	Significant
14	a=1.2670	a=1.0605			
	b=-0.1075	b=0.0068	91.7935	0.000	Significant
15	a=1.4303	a=1.1766			
	b=0.0316	b=0.0928	94.5365	0.000	Significant
16	a=0.9488	a=0.8213			
	b=-0.1310	b=-0.1715	149.651	0.000	Significant
17	a=1.4651	a=0.9592			
	b=-0.0720	b=-0.0908	203.472	0.000	Significant
18	a=0.9194	a=0.9249			
	b=0.0100	b=-0.0637	74.9266	0.000	Significant

Item	Item 4= 0	Item 4= 1	χ^2	p	Significance
19	a=1.3270 b=-0.0608	a=1.0523 b=-0.0440	119.013	0.000	Significant
20	a=0.8860 b=-0.0163	a=0.9583 b=-0.0545	46.4584	0.000	Significant
21	a=1.7145 b=0.0585	a=1.4340 b=0.3958	49.4244	0.000	Significant
22	a=1.7047 b=0.1075	a=1.5095 b=0.4448	40.8307	0.000	Significant
23	a=1.0901 b=-0.1313	a=0.8917 b=-0.1074	129.961	0.000	Significant
24	a=1.3709 b=-0.0038	a=1.1458 b=0.1095	82.3213	0.000	Significant
25	a=0.9126 b=0.0797	a=1.1170 b=0.1263	14.6675	0.000	Significant
26	a=1.3998 b=-0.1597	a=1.0496 b=-0.0150	109.886	0.000	Significant
27	a=1.5478 b=-0.0282	a=1.2715 b=0.1601	70.0500	0.000	Significant
28	a=0.6674 b=0.0863	a=0.8067 b=-0.0620	24.9784	0.000	Significant
29	a=1.2054 b=-0.1630	a=1.0146 b=-0.0450	86.1504	0.000	Significant
30	a=1.1541 b=0.0877	a=1.2344 b=0.1211	37.0525	0.000	Significant
31	a=2.1419 b=0.0824	a=1.7511 b=0.7317	21.5298	0.000	Significant
32	a=1.3156 b=-0.0847	a=1.2734 b=0.1474	36.3006	0.000	Significant
33	a=2.6624 b=0.0774	a=1.7828 b=0.7321	36.2341	0.000	Significant
34	a=1.1153 b=-0.0296	a=1.0888 b=-0.0049	65.3123	0.000	Significant
35	a=1.2458 b=-0.0215	a=1.4810 b=0.3758	4.64003	0.031	Not Significant
36	a=1.6668 b=-0.1514	a=1.6164 b=0.4168	12.2637	0.001	Significant
37	a=2.4473 b=-0.4027	a=1.4047 b=0.1482	76.4293	0.000	Significant
38	a=2.5116 b=-0.2741	a1.6409= b=0.3127	49.6341	0.000	Significant

Item	Item 4= 0	Item 4= 1	χ^2	p	Significance
39	a=1.9396	a=1.8181			
	b=-0.1415	b=0.7369	3.13833	0.076	Not Significant
40	a=0.7198	a=0.8262			
	b=0.0939	b=-0.0622	38.5100	0.000	Significant
41	a=2.6985	a=1.8965			
	b=-0.4424	b=0.5192	13.6205	0.000	Significant
42	a=1.1280	a=1.3818			
	b=-0.0447	b=0.1778	9.39793	0.002	Significant
43	a=1.0784	a=1.5142			
	b=0.0076	b=0.3865	0.0040	0.949	Not Significant
44	a=1.1440	a=1.4329			
	b=-0.0257	b=0.2535	5.1834	0.023	Not Significant
45	a=2.1825	a=1.9538			
	b=-0.5212	b=0.5689	0.1410	0.707	Not Significant
46	a=1.4327	a=1.3041			
	b=-0.3004	b=-0.0060	42.181	0.000	Significant
47	a=1.1916	a=1.4179			
	b=-0.0593	b=0.1505	12.4699	0.000	Significant
48	a=2.5250	a=2.0811			
	b=-0.3839	b=0.4870	6.8483	0.009	Significant
49	a=2.5640	a=2.1472			
	b=-0.3526	b=0.7551	0.7938	0.373	Not Significant
50	a=2.2283	a=1.9224			
	b=-0.3932	b=0.4606	6.354	0.117	Not Significant

31

TABLE A.5

The Table showing the values of item parameters a and b of all items conditioned on item no. 5

Item	Item 5= 0	Item 5= 1	χ^2	p	Significance
1	a=0.6480	a=0.7484			
	b=0.0389	b=-0.1999	77.5847	0.000	Significant
2	a=1.5488	a=1.1440			
	b=0.0161	b=0.0491	109.861	0.000	Significant
3	a=1.0531	a=0.7927			
	b=-0.0753	b=-0.1906	253.818	0.000	Significant
4	a=1.1785	a=0.9069			
	b=0.0139	b=-0.1342	178.484	0.000	Significant
6	a=1.3693	a=1.1130			
	b=-0.0168	b=0.0069	94.8608	0.000	Significant
7	a=1.4533	a=1.0678			
	b=-0.1161	b=-0.0185	116.174	0.000	Significant
8	a=1.3234	a=0.9349			
	b=-0.1433	b=-0.1423	174.818	0.000	Significant
9	a=1.6946	a=1.3525			
	b=0.1132	b=0.2026	77.4488	0.000	Significant
10	a=1.3813	a=0.9360			
	b=-0.0805	b=-0.0864	186.468	0.000	Significant
11	a=1.6366	a=1.3156			
	b=0.2175	b=0.2263	87.0741	0.000	Significant
12	a=0.8638	a=0.7700			
	b=-0.0071	b=-0.1718	179.851	0.000	Significant
13	a=1.1366	a=1.0051			
	b=0.0743	b=-0.0199	102.554	0.000	Significant
14	a=1.5047	a=1.0223			
	b=-0.1079	b=-0.0042	142.917	0.000	Significant
15	a=1.2801	a=1.2170			
	b=0.0351	b=0.0878	57.2588	0.000	Significant
16	a=1.0657	a=0.8052			
	b=-0.2055	b=-0.1567	186.497	0.000	Significant
17	a=1.2573	a=1.6191			
	b=-0.1575	b=-0.0715	100.582	0.000	Significant
18	a=0.9104	a=0.9208			
	b=0.0183	b=-0.0599	69.0846	0.000	Significant

Item	Item 5= 0	Item 5= 1	χ^2	p	Significance
19	a=1.3957 b=-0.0819	a=1.0492 b=-0.0398	119.620	0.000	Significant
20	a=1.0097 b=-0.0871	a=0.9123 b=-0.0432	86.1866	0.000	Significant
21	a=1.5793 b=-0.0327	a=1.4676 b=0.3933	26.7446	0.000	Significant
22	a=1.5840 b=0.0897	a=1.5239 b=0.4347	40.8307	0.000	Significant
23	a=1.2071 b=-0.2187	a=0.8831 b=-0.0948	143.453	0.000	Significant
24	a=1.1796 b=-0.0118	a=1.1999 b=0.1101	38.2035	0.000	Significant
25	a=0.8832 b=0.1219	a=1.0995 b=0.1116	15.0907	0.0001	Significant
26	a=1.3679 b=-0.1562	a=1.0660 b=-0.0166	92.6676	0.000	Significant
27	a=1.3409 b=-0.0344	a=1.3283 b=0.1516	35.2067	0.000	Significant
28	a=0.7356 b=0.0825	a=0.7627 b=-0.0489	72.7970	0.000	Significant
29	a=1.3211 b=-0.2150	a=1.0012 b=-0.0429	98.7079	0.000	Significant
30	a=1.0624 b=0.0568	a=1.2614 b=0.1202	17.7337	0.000	Significant
31	a=1.7844 b=0.4034	a=1.7486 b=0.6758	24.3515	0.000	Significant
32	a=1.3625 b=-0.1636	a=1.2659 b=0.1400	33.3503	0.000	Significant
33	a=2.0503 b=0.0526	a=1.8636 b=0.7283	10.1407	0.001	Significant
34	a=1.0310 b=0.0059	a=1.0828 b=-0.0108	40.7256	0.000	Significant
35	a=1.1832 b=0.0387	a=1.4596 b=0.3434	4.5971	0.032	Not Significant
36	a=1.7372 b=0.0042	a=1.5526 b=0.3569	29.6761	0.000	Significant
37	a=2.1883 b=-0.6274	a=1.4915 b=0.1561	27.6785	0.000	Significant
38	a=2.0738 b=-0.2417	a=0.7105 b=0.2904	25.3530	0.000	Significant

Item	Item 5= 0	Item 5= 1	χ^2	p	Significance
39	a=1.7005 b=0.1433	a=1.7935 b=0.6545	7.7193	0.005	Significant
40	a=0.7720 b=0.0477	a=0.8019 b=-0.0513	55.026	0.000	Significant
41	a=2.6758 b=-0.4154	a=1.8888 b=0.4670	14.2186	0.000	Significant
42	a=1.2342 b=-0.0140	a=1.3179 b=0.1456	24.640	0.000	Significant
43	a=1.0220 b=0.1452	a=0.4961 b=0.3128	0.3357	0.562	Not Significant
44	a=1.0842 b=0.0621	a=1.4319 b=0.2050	4.597	0.032	Significant
45	a=2.8161 b=-0.3818	a=1.8243 b=0.4412	21.170	0.000	Significant
46	a=1.7060 b=-0.6156	a=1.3125 b=-0.0067	30.347	0.000	Significant
47	a=1.1015 b=-0.0640	a=1.4453 b=0.1338	3.54113	0.059	Not Significant
48	a=2.2966 b=-0.4484	a=2.1460 b=0.4499	0.8265	0.363	Not Significant
49	a=1.8919 b=-0.1198	a=2.1975 b=0.7032	0.2499	0.6171	Not Significant
50	a=2.2579 b=-0.4393	a=1.9749 b=0.3851	4.3268	0.0375	Not Significant

TABLE A.6

The Table showing the values of item parameters a and b of all items conditioned on item no. 6

Item	Item 6= 0	Item 6= 1	χ^2	p	Significance
1	a=0.6583 b=-0.0527	a=0.7484 b=-0.1999	38.5844	0.000	Significant
2	a=1.6253 b=0.3571	a=1.1440 b=0.0491	310.759	0.000	Significant
3	a=0.8920 b=-0.1147	a=0.7927 b=-0.1906	135.510	0.000	Significant
4	a=1.1286 b=-0.0153	a=0.9069 b=-0.1342	201.720	0.000	Significant
5	a=0.8866 b=-0.1061	a=1.1130 b=0.0069	94.8608	0.000	Significant
7	a=1.5487 b=0.1017	a=1.0678 b=-0.0185	280.218	0.000	Significant
8	a=1.3435 b=-0.0428	a=0.9349 b=-0.1423	310.832	0.000	Significant
9	a=1.9193 b=0.3930	a=1.3525 b=0.2026	235.626	0.000	Significant
10	a=1.1394 b=-0.0603	a=0.9360 b=-0.0864	128.702	0.000	Significant
11	a=1.7292 b=0.3897	a=1.3156 b=0.2263	188.537	0.000	Significant
12	a=0.7790 b=-0.0785	a=0.7700 b=-0.1718	77.9319	0.000	Significant
13	a=1.1124 b=0.0349	a=1.0051 b=-0.0199	98.2252	0.000	Significant
14	a=1.2248 b=-0.0665	a=1.0223 b=-0.0042	87.0506	0.000	Significant
15	a=1.4992 b=0.2113	a=1.2170 b=0.0878	179.039	0.000	Significant
16	a=0.8966 b=-0.1296	a=0.8052 b=-0.1567	109.024	0.000	Significant
17	a=1.3010 b=-0.0302	a=1.0191 b=-0.0715	182.379	0.000	Significant
18	a=0.9388 b=-0.0139	a=0.9208 b=-0.0599	75.0031	0.000	Significant

Item	Item 6= 0	Item 6= 1	χ^2	p	Significance
19	a=1.3801 b=0.0081	a=1.0492 b=-0.0398	179.510	0.000	Significant
20	a=0.9121 b=-0.0442	a=0.9123 b=-0.0482	43.9381	0.000	Significant
21	a=1.7385 b=0.1170	a=1.4676 b=0.3933	59.0819	0.000	Significant
22	a=1.7734 b=0.2253	a=1.5239 b=0.4347	65.9104	0.000	Significant
23	a=1.0061 b=-0.1161	a=0.8831 b=-0.0948	93.5171	0.000	Significant
24	a=1.2597 b=0.0161	a=1.1999 b=0.1101	55.482	0.000	Significant
25	a=0.9508 b=0.1197	a=1.0995 b=0.1116	18.9283	0.000	Significant
26	a=1.2642 b=-0.0936	a=1.0660 b=-0.0166	90.4249	0.000	Significant
27	a=1.4681 b=0.0516	a=1.3283 b=0.1516	70.1802	0.000	Significant
28	a=0.6843 b=0.0179	a=0.7627 b=-0.0489	13.7723	0.000	Significant
29	a=1.1905 b=-0.1026	a=1.0012 b=-0.0429	100.874	0.000	Significant
30	a=1.1934 b=0.1519	a=1.2614 b=0.1202	52.6423	0.000	Significant
31	a=2.0329 b=0.2451	a=1.7486 b=0.6758	24.6925	0.000	Significant
32	a=1.3095 b=-0.0932	a=1.2659 b=0.1400	26.1037	0.000	Significant
33	a=2.3979 b=0.3436	a=1.8636 b=0.7283	58.7442	0.000	Significant
34	a=1.0868 b=-0.0332	a=1.0828 b=-0.0108	51.4758	0.000	Significant
35	a=1.3467 b=0.0131	a=1.4596 b=0.3434	7.8706	0.005	Significant
36	a=1.6116 b=-0.0206	a=1.5526 b=0.3569	10.3549	0.001	Significant
37	a=2.0458 b=-0.1444	a=1.4915 b=0.1561	89.5069	0.000	Significant
38	a=2.1446 b=0.0107	a=1.7105 b=0.2904	61.3517	0.000	Significant

Item	Item 6= 0	Item 6= 1	χ^2	p	Significance
39	a=1.8499 b=-0.0203	a=1.7935 b=0.6545	0.00037	0.984	Not Significant
40	a=0.7252 b=0.0360	a=0.8015 b=-0.0513	20.6467	0.000	Significant
41	a=2.4697 b=-0.1138	a=1.8888 b=0.4670	21.6209	0.000	Significant
42	a=1.2120 b=-0.0260	a=1.3179 b=0.1456	10.8405	0.001	Significant
43	a=1.2277 b=0.0490	a=1.4961 b=0.3128	1.82206	0.177	Not Significant
44	a=1.1315 b=0.0554	a=1.4319 b=0.2050	0.7078	0.400	Not Significant
45	a=2.1253 b=-0.0835	a=1.8243 b=0.4412	9.5242	0.002	Significant
46	a=1.4514 b=-0.1915	a=1.3125 b=-0.0067	51.170	0.000	Significant
47	a=1.2233 b=0.0036	a=1.4453 b=0.1338	9.732	0.002	Significant
48	a=2.4994 b=-0.0853	a=2.1460 b=0.4499	15.68	0.000	Significant
49	a=2.1665 b=0.0414	a=2.1975 b=0.7032	0.507	0.811	Not Significant
50	a=2.1514 b=-0.0899	a=1.9749 b=0.3851	12.418	0.000	Significant

TABLE A.7

The Table showing the values of item parameters a and b of all items conditioned on item no. 7

Item	Item 7= 0	Item 7= 1	χ^2	p	Significance
1	a=0.6612 b=-0.0366	a=0.7776 b=-0.2204	55.658	0.000	Significant
2	a=1.6206 b=0.2348	a=1.0236 b=-0.0210	259.11	0.000	Significant
3	a=0.9146 b=-0.1128	a=0.8093 b=-0.2011	173.32	0.000	Significant
4	a=1.2006 b=0.0089	a=0.8486 b=-0.1689	279.660	0.000	Significant
5	a=0.9005 b=-0.1110	a=0.8490 b=-0.1563	116.174	0.000	Significant
6	a=1.5608 b=0.1567	a=0.9727 b=-0.0637	280.218	0.000	Significant
8	a=1.3901 b=-0.0132	a=0.8401 b=-0.1920	363.008	0.000	Significant
9	a=1.9146 b=0.3079	a=1.2008 b=0.1547	209.670	0.000	Significant
10	a=1.1506 b=-0.0763	a=0.9510 b=-0.0853	138.834	0.000	Significant
11	a=1.6749 b=0.3284	a=1.2328 b=0.1939	159.929	0.000	Significant
12	a=0.7817 b=0.0777	a=0.8126 b=-0.1774	91.7697	0.000	Significant
13	a=1.0932 b=-0.0152	a=1.0235 b=0.0005	83.1214	0.000	Significant
14	a=1.2746 b=-0.0324	a=1.0276 b=-0.0048	127.970	0.000	Significant
15	a=1.4275 b=0.0914	a=1.1434 b=0.0841	123.423	0.000	Significant
16	a=0.9242 b=-0.1258	a=0.8216 b=-0.1798	149.719	0.000	Significant
17	a=1.3295 b=-0.0793	a=0.9525 b=-0.0835	188.697	0.000	Significant
18	a=0.9268 b=-0.0131	a=0.9324 b=-0.0637	76.3467	0.000	Significant

Item	Item 7= 0	Item 7= 1	χ^2	p	Significance
19	a=1.3954 b=-0.0627	a=1.0011 b=-0.0411	170.678	0.000	Significant
20	a=0.9332 b=-0.0429	a=0.9491 b=-0.0489	64.947	0.000	Significant
21	a=1.7232 b=0.0987	a=1.4104 b=0.4283	60.0100	0.000	Significant
22	a=1.7416 b=0.2111	a=1.4691 b=0.4527	64.097	0.000	Significant
23	a=1.0571 b=-0.1353	a=0.8883 b=-0.1026	131.057	0.000	Significant
24	a=1.2288 b=0.0228	a=1.1958 b=0.1255	54.293	0.000	Significant
25	a=0.9589 b=0.0849	a=1.1284 b=0.1299	21.9352	0.000	Significant
26	a=1.2879 b=-0.1222	a=1.0548 b=-0.0025	99.6933	0.000	Significant
27	a=1.5474 b=-0.0519	a=1.2580 b=0.1921	72.9657	0.000	Significant
28	a=0.6824 b=0.0424	a=0.8303 b=-0.0634	21.7680	0.000	Significant
29	a=1.1635 b=-0.1338	a=1.0132 b=-0.0389	88.3579	0.000	Significant
30	a=1.2343 b=0.1645	a=1.1878 b=0.1005	75.1336	0.000	Significant
31	a=1.9730 b=0.3483	a=1.7242 b=0.7394	35.3902	0.000	Significant
32	a=1.3018 b=-0.0334	a=1.2839 b=0.1638	37.6975	0.000	Significant
33	a=2.2439 b=0.3407	a=1.7675 b=0.7496	43.7079	0.000	Significant
34	a=1.0729 b=-0.0217	a=1.0896 b=-0.0040	50.9413	0.000	Significant
35	a=1.3278 b=0.0248	a=1.4789 b=0.4117	8.4011	0.004	Significant
36	a=1.6269 b=0.0085	a=1.6249 b=0.4380	16.369	0.000	Significant
37	a=1.9537 b=-0.1897	a=1.4064 b=0.1713	68.9356	0.000	Significant
38	a=1.8649 b=-0.0465	a=1.7310 b=0.3503	24.919	0.000	Significant

Item	Item 7= 0	Item 7= 1	χ^2	p	Significance
39	a=1.7428 b=0.0712	a=1.9061 b=0.7996	0.2575	0.6117	Not Significant
40	a=0.7396 b=0.0440	a=0.8457 b=-0.0717	32.8695	0.000	Significant
41	a=2.1713 b=-0.0447	a=1.8929 b=0.5567	15.0326	0.000	Significant
42	a=1.1892 b=-0.0151	a=1.4079 b=0.1976	9.573	0.002	Significant
43	a=1.1589 b=0.1327	a=1.5488 b=0.3693	1.2917	0.255	Not Significant
44	a=1.1180 b=0.0552	a=1.5453 b=0.2668	0.4838	0.486	Not Significant
45	a=2.0914 b=-0.1866	a=1.9248 b=0.5938	2.5967	0.107	Not Significant
46	a=1.4609 b=-0.2107	a=1.2825 b=0.0016	51.266	0.000	Significant
47	a=1.1215 b=0.0766	a=1.5511 b=0.1239	3.7432	0.053	Significant
48	a=2.2901 b=0.0217	a=2.0389 b=0.4728	18.2095	0.000	Significant
49	a=2.1228 b=0.0342	a=2.2049 b=0.8191	0.0005	0.981	Not Significant
50	a=2.1790 b=-0.1813	a=1.9148 b=0.4948	7.6332	0.006	Significant

40

TABLE A.8

The Table showing the values of item parameters a and b of all items conditioned on item no. 8

Item	Item 8= 0	Item 8= 1	χ^2	p	Significance
1	a= 0.6228 b=0.0102	a=0.7855 b=-0.2143	49.3508	0.000	Significant
2	a=1.7228 b=0.1289	a=1.0676 b=0.0218	243.038,	0.000	Significant
3	a=0.9304 b=-0.0812	a=0.8106 b=-0.2024	224.070,	0.000	Significant
4	a=1.3137 b=0.0215	a=0.8513 b=-0.1562	353.138	0.000	Significant
5	a= 0.9264 b=-0.0769	a=0.8392 b=-0.1637	174.818,	0.000	Significant
6	a=1.7251 b= 0.1324	a=0.9932 b=-0.0406	310.832	0.000	Significant
7	a=1.8065 b=0.0957	a= 0.9506 b=-0.0741	363.008	0.000	Significant
9	a= 2.3133 b=0.2362	a=1.2134 b=0.1748	248.205	0.000	Significant
10	a=1.2344 b= -0.1059	a=0.9469 b=-0.0787	182.414,	0.000	Significant
11	a=1.9353 b= 0.2000	a=1.2427 b=0.2250	181.349	0.000	Significant
12	a=0.7705 b=-0.0460	a=0.8108 b=-0.1753	115.867	0.000	Significant
13	a=1.1330 b= -0.0106	a=1.0116 b=-0.0009	118.457	0.000	Significant
14	a=1.3844 b=-0.1271	a=1.0299 b=0.0147	151.168	0.000	Significant
15	a=1.6106 b=0.0147	a=1.1330 b=0.0981	162.568,	0.000	Significant
16	a=0.9384 b=-0.1079	a=0.8229 b=-0.1772	186.261	0.000	Significant
17	a=1.5989 b= -0.0796	a=0.9290 b=-0.0885	295.585	0.000	Significant
18	a=0.9144 b=0.0350	a=0.9283 b=-0.0651	100.420	0.000	Significant

Item	Item 8= 0	Item 8= 1	χ^2	p	Significance
19	a=1.4359 b= -0.1235	a=1.0291 b=-0.0253	169.936	0.000	Significant
20	a=0.9178 b=-0.0246	a=0.9493 b=-0.0498	79.8044,	0.000	Significant
21	a=1.8692 b= 0.0500	a=1.4071 b=0.3965	85.6139,	0.000	Significant
22	a=1.8570 b=0.0685	a=1.4893 b=0.4483	69.0151	0.000	Significant
23	a=1.1063 b=-0.1308	a=0.8828 b=-0.1046	176.503	0.000	Significant
24	a=1.2753 b=-0.0539	a=1.1868 b=0.1276	70.8670	0.000	Significant
25	a=0.8602 b=0.1071	a=1.1692 b=0.1230	11.7388	0.000	Significant
26	a=1.4392 b=-0.1665	a=1.0334 b= -0.0107	155.386	0.000	Significant
27	a=1.6687 b=-0.0893	a=1.2486 b=0.1663	108.208,	0.000	Significant
28	a=0.6906 b= 0.1159	a=0.7924 b=-0.0684	69.4634	0.000	Significant
29	a=1.2563 b=-0.2005	a=0.9981 b=-0.0369	129.670,	0.000	Significant
30	a=1.0677 b=0.0647	a=1.2934 b=0.1288	29.6149	0.000	Significant
31	a=2.2677 b=0.0046	a=1.7499 b=0.7309	35.7200	0.000	Significant
32	a=1.2533 b=-0.1098	a= 1.3047 b= 0.1561	39.5395	0.000	Significant
33	a= 2.7247 b=0.0115	a= 1.7863 b= 0.7314	50.6770	0.000	Significant
34	a=1.0414 b=0.0298	a=1.0781 b=-0.0186	77.7321	0.000	Significant
35	a=1.2292 b=-0.0534	a=1.5100 b=0.3794	8.13491	0.005	Significant
36	a=1.9406 b=-0.2953	a=1.5871 b= 0.4034	34.1487	0.000	Significant
37	a=2.4585 b=-0.4535	a=1.3903 b=0.1637	100.379	0.000	Significant
38	a=2.4741 b=-0.4091	a= 1.6833 b=0.3139	53.4829	0.000	Significant

Item	Item 8= 0	Item 8= 1	χ^2	p	Significance
39	a=2.1943	a=1.8706			
	b=-0.4474	b=0.7550	2.72678,	0.000	Significant
40	a=0.6876	a=0.8375			
	b= 0.1596	b=-0.0745	50.6760	0.000	Significant
41	a=2.3437	a=1.9238			
	b=-0.3740	b= 0.5307	17.2154,	0.000	Significant
42	a= 1.1021	a=1.4062			
	b=-0.0733	b=0.1862	13.2025	0.000	Significant
43	a=1.0407	a= 1.5655			
	b=0.0648	b= 0.3534	0.905087,	0.341	Not Significant
44	a=0.9978	a=1.5409			
	b=0.0528	b=0.2468	1.10540,	0.293	Not Significant
45	a=2.2266	a=1.8935			
	b=-0.3607	b=0.5141	14.3426,	0.000	Significant
46	a=1.8834	a=1.2298			
	b=-0.5100	b= 0.0016	99.3135,	0.000	Significant
47	a=1.0530	a= 1.5250			
	b=0.0138	b= 0.1234	7.05366,	0.008	Significant
48	a=2.5753	a=2.0266			
	b=-0.2706	b= 0.4540	27.6659	0.000	Significant
49	a=2.2244	a=2.2475			
	b=-0.2911	b=0.7497	0.232138	0.629	Not Significant
50	a=2.0346	a=1.9812			
	b=-0.3403	b=0.4482	7.75250,	0.005	Significant

23

TABLE A.9

The Table showing the values of item parameters a and b of all items conditioned on item no. 9

Item	Item 9= 0	Item 9= 1	χ^2	p	Significance
1	a=0.6772 b=-0.0953	a=0.8074 b=-0.2164	26.488	0.000	Significant
2	a=1.5633 b=0.2802	a=0.9256 b=-0.1002	325.689	0.000	Significant
3	a=0.8599 b=-0.1361	a=0.8478 b=-0.2009	83.861	0.000	Significant
4	a=1.0519 b=-0.0602	a=0.8900 b=-0.1548	135.094	0.000	Significant
5	a=0.8792 b=-0.1144	a=0.8649 b=-0.1660	77.448	0.000	Significant
6	a=1.4074 b=0.1271	a=0.9422 b=-0.0928	235.626	0.000	Significant
7	a=1.3662 b=0.0318	a=0.9340 b=-0.0830	209.670	0.000	Significant
8	a=1.2062 b=-0.0872	a=0.8326 b=-0.1917	248.205	0.000	Significant
10	a=1.1115 b=-0.0413	a=0.9305 b=-0.1136	127.492	0.000	Significant
11	a=1.5904 b=0.3110	a=1.1892 b=0.1870	141.084	0.000	Significant
12	a=0.7879 b=-0.1022	a=0.8233 b=-0.1885	69.128	0.000	Significant
13	a=1.1236 b=0.0534	a=0.9626 b=-0.0480	118.879	0.000	Significant
14	a=1.2006 b=-0.0238	a=1.0310 b=0.0046	91.892	0.000	Significant
15	a=1.5069 b=0.3871	a=0.9510 b=-0.0700	318.154	0.000	Significant
16	a=0.8800 b=-0.1343	a=0.8495 b=-0.1879	88.097	0.000	Significant
17	a=1.2522 b=-0.0520	a=0.9173 b=-0.0997	175.272	0.000	Significant
18	a=0.9222 b=-0.0439	a=0.9532 b= -0.0461	48.6862	0.000	Significant

Item	Item 9= 0	Item 9= 1	χ^2	p	Significance
19	a=1.3123 b=-0.0143	a=0.9586 b=-0.0584	166.920	0.000	Significant
20	a=0.9548 b=-0.0172	a=0.9310 b=-0.0714	74.307	0.000	Significant
21	a=1.6039 b=0.2382	a=1.3991 b= 0.4363	56.3843	0.000	Significant
22	a=1.6648 b=0.2592	a= 1.4573 b= 0.5110	49.865	0.000	Significant
23	a=0.9829 b=-0.1000	a=0.9181 b=-0.1165	84.127	0.000	Significant
24	a=1.2573 b=0.0718	a=1.1603 b=0.1237	65.864	0.000	Significant
25	a=0.9920 b=0.1184	a=1.1431 b=0.1217	23.584	0.000	Significant
26	a=1.2007 b=-0.0649	a=1.0712 b= -0.0044	73.904	0.000	Significant
27	a=1.4515 b=0.0556	a=1.2511 b=0.1951	66.8765	0.000	Significant
28	a=0.6922 b=0.0029	a= 0.8925 b=-0.0595	5.4762	0.019	Significant
29	a=1.1349 b=-0.0861	a=1.0028 b=-0.0413	82.937	0.000	Significant
30	a=1.2249 b=0.1617	a=1.2013 b=0.0972	64.222	0.000	Significant
31	a=1.8538 b=0.3045	a=1.8399 b=0.8898	7.636	0.005	Significant
32	a=1.2825 b=0.0349	a= 1.3025 b= 0.1743	33.850	0.000	Significant
33	a=2.1476 b=0.4807	a=1.6995 b=0.7762	56.889	0.000	Significant
34	a=1.0967 b=0.0055	a= 1.0704 b=-0.0210	60.468	0.000	Significant
35	a=1.3404 b=0.1087	a=1.5223 b=0.4664	6.8100	0.009	Significant
36	a=1.6387 b=0.1341	a=1.6009 b= 0.4635	23.578	0.000	Significant
37	a=1.7731 b=-0.0251	a= 1.3745 b= 0.1678	75.813	0.000	Significant
38	a=1.8821 b=0.0326	a=1.7058 b=0.4046	27.746	0.000	Significant

Item	Item 9= 0	Item 9= 1	χ^2	p	Significance
39	a=1.8922 b=0.2027	a=1.8653 b=0.8380	5.3385	0.020	Not Significant
40	a=0.7560 b=0.0080	a=0.8751 b=-0.0764	25.212	0.000	Significant
41	a=2.2659 b=-0.0258	a=1.8896 b=0.6665	12.209	0.000	Significant
42	a=1.2909 b=-0.0370	a=1.3735 b=0.2823	13.632	0.000	Significant
43	a=1.2779 b=0.0413	a=1.5628 b=0.5316	0.183	0.668	Not Significant
44	a=1.2741 b=0.0607	a=1.4877 b=0.3138	8.751	0.003	Significant
45	a=2.1787 b=0.0581	a=1.8147 b=0.6072	20.966	0.000	Significant
46	a=1.4319 b=-0.1611	a=1.2859 b= 0.0390	47.324	0.000	Significant
47	a=1.2216 b=0.0341	a=1.5740 b=0.2084	3.7745	0.052	Not Significant
48	a=2.4748 b=-0.0454	a=1.9999 b=0.6672	9.204	0.002	Significant
49	a=2.2608 b=0.2415	a= 2.1146 b=0.8785	5.748	0.016	Not Significant
50	a=2.0863 b=-0.0374	a=1.9615 b=0.6181	4.392	0.036	Not Significant

TABLE A.10

The Table showing the values of item parameters a and b
of all items conditioned on item no. 10

Item	Item 10= 0	Item 10= 1	χ^2	p	Significance
1	a=0.6564 b=-0.0414	a=0.7703 b=-0.2046	49.975	0.000	Significant
2	a=1.4754 b= 0.0904	a=1.1133 b=0.0363	132.107	0.000	Significant
3	a=0.9386 b=-0.1164	a=0.8053 b=-0.194	180.758	0.000	Significant
4	a=1.0799 b=-0.0816	a=0.9173 b=-0.1235	130.973	0.000	Significant
5	a=0.9770 b=-0.0872	a=0.8154 b=-0.166	186.468	0.000	Significant
6	a=1.3618 b=0.0326	a=1.0714 b=-0.0132	128.702	0.000	Significant
7	a=1.3738 b= -0.0503	a=1.0351 b=-0.0329	138.834	0.000	Significant
8	a=1.2247 b= -0.1353	a=0.9113 b=-0.1478	182.414	0.000	Significant
9	a=1.7267 b=0.2314	a=1.2806 b=0.1716	127.492	0.000	Significant
11	a=1.5309 b=0.1091	a=1.3384 b=0.2657	62.3491	0.000	Significant
12	a=0.8471 b=-0.0447	a=0.7679 b=-0.1858	180.896	0.000	Significant
13	a=1.1463 b=0.0610	a= 0.9872 b= -0.0275	123.145	0.000	Significant
14	a=1.4338 b=-0.0293	a= 0.9846 b= -0.0106	181.401	0.000	Significant
15	a=1.3611 b=0.0488	a= 1.1813 b= 0.0947	85.198	0.000	Significant
16	a=1.0119 b=-0.1582	a= 0.7896 b= -0.1684	210.469	0.000	Significant
17	a=1.2409 b=-0.1251	a= 0.9979 b= -0.0698	122.133	0.000	Significant
18	a=0.9067 b=0.0048	a= 0.9312 b= -0.0647	68.704	0.000	Significant

Item	Item 10= 0	Item 10= 1	χ^2	p	Significance
19	a=1.3089 b=-0.0083	a= 1.0302 b= -0.0504	139.215	0.000	Significant
20	a=0.9650 b=-0.0481	a= 0.9217 b= -0.0475	82.544	0.000	Significant
21	a=1.5048 b=0.0068	a= 1.5048 b= 0.4516	17.681	0.000	Significant
22	a=1.5631 b=0.1300	a= 1.5436 b= 0.4742	25.886	0.000	Significant
23	a=1.1037 b=-0.1610	a= 0.8754 b= -0.0975	144.241	0.000	Significant
24	a=1.1929 b=-0.0048	a= 1.2048 b= 0.1297	40.843	0.000	Significant
25	a=0.9418 b=0.1331	a= 1.1065 b= 0.1101	25.912	0.000	Significant
26	a=1.3462 b= -0.1288	a= 1.0382 b= -0.0083	113.963	0.000	Significant
27	a=1.3766 b=0.1172	a= 1.294 b= 0.1378	65.119	0.000	Significant
28	a=0.7351 b=0.0716	a= 0.7708 b= -0.0669	76.558	0.000	Significant
29	a=1.2516 b=-0.1424	a= 0.9827 b= -0.0437	116.432	0.000	Significant
30	a=1.0727 b=0.1262	a= 1.2895 b= 0.115	21.5606	0.000	Significant
31	a=1.9278 b=0.1848	a= 1.7676 b= 0.7572	15.4489	0.000	Significant
32	a=1.3755 b=-0.0838	a= 1.2482 b= 0.1537	48.3220	0.000	Significant
33	a=2.0320 b=0.3018	a= 1.8314 b= 0.7396	25.1730	0.000	Significant
34	a=1.0744 b=0.0366	a= 1.0672 b= -0.023	65.875	0.000	Significant
35	a=1.3848 b=0.0566	a= 1.413 b= 0.3572	23.264	0.000	Significant
36	a=1.6195 b=0.0576	a= 1.5944 b= 0.3868	25.491	0.000	Significant
37	a=1.8835 b=-0.2147	a= 1.4422 b= 0.1563	56.327	0.000	Significant
38	a=2.0561 b=-0.0724	a= 1.6737 b= 0.3097	42.332	0.000	Significant

Item	Item 10= 0	Item 10= 1	χ^2	p	Significance
39	a=1.8536 b= 0.0480	a= 1.8213 b= 0.7361	4.980	0.025	Not Significant
40	a=0.7831 b=0.0123	a= 0.8057 b= -0.055	62.327	0.000	Significant
41	a=2.3001 b=-0.1309	a= 1.8693 b= 0.535	17.249	0.000	Significant
42	a=1.2317 b=-0.0243	a= 1.3599 b= 0.1709	19.283	0.000	Significant
43	a=1.1676 b=0.0802	a= 1.5145 b= 0.3571	2.0973	0.147	Not Significant
44	a=1.1586 b=0.0583	a= 1.4718 b= 0.2312	6.0328	0.014	Not Significant
45	a=2.1882 b=-0.2172	a= 1.9093 b= 0.5324	6.867	0.008	Significant
46	a=1.5544 b=-0.2857	a= 1.2738 b= 0.0031	55.952	0.000	Significant
47	a=1.1490 b=0.0536	a= 1.4828 b= 0.132	8.211	0.004	Significant
48	a=2.4476 b=-0.2048	a= 2.0843 b= 0.4924	8.644	0.003	Significant
49	a=2.0592 b= 0.0802	a= 2.1871 b= 0.7548	0.981	0.321	Not Significant
50	a=2.2901 b=-0.3209	a= 1.943 b= 0.4792	5.281	0.021	Not Significant

:24

TABLE A.11

The Table showing the values of item parameters a and b of all items conditioned on item no. 11

Item	Item 11= 0	Item 11= 1	χ^2	p	Significance
1	a= 0.6974 b= -0.1240	a=0.7897 b=-0.2219	23.513	0.000	Significant
2	a=1.3159 b=0.0650	a=1.0516 b=-0.0267	125.960	0.000	Significant
3	a=0.8909 b=-0.1540	a=0.8235 b=-0.2064	85.045	0.000	Significant
4	a=1.0164 b=-0.0999	a=0.8677 b=-0.1836	140.203	0.000	Significant
5	a=0.9196 b=-0.1151	a=0.8345 b=-0.1742	87.0741	0.000	Significant
6	a=1.2245 b=0.0034	a=0.9546 b=-0.0989	188.537	0.000	Significant
7	a= 1.2074 b=-0.0347	a=0.9553 b=-0.1010	159.929	0.000	Significant
8	a=1.0749 b=-0.1458	a=0.8523 b=-0.1888	181.349	0.000	Significant
9	a=1.5247 b=0.2145	a=1.1747 b=0.1150	141.084	0.000	Significant
10	a=1.4395 b= 0.2339	a=0.9712 b=-0.0827	62.3491	0.000	Significant
12	a=0.8327 b=-0.1120	a=0.8548 b= -0.1698	23.0103	0.000	Significant
13	a=1.0919 b=0.0015	a=1.0118 b=-0.0100	56.7577	0.000	Significant
14	a=1.1960 b=-0.0523	a=1.0618 b=0.0125	53.3500	0.000	Significant
15	a=1.3046 b=0.0931	a=1.1012 b= 0.0458	102.245	0.000	Significant
16	a=0.9104 b=-0.1644	a=0.8549 b=-0.1859	57.9864	0.000	Significant
17	a=1.1173 b=-0.0806	a=0.9114 b= -0.1245	158.796	0.000	Significant
18	a=0.9069 b=-0.0392	a=0.9152 b=-0.0726	57.6530	0.000	Significant

Item	Item 11= 0	Item 11= 1	χ^2	p	Significance
19	a=1.1809 b=-0.0224	a=0.9926 b=-0.0465	106.286	0.000	Significant
20	a=0.9403 b=-0.0556	a=1.0030 b=-0.0289	16.0550	0.000	Significant
21	a=1.4217 b=0.2156	a=1.3866 b=0.3928	48.8412	0.000	Significant
22	a=1.4828 b=0.2967	a=1.4343 b=0.4466	48.6698	0.000	Significant
23	a=0.9949 b=-0.1239	a=0.9186 b=-0.1195	58.7661	0.000	Significant
24	a=1.1640 b=0.0390	a=1.1348 b=0.1098	56.1389	0.000	Significant
25	a=0.9894 b=0.1133	a=1.1512 b=0.1405	9.50529	0.002	Significant
26	a=1.1974 b=-0.0593	a=1.0242 b=-0.0096	76.887	0.000	Significant
27	a=1.3211 b=0.1182	a=1.2914 b=0.1770	38.007	0.000	Significant
28	a=0.7551 b=0.0021	a=0.8393 b=-0.0463	9.955	0.001	Significant
29	a=1.0958 b=-0.1166	a=1.0090 b=-0.0370	55.614	0.000	Significant
30	a=1.1520 b=0.1182	a=1.1356 b=0.0965	67.825	0.000	Significant
31	a=1.7444 b=0.6031	a=1.7281 b=0.7834	19.828	0.000	Significant
32	a=1.2654 b=0.0823	a=1.3860 b=0.2429	4.135	0.041	Significant
33	a=1.8287 b=0.5089	a=1.7348 b=0.7746	32.957	0.000	Significant
34	a=1.0866 b=0.0256	a=1.1112 b=-0.0002	26.245	0.000	Significant
35	a=1.3598 b=0.2665	a=1.4947 b=0.4621	3.320	0.068	Not Significant
36	a=1.5136 b=0.2958	a=1.6686 b=0.5335	3.188	0.074	Not Significant
37	a=1.6206 b=0.0245	a=1.3276 b=0.1423	74.427	0.000	Significant
38	a=1.7378 b=0.2707	a=1.6945 b=0.3866	18.980	0.000	Significant

Item	Item 11= 0	Item 11= 1	χ^2	p	Significance
39	a=1.6970 b=0.4912	a=1.9126 b=0.8365	0.421	0.516	Not Significant
40	a=0.8031 b=-0.0271	a=0.8829 b=-0.0739	10.078	0.001	Significant
41	a=1.9503 b=0.3176	a=1.9083 b=0.6262	6.5746	0.010	Not Significant
42	a=1.2399 b=0.1034	a=1.3863 b=0.2065	10.075	0.001	Significant
43	a=1.2598 b=0.2089	a=1.5266 b=0.4419	0.827	0.363	Not Significant
44	a=1.2413 b=0.1807	a=1.4746 b=0.3042	3.320	0.068	Not Significant
45	a=1.8246 b=0.2923	a=1.7675 b=0.6305	12.196	0.000	Significant
46	a=1.3892 b=-0.0681	a=1.2257 b=0.0078	51.449	0.000	Significant
47	a=1.2828 b=0.0898	a=1.4414 b=0.1475	12.937	0.000	Significant
48	a=2.0808 b=0.2537	a=2.0256 b=0.5512	10.233	0.001	Significant
49	a=1.9510 b=0.5772	a=2.1402 b=0.9065	0.244	0.620	Not Significant
50	a=1.9090 b=0.1499	a= 1.8493 b= 0.5609	8.098	0.004	Significant

TABLE A.12

The Table showing the values of item parameters a and b of all items conditioned on item no. 12

Item	Item 12= 0	Item 12= 1	χ^2	p	Significance
1	a=1.8562 b=0.2758	a=0.7522 b=-0.1927	55.0796	0.000	Significant
2	a=1.2717 b=-0.1454	a=1.1691 b=0.0611	77.1963	0.000	Significant
3	a=1.2542 b=-0.0266	a=0.8066 b=-0.1835	200.167	0.000	Significant
4	a=1.0435 b=-0.0715	a=0.9360 b=-0.1189	105.989	0.000	Significant
5	a=1.3441 b=0.0374	a=0.8253 b=-0.1593	179.851	0.000	Significant
6	a=1.4648 b=0.0169	a=1.1177 b=0.0052	77.9319	0.000	Significant
7	a=1.1693 b=-0.0966	a=1.0775 b=-0.0216	91.7697	0.000	Significant
8	a=1.6596 b=0.0994	a=0.9547 b=-0.1364	115.867	0.000	Significant
9	a=1.2799 b=-0.1738	a=1.3521 b=0.1988	69.1288	0.000	Significant
10	a=1.4015 b=0.3100	a=0.9341 b=-0.0940	180.896	0.000	Significant
11	a=0.8562 b=-0.0942	a=1.3873 b=0.2578	23.0103	0.000	Significant
13	a=1.0859 b=-0.0379	a=0.9959 b=-0.0200	113.039	0.000	Significant
14	a=1.1945 b=-0.1439	a=1.0083 b=-0.0094	173.541	0.000	Significant
15	a=1.3751 b=-0.0386	a=1.2100 b=0.0941	57.3046	0.000	Significant
16	a=0.9854 b=-0.1686	a=0.7801 b=-0.1569	284.043	0.000	Significant
17	a=1.3780 b=-0.0554	a=0.9968 b=-0.0690	129.083	0.000	Significant
18	a=1.1589 b=-0.1090	a=0.9203 b=-0.0610	66.1465	0.000	Significant

Item	Item 12= 0	Item 12= 1	χ^2	p	Significance
19	a=1.1194 b=-0.0856	a=1.0645 b=-0.0407	96.3842	0.000	Significant
20	a=0.9001 b=-0.0878	a=0.8944 b=-0.0459	115.996	0.000	Significant
21	a=1.4693 b=0.1157	a=1.4597 b=0.3844	27.1700	0.000	Significant
22	a=1.3660 b=0.4551	a=1.5534 b=0.4313	15.4786	0.000	Significant
23	a=1.1874 b=-0.2681	a=0.8854 b=-0.1017	141.470	0.000	Significant
24	a=1.2807 b=0.0179	a=1.1890 b=0.1087	40.7057	0.000	Significant
25	a=1.0118 b=0.0375	a=1.0658 b=0.1014	31.9399	0.000	Significant
26	a=1.2995 b=-0.1993	a=1.0460 b=-0.0158	112.892	0.000	Significant
27	a=1.2793 b=0.0306	a=1.3022 b=0.1444	46.1420	0.000	Significant
28	a=0.7891 b=-0.0074	a=0.7559 b=-0.0432	80.1661	0.000	Significant
29	a=1.2143 b=-0.2150	a=0.9878 b=-0.0512	120.510	0.000	Significant
30	a=1.0840 b=0.2172	a=1.2839 b=0.1060	10.3509	0.001	Significant
31	a=1.4497 b=0.2869	a=1.7602 b=0.6937	13.5000	0.000	Significant
32	a=1.3379 b=-0.0723	a=1.2712 b=0.1242	31.1841	0.000	Significant
33	a=1.9645 b=0.5043	a=1.8918 b=0.7267	4.34750	0.037	Significant
34	a=1.0800 b=0.0187	a=1.0614 b=-0.0253	59.5157	0.000	Significant
35	a=1.2325 b=0.0109	a=1.4012 b=0.3327	15.5598	0.000	Significant
36	a=1.5930 b=-0.1229	a=1.5704 b=0.3429	24.9314	0.000	Significant
37	a=2.0035 b=-0.3036	a=1.4906 b=0.1227	35.4518	0.000	Significant
38	a=1.7662 b=-0.1551	a=1.7133 b=0.2764	26.0584	0.000	Significant

Item	Item 12= 0	Item 12= 1	χ^2	p	Significance
39	a=1.6909 b=0.0355	a=1.7938 b=0.6732	3.33089	0.067	Not Significant
40	a=0.7217 b=0.0577	a= 0.7927 b=-0.0439	66.5172	0.000	Significant
41	a=3.2936 b=-0.4181	a=1.9532 b=0.4761	3.42677	0.064	Not Significant
42	a=1.2515 b=-0.1028	a=1.3402 b=0.1612	11.3561	0.000	Significant
43	a=1.3736 b=-0.0894	a=1.4635 b=0.3131	1.49304	0.221	Not Significant
44	a=1.0538 b=-0.0780	a=1.3883 b=0.2243	8.96241	0.002	Significant
45	a=1.9340 b=-0.2472	a=1.8785 b=0.4531	8.31925	0.003	Significant
46	a=1.7134 b=-0.4348	a=1.3415 b=-0.0289	25.6225	0.000	Significant
47	a=1.2433 b=-0.0799	a=1.4258 b=0.1118	8.86443	0.002	Significant
48	a=2.2823 b= -0.1674	a=2.1148 b=0.4297	3.65431	0.055	Not Significant
49	a=2.9340 b=-0.2052	a=2.1771 b=0.6607	.729087	0.393	Not Significant
50	a=2.6420 b=-0.3969	a=1.9720 b=0.3790	4.55856	0.032	Not Significant

TABLE A.13

The Table showing the values of item parameters a and b of all items conditioned on item no. 13

Item	Item 13= 0	Item 13= 1	χ^2	p	Significance
1	a=0.6690 b=-0.0768	a=0.7716 b=-0.1984	24.8564	0.000	Significant
2	a=1.4082 b=0.1239	a=1.1155 b=0.0189	99.2909	0.000	Significant
3	a=0.8925 b=-0.1252	a=0.8234 b=-0.1949	97.3540	0.000	Significant
4	a=1.0125 b=-0.0896	a=0.9444 b=-0.1208	63.4122	0.000	Significant
5	a=0.9232 b=-0.0911	a=0.8344 b=-0.1687	102.554	0.000	Significant
6	a=1.3224 b=0.0596	a=1.0689 b=-0.0265	98.2252	0.000	Significant
7	a=1.2883 b=-0.0513	a=1.0515 b=-0.0270	83.1214	0.000	Significant
8	a=1.1596 b=-0.1324	a=0.9215 b=-0.1489	118.457	0.000	Significant
9	a=1.7148 b=0.2975	a=1.2495 b=0.1466	118.879	0.000	Significant
10	a=1.1666 b=-0.0398	a=0.9283 b=-0.1066	123.145	0.000	Significant
11	a=1.5238 b=0.1859	a=1.3039 b=0.2368	56.7577	0.000	Significant
12	a=0.8279 b=-0.0704	a=0.7686 b=-0.1824	113.039	0.000	Significant
14	a=1.3041 b=0.0034	a=1.0039 b=-0.0186	111.480	0.000	Significant
15	a=1.3154 b=0.1370	a=1.1791 b=0.0673	64.0746	0.000	Significant
16	a=0.9475 b=-0.1673	a=0.8082 b=-0.1616	110.249	0.000	Significant
17	a=1.2551 b=-0.0627	a=0.9728 b=-0.0915	113.855	0.000	Significant
18	a=0.9333 b=-0.0044	a=0.9185 b=-0.0674	52.3969	0.000	Significant

Item	Item 13= 0	Item 13= 1	χ^2	p	Significance
19	a=1.3166 b=0.0572	a=1.0043 b=-0.0774	129.649	0.000	Significant
20	a=1.0247 b=-0.0288	a=0.8855 b=-0.0570	89.9279	0.000	Significant
21	a=1.5247 b=0.1647	a=1.4586 b=0.4331	19.1577	0.000	Significant
22	a=1.5449 b=0.3212	a=1.5123 b=0.4364	27.0530	0.000	Significant
23	a=1.0753 b=-0.1007	a=0.8715 b=-0.1154	109.259	0.000	Significant
24	a=1.2191 b=0.0674	a=1.1821 b=0.1111	34.9826	0.000	Significant
25	a=0.9894 b=0.1095	a=1.0876 b=0.1195	17.7236	0.000	Significant
26	a=1.3445 b=-0.0622	a=1.0156 b=-0.0209	99.5398	0.000	Significant
27	a=1.4230 b=0.1661	a=1.2620 b=0.1185	59.7549	0.000	Significant
28	a=0.7340 b=0.0016	a=0.7823 b=-0.0444	30.4836	0.000	Significant
29	a=1.2185 b=-0.0216	a=0.9695 b=-0.0786	104.383	0.000	Significant
30	a=1.2001 b=0.1662	a=1.2079 b=0.0982	38.0964	0.000	Significant
31	a=1.9384 b=0.2788	a=1.7328 b=0.7929	10.2564	0.001	Significant
32	a=1.3499 b=0.0298	a=1.2362 b=0.1410	38.4593	0.000	Significant
33	a=2.0474 b=0.3736	a=1.8101 b=0.7646	17.8418	0.000	Significant
34	a=1.0659 b=0.0137	a=1.0861 b=-0.0200	34.2275	0.000	Significant
35	a=1.2881 b=0.1821	a=1.4579 b=0.3592	7.57953	0.005	Significant
36	a=1.7486 b=0.1206	a=1.5206 b=0.4005	28.5666	0.000	Significant
37	a=1.6803 b=-0.0571	a=1.4683 b=0.1480	32.8703	0.000	Significant
38	a=2.0337 b=0.1763	a=1.5879 b=0.2856	56.4309	0.000	Significant

Item	Item 13= 0	Item 13= 1	χ^2	p	Significance
39	a=1.8403	a=1.8092			
	b=0.1523	b=0.7843	1.15412	0.282	Not Significant
40	a=0.7385	a=0.8513			
	b=0.0173	b=-0.0632	12.7892	0.000	Significant
41	a=2.2940	a=1.8506			
	b=-0.0832	b=0.5946	6.85906	0.008	Significant
42	a=1.2225	a=1.3636			
	b=0.0089	b=0.2046	7.13005	0.007	Significant
43	a=1.0954	a=1.6131			
	b=0.0655	b=0.4534	8.37426	0.003	Significant
44	a=1.1266	a=1.5254			
	b=0.0550	b=0.2844	0.255191	0.613	Not Significant
45	a=2.2198	a=1.8068			
	b=-0.0369	b=0.5628	9.14210	0.002	Significant
46	a=1.2424	a=1.3977			
	b=-0.1296	b=-0.0009	8.38307	0.003	Significant
47	a=1.1316	a=1.5432			
	b=0.0205	b=0.1694	0.005887	0.938	Not Significant
48	a=2.2398	a=2.0321			
	b=0.0240	b=0.5204	5.71150	0.016	Not Significant
49	a=2.0481	a=2.1617			
	b=0.2194	b=0.7885	0.140979	0.707	Not Significant
50	a=2.0538	a=1.9328			
	b=-0.1419	b=0.5457	.237800	0.000	Significant

TABLE A.14

The Table showing the values of item parameters a and b of all items conditioned on item no. 14

Item	Item 14= 0	Item 14= 1	χ^2	p	Significance
1	a=0.6607 b=-0.0729	a=0.7897 b=-0.2070	22.4910	0.000	Significant
2	a=1.3789 b=0.0169	a=1.1344 b=0.0696	82.7348	0.000	Significant
3	a=0.9145 b=-0.1029	a=0.8065 b=-0.2096	154.798	0.000	Significant
4	a=1.0313 b=-0.0895	a=0.9300 b=-0.1210	91.7935	0.000	Significant
5	a=0.9416 b=-0.0984	a=0.8204 b=-0.1683	142.917	0.000	Significant
6	a=1.2831 b=-0.0071	a=1.0880 b=0.0037	87.0506	0.000	Significant
7	a=1.3188 b=-0.0177	a=1.0231 b=-0.0424	127.970	0.000	Significant
8	a=1.1712 b=-0.1445	a=0.9077 b=-0.1440	151.168	0.000	Significant
9	a=1.6293 b=0.1690	a=1.2943 b=0.1959	91.8925	0.000	Significant
10	a=1.2167 b=-0.0590	a=0.8970 b=-0.1005	181.401	0.000	Significant
11	a=1.4597 b=0.1555	a=1.3337 b=0.2537	53.3500	0.000	Significant
12	a=0.8482 b=-0.0777	a=0.7533 b=-0.1833	173.541	0.000	Significant
13	a=1.1265 b=0.0419	a=0.9709 b=-0.0315	111.480	0.000	Significant
15	a=1.3450 b=0.0386	a=1.1760 b=0.1092	71.6950	0.000	Significant
16	a=1.0076 b=-0.1372	a=0.7712 b=-0.1785	221.855	0.000	Significant
17	a=1.2471 b=-0.1197	a=0.9706 b=-0.0668	125.814	0.000	Significant
18	a=0.9480 b=-0.0039	a=0.9067 b=-0.0685	83.5364	0.000	Significant

Item	Item 14= 0	Item 14= 1	χ^2	p	Significance
19	a=1.2609 b=-0.0460	a=1.0302 b=-0.0390	109.278	0.000	Significant
20	a=1.0054 b=-0.0266	a=0.8895 b=-0.0583	108.045	0.000	Significant
21	a=1.5937 b=0.2267	a=1.4066 b=0.4032	51.1332	0.000	Significant
22	a=1.5809 b=0.2774	a=1.4970 b=0.4587	37.9719	0.000	Significant
23	a=1.0586 b=-0.1519	a=0.8781 b=-0.0900	116.387	0.000	Significant
24	a=1.1988 b=0.0308	a=1.2024 b=0.1341	37.9957	0.000	Significant
25	a=0.9598 b=0.0971	a=1.1217 b=0.1295	16.6479	0.000	Significant
26	a=1.2930 b=-0.0831	a=1.0277 b=-0.0090	103.875	0.000	Significant
27	a=1.3753 b=0.0699	a=1.2988 b=0.1632	47.7399	0.000	Significant
28	a=0.7417 b=0.0548	a=0.7742 b=-0.0726	66.1181	0.000	Significant
29	a=1.2055 b=-0.1624	a=0.9830 b=-0.0224	89.4002	0.000	Significant
30	a=1.0956 b=0.1467	a=1.3007 b=0.1077	19.4555	0.000	Significant
31	a=1.7876 b=0.5113	a=1.7276 b=0.7225	25.1380	0.000	Significant
32	a=1.2950 b=0.0109	a=1.2657 b=0.1562	34.1467	0.000	Significant
33	a=1.7871 b=0.3771	a=1.9234 b=0.7963	4.74881	0.029	Not Significant
34	a=1.0184 b=-0.0013	a=1.1217 b=-0.0087	25.6069	0.000	Significant
35	a=1.3060 b=0.2168	a=1.4423 b=0.3398	16.7702	0.000	Significant
36	a=1.5324 b=0.1596	a=1.6140 b=0.4032	14.4701	0.000	Significant
37	a=1.6704 b=-0.1030	a=1.4710 b=0.1689	34.7315	0.000	Significant
38	a=1.8149 b=0.1301	a=1.6785 b=0.3072	33.5127	0.000	Significant

6

Item	Item 14= 0	Item 14= 1	χ^2	p	Significance
39	a=1.6947 b=0.3235	a=1.8201 b=0.7343	4.07328	0.043	Not Significant
40	a=0.8088 b=-0.0033	a=0.7970 b=-0.0576	62.2655	0.000	Significant
41	a=2.0031 b=0.1648	a=1.8630 b=0.5162	17.0733	0.000	Significant
42	a=1.2057 b=0.0782	a=1.3785 b=0.1652	13.4887	0.000	Significant
43	a=1.1333 b=0.1512	a=1.5991 b=0.3739	0.282270	0.595	Not Significant
44	a=1.1376 b=0.1487	a=1.5337 b=0.2197	1.75596	0.185	Not Significant
45	a=1.8897 b=0.1033	a=1.8981 b=0.5164	6.54355	0.010	Not Significant
46	a=1.4141 b=-0.1590	a=1.2950 b=0.0011	38.4039	0.000	Significant
47	a=1.2020 b=0.1173	a=1.4704 b=0.1110	10.6069	0.001	Significant
48	a=2.1234 b=0.0634	a=2.0932 b=0.4870	6.11897	0.013	Not Significant
49	a=1.9498 b=0.3338	a=2.1920 b=0.7241	1.48054	0.223	Not Significant
50	a=1.9168 b=-0.0026	a=2.0001 b=0.4524	2.86504	0.090	Not Significant

TABLE A.15

The Table showing the values of item parameters a and b of all items conditioned on item no. 15

Item	Item 15= 0	Item 15= 1	χ^2	p	Significance
1	a=1.8562 b=0.2758	a=0.7836 b=-0.2005	23.5563	0.000	Significant
2	a=1.2717 b=-0.1454	a=1.0024 b=-0.0620	206.063	0.000	Significant
3	a=1.2542 b=-0.0266	a=0.8440 b=-0.2021	68.0446	0.000	Significant
4	a=1.0435 b=-0.0715	a=0.9088 b=-0.1377	94.5365	0.000	Significant
5	a=1.3441 b=0.0374	a=0.8671 b=-0.1683	57.2588	0.000	Significant
6	a=1.4648 b=0.0169	a=0.9807 b=-0.0814	179.039	0.000	Significant
7	a=1.1693 b=-0.0966	a=0.9993 b=-0.0605	123.423	0.000	Significant
8	a=1.6596 b=0.0994	a=0.8764 b=-0.1683	162.568	0.000	Significant
9	a=1.2799 b=-0.1738	a=1.0651 b=-0.0031	318.154	0.000	Significant
10	a=1.4015 b=0.3100	a=0.9504 b=-0.0948	85.1986	0.000	Significant
11	a=0.8562 b=-0.0942	a=1.2273 b=0.1868	102.245	0.000	Significant
12	a=1.0859 b=-0.0379	a=0.8088 b=-0.1808	57.3046	0.000	Significant
13	a=1.1945 b=-0.1439	a=1.0076 b=-0.0384	64.0746	0.000	Significant
14	a=1.3751 b=-0.0386	a=1.0311 b=0.0104	71.6950	0.000	Significant
16	a=0.9854 b=-0.1686	a=0.8218 b=-0.1928	102.523	0.000	Significant
17	a=1.3780 b=-0.0554	a=0.9284 b=-0.1133	156.009	0.000	Significant
18	a=1.1589 b=-0.1090	a=0.9530 b=-0.0506	34.5634	0.000	Significant

Item	Item 15= 0	Item 15= 1	χ^2	p	Significance
19	a=1.1194 b=-0.0856	a=0.9838 b=-0.0806	137.493	0.000	Significant
20	a=0.9001 b=-0.0878	a=0.9481 b=-0.0811	48.7009	0.000	Significant
21	a=1.4693 b=0.1157	a=1.4295 b=0.4495	32.6959	0.000	Significant
22	a=1.3660 b=0.4551	a=1.4704 b=0.4619	42.0588	0.000	Significant
23	a=1.1874 b=-0.2681	a=0.8652 b=-0.1115	115.115	0.000	Significant
24	a=1.2807 b=0.0179	a=1.1387 b=0.1157	62.2183	0.000	Significant
25	a=1.0118 b=0.0375	a=1.1196 b=0.0976	20.9169	0.000	Significant
26	a=1.2995 b=-0.1993	a=1.0412 b=-0.0073	76.7801	0.000	Significant
27	a=1.2793 b=0.0306	a=1.2723 b=0.1918	45.9697	0.000	Significant
28	a=0.7891 b=-0.0074	a=0.8404 b=-0.0532	10.3135	0.001	Significant
29	a=1.2143 b=-0.2150	a=0.9880 b=-0.0562	81.0396	0.000	Significant
30	a=1.0840 b=0.2172	a=1.2052 b=0.1037	47.0616	0.000	Significant
31	a=1.4497 b=0.2869	a=1.8750 b=0.8813	1.54829	0.213	Not Significant
32	a=1.3379 b=-0.0723	a=1.2969 b=0.1551	25.8645	0.000	Significant
33	a=1.9645 b=0.5043	a=1.7777 b=0.7548	34.0034	0.000	Significant
34	a=1.0800 b=0.0187	a=1.0544 b=-0.0199	53.6235	0.000	Significant
35	a=1.2325 b=0.0109	a=1.5052 b=0.4902	1.28015	0.257	Not Significant
36	a=1.5930 b=-0.1229	a=1.5924 b=0.4306	18.5863	0.000	Significant
37	a=2.0035 b=-0.3036	a=1.3937 b=0.1820	53.0855	0.000	Significant
38	a=1.7662 b=-0.1551	a=1.6743 b=0.3617	27.8271	0.000	Significant

Item	Item 15= 0	Item 15= 1	χ^2	p	Significance
39	a=1.6909 b=0.0355	a=1.8483 b=0.7938	3.62179	0.057	Not Significant
40	a=0.7217 b=0.0577	a=0.8820 b=-0.0750	11.2146	0.000	Significant
41	a=3.2936 b=-0.4181	a=1.8425 b=0.6530	9.05922	0.002	Significant
42	a=1.2515 b=-0.1028	a=1.3699 b=0.2044	13.6287	0.000	Significant
43	a=1.3736 b=-0.0894	a=1.5930 b=0.4746	.568412	0.450	Not Significant
44	a=1.0538 b=-0.0780	a=1.5572 b=0.3330	.009287	0.923	Not Significant
45	a=1.9340 b=-0.2472	a=1.8317 b=0.6000	9.97885	0.001	Significant
46	a=1.7134 b=-0.4348	a=1.3253 b=0.0256	26.6400	0.000	Significant
47	a=1.2433 b=-0.0799	a=1.5465 b=0.2067	.828989	0.362	Not Significant
48	a=2.2823 b=-0.1674	a=1.9174 b=0.5427	21.5760	0.000	Significant
49	a=2.9340 b=-0.2052	a=2.0277 b=0.8769	3.37378	0.066	Not Significant
50	a=2.6420 b=-0.3969	a=1.9219 b=0.5720	3.08759	0.078	Not Significant

64

TABLE A.16

The Table showing the values of item parameters a and b of all items conditioned on item no. 16

Item	Item 16= 0	Item 16= 1	χ^2	p	Significance
1	a=1.1935 b=0.0791	a=0.7684 b=-0.2046	55.0242	0.000	Significant
2	a=0.8157 b=-0.1824	a=1.1401 b=0.0534	124.982	0.000	Significant
3	a=0.9203 b=-0.1046	a=0.8049 b=-0.1859	225.102	0.000	Significant
4	a=0.8394 b=-0.1606	a=0.9233 b=-0.1219	149.651	0.000	Significant
5	a=1.1166 b=-0.0053	a=0.8271 b=-0.1500	186.497	0.000	Significant
6	a=1.1015 b=-0.0161	a=1.1045 b=0.0072	109.024	0.000	Significant
7	a=0.9416 b=-0.1572	a=1.0499 b=-0.0283	149.709	0.000	Significant
8	a=1.4164 b=0.2413	a= 0.9307 b=-0.1439	186.261	0.000	Significant
9	a=0.9919 b=-0.0735	a=1.3465 b=0.2090	88.0973	0.000	Significant
10	a=1.4057 b=0.2703	a=0.9242 b=-0.0823	210.469	0.000	Significant
11	a=0.8220 b=-0.1671	a=1.3583 b=0.2503	57.9864	0.000	Significant
12	a=1.0203 b=-0.0253	a= 0.7451 b=-0.1678	284.043	0.000	Significant
13	a=0.9985 b=-0.0737	a=0.9978 b=-0.0021	110.249	0.000	Significant
14	a=1.2916 b=0.1193	a=0.9829 b=-0.0120	221.855	0.000	Significant
15	a=0.8156 b=-0.1795	a=1.1783 b=0.0785	102.523	0.000	Significant
17	a=1.0272 b=-0.0551	a=0.9726 b=-0.0731	195.355	0.000	Significant
18	a=0.8830 b=-0.0719	a=0.9224 b=-0.0619	91.1426	0.000	Significant

Item	Item 16= 0	Item 16= 1	χ^2	p	Significance
19	a=1.0985 b=-0.0461	a=1.0466 b=-0.0429	144.466	0.000	Significant
20	a=0.9148 b=-0.0611	a=0.8770 b=-0.0477	179.090	0.000	Significant
21	a=1.3976 b=0.3325	a=1.4538 b=0.4036	44.0826	0.000	Significant
22	a=1.5337 b=0.3769	a=1.5516 b=0.4466	29.9736	0.000	Significant
23	a=0.8979 b=-0.1004	a=0.8725 b=-0.0926	186.706	0.000	Significant
24	a=1.1734 b=0.0576	a=1.1745 b=0.1111	72.8370	0.000	Significant
25	a=1.0391 b=0.1143	a=1.1057 b=0.1044	27.1821	0.000	Significant
26	a=1.0676 b=-0.0297	a=1.0355 b=-0.0031	140.693	0.000	Significant
27	a=1.2947 b=0.1327	a=1.3284 b=0.1634	46.1437	0.000	Significant
28	a=0.7842 b=-0.0481	a=0.7546 b=-0.0585	121.922	0.000	Significant
29	a=0.9369 b=-0.1016	a=0.9921 b=-0.0473	131.280	0.000	Significant
30	a=1.2612 b=0.1148	a=1.2854 b=0.1145	23.0668	0.000	Significant
31	a=1.7183 b=0.6758	a=1.7651 b=0.6980	26.2761	0.000	Significant
32	a=1.1901 b=0.1374	a=1.2585 b=0.1258	56.1264	0.000	Significant
33	a=1.8074 b=0.5988	a= 1.8825 b=0.7556	10.9488	0.000	Significant
34	a=1.1133 b=-0.0084	a=1.0644 b=-0.0270	76.9235	0.000	Significant
35	a=1.4712 b=0.3919	a=1.4518 b=0.3521	12.2419	0.000	Significant
36	a=1.4722 b=0.3734	a=1.5658 b=0.3726	33.2695	0.000	Significant
37	a=1.5192 b=0.1196	a=1.5007 b=0.1493	38.9425	0.000	Significant
38	a=1.6236 b=0.3608	a=1.6807 b=0.2950	45.4375	0.000	Significant

66

Item	Item 16= 0	Item 16= 1	χ^2	p	Significance
39	a=1.8200 b=0.6329	a=1.8049 b=0.6752	10.4658	0.001	Significant
40	a=0.7564 b=-0.0215	a=0.7755 b=-0.0429	119.415	0.000	Significant
41	a= 2.0528 b=0.5493	a=1.9099 b= 0.4961	14.2905	0.000	Significant
42	a=1.2972 b=0.1489	a=1.3293 b=0.1482	31.4809	0.000	Significant
43	a=1.3497 b=0.2636	a=1.5319 b=0.3291	0.357121	0.550	Not Significant
44	a=1.4138 b=0.2160	a= 1.4888 b=0.2206	2.19295	0.138	Not Significant
45	a=1.8488 b=0.5054	a=1.9191 b=0.4856	6.50325	0.010	Significant
46	a=1.3590 b=0.0170	a=1.2800 b=-0.0053	60.9504	0.000	Significant
47	a=1.4653 b=0.1326	a=1.4538 b=0.1207	10.6317	0.001	Significant
48	a=2.1868 b=0.3765	a= 2.1018 b=0.4637	6.64784	0.009	Significant
49	a=2.1499 b=0.7528	a= 2.1842 b=0.7158	0.534668	0.464	Not Significant
50	a=1.9868 b=0.3118	a=1.8936 b=0.4037	19.2660	0.000	Significant

TABLE A.17

The Table showing the values of item parameters a and b of all items conditioned on item no. 17

Item	Item 17= 0	Item 17= 1	χ^2	p	Significance
1	a=0.6615 b=-0.0366	a=0.7784 b=-0.2214	56.8824	0.000	Significant
2	a=1.5214 b=0.1417	a=1.0683 b=0.0110	185.507	0.000	Significant
3	a=0.8872 b=-0.1171	a=0.8259 b=-0.1982	138.302	0.000	Significant
4	a=1.1274 b=-0.0270	a=0.8809 b=-0.1535	203.472	0.000	Significant
5	a=0.8822 b=-0.1008	a=0.8605 b=-0.1615	100.582	0.000	Significant
6	a=1.4000 b=0.0979	a=1.0308 b=-0.0404	182.379	0.000	Significant
7	a=1.4223 b=-0.0146	a=0.9964 b=-0.0462	188.697	0.000	Significant
8	a=1.3137 b=-0.0653	a=0.8579 b=-0.1794	295.585	0.000	Significant
9	a=1.8333 b=0.2464	a=1.2207 b=0.1655	175.272	0.000	Significant
10	a=1.1197 b=-0.0906	a=0.9561 b=-0.0838	122.133	0.000	Significant
11	a=1.6549 b=0.3276	a=1.2241 b= 0.1860	158.796	0.000	Significant
12	a= 0.8049 b=-0.0784	a=0.7857 b=-0.1793	129.083	0.000	Significant
13	a=1.1163 b=0.0303	a=0.9894 b=-0.0261	113.855	0.000	Significant
14	a=1.2872 b=-0.0808	a=1.0144 b=0.0065	125.814	0.000	Significant
15	a=1.4536 b=0.1452	a=1.1061 b=0.0533	156.009	0.000	Significant
16	a=0.9562 b=-0.1239	a=0.7920 b=-0.1817	195.355	0.000	Significant
18	a=0.9464 b=0.0421	a=0.9087 b=-0.0864	107.058	0.000	Significant

Item	Item 17= 0	Item 17= 1	χ^2	p	Significance
19	a=1.3473 b=-0.0354	a=1.0090 b=-0.0457	159.643	0.000	Significant
20	a=0.9806 b= 0.0072	a=0.9087 b=-0.0699	110.929	0.000	Significant
21	a=1.6916 b=0.1871	a=1.3985 b=0.3973	71.6218	0.000	Significant
22	a=1.7235 b=0.3318	a=1.4357 b=0.4225	84.4608	0.000	Significant
23	a=1.0779 b=-0.1240	a=0.8756 b=-0.1058	147.600	0.000	Significant
24	a=1.2906 b=0.0713	a=1.1506 b=0.1045	84.2477	0.000	Significant
25	a=0.9283 b=0.0773	a=1.1606 b=0.1386	11.4944	0.000	Significant
26	a=1.3611 b=-0.1094	a=1.0208 b=-0.0078	131.802	0.000	Significant
27	a=1.5635 b=0.0839	a=1.2208 b=0.1464	109.663	0.000	Significant
28	a=0.6860 b=0.0416	a=0.8286 b=-0.0648	23.7399	0.000	Significant
29	a=1.1664 b=-0.1238	a=1.0099 b=-0.0400	92.4375	0.000	Significant
30	a=1.1814 b=0.1096	a=1.2386 b=0.1165	47.3071	0.000	Significant
31	a=1.9089 b=0.3167	a=1.7741 b=0.7371	27.4236	0.000	Significant
32	a=1.3045 b=-0.0274	a=1.2799 b=0.1601	41.1860	0.000	Significant
33	a=2.3877 b=0.1618	a=1.7980 b=0.7739	32.6715	0.000	Significant
34	a=1.0570 b=-0.0139	a=1.0974 b=-0.0115	50.7343	0.000	Significant
35	a=1.3378 b=0.0427	a=1.4670 b=0.3974	13.1122	0.000	Significant
36	a=1.6582 b=-0.0780	a=1.6369 b=0.4632	12.6935	0.000	Significant
37	a=2.1097 b=-0.1477	a=1.3533 b=0.1493	106.018	0.000	Significant
38	a=2.0433 b=-0.0430	a=1.6671 b=0.3295	47.1303	0.000	Significant

Item	Item 17= 0	Item 17= 1	χ^2	p	Significance
39	a=1.8620	a=1.9086			
	b=-0.0783	b=0.8412	0.001872	0.965	Not Significant
40	a=0.7238	a=0.8611			
	b=0.0331	b=-0.0636	25.0653	0.000	Significant
41	a=2.4062	a=1.8973			
	b=-0.1882	b=0.5721	15.8116	0.000	Significant
42	a=1.1898	a=1.4157			
	b=-0.0626	b=0.2214	8.45094	0.003	Significant
43	a=1.1253	a=1.6017			
	b=0.0537	b=0.4224	0.145737	0.702	Not Significant
44	a=1.1193	a=1.5556			
	b=0.0231	b= 0.2805	0.525277	0.468	Not Significant
45	a=2.0992	a=1.9199			
	b=-0.1443	b=0.5683	7.25592	0.007	Significant
46	a=1.4417	a=1.2990			
	b=-0.2391	b=0.0140	47.1506	0.000	Significant
47	a=1.1367	a=1.5479			
	b=0.0165	b=0.1543	3.41754	0.064	Not Significant
48	a=2.4199	a=2.0660			
	b=-0.1122	b=0.5033	14.1083	0.000	Significant
49	a=2.1928	a=2.1330			
	b=0.1061	b=0.7860	3.85754	0.049	Not Significant
50	a=2.3957	a=1.9085			
	b=-0.2805	b=0.4964	10.8085	0.001	Significant

TABLE A.18

The Table showing the values of item parameters a and b of all items conditioned on item no. 18

Item	Item 18= 0	Item 18= 1	χ^2	p	Significance
1	a= 0.6918 b= -0.0702	a= 0.7465 b= -0.1931	49.3508	0.000	Significant
2	a= 1.3777 b= 0.0555	a= 1.1479 b= 0.0473	66.8258	0.000	Significant
3	a= 0.895 b= -0.1417	a= 0.8266 b= -0.1839	86.1200	0.000	Significant
4	a= 1.0388 b= -0.0719	a= 0.9323 b= -0.1277	74.9266	0.000	Significant
5	a= 0.8979 b= -0.1115	a= 0.8507 b= -0.1555	69.0846	0.000	Significant
6	a= 1.3065 b= 0.0212	a= 1.0899 b= -0.0096	75.0031	0.000	Significant
7	a= 1.2841 b= -0.0379	a= 1.0611 b= -0.0356	76.3467	0.000	Significant
8	a= 1.1373 b= -0.1108	a= 0.9378 b= -0.1555	100.420	0.000	Significant
9	a= 1.5979 b= 0.096	a= 1.3408 b= 0.2126	48.6862	0.000	Significant
10	a= 1.087 b= -0.071	a= 0.9717 b= -0.0929	68.7049	0.000	Significant
11	a= 1.5278 b= 0.2104	a= 1.303 b= 0.2219	57.6530	0.000	Significant
12	a= 0.7882 b= -0.0754	a= 0.7913 b= -0.1729	66.1465	0.000	Significant
13	a= 1.0674 b= 0.0208	a= 1.0125 b= -0.0191	52.3969	0.000	Significant
14	a= 1.2604 b= -0.0352	a= 1.0272 b= -0.0158	83.5364	0.000	Significant
15	a= 1.2645 b= 0.0212	a= 1.2109 b= 0.0972	34.5634	0.000	Significant
16	a= 0.9058 b= -0.1264	a= 0.8207 b= -0.1746	91.1426	0.000	Significant
17	a= 1.2245 b= -0.03	a= 0.9798 b=-0.1056	107.058	0.000	Significant

Item	Item 18= 0	Item 18= 1	χ^2	p	Significance
19	a= 1.2982 b= -0.0054	a= 1.0315 b= -0.0558	98.7682	0.000	Significant
20	a= 1.0051 b= 0.0064	a= 0.8961 b= -0.0666	84.6256	0.000	Significant
21	a= 1.4545 b= 0.1808	a= 1.4821 b= 0.41	14.9800	0.000	Significant
22	a= 1.5885 b= 0.3663	a= 1.478 b= 0.4125	38.6506	0.000	Significant
23	a= 1.1053 b= -0.1109	a= 0.8722 b= -0.1101	116.299	0.000	Significant
24	a= 1.3006 b= 0.071	a= 1.1445 b= 0.1067	56.0421	0.000	Significant
25	a= 1.0093 b= 0.114	a= 1.0629 b= 0.116	26.1147	0.000	Significant
26	a= 1.251 b= -0.0184	a= 1.0579 b= -0.0354	74.5414	0.000	Significant
27	a= 1.4343 b= 0.1622	a= 1.2632 b= 0.126	59.1576	0.000	Significant
28	a= 0.7287 b= 0.0113	a= 0.7803 b= -0.0437	31.5422	0.000	Significant
29	a= 1.1064 b= -0.123	a= 1.0382 b= -0.0415	40.9874	0.000	Significant
30	a= 1.1678 b= 0.0647	a= 1.238 b= 0.1375	19.7368	0.000	Significant
31	a= 1.7182 b= 0.329	a= 1.8118 b= 0.7521	4.37273	0.036	Not Significant
32	a= 1.3986 b= -0.0189	a= 1.2244 b= 0.1462	41.6346	0.000	Significant
33	a= 1.9061 b= 0.3062	a= 1.8662 b= 0.7729	6.54620	0.010	Not Significant
34	a= 1.1121 b= 0.0029	a= 1.054 b= -0.0133	48.5232	0.000	Significant
35	a= 1.3235 b= 0.0526	a= 1.433 b= 0.3911	5.09385	0.024	Not Significant
36	a= 1.5658 b= 0.1039	a= 1.5925 b= 0.3993	11.7227	0.000	Significant
37	a= 1.6525 b= -0.0643	a= 1.4809 b= 0.1398	30.7501	0.000	Significant
38	a= 1.8113 b= 0.1179	a= 1.6933 b= 0.2958	26.3307	0.000	Significant

Item	Item 18= 0	Item 18= 1	χ^2	p	Significance
39	a= 1.7379 b= 0.1737	a= 1.8147 b= 0.7522	0.851017	0.356	Not Significant
40	a= 0.7546 b= 0.0052	a= 0.8304 b= -0.0538	22.0293	0.000	Significant
41	a= 2.2853 b= 0.087	a= 1.8042 b= 0.5042	23.5651	0.000	Significant
42	a= 1.3026 b= -0.0243	a= 1.3151 b= 0.188	16.3988	0.000	Significant
43	a= 1.3136 b= 0.0997	a= 1.4022 b= 0.3645	8.12144	0.004	Significant
44	a= 1.255 b= 0.0339	a= 1.3995 b= 0.2636	6.22374	0.012	Not Significant
45	a= 2.0344 b= 0.0246	a= 1.8388 b= 0.5264	7.59771	0.005	Significant
46	a= 1.3687 b= -0.1733	a= 1.3314 b= -0.0019	22.2537	0.000	Significant
47	a= 1.3124 b= 0.0156	a= 1.3814 b= 0.1495	14.8284	0.000	Significant
48	a= 2.0445 b= 0.0982	a= 2.0806 b= 0.4815	4.89333	0.026	Not Significant
49	a= 2.1503 b= 0.2477	a= 2.0542 b= 0.7562	3.24362	0.071	Not Significant
50	a= 2.076 b= -0.0946	a= 1.9164 b= 0.4758	2.94126	0.086	Not Significant

93

TABLE A.19

The Table showing the values of item parameters a and b of all items conditioned on item no. 19

Item	Item 19= 0	Item 19= 1	χ^2	p	Significance
1	a= 0.6544 b= -0.074	a= 0.7997 b= -0.2078	18.3552	0.000	Significant
2	a= 1.4466 b= 0.1602	a= 1.0725 b= -0.0032	157.890	0.000	Significant
3	a= 0.8559 b= -0.1202	a= 0.8462 b= -0.2008	87.2147	0.000	Significant
4	a= 1.0477 b= -0.0605	a= 0.9155 b= -0.1404	119.013	0.000	Significant
5	a= 0.9136 b= -0.1016	a= 0.8377 b= -0.1688	119.620	0.000	Significant
6	a= 1.4008 b= 0.0968	a= 1.0114 b= -0.0478	75.0031	0.000	Significant
7	a= 1.3847 b= -0.0074	a= 0.9898 b= -0.0522	170.678	0.000	Significant
8	a= 1.1772 b= -0.126	a= 0.8999 b= -0.1563	169.936	0.000	Significant
9	a= 1.797 b= 0.2465	a= 1.2038 b= 0.1574	166.920	0.000	Significant
10	a= 1.135 b= -0.0496	a= 0.9321 b= -0.1077	139.215	0.000	Significant
11	a= 1.6098 b= 0.1961	a= 1.2489 b= 0.2335	106.286	0.000	Significant
12	a= 0.7881 b= -0.0789	a= 0.796 b= -0.1838	96.3842	0.000	Significant
13	a= 1.1249 b= 0.0768	a= 0.9661 b= -0.0519	129.649	0.000	Significant
14	a= 1.2415 b= -0.0503	a= 1.017 b= -0.0016	109.278	0.000	Significant
15	a= 1.4074 b= 0.1472	a= 1.1068 b= 0.0456	137.493	0.000	Significant
16	a= 0.9097 b= -0.11	a= 0.8087 b= -0.1949	144.466	0.000	Significant
17	a= 1.2611 b= -0.0846	a= 0.9477 b= -0.0906	159.643	0.000	Significant

Item	Item 19= 0	Item 19= 1	χ^2	p	Significance
18	a= 0.9494	a= 0.8951			
	b= 0.0052	b= -0.0804	98.7682	0.000	Significant
20	a= 0.9801	a= 0.9068			
	b= -0.0136	b= -0.0668	98.4616	0.000	Significant
21	a= 1.6089	a= 1.4314			
	b= 0.156	b= 0.4384	45.1546	0.000	Significant
22	a= 1.6944	a= 1.4553			
	b= 0.2563	b= 0.4642	59.5082	0.000	Significant
23	a= 1.0226	a= 0.8899			
	b= -0.0892	b= -0.1199	117.750	0.000	Significant
24	a= 1.295	a= 1.1511			
	b= 0.0031	b= 0.1452	65.0870	0.000	Significant
25	a= 1.0125	a= 1.0737			
	b= 0.1585	b= 0.0957	49.1621	0.000	Significant
26	a= 1.3472	a= 1.0069			
	b= -0.0806	b= -0.017	134.143	0.000	Significant
27	a= 1.4881	a= 1.2224			
	b= 0.151	b= 0.1305	103.594	0.000	Significant
28	a= 0.7016	a= 0.8255			
	b= 0.0095	b= -0.05	21.9935	0.000	Significant
29	a= 1.1962	a= 0.9765			
	b= -0.0652	b= -0.0632	119.172	0.000	Significant
30	a= 1.2305	a= 1.1852			
	b= 0.1792	b= 0.0969	72.2431	0.000	Significant
31	a= 1.9211	a= 1.8086			
	b= 0.2099	b= 0.8304	10.5922	0.000	Significant
32	a= 1.328	a= 1.261			
	b= 0.0057	b= 0.1564	46.5367	0.000	Significant
33	a= 2.3464	a= 1.7748			
	b= 0.2192	b= 0.8035	32.9791	0.000	Significant
34	a= 1.0878	a= 1.0617			
	b= 0.0474	b= -0.0305	71.3639	0.000	Significant
35	a= 1.33	a= 1.4924			
	b= 0.0283	b= 0.4476	5.95820	0.014	Not Significant
36	a= 1.7069	a= 1.5853			
	b= 0.0405	b= 0.4369	26.5055	0.000	Significant
37	a= 1.7895	a= 1.4341			
	b= -0.1174	b= 0.1733	57.2686	0.000	Significant
38	a= 2.1999	a= 1.5927			
	b= -0.0219	b= 0.3447	61.2783	0.000	Significant

Item	Item 19= 0	Item 19= 1	χ^2	p	Significance
39	a= 1.9024 b= 0.0462	a= 1.8827 b= 0.8276	1.53779	0.214	Not Significant
40	a= 0.7253 b= 0.0461	a= 0.8733 b= -0.0801	20.0753	0.000	Significant
41	a= 2.2645 b= -0.0455	a= 1.8774 b= 0.5954	16.6282	0.000	Significant
42	a= 1.2368 b= -0.0117	a= 1.3777 b= 0.2272	13.9143	0.000	Significant
43	a= 1.2059 b= 0.1075	a= 1.5459 b= 0.4102	1.53339	0.215	Not Significant
44	a= 1.1941 b= 0.0284	a= 1.5001 b= 0.3122	2.31248	0.128	Not Significant
45	a= 2.0346 b= -0.0034	a= 1.9093 b= 0.5813	9.25292	0.002	Significant
46	a= 1.3927 b= -0.2031	a= 1.3263 b= 0.0255	32.977	0.000	Significant
47	a= 1.1239 b= 0.0508	a= 1.5926 b= 0.1784	0.666251	0.414	Not Significant
48	a= 2.3365 b= -0.0602	a= 2.0553 b= 0.5735	8.23165	0.004	Significant
49	a= 2.16 b= 0.1749	a= 2.1471 b= 0.8242	2.68120	0.101	Not Significant
50	a= 2.1767 b= -0.2121	a= 1.9408 b= 0.5859	2.07479	0.149	Not Significant

76

TABLE A.20

The Table showing the values of item parameters a and b of all items conditioned on item no. 20

Item	Item 20= 0	Item 20= 1	χ^2	p	Significance
1	a=0.6527 b=-0.0720	a=0.7783 b=-0.1940	15.7301	0.000	Significant
2	a=1.3489 b=0.0400	a=1.1582 b=0.0556	63.7022	0.000	Significant
3	a=0.9318 b=-0.1521	a=0.8094 b=-0.1810	127.183	0.000	Significant
4	a=0.9776 b=-0.1005	a=0.9640 b=-0.1130	46.4584	0.000	Significant
5	a=0.9175 b=-0.1368	a=0.8422 b=-0.1451	86.1866	0.000	Significant
6	a=1.2215 b=-0.0537	a=1.1317 b=0.0233	43.938	0.000	Significant
7	a=1.2444 b=-0.0721	a=1.0772 b=-0.0201	64.947	0.000	Significant
8	a=1.0907 b=-0.1445	a=0.9567 b=-0.1412	79.8044	0.000	Significant
9	a=1.6131 b=0.2025	a=1.3142 b=0.1826	74.3070	0.000	Significant
10	a=1.1202 b=-0.1060	a=0.9590 b=-0.0785	82.5445	0.000	Significant
11	a= 1.3701 b=0.0605	a=1.3946 b=0.2886	16.0550	0.000	Significant
12	a=0.8368 b=-0.0978	a=0.7665 b=-0.1666	115.996	0.000	Significant
13	a=1.1430 b=0.0258	a=0.9753 b=-0.0211	89.9279	0.000	significant
14	a=1.3079 b=-0.0360	a=1.0050 b= -0.0138	108.045	0.000	significant
15	a=1.2441 b= 0.1266	a=1.2044 b=0.0619	48.7009	0.000	Significant
16	a=1.0174 b=-0.1635	a=0.7754 b=-0.1639	179.090	0.000	Significant
17	a=1.2302 b= -0.0571	a=0.9742 b=-0.0956	110.929	0.000	Significant

Item	Item 20= 0	Item 20= 1	χ^2	p	Significance
18	a=0.9650 b=0.0200	a=0.8850 b=-0.0753	84.625	0.000	significant
19	a=1.2695 b=-0.0157	a=1.0250 b=-0.0574	98.461	0.000	Significant
21	a=1.5414 b=0.2715	a=1.4231 b= 0.3792	37.0447	0.000	Significant
22	a=1.5033 b=0.2200	a=1.5412 b=0.4667	14.2974	0.000	Significant
23	a=1.0886 b=-0.1147	a=0.8722 b=-0.1070	115.441	0.000	Significant
24	a=1.2837 b=0.1641	a=1.1328 b=0.0809	72.4828	0.000	Significant
25	a=1.0352 b=0.1577	a=1.0419 b=0.1005	42.2322	0.000	Significant
26	a=1.3234 b=-0.0258	a=1.0253 b=-0.0306	101.699	0.000	Significant
27	a=1.3258 b=0.0166	a=1.3344 b=0.1739	21.7119	0.000	Significant
28	a=0.7437 b=0.0861	a=0.7654 b=-0.0734	60.2633	0.000	Significant
29	a=1.1753 b= -0.0787	a=0.9976 b=-0.0546	75.4807	0.000	Significant
30	a=1.1115 b=0.1306	a=1.2669 b=0.1142	16.7139	0.000	Significant
31	a= 1.7220 b=0.3913	a= 1.7828 b=0.7448	7.11796	0.007	Significant
32	a=1.3431 b=0.0786	a=1.2272 b=0.1226	46.3026	0.000	Significant
33	a=1.7886 b=0.3985	a=1.8960 b=0.7560	5.63724	0.017	Not Significant
34	a=1.1495 b=0.0020	a=1.0340 b=-0.0138	61.5551	0.000	Significant
35	a=1.2680 b=0.1300	a=1.4614 b=0.3672	4.45392	0.034	Significant
36	a=1.6418 b=0.1969	a=1.5353 b=0.3711	27.4157	0.000	Significant
37	a=1.6669 b=-0.1389	a=1.4885 b=0.1632	23.9944	0.000	Significant
38	a=1.9774 b=-0.0002	a=1.6557 b=0.3239	27.6904	0.000	Significant

Item	Item 20= 0	Item 20= 1	χ^2	p	Significance
39	a=1.7180	a= 1.7918			
	b=0.2915	b= 0.7151	4.1917	0.040	Not Significant
40	a=0.7973	a=0.8044			
	b=-0.0174	b=-0.0482	42.7286	0.000	Significant
42	a=1.2708	a=1.3215			
	b=0.0323	b=0.1697	18.5733	0.000	Significant
43	a=1.1910	a=1.4846			
	b=0.1075	b=0.3729	0.505	0.476	Not Significant
44	a=1.2194	a=1.4250			
	b=0.0417	b= 0.2607	3.970	0.046	Not Significant
45	a=2.1296	a= 1.8229			
	b=0.0488	b= 0.4894	14.9573	0.000	Significant
46	a=1.4656	a=1.3011			
	b=-0.2473	b=0.0101	29.8678	0.000	Significant
47	a=1.2041	a=1.4627			
	b=0.0226	b=0.1390	4.70725	0.030	Not Significant
48	a=2.0445	a=2.0878			
	b=0.0716	b=0.4846	4.38762	0.036	Not Significant
49	a=1.9127	a=2.1663			
	b=0.2394	b= 0.7739	0.000	0.981	Not Significant
50	a=1.9468	a=1.9892			
	b=-0.1132	b=0.4785	0.412693	0.520	Not Significant

TABLE A.21

The Table showing the values of item parameters a and b of all items conditioned on item no. 21

Item	Item 21= 0	Item 21= 1	χ^2	p	Significance
1	a=0.7049	a=0.7923			
	b=-0.1244	b=-0.21	9.89993	0.000	Significant
2	a=1.2967	a=1.116			
	b=0.0713	b=0.0479	44.7298	0.000	Significant
3	a=0.8694	a=0.8323			
	b=-0.1475	b=-0.2019	46.2183	0.000	Significant
4	a=1.0095	a=0.919			
	b=-0.0839	b=-0.1393	49.4244	0.000	Significant
5	a=0.8752	a=0.8763			
	b=-0.1349	b=-0.146	26.7446	0.000	Significant
6	a=1.2445	a=1.04			
	b=0.0270	b=-0.0197	59.0819	0.000	Significant
7	a=1.2140	a=1.0144			
	b=-0.0151	b=-0.0449	60.0100	0.000	Significant
8	a=1.0840	a=0.8901			
	b=-0.1098	b=-0.1771	85.6139	0.000	Significant
9	a=1.5172	a=1.2534			
	b=0.2285	b=0.1624	56.3843	0.000	Significant
10	a=1.0194	a=1.0212			
	b=-0.1035	b=-0.0434	17.6814	0.000	Significant
11	a=1.4507	a=1.2603			
	b=0.2682	b=0.1914	48.8412	0.000	Significant
12	a=0.7896	a=0.8179			
	b=-0.1261	b=-0.1745	27.1700	0.000	Significant
13	a=1.0396	a=1.0503			
	b=-0.0094	b=0.0069	19.1577	0.000	Significant
14	a=1.1675	a=1.0098			
	b=-0.0169	b=-0.0029	51.1332	0.000	Significant
15	a=1.2693	a=1.1753			
	b=0.0850	b=0.0969	32.6959	0.000	Significant
16	a=0.8729	a=0.8343			
	b=-0.1520	b=-0.1747	44.0826	0.000	Significant
17	a=1.1443	a=0.9472			
	b= -0.0637	b=-0.105	71.6218	0.000	Significant

Item	Item 21= 0	Item 21= 1	χ^2	p	Significance
18	a=0.9049 b=-0.0357	a=0.9682 b=-0.0602	14.9800	0.000	Significant
19	a=1.1641 b=-0.0349	a=1.0413 b=-0.0462	45.1546	0.000	Significant
21	a=0.9483 b=-0.0296	a=0.9142 b=-0.0693	37.0447	0.000	Significant
22	a=1.5743 b=0.4181	a=1.4232 b=0.4337	33.4550	0.000	Significant
23	a=0.9674 b=-0.1001	a=0.9181 b=-0.1145	36.4687	0.000	Significant
24	a=1.2361 b=0.1031	a=1.1398 b=0.1258	33.4972	0.000	Significant
25	a=1.0075 b=0.1227	a=1.1374 b=0.1312	6.64456	0.009	Significant
26	a=1.1889 b=-0.0620	a=1.0465 b=0.0257	37.9051	0.000	Significant
27	a=1.4343 b=0.1594	a=1.1685 b=0.1433	59.3323	0.000	Significant
28	a=0.7459 b=0.0028	a=0.81 b=-0.081	15.7373	0.000	Significant
29	a=1.1043 b=-0.0906	a=1.0104 b=-0.0167	31.6408	0.000	Significant
30	a=1.2142 b=0.1331	a=1.2124 b=0.1393	21.1032	0.000	Significant
31	a=1.7621 b=0.6017	a=1.7205 b=0.7975	10.4905	0.000	Significant
32	a=1.3028 b=0.1017	a=1.2369 b=0.1571	24.1791	0.000	Significant
33	a=1.8411 b=0.6178	a=1.8485 b=0.8106	8.93497	0.002	Significant
34	a=1.0826 b=0.0052	a=1.0894 b=-0.0111	20.3343	0.000	Significant
35	a=1.3535 b=0.2474	a=1.4553 b=0.4293	4.64851	0.031	Not Significant
36	a=1.5680 b=0.2806	a=1.5806 b=0.4566	9.32510	0.002	Significant
37	a=1.6769 b=0.1169	a=1.2975 b=0.1284	58.9138	0.000	Significant
38	a=1.7821 b=0.1911	a=1.67 b=0.401	13.8493	0.000	Significant

Item	Item 21= 0	Item 21= 1	χ^2	p	Significance
39	a=1.7510	a=1.7865			
	b=0.4802	b=0.8481	1.96262	0.161	Not Significant
40	a=0.7995	a=0.8456			
	b=-0.0518	b=0.0301	12.0341	0.000	Significant
41	a=1.9375	a=1.8147			
	b=0.3685	b=-0.559	14.4760	0.000	Significant
42	a=1.2730	a=1.3875			
	b=0.0988	b=0.2403	4.74361	0.029	Not Significant
43	a=1.2946	a=1.544			
	b=0.2323	b=0.4421	0.262177	0.608	Not Significant
44	a=1.2623	a=1.5535			
	b= 0.1425	b=0.3393	.043992	0.833	Not Significant
45	a=1.8473	a=1.8935			
	b=0.3161	b=0.6065	3.56280	0.059	Not Significant
46	a=1.3937	a=1.282			
	b=-0.0794	b=0.0207	22.1059	0.000	Significant
47	a=1.3163	a=1.4516			
	b=0.1105	b=0.1632	6.73259	0.009	Significant
48	a=2.1189	a=1.9808			
	b=0.2902	b=0.5675	8.19808	0.004	Significant
49	a=2.0135	a=2.1156			
	b=0.5297	b=0.8512	1.69753	0.192	Not Significant
50	a=1.9823	a=1.8757			
	b=0.1974	b=0.5911	3.16080	0.075	Not Significant

TABLE A.22

The Table showing the values of item parameters a and b of all items conditioned on item no. 22

Item	Item 22= 0	Item 22= 1	χ^2	p	Significance
1	a=0.7116	a=0.7826			
	b=-0.1225	b=-0.2253	12.5263	0.000	Significant
2	a=1.2666	a=1.1585			
	b=0.064	b=0.0631	26.9025	0.000	Significant
3	a=0.8681	a=0.8336			
	b=-0.1467	b=-0.209	38.9922	0.000	Significant
4	a=1.0053	a=0.9215			
	b=-0.0849	b=-0.1428	40.8307	0.000	Significant
5	a=0.8812	a=0.867			
	b=-0.13	b=-0.1544	40.8307	0.000	Significant
6	a=1.2507	a=1.0183			
	b=0.0483	b=-0.0492	65.9104	0.000	Significant
7	a=1.2187	a=0.9972			
	b=0.0015	b=-0.0672	64.0979	0.000	Significant
8	a=1.0723	a=0.8994			
	b=-0.112	b=-0.1795	69.0151	0.000	Significant
9	a=1.5156	a=1.2391			
	b=0.2188	b=0.1742	49.8652	0.000	Significant
10	a=1.0351	a=0.9927			
	b=-0.0818	b=-0.0736	25.8867	0.000	Significant
11	a=1.4553	a=1.2409			
	b=0.2714	b=0.1844	48.6698	0.000	Significant
12	a=0.7828	a=0.8367			
	b=-0.1252	b=-0.1821	15.4786	0.000	Significant
13	a=1.0489	a= 1.0275			
	b=0.0233	b= -0.0484	27.0530	0.000	Significant
14	a=1.148	a= 1.0287			
	b=-0.0115	b= -0.0084	37.9719	0.000	Significant
15	a=1.281	a= 1.1378			
	b=0.115	b= 0.0523	42.0588	0.000	Significant
16	a=0.8601	a= 0.8562			
	b=-0.1415	b= -0.1957	29.9736	0.000	Significant
17	a=1.1567	a= 0.9204			
	b=-0.0487	b= -0.1258	84.4608	0.000	Significant

Item	Item 22= 0	Item 22= 1	χ^2	p	Significance
18	a=0.9389	a= 0.8984			
	b=-0.0179	b= -0.0957	38.6506	0.000	Significant
19	a=1.187	a= 0.9994			
	b=-0.0228	b= -0.0653	59.5082	0.000	Significant
20	a=0.9248	a= 0.9673			
	b=-0.0487	b= -0.0401	14.2974	0.000	Significant
21	a=1.5308	a= 0.8371			
	b=0.3363	b= 0.3913	33.4550	0.000	Significant
23	a=1.0111	a= 1.1394			
	b=-0.0691	b= -0.156	83.8162	0.000	Significant
24	a=1.2284	a= 1.168			
	b=0.1279	b= 0.0892	34.4944	0.000	Significant
25	a=1.0056	a= 1.0487			
	b=0.0855	b= 0.1982	1.43965	0.230	Not Significant
26	a= 1.1727	a= 1.1679			
	b= -0.0182	b= -0.0265	39.9188	0.000	Significant
27	a= 1.4142	a= 0.8321			
	b= 0.1872	b= 0.1079	59.2111	0.000	Significant
28	a= 0.7418	a= 0.9885			
	b= -0.0023	b= -0.0804	8.84798	0.002	Significant
29	a= 1.1095	a= 1.1595			
	b= -0.0509	b= -0.0669	42.9086	0.000	Significant
30	a= 1.232	a= 1.7262			
	b= 0.1693	b= 0.0875	33.6551	0.000	Significant
31	a= 1.7507	a= 1.2407			
	b= 0.6384	b= 0.772	12.7611	0.000	Significant
32	a= 1.3013	a= 1.6703			
	b= 0.0993	b= 0.1657	20.3168	0.000	Significant
33	a= 1.9263	a= 1.0341			
	b= 0.6818	b= 0.7531	28.5520	0.000	Significant
34	a= 1.1183	a= 1.464			
	b= -0.0102	b= 0.0131	28.9601	0.000	Significant
35	a= 1.352	a= 1.5767			
	b= 0.279	b= 0.403	5.39830	0.020	Not Significant
36	a= 1.5831	a= 1.3604			
	b= 0.2667	b= 0.4924	6.91749	0.008	Significant
37	a= 1.6223	a= 1.7062			
	b= 0.1108	b= 0.1346	38.6075	0.000	Significant
38	a= 1.7457	a= 1.7289			
	b= 0.2186	b= 0.3885	10.2003	0.001	Significant

Item	Item 22= 0	Item 22= 1	χ^2	p	Significance
39	a= 1.7725 b= 0.5045	a= 0.9082 b= 0.86	3.09992	0.078	Not Significant
40	a= 0.7766 b= 0.0395	a= 1.8147 b= -0.0536	1.28496	0.256	Not Significant
41	a= 1.9573 b= -0.3332	a= 1.3604 b= 0.6185	8.45282	0.003	Significant
42	a= 1.2995 b= 0.0946	a= 1.7289 b= 0.253	6.07081	0.013	Not Significant
43	a= 1.2849 b= 0.2417	a= 0.9082 b= 0.4491	0.04383	0.834	Not Significant
44	a= 1.2929 b= 0.1252	a= 1.8147 b= 0.3797	0.045537	0.831	Not Significant
45	a= 1.8795 b= 0.2432	a= 1.3495 b= 0.7439	0.024585	0.875	Not Significant
46	a= 1.4056 b= -0.0886	a= 1.9039 b= 0.0449	20.2632	0.000	Significant
47	a= 1.2713 b= 0.0578	a= 1.2557 b= 0.2786	0.4676	0.494	Not Significant
48	a= 2.0927 b= 0.279	a= 1.6093 b= 0.6373	2.85589	0.091	Not Significant
49	a= 2.0277 b= 0.457	a= 1.9943 b= 1.0077	0.725772	0.394	Not Significant
50	a= 1.9939 b= 0.1913	a= 1.8568 b= 0.6328	1.81005	0.178	Not Significant

TABLE A.23

The Table showing the values of item parameters a and b of all items conditioned on item no. 23

Item	Item 23= 0	Item 23= 1	χ^2	p	Significance
1	a= 0.6572	a= 0.7737			
	b= -0.0433	b= -0.2077	45.3188	0.000	Significant
2	a= 1.4221	a= 1.1334			
	b= 0.0305	b= 0.0582	100.339	0.000	Significant
3	a= 0.9472	a= 0.7989			
	b= -0.092	b= -0.2046	38.9922	0.000	Significant
4	a= 1.0754	a= 0.9151			
	b= -0.0684	b= -0.1288	129.961	0.000	Significant
5	a= 0.9418	a= 0.8293			
	b= -0.1038	b= -0.1602	143.453	0.000	Significant
6	a= 1.2958	a= 1.0959			
	b= -0.0063	b= 0.0012	93.5171	0.000	Significant
7	a= 1.354	a= 1.0353			
	b= -0.0467	b= -0.0337	131.057	0.000	Significant
8	a= 1.2065	a= 0.9106			
	b= -0.1184	b= -0.1543	176.503	0.000	Significant
9	a= 1.6178	a= 1.3257			
	b= 0.1401	b= 0.1985	84.1277	0.000	Significant
10	a= 1.1822	a= 0.9343			
	b= -0.0948	b= -0.0877	144.241	0.000	Significant
11	a= 1.4643	a= 1.3385			
	b= 0.1489	b= 0.2419	58.7661	0.000	Significant
12	a= 0.8153	a= 0.7744			
	b= -0.0611	b= -0.1785	141.470	0.000	Significant
13	a= 1.1147	a= 0.9856			
	b= 0.0455	b= -0.0278	109.259	0.000	Significant
14	a= 1.3057	a= 1.0173			
	b= -0.1144	b= 0.0075	116.387	0.000	Significant
15	a= 1.4284	a= 1.1364			
	b= 0.0688	b= 0.0757	115.115	0.000	Significant
16	a= 0.9717	a= 0.7921			
	b= -0.1528	b= -0.1678	186.706	0.000	Significant
17	a= 1.2769	a= 0.9673			
	b= -0.1211	b= -0.0796	147.600	0.000	Significant

Item	Item 23= 0	Item 23= 1	χ^2	p	Significance
18	a= 0.9654	a= 0.8854			
	b= 0.0164	b= -0.0738	116.299	0.000	Significant
19	a= 1.2488	a= 1.0365			
	b= -0.0315	b= -0.054	117.750	0.000	Significant
20	a= 0.9937	a= 0.8903			
	b= -0.0174	b= -0.0612	115.441	0.000	Significant
21	a= 1.5062	a= 1.4575			
	b= 0.1465	b= 0.3919	36.4687	0.000	Significant
22	a= 1.6148	a= 1.4353			
	b= 0.4468	b= 0.3758	83.8162	0.000	Significant
24	a= 1.2927	a= 1.1467			
	b= 0.0745	b= 0.1032	82.3716	0.000	Significant
25	a= 0.9523	a= 1.0995			
	b= 0.1566	b= 0.1009	30.9140	0.000	Significant
26	a= 1.4405	a= 0.9916			
	b= -0.0227	b= -0.0324	176.613	0.000	Significant
27	a= 1.4931	a= 1.254			
	b= 0.0729	b= 0.1479	83.3602	0.000	Significant
28	a= 0.7392	a= 0.7738			
	b= 0.0366	b= -0.0562	70.6323	0.000	Significant
29	a= 1.2611	a= 0.9676			
	b= -0.0757	b= -0.0563	139.205	0.000	Significant
30	a= 1.0851	a= 1.2784			
	b= 0.185	b= 0.098	30.6002	0.000	Significant
31	a= 1.8181	a= 1.7845			
	b= 0.3195	b= 0.7323	18.6127	0.000	Significant
32	a= 1.3845	a= 1.2211			
	b= 0.0396	b= 0.1288	69.8267	0.000	Significant
33	a= 1.9955	a= 1.8933			
	b= 0.1789	b= 0.7814	10.3344	0.000	Significant
34	a= 1.0326	a= 1.094			
	b= 0.0367	b= -0.0232	47.4890	0.000	Significant
35	a= 1.3116	a= 1.4459			
	b= 0.1211	b= 0.3519	17.4369	0.000	Significant
36	a= 1.7192	a= 1.5752			
	b= -0.026	b= 0.4109	23.9718	0.000	Significant
37	a= 1.9644	a= 1.411			
	b= -0.18	b= 0.1543	70.1191	0.000	Significant
38	a= 2.0858	a= 1.6883			
	b= -0.151	b= 0.3379	32.0704	0.000	Significant

Item	Item 23= 0	Item 23= 1	χ^2	p	Significance
39	a= 1.8625	a= 1.8301			
	b= 0.0243	b= 0.758	3.03126	0.081	Not Significant
40	a= 0.7708	a= 0.8191			
	b= 0.008	b= -0.0573	50.4251	0.000	Significant
41	a= 2.2923	a= 1.9095			
	b= -0.2017	b= 0.5558	9.67788	0.001	Significant
42	a= 1.2194	a= 1.3592			
	b= -0.0308	b= 0.1953	15.3972	0.000	Significant
43	a= 1.1159	a= 1.5703			
	b= 0.0174	b= 0.4095	0.635180	0.425	Not Significant
44	a= 1.1078	a= 1.528			
	b= 0.0325	b= 0.2566	0.579410	0.446	Not Significant
45	a= 2.0264	a= 1.9116			
	b= -0.1056	b= 0.5244	6.55763	0.010	Not Significant
46	a= 1.4774	a= 1.3036			
	b= -0.2872	b= 0.0132	40.247 6	0.000	Significant
47	a= 1.1282	a= 1.52			
	b= 0.016	b= 0.1461	2.71398	0.099	Not Significant
48	a= 2.2652	a= 2.0959			
	b= -0.1643	b= 0.5174	4.22187	0.039	Not Significant
49	a= 2.0184	a= 2.169			
	b= 0.078	b= 0.7923	0.0606	0.805	Significant
50	a= 2.2869	a= 1.9472			
	b= -0.3289	b= 0.4849	3.72219	0.053	Not Significant

TABLE A.24

The Table showing the values of item parameters a and b of all items conditioned on item no. 24

Item	Item 24= 0	Item 24= 1	χ^2	p	Significance
1	a= 0.6971 b= -0.1046	a= 0.7736 b= -0.2087	21.5506	0.000	Significant
2	a= 1.3094 b= 0.0518	a= 1.141 b= 0.0609	45.8252	0.000	Significant
3	a= 0.8589 b= -0.1523	a= 0.849 b= -0.1856	41.3883	0.000	Significant
4	a= 1.0443 b= -0.0646	a= 0.899 b= -0.1476	82.3213	0.000	Significant
5	a= 0.8763 b= -0.1242	a= 0.8668 b= -0.156	38.2035	0.000	Significant
6	a= 1.2495 b= 0.0146	a= 1.0781 b= -0.0036	55.4824	0.000	Significant
7	a= 1.2082 b= -0.0152	a= 1.0584 b= -0.0414	54.2933	0.000	Significant
8	a= 1.0782 b= -0.1194	a= 0.933 b= -0.1581	70.8670	0.000	Significant
9	a= 1.5559 b= 0.2366	a= 1.2747 b= 0.1624	65.8640	0.000	Significant
10	a= 1.0495 b= -0.0874	a= 0.9815 b= -0.0777	40.8430	0.000	Significant
11	a= 1.4902 b= 0.2548	a= 1.2656 b= 0.2087	56.1389	0.000	Significant
12	a= 0.7913 b= -0.1171	a= 0.8038 b= -0.1734	40.705	0.000	Significant
13	a= 1.0509 b= 0.0156	a= 1.024 b= -0.0218	34.9826	0.000	Significant
14	a= 1.148 b= 0.0384	a= 1.062 b= 0.007	37.9957	0.000	Significant
15	a= 1.3244 b= -0.1157	a= 1.1355 b= 0.0604	62.2183	0.000	Significant
16	a= 0.8924 b= -0.1359	a= 0.8174 b= -0.1868	72.8370	0.000	Significant
17	a= 1.1638 b= -0.0449	a= 0.9659 b= -0.1145	84.2477	0.000	Significant

Item	Item 24= 0	Item 24= 1	χ^2	p	Significance
18	a= 0.9524 b= -0.0199	a= 0.8903 b= -0.0729	56.0421	0.000	Significant
19	a= 1.2136 b= -0.0525	a= 1.0217 b= -0.039	65.0870	0.000	Significant
20	a= 0.9774 b= 0.0038	a= 0.8827 b= -0.0907	72.4828	0.000	Significant
21	a= 1.5486 b= 0.2859	a= 1.3846 b= 0.3963	33.4972	0.000	Significant
22	a= 1.5632 b= 0.3881	a= 1.4591 b= 0.41	34.4944	0.000	Significant
23	a= 1.0153 b= -0.0925	a= 0.8689 b= -0.125	82.3716	0.000	Significant
25	a= 1.0007 b= 0.0966	a= 1.1145 b= 0.1451	9.28612	0.0023	Significant
26	a= 1.2367 b= -0.0025	a= 1.0188 b= -0.046	77.9670	0.000	Significant
27	a= 1.4412 b= 0.1542	a= 1.2175 b= 0.1343	59.7382	0.000	Significant
28	a= 0.7386 b= 0.0032	a= 0.8008 b= -0.0608	21.2380	0.000	Significant
29	a= 1.1566 b= -0.0321	a= 0.9696 b= -0.0794	77.9812	0.000	Significant
30	a= 1.2246 b= 0.159	a= 1.1945 b= 0.1044	36.6782	0.000	Significant
31	a= 1.8151 b= 0.6141	a= 1.6803 b= 0.7217	27.0419	0.000	Significant
32	a= 1.3099 b= 0.1223	a= 1.2353 b= 0.1152	36.4291	0.000	Significant
33	a= 1.9312 b= 0.5171	a= 1.8016 b= 0.8025	13.4706	0.000	Significant
34	a= 1.1358 b= -0.0336	a= 1.0378 b= 0.0136	40.4100	0.000	Significant
35	a= 1.35 b= 0.1611	a= 1.457 b= 0.4405	3.61277	0.057	Not Significant
36	a= 1.5666 b= 0.2569	a= 1.5892 b= 0.412	13.6756	0.000	Significant
37	a= 1.5741 b= 0.0426	a= 1.4911 b= 0.1573	22.3417	0.000	Significant
38	a= 1.8495 b= 0.1422	a= 1.6491 b= 0.3631	20.6634	0.000	Significant

Item	Item 24= 0	Item 24= 1	χ^2	p	Significance
39	a= 1.7406 b= 0.4119	a= 1.8066 b= 0.7992	2.0332	0.153	Not Significant
40	a= 0.7642 b= -0.0286	a= 0.8746 b= -0.056	6.13306	0.013	Not Significant
41	a= 2.067 b= 0.2856	a= 1.7732 b= 0.543	20.4032	0.000	Significant
42	a= 1.2483 b= 0.1013	a= 1.3807 b= 0.1883	7.0402	0.007	Significant
43	a= 1.3362 b= 0.1414	a= 1.4327 b= 0.4467	1.8009	0.179	Not Significant
44	a= 1.2871 b= 0.0463	a= 1.4472 b= 0.3573	0.39764	0.528	Not Significant
45	a= 1.8916 b= 0.0935	a= 1.9269 b= 0.6937	0.14766	0.700	Not Significant
46	a= 1.3529 b= -0.126	a= 1.3481 b= 0.0336	12.4867	0.000	Significant
47	a= 1.3194 b= 0.0437	a= 1.4111 b= 0.197	6.22736	0.012	Not Significant
48	a= 2.1218 b= 0.2395	a= 1.9896 b= 0.5321	7.93559	0.004	Significant
49	a= 1.9574 b= 0.4093	a= 2.1846 b= 0.8596	.099586	0.752	Not Significant
50	a= 1.9598 b= 0.0919	a= 1.9388 b= 0.5584	0.649238	0.420	Not Significant

90A

TABLE A.25

The Table showing the values of item parameters a and b of all items conditioned on item no. 25

Item	Item 25= 0	Item 25= 1	χ^2	p	Significance
1	a= 0.7077	a= 0.7518			
	b= -0.1262	b= -0.1797	13.0535	0.000	Significant
2	a= 1.2957	a= 1.1541			
	b= 0.086	b= 0.0312	29.3054	0.000	Significant
3	a= 0.8761	a= 0.8326			
	b= -0.1534	b= -0.1818	41.3883	0.000	Significant
4	a= 0.9754	a= 0.9667			
	b= -0.0994	b= -0.1163	82.3213	0.000	Significant
5	a= 0.8703	a= 0.8704			
	b= -0.1415	b= -0.1404	38.2035	0.000	Significant
6	a= 1.1878	a= 1.1327			
	b= 0.0282	b= -0.0167	55.4824	0.000	Significant
7	a= 1.179	a= 1.0893			
	b= -0.0303	b= -0.0306	54.2933	0.000	Significant
8	a= 0.9999	a= 1.0065			
	b= -0.1329	b= -0.1472	70.867	0.000	Significant
9	a= 1.4705	a= 1.3509			
	b= 0.2307	b= 0.1644	23.5841	0.000	Significant
10	a= 1.0474	a= 0.981			
	b= -0.0616	b= -0.1007	25.9121	0.000	Significant
11	a= 1.387	a= 1.3644			
	b= 0.1985	b= 0.2487	9.5052	0.002	Significant
12	a= 0.8069	a= 0.7838			
	b= -0.1165	b= -0.1699	31.939	0.000	Significant
13	a= 1.0554	a= 1.0195			
	b= 0.0064	b= -0.0127	17.7236	0.000	Significant
14	a= 1.1344	a= 1.0725			
	b= -0.0428	b= 0.006	16.647	0.000	Significant
15	a= 1.2432	a= 1.2039			
	b= 0.1404	b= 0.0404	20.916	0.000	Significant
16	a= 0.8701	a= 0.8392			
	b= -0.1405	b= -0.1803	27.1821	0.000	Significant
17	a= 1.0649	a= 1.0595			
	b= -0.0931	b= -0.0761	11.4944	0.000	Significant

Item	Item 25= 0	Item 25= 1	χ^2	p	Significance
18	a= 0.9466	a= 0.8973			
	b= -0.0358	b= -0.0584	26.1147	0.000	Significant
19	a= 1.2032	a= 1.0274			
	b= 0.0265	b= -0.0892	49.162	0.000	Significant
20	a= 0.991	a= 0.8802			
	b= -0.025	b= -0.0616	42.232	0.000	Significant
21	a= 1.4591	a= 1.4551			
	b= 0.2866	b= 0.3966	6.6445	0.009	Significant
22	a= 1.4952	a= 1.5372			
	b= 0.2613	b= 0.5089	1.4396	0.230	Not Significant
23	a= 0.9761	a= 0.9067			
	b= -0.089	b= -0.1253	82.3716	0.000	Significant
24	a= 1.1933	a= 1.1881			
	b= 0.0588	b= 0.1277	9.28612	0.002	Significant
26	a= 1.2041	a= 1.0522			
	b= -0.0098	b= -0.0388	36.0097	0.000	Significant
27	a= 1.3981	a= 1.2622			
	b= 0.1299	b= 0.145	23.3093	0.000	Significant
28	a= 0.7303	a= 0.7985			
	b= -0.026	b= -0.0274	3.48058	0.062	Not Significant
29	a= 1.1406	a= 0.9884			
	b= -0.0506	b= -0.0668	40.5640	0.000	Significant
30	a= 1.2244	a= 1.1926			
	b= 0.1297	b= 0.1258	16.5085	0.000	Significant
31	a= 1.7314	a= 1.7816			
	b= 0.4265	b= 0.8548	0.012036	0.912	Not Significant
32	a= 1.3552	a= 1.2003			
	b= 0.0819	b= 0.1423	24.8632	0.000	Significant
33	a= 1.8058	a= 1.8974			
	b= 0.421	b= 0.8746	0.024396	0.875	Not Significant
34	a= 1.1346	a= 1.0299			
	b= 0.0047	b= -0.0151	31.1884	0.000	Significant
35	a= 1.3779	a= 1.3772			
	b= 0.2156	b= 0.3925	5.76406	0.016	Not Significant
36	a= 1.6025	a= 1.537			
	b= 0.2405	b= 0.4153	8.81092	0.002	Significant
37	a= 1.6328	a= 1.4433			
	b= 0.0114	b= 0.1686	16.5588	0.000	Significant
38	a= 1.8148	a= 1.6548			
	b= 0.1719	b= 0.3345	13.1294	0.000	Significant

Item	Item 25= 0	Item 25= 1	χ^2	p	Significance
39	a= 1.7625 b= 0.4643	a= 1.736 b= 0.7449	3.76074	0.052	Not Significant
40	a= 0.8018 b= -0.0004	a= 0.8101 b= -0.0728	21.1357	0.000	Significant
41	a= 1.938 b= 0.2087	a= 1.8876 b= 0.591	1.48447	0.223	Not Significant
42	a= 1.3019 b= 0.1184	a= 1.2966 b= 0.165	12.7661	0.000	Significant
43	a= 1.3819 b= 0.1746	a= 1.3548 b= 0.4002	5.76531	0.016	Not Significant
44	a= 1.3876 b= 0.0965	a= 1.3103 b= 0.2913	10.2716	0.000	Significant
45	a= 2.0214 b= 0.2868	a= 1.7322 b= 0.5182	15.0724	0.000	Significant
46	a= 1.3768 b= -0.0785	a= 1.3131 b= -0.0104	14.9301	0.000	Significant
47	a= 1.3231 b= 0.096	a= 1.3769 b= 0.1603	6.88048	0.008	Significant
48	a= 2.1438 b= 0.2512	a= 1.9592 b= 0.5294	5.97826	0.014	Not Significant
49	a= 2.1987 b= 0.4035	a= 1.9523 b= 0.8374	2.60076	0.106	Not Significant
50	a= 2.2452 b= 0.0958	a= 1.7517 b= 0.5264	7.98857	0.004	Significant

TABLE A.26

The Table showing the values of item parameters a and b of all items conditioned on item no. 26

Item	Item 26= 0	Item 26= 1	χ^2	p	Significance
1	a= 0.674 b= -0.0899	a= 0.7899 b= -0.207	25.4675	0.000	Significant
2	a= 1.3418 b= 0.0427	a= 1.1366 b= 0.0625	76.0474	0.000	Significant
3	a= 0.8904 b= -0.1207	a= 0.8175 b= -0.2069	119.393	0.000	Significant
4	a= 1.0473 b= -0.0731	a= 0.9101 b= -0.1357	109.886	0.000	Significant
5	a= 0.897 b= -0.1071	a= 0.8473 b= -0.1667	92.6676	0.000	Significant
6	a= 1.2748 b= 0.0153	a= 1.0738 b= -0.0071	55.4824	0.000	Significant
7	a= 1.2594 b= -0.0287	a= 1.0375 b= -0.0361	99.6933	0.000	Significant
8	a= 1.149 b= -0.1094	a= 0.8979 b= -0.1625	155.386	0.000	Significant
9	a= 1.5662 b= 0.1676	a= 1.3081 b= 0.2072	73.9040	0.000	Significant
10	a= 1.1183 b= -0.0778	a= 0.9338 b= -0.0927	113.963	0.000	Significant
11	a= 1.5202 b= 0.2017	a= 1.2789 b= 0.2361	76.8870	0.000	Significant
12	a= 0.812 b= -0.0932	a= 0.7773 b= -0.1838	112.892	0.000	Significant
13	a= 1.1099 b= 0.0322	a= 0.9734 b= -0.0342	99.5398	0.000	Significant
14	a= 1.2331 b= -0.0416	a= 1.0068 b= -0.0022	103.875	0.000	Significant
15	a= 1.3216 b= 0.0737	a= 1.1572 b= 0.0863	76.7801	0.000	Significant
16	a= 0.9251 b= -0.1476	a= 0.7964 b= -0.1739	140.693	0.000	Significant
17	a= 1.2195 b= -0.092	a= 0.9516 b= -0.086	131.802	0.000	Significant

Item	Item 26= 0	Item 26= 1	χ^2	p	Significance
18	a= 0.9238 b= 0.0147	a= 0.9109 b= -0.0888	74.5414	0.000	Significant
19	a= 1.2722 b= -0.0195	a= 0.9936 b= -0.0628	134.143	0.000	Significant
20	a= 0.9784 b= -0.0057	a= 0.8868 b= -0.0757	101.699	0.000	Significant
21	a= 1.5805 b= 0.1556	a= 1.4145 b= 0.4422	37.9051	0.000	Significant
22	a= 1.5585 b= 0.301	a= 1.4927 b= 0.4406	39.9188	0.000	Significant
23	a= 1.0815 b= -0.0777	a= 0.8296 b= -0.1327	176.613	0.000	Significant
24	a= 1.2573 b= 0.1162	a= 1.1288 b= 0.0848	77.9670	0.000	Significant
25	a= 0.9979 b= 0.1449	a= 1.0764 b= 0.0937	36.0097	0.000	Significant
27	a= 1.441 b= 0.1485	a= 1.2358 b= 0.1348	83.2557	0.000	Significant
28	a= 0.7358 b= 0.019	a= 0.7904 b= -0.0631	46.5962	0.000	Significant
29	a= 1.2403 b= -0.0737	a= 0.9369 b= -0.0557	138.657	0.000	Significant
30	a= 1.1388 b= 0.0993	a= 1.2957 b= 0.1401	19.7947	0.000	Significant
31	a= 1.7822 b= 0.4803	a= 1.7657 b= 0.7549	20.8598	0.000	Significant
32	a= 1.3159 b= 0.0591	a= 1.252 b= 0.1459	45.8023	0.000	Significant
33	a= 1.9904 b= 0.3779	a= 1.8346 b= 0.8193	16.3130	0.000	Significant
34	a= 1.0954 b= -0.0035	a= 1.0665 b= -0.0134	53.6039	0.000	Significant
35	a= 1.3691 b= 0.148	a= 1.4292 b= 0.3983	16.4961	0.000	Significant
36	a= 1.6634 b= 0.2207	a= 1.5236 b= 0.3908	40.2067	0.000	Significant
37	a= 1.7334 b= -0.1091	a= 1.4381 b= 0.2033	41.2141	0.000	Significant
38	a= 1.9217 b= 0.1952	a= 1.6026 b= 0.3023	60.9910	0.000	Significant

Item	Item 26= 0	Item 26= 1	χ^2	p	Significance
39	a= 1.7669	a= 1.8464			
	b= 0.2516	b= 0.8097	2.28842	0.130	Not Significant
40	a= 0.7648	a= 0.8479			
	b= -0.006	b= -0.0595	27.4443	0.000	Significant
41	a= 1.9646	a= 1.8998			
	b= 0.1983	b= 0.5383	16.9021	0.000	Significant
42	a= 1.1956	a= 1.4407			
	b= 0.0125	b= 0.2216	4.35317	0.036	Not Significant
43	a= 1.1721	a= 1.6281			
	b= 0.0875	b= 0.4548	1.46133	0.226	Not Significant
44	a= 1.2329	a= 1.4817			
	b= 0.0488	b= 0.3019	3.11182	0.077	Significant
45	a= 1.9998	a= 1.8999			
	b= 0.0568	b= 0.5664	6.88398	0.008	Significant
46	a= 1.3363	a= 1.3571			
	b= -0.1539	b= 0.02	21.4920	0.000	Significant
47	a= 1.2341	a= 1.499			
	b= 0.0243	b= 0.1686	5.45309	0.019	Not Significant
48	a= 2.2211	a= 2.0936			
	b= 0.0125	b= 0.5572	4.40852	0.035	Significant
49	a= 2.0142	a= 2.1113			
	b= 0.3875	b= 0.7691	5.41374	0.019	Not Significant
50	a= 2.0128	a= 1.9624			
	b= 0.0206	b= 0.4901	5.67329	0.017	Not Significant

TABLE A.27

The Table showing the values of item parameters *a* and *b* of all items conditioned on item no. 27

Item	Item 27= 0	Item 27= 1	χ^2	*p*	Significance
1	a= 0.6913	a= 0.7997			
	b= -0.113	b= -0.2113	11.3512	0.000	Significant
2	a= 1.352	a= 1.071			
	b= 0.1094	b= 0.0029	90.4552	0.000	Significant
3	a= 0.8474	a= 0.8667			
	b= -0.153	b= -0.1873	34.1120	0.000	Significant
4	a= 1.0223	a= 0.9135			
	b= -0.084	b= -0.1375	70.0500	0.000	Significant
5	a= 0.8683	a= 0.882			
	b= -0.1263	b= -0.1561	35.2067	0.000	Significant
6	a= 1.2439	a= 1.061			
	b= 0.0387	b= -0.0343	70.1802	0.000	Significant
7	a= 1.2372	a= 1.019			
	b= -0.0418	b= -0.0199	72.9657	0.000	Significant
8	a= 1.1047	a= 0.8931			
	b= -0.1195	b= -0.1659	108.208	0.000	Significant
9	a= 1.5519	a= 1.2638			
	b= 0.1953	b= 0.1932	66.8765	0.000	Significant
10	a= 1.0548	a= 0.96			
	b= -0.0484	b= -0.123	65.1191	0.000	Significant
11	a= 1.4427	a= 1.3161			
	b= 0.1888	b= 0.2715	38.0075	0.000	Significant
12	a= 0.7866	a= 0.8114			
	b= -0.1089	b= -0.188	46.1420	0.000	Significant
13	a= 1.0657	a= 0.9965			
	b= 0.0438	b= -0.0618	59.7549	0.000	Significant
14	a= 1.1501	a= 1.051			
	b= -0.0356	b= 0.0096	47.7399	0.000	Significant
15	a= 1.2858	a= 1.1704			
	b= 0.0663	b= 0.1044	45.9697	0.000	Significant
16	a= 0.8547	a= 0.8589			
	b= -0.1366	b= -0.1906	46.1437	0.000	Significant
17	a= 1.1792	a= 0.9326			
	b= -0.0579	b= -0.1128	109.663	0.000	Significant

Item	Item 27= 0	Item 27= 1	χ^2	p	Significance
18	a= 0.9361	a= 0.9018			
	b= -0.0029	b= -0.0982	59.1576	0.000	Significant
19	a= 1.2156	a= 0.9865			
	b= 0.0128	b= -0.096	103.594	0.000	Significant
20	a= 0.9127	a= 0.9722			
	b= -0.0514	b= -0.0378	21.7119	0.000	Significant
21	a= 1.5936	a= 1.3231			
	b= 0.3119	b= 0.3893	59.3323	0.000	Significant
22	a= 1.6098	a= 1.3925			
	b= 0.4103	b= 0.3991	59.2111	0.000	Significant
23	a= 1.0007	a= 0.8686			
	b= -0.0941	b= -0.1277	83.3602	0.000	Significant
24	a= 1.2606	a= 1.1115			
	b= 0.1074	b= 0.0955	59.7382	0.000	Significant
25	a= 1.0242	a= 1.0762			
	b= 0.1198	b= 0.1174	23.3093	0.000	Significant
26	a= 1.2166	a= 1.0069			
	b= -0.0122	b= -0.0464	83.2557	0.000	Significant
28	a= 0.7456	a= 0.8007			
	b= 0.0076	b= -0.0754	28.5616	0.000	Significant
29	a= 1.135	a= 0.9818			
	b= -0.0643	b= -0.0551	65.8258	0.000	Significant
30	a= 1.3141	a= 1.0907			
	b= 0.1557	b= 0.1195	76.8028	0.000	Significant
31	a= 1.8229	a= 1.6829			
	b= 0.5794	b= 0.7781	24.7712	0.000	Significant
32	a= 1.338	a= 1.2196			
	b= 0.0769	b= 0.1679	38.2435	0.000	Significant
33	a= 1.9986	a= 1.7137			
	b= 0.5808	b= 0.7989	31.3895	0.000	Significant
34	a= 1.1129	a= 1.0459			
	b= 0.0144	b= -0.0215	46.0233	0.000	Significant
35	a= 1.3998	a= 1.3766			
	b= 0.2676	b= 0.3743	23.5218	0.000	Significant
36	a= 1.5786	a= 1.5926			
	b= 0.2549	b= 0.4458	14.7425	0.000	Significant
37	a= 1.7308	a= 1.3337			
	b= 0.0549	b= 0.1623	61.5611	0.000	Significant
38	a= 1.8434	a= 1.6016			
	b= 0.2482	b= 0.3122	44.0255	0.000	Significant

Item	Item 27= 0	Item 27= 1	χ^2	p	Significance
39	a= 1.7769 b= 0.3305	a= 1.8704 b= 0.9121	0.099042	=0.752	Not Significant
40	a= 0.7743 b= -0.0162	a= 0.8762 b= -0.0727	12.3844	0.000	Significant
41	a= 2.0036 b= 0.1377	a= 1.9238 b= 0.7231	1.72548	0.188	Not Significant
42	a= 1.2984 b= 0.0202	a= 1.3629 b= 0.2804	7.40453	0.006	Significant
43	a= 1.3039 b= 0.1368	a= 1.5287 b= 0.4943	0.257018	0.612	Not Significant
44	a= 1.3146 b= 0.0809	a= 1.4329 b= 0.3568	4.57978	0.032	Not Significant
45	a= 1.8935 b= 0.1636	a= 1.9477 b= 0.6932	.840714	0.359	Not Significant
46	a= 1.3554 b= -0.0984	a= 1.3424 b= 0.0344	18.8456	0.000	Significant
47	a= 1.2636 b= 0.0559	a= 1.5267 b= 0.2228	1.86158	0.172	Not Significant
48	a= 2.2101 b= 0.1681	a= 2.0092 b= 0.6082	7.35080	0.006	Significant
49	a= 2.0755 b= 0.3507	a= 2.1881 b= 0.933	.018838	0.890	Not Significant
50	a= 2.0393 b= 0.0515	a= 1.9351 b= 0.6392	1.06438	0.302	Not Significant

TABLE A.28

The Table showing the values of item parameters a and b of all items conditioned on item no. 28

Item	Item 28= 0	Item 28= 1	χ^2	p	Significance
1	a= 0.6871 b= -0.0707	a= 0.7771 b= -0.1927	34.4542	0.000	Significant
2	a= 1.32 b= -0.0009	a= 1.1393 b= 0.0675	31.4518	0.000	Significant
3	a= 0.8978 b= -0.1555	a= 0.8431 b= -0.1589	62.6679	0.000	Significant
4	a= 0.9738 b= -0.1285	a= 0.9012 b= -0.1455	24.9784	0.000	Significant
5	a= 0.9399 b= -0.1192	a= 0.8446 b= -0.1446	72.7970	0.000	Significant
6	a= 1.1595 b= -0.106	a= 1.0789 b= 0.0025	13.7723	0.000	Significant
7	a= 1.1633 b= -0.1299	a= 1.0985 b= -0.0046	21.7680	0.000	Significant
8	a= 1.1349 b= -0.1489	a= 0.908 b= -0.1328	69.4634	0.000	Significant
9	a= 1.3762 b= -0.0265	a= 1.3522 b= 0.1935	5.47620	0.019	Not Significant
10	a= 1.1659 b= -0.0712	a= 0.9155 b= -0.1058	76.5581	0.000	Significant
11	a= 1.374 b= 0.0414	a= 1.3438 b= 0.2653	9.95526	0.001	Significant
12	a= 0.8398 b= -0.1124	a= 0.7812 b= -0.1635	80.1661	0.000	Significant
13	a= 1.0574 b= -0.0283	a= 1.0029 b= -0.0171	30.4836	0.000	Significant
14	a= 1.2739 b= -0.0334	a= 1.0631 b= 0.05	66.1181	0.000	Significant
15	a= 1.175 b= -0.0196	a= 1.1278 b= 0.04	45.9697	0.000	Significant
16	a= 1.0062 b= -0.1563	a= 0.7864 b= -0.152	121.922	0.000	Significant
17	a= 1.0816 b= -0.1682	a= 0.9947 b= -0.0786	23.7399	0.000	Significant

Item	Item 28= 0	Item 28= 1	χ^2	p	Significance
18	a= 0.9277	a= 0.9397			
	b= -0.08	b= -0.0279	31.5422	0.000	Significant
19	a= 1.1361	a= 1.1474			
	b= -0.1505	b= -0.0027	21.9935	0.000	Significant
20	a= 0.9821	a= 0.847			
	b= 0.0284	b= -0.1142	60.2633	0.000	Significant
21	a= 1.4191	a= 1.3977			
	b= 0.2971	b= 0.4557	15.7373	0.000	Significant
22	a= 1.4113	a= 1.5721			
	b= 0.3203	b= 0.5249	8.84798	0.002	Significant
23	a= 1.0941	a= 0.8166			
	b= -0.1911	b= -0.1001	70.6323	0.000	Significant
24	a= 1.1932	a= 1.1617			
	b= 0.0452	b= 0.1319	21.2380	0.000	Significant
25	a= 0.9242	a= 1.0729			
	b= 0.072	b= 0.0585	3.48058	0.062	Not Significant
26	a= 1.2714	a= 1.0298			
	b= -0.1237	b= -0.0385	46.5962	0.000	Significant
27	a= 1.3716	a= 1.2599			
	b= 0.1099	b= 0.1801	28.5616	0.000	Significant
29	a= 1.2312	a= 0.9754			
	b= -0.1567	b= -0.0185	52.7605	0.000	Significant
30	a= 1.0297	a= 1.2137			
	b= 0.1327	b= 0.0982	2.34572	0.125	Not Significant
31	a= 1.6046	a= 1.6523			
	b= 0.6747	b= 0.6579	9.35158	0.002	Significant
32	a= 1.3428	a= 1.3068			
	b= 0.1348	b= 0.1161	33.6852	0.000	Significant
33	a= 1.7817	a= 1.8547			
	b= 0.6731	b= 0.7254	11.7383	0.000	Significant
34	a= 1.0053	a= 1.068			
	b= 0.0227	b= -0.0314	11.4627	0.000	Significant
35	a= 1.235	a= 1.3933			
	b= 0.2135	b= 0.2659	2.33083	0.126	Not Significant
36	a= 1.5749	a= 1.5612			
	b= 0.4195	b= 0.2069	24.2417	0.000	Significant
37	a= 1.5791	a= 1.5177			
	b= -0.0237	b= 0.1283	14.9740	0.000	Significant
38	a= 1.6825	a= 1.7162			
	b= 0.142	b= 0.2553	7.38462	0.006	Significant

Item	Item 28= 0	Item 28= 1	χ^2	p	Significance
39	a= 1.528	a= 1.7155			
	b= 0.8046	b= 0.6075	11.2546	0.000	Significant
40	a= 0.9327	a= 0.8114			
	b= -0.1049	b= -0.0349	67.0788	0.000	Significant
41	a= 1.7881	a= 1.7954			
	b= 0.3671	b= 0.5298	6.53367	0.010	Significant
42	a= 1.2633	a= 1.3352			
	b= 0.1406	b= 0.1472	12.8248	0.000	Significant
43	a= 1.1556	a= 1.4985			
	b= 0.3888	b= 0.406	3.13383	0.076	Not Significant
44	a= 1.2171	a= 1.4633			
	b= 0.2059	b= 0.1508	5.18808	0.022	Not Significant
45	a= 1.7092	a= 1.7836			
	b= 0.2585	b= 0.3356	1.71891	0.189	Not Significant
46	a= 1.6847	a= 1.3214			
	b= -0.2171	b= 0.0239	39.5234	0.000	Significant
47	a= 1.2198	a= 1.5119			
	b= 0.1111	b= 0.1841	4.19482	0.040	Not Significant
48	a= 2.1116	a= 2.0936			
	b= 0.3205	b= 0.5217	10.9888	0.000	Significant
49	a= 1.6753	a= 2.2242			
	b= 0.403	b= 0.9208	2.58437	0.107	Not Significant
50	a= 1.8654	a= 1.9161			
	b= 0.2812	b= 0.4300	7.77614	0.005	Significant

TABLE A.29

The Table showing the values of item parameters a and b of all items conditioned on item no. 29

Item	Item 29= 0	Item 29= 1	χ^2	p	Significance
1	a= 0.6726 b= -0.0879	a= 0.7862 b= -0.2048	26.2300	0.000	Significant
2	a= 1.3714 b= 0.063	a= 1.1213 b= 0.0471	90.5465	0.000	Significant
3	a= 0.8957 b= -0.1445	a= 0.8182 b= -0.1895	113.146	0.000	Significant
4	a= 1.0249 b= -0.0857	a= 0.9305 b= -0.1247	86.1504	0.000	Significant
5	a= 0.9087 b= -0.1186	a= 0.839 b= -0.1586	98.7079	0.000	Significant
6	a= 1.2964 b= 0.0264	a= 1.0648 b= -0.0162	100.874	0.000	Significant
7	a= 1.2463 b= -0.0379	a= 1.0541 b= -0.0294	88.3579	0.000	Significant
8	a= 1.132 b= -0.1326	a= 0.9165 b= -0.1481	129.670	0.000	Significant
9	a= 1.5987 b= 0.1737	a= 1.2947 b= 0.1974	82.9379	0.000	Significant
10	a= 1.1247 b= -0.0773	a= 0.9356 b= -0.0917	116.432	0.000	Significant
11	a= 1.4742 b= 0.161	a= 1.3181 b= 0.2526	55.6144	0.000	Significant
12	a= 0.8139 b= -0.0817	a= 0.7745 b= -0.1873	120.510	0.000	Significant
13	a= 1.1029 b= 0.0639	a= 0.9774 b= -0.0468	104.383	0.000	Significant
14	a= 1.231 b= -0.086	a= 1.021 b= 0.0179	89.4002	0.000	Significant
15	a= 1.3232 b= 0.0855	a= 1.1558 b= 0.0738	81.0396	0.000	Significant
16	a= 0.9082 b= -0.1228	a= 0.8083 b= -0.1866	131.280	0.000	Significant
17	a= 1.1596 b= -0.107	a= 0.9976 b= -0.0758	92.4375	0.000	Significant

Item	Item 29= 0	Item 29= 1	χ^2	p	Significance
18	a= 0.8937 b= -0.044	a= 0.9451 b= -0.0486	40.9874	0.000	Significant
19	a= 1.2419 b= -0.013	a= 1.0161 b= -0.064	119.172	0.000	Significant
20	a= 0.9507 b= -0.0265	a= 0.9129 b= -0.0622	75.4807	0.000	Significant
21	a= 1.559 b= 0.1261	a= 1.439 b= 0.4405	31.6408	0.000	Significant
22	a= 1.5821 b= 0.2789	a= 1.4848 b= 0.4407	42.9086	0.000	Significant
23	a= 1.0458 b= -0.0945	a= 0.859 b= -0.1187	139.205	0.000	Significant
24	a= 1.2582 b= 0.1092	a= 1.13 b= 0.0867	77.9812	0.000	Significant
25	a= 1.0038 b= 0.1411	a= 1.0698 b= 0.0956	40.5640	0.000	Significant
26	a= 1.3337 b= -0.0644	a= 0.9844 b= -0.0247	138.657	0.000	Significant
27	a= 1.4359 b= 0.0552	a= 1.2546 b= 0.1574	65.8258	0.000	Significant
28	a= 0.7311 b= 0.0248	a= 0.7798 b= -0.0572	52.7605	0.000	Significant
30	a= 1.1968 b= 0.2011	a= 1.2007 b= 0.0884	59.2098	0.000	Significant
31	a= 1.7989 b= 0.4132	a= 1.7743 b= 0.7778	16.6113	0.000	Significant
32	a= 1.3318 b= 0.1096	a= 1.2269 b= 0.1209	62.9850	0.000	Significant
33	a= 1.9436 b= 0.3422	a= 1.8704 b= 0.8254	11.0673	0.000	Significant
34	a= 1.0818 b= -0.0171	a= 1.08 b= 0.0015	46.2685	0.000	Significant
35	a= 1.4081 b= 0.0756	a= 1.4117 b= 0.4255	15.4892	0.000	Significant
36	a= 1.6427 b= 0.2101	a= 1.5404 b= 0.3945	36.2238	0.000	Significant
37	a= 1.6976 b= -0.0747	a= 1.4565 b= 0.1825	42.6037	0.000	Significant
38	a= 2.029 b= 0.134	a= 1.5793 b= 0.317	62.9030	0.000	Significant

10?

Item	Item 29= 0	Item 29= 1	χ^2	p	Significance
39	a= 1.6843	a= 1.8912			
	b= 0.2856	b= 0.7872	1.47707	0.224	Not Significant
40	a= 0.7799	a= 0.8289			
	b= -0.009	b= -0.0564	38.8006	0.000	Significant
41	a= 2.0826	a= 1.8764			
	b= 0.0957	b= 0.5724	14.3720	0.000	Significant
42	a= 1.2891	a= 1.3192			
	b= 0.0566	b= 0.1934	26.3124	0.000	Significant
43	a= 1.2265	a= 1.5221			
	b= 0.1468	b= 0.4000	2.05482	0.151	Not Significant
44	a= 1.2316	a= 1.4625			
	b= 0.0333	b= 0.3185	2.68035	0.151	Not Significant
45	a= 1.9982	a= 1.835			
	b= 0.1114	b= 0.5677	11.8107	0.000	Significant
46	a= 1.4121	a= 1.3153			
	b= -0.204	b= 0.0396	27.6909	0.000	Significant
47	a= 1.2	a= 1.5067			
	b= 0.0527	b= 0.1735	3.88142	0.151	Not Significant
48	a= 2.2336	a= 1.9878			
	b= 0.1367	b= 0.5178	15.7653	0.000	Significant
49	a= 2.0826	a= 2.1211			
	b= 0.2506	b= 0.8465	0.585822	0.444	Not Significant
50	a= 1.9855	a= 1.9478			
	b= 0.0043	b= 0.5231	3.33107	0.067	Not Significant

TABLE A.30

The Table showing the values of item parameters a and b of all items conditioned on item no. 30

Item	Item 30= 0	Item 30= 1	χ^2	p	Significance
1	a= 0.7036	a= 0.7718			
	b= -0.1191	b= -0.2006	12.7161	0.000	Significant
2	a= 1.3534	a= 1.0715			
	b= 0.1513	b= -0.038	78.7956	0.000	Significant
3	a= 0.8521	a= 0.8587			
	b= -0.1488	b= -0.1947	24.4573	0.000	Significant
4	a= 1.0027	a= 0.9369			
	b= -0.0798	b= -0.1399	37.0525	0.000	Significant
5	a= 0.8672	a= 0.8813			
	b= -0.1399	b= -0.1403	17.7337	0.000	Significant
6	a= 1.234	a= 1.073			
	b= 0.0712	b= -0.0669	52.6423	0.000	Significant
7	a= 1.2466	a= 1.0066			
	b= 0.0311	b= -0.0921	75.1336	0.000	Significant
8	a= 1.0277	a= 0.9796			
	b= -0.1206	b= -0.1626	29.6149	0.000	Significant
9	a= 1.5539	a= 1.2523			
	b= 0.2643	b= 0.1252	64.2226	0.000	Significant
10	a= 1.0226	a= 1.0076			
	b= -0.0717	b= -0.0933	21.5606	0.000	Significant
11	a= 1.5372	a= 1.2077			
	b= 0.2845	b= 0.179	67.8255	0.000	Significant
12	a= 0.7679	a= 0.8408			
	b= -0.1185	b= -0.1772	10.3509	0.000	Significant
13	a= 1.0726	a= 0.9961			
	b= 0.0282	b= -0.038	38.0964	0.000	Significant
14	a= 1.1143	a= 1.0941			
	b= -0.0205	b= -0.0042	19.4555	0.000	Significant
15	a= 1.3068	a= 1.1415			
	b= 0.1225	b= 0.0474	47.0616	0.000	Significant
16	a= 0.8492	a= 0.868			
	b= -0.1346	b= -0.1934	23.0668	0.000	Significant
17	a= 1.1273	a= 0.995			
	b= -0.0563	b= -0.1071	47.3071	0.000	Significant

Item	Item 30= 0	Item 30= 1	χ^2	p	Significance
18	a= 0.9246 b= -0.0487	a= 0.9291 b= -0.0421	19.7368	0.000	Significant
19	a= 1.213 b= 0.0211	a= 0.9984 b= -0.0971	72.2431	0.000	Significant
20	a= 0.9226 b= -0.0375	a= 0.9536 b= -0.0573	16.7139	0.000	Significant
21	a= 1.5475 b= 0.2661	a= 1.3873 b= 0.4401	21.1032	0.000	Significant
22	a= 1.6009 b= 0.3823	a= 1.4187 b= 0.4234	33.6551	0.000	Significant
23	a= 0.9482 b= -0.0723	a= 0.9338 b= -0.1499	30.6002	0.000	Significant
24	a= 1.2488 b= 0.1052	a= 1.1287 b= 0.0996	36.6782	0.000	Significant
25	a= 1.0397 b= 0.0998	a= 1.0526 b= 0.1398	16.5085	0.000	Significant
26	a= 1.1344 b= -0.0502	a= 1.1088 b= -0.0116	19.7947	0.000	Significant
27	a= 1.5262 b= 0.1321	a= 1.1286 b= 0.1403	76.8028	0.000	Significant
28	a= 0.7129 b= -0.001	a= 0.8376 b= -0.0555	2.34572	0.125	Not Significant
29	a= 1.1253 b= -0.0277	a= 0.9732 b= -0.1004	59.2098	0.000	Significant
31	a= 1.8484 b= 0.5281	a= 1.6779 b= 0.8108	15.5016	0.000	Significant
32	a= 1.3268 b= 0.0939	a= 1.221 b= 0.1425	29.1752	0.000	Significant
33	a= 1.9838 b= 0.6737	a= 1.692 b= 0.6963	45.5938	0.000	Significant
34	a= 1.1782 b= 0.0094	a= 0.9789 b= -0.0169	62.9297	0.000	Significant
35	a= 1.3861 b= 0.1721	a= 1.4156 b= 0.4609	5.18772	0.126	Not Significant
36	a= 1.6447 b= 0.1931	a= 1.547 b= 0.4757	11.9321	0.000	Significant
37	a= 1.7586 b= 0.0931	a= 1.3122 b= 0.1138	68.4893	0.000	Significant
38	a= 2.0192 b= 0.1965	a= 1.4955 b= 0.324	55.4738	0.000	Significant

Item	Item 30= 0	Item 30= 1	χ^2	p	Significance
39	a= 1.8415 b= 0.2976	a= 1.8167 b= 0.8935	0.641180	0.423	Not Significant
40	a= 0.7469 b= -0.0159	a= 0.91 b=-0.058	0.842820	0.358	Not Significant
41	a= 2.212 b= 0.1836	a= 1.7651 b= 0.5995	19.3366	0.000	Significant
42	a= 1.2789 b= 0.0225	a= 1.3669 b= 0.2896	3.30156	0.069	Not Significant
43	a= 1.3562 b= 0.0957	a= 1.4274 b= 0.5408	0.581181	0.445	Not Significant
44	a= 1.3357 b= 0.0451	a= 1.3956 b= 0.3944	2.49096	0.114	Not Significant
45	a= 2.1504 b= 0.1276	a= 1.7721 b= 0.6469	9.50758	0.002	Significant
46	a= 1.389 b= -0.1042	a= 1.2972 b= 0.0442	20.1766	0.000	Significant
47	a= 1.3775 b= 0.0423	a= 1.3458 b= 0.2279	12.8933	0.000	Significant
48	a= 2.4315 b= 0.0758	a= 1.9227 b= 0.6801	5.93928	0.014	Not Significant
49	a= 2.3655 b= 0.2401	a= 2.034 b= 0.9819	.611725	0.434	Not Significant
50	a= 2.1286 b= 0.027	a= 1.8716 b= 0.6724	1.26267	0.261	Not Significant

TABLE A.31

The Table showing the values of item parameters *a* and *b* of all items conditioned on item no. 31

Item	Item 31= 0	Item 31= 1	χ^2	p	Significance
1	a= 0.7173	a= 0.8231			
	b= -0.1429	b= -0.2133	0.572606	0.449	Not Significant
2	a= 1.2532	a= 1.1441			
	b= 0.0748	b= 0.043	16.4131	0.000	Significant
3	a= 0.8639	a= 0.8453			
	b= -0.1606	b= -0.1962	17.6729	0.000	Significant
4	a= 0.9974	a= 0.9178			
	b= -0.097	b= -0.1962	21.5298	0.000	Significant
5	a= 0.8884	a= 0.8404			
	b= -0.127	b= -0.1258	24.3515	0.000	Significant
6	a= 1.2044	a= 1.05			
	b= 0.0213	b= -0.0127	24.6925	0.000	Significant
7	a= 1.1834	a= 0.9915			
	b= -0.0026	b= -0.0795	35.3902	0.000	Significant
8	a= 1.0447	a= 0.9013			
	b= -0.124	b= -0.1691	35.7200	0.000	Significant
9	a= 1.4365	a= 1.3645			
	b= 0.1792	b= 0.2992	7.63663	0.005	Significant
10	a= 1.0368	a= 0.9718			
	b= -0.0834	b= -0.0568	15.4489	0.000	Significant
11	a= 1.4166	a= 1.2611			
	b= 0.2492	b= 0.2231	19.8286	0.000	Significant
12	a= 0.8009	a= 0.812			
	b= -0.1418	b= -0.1641	13.5000	0.000	Significant
13	a= 1.0555	a= 1.021			
	b= -0.0141	b= 0.0487	10.2564	0.000	Significant
14	a= 1.1414	a= 1.0005			
	b= -0.0117	b= 0.0098	25.1380	0.000	Significant
15	a= 1.2188	a= 1.3216			
	b= 0.0657	b= 0.2049	1.54829	0.213	Not Significant
16	a= 0.8736	a= 0.8211			
	b= -0.151	b= -0.1982	26.2761	0.000	Significant
17	a= 1.1003	a= 0.974			
	b= -0.0689	b= -0.1006	27.4236	0.000	Significant

Item	Item 31= 0	Item 31= 1	χ^2	p	Significance
18	a= 0.9189 b= -0.0466	a= 0.9784 b= -0.0393	4.37273	0.036	Not Significant
19	a= 1.1314 b= -0.0469	a= 1.0911 b= -0.0014	10.5922	0.000	Significant
20	a= 0.9362 b= -0.0526	a= 0.9627 b= -0.0163	7.11796	0.007	Significant
21	a= 1.4929 b= 0.3293	a= 1.3749 b= 0.4854	10.4905	0.000	Significant
22	a= 1.5409 b= 0.4056	a= 1.4325 b= 0.4645	12.7611	0.000	Significant
23	a= 0.9608 b= -0.1043	a= 0.9063 b= -0.114	18.6127	0.000	Significant
24	a= 1.2309 b= 0.1168	a= 1.0819 b= 0.0826	27.0419	0.000	Significant
25	a= 1.0187 b= 0.091	a= 1.2021 b= 0.2432	0.012036	0.912	Not Significant
26	a= 1.1495 b= -0.0229	a= 1.0518 b= -0.0289	20.8598	0.000	Significant
27	a= 1.3719 b= 0.1418	a= 1.1894 b= 0.1563	24.7712	0.000	Significant
28	a= 0.7568 b= -0.009	a= 0.8107 b= -0.0989	9.35158	0.002	Significant
29	a= 1.0805 b= -0.0619	a=1.0154 b=-0.047	16.6113	0.000	Significant
30	a= 1.227 b= 0.1324	a=1.1637 b=0.1313	15.5016	0.000	Significant
32	a= 1.343 b= 0.1856	a=1.0311 b=0.0227	60.6016	0.000	Significant
33	a= 1.8579 b= 0.7053	a=1.6934 b=0.7971	13.4114	0.000	Significant
34	a= 1.0919 b= -0.0041	a=1.0878 b=0.0215	9.80338	0.001	Significant
35	a= 1.3818 b= 0.3278	a=1.3597 b=0.3858	9.79679	0.001	Significant
36	a= 1.5823 b= 0.3662	a=1.4778 b=0.4008	14.6119	0.000	Significant
37	a= 1.5697 b= 0.0959	a=1.3932 b=0.2234	13.9871	0.000	Significant
38	a= 1.756 b= 0.2742	a=1.5917 b=0.3796	13.1717	0.000	Significant

\\\\ 10

Item	Item 31= 0	Item 31= 1	χ^2	p	Significance
39	a= 1.7538	a= 1.6277			
	b= 0.6511	b= 0.7346	14.1216	0.000	Significant
40	a= 0.8022	a= 0.8868			
	b= -0.0323	b= -0.0897	4.42337	0.035	Not Significant
41	a= 1.8754	a= 1.7691			
	b= 0.4986	b= 0.4434	17.8839	0.000	Significant
42	a= 1.2828	a= 1.4559			
	b= 0.1156	b= 0.3329	0.156491	0.692	Not Significant
43	a= 1.3552	a= 1.4136			
	b= 0.3204	b= 0.3629	5.36677	0.020	Not Significant
44	a= 1.3097	a= 1.5113			
	b= 0.2119	b= 0.2986	0.916695	0.338	Not Significant
45	a= 1.8453	a= 1.7805			
	b= 0.4379	b= 0.5746	5.99383	0.014	Significant
46	a= 1.3607	a= 1.3321			
	b= -0.0456	b= 0.0286	7.47002	0.006	Not Significant
47	a= 1.3146	a= 1.59			
	b= 0.1296	b= 0.1987	0.069813	0.791	Not Significant
48	a= 2.029	a= 1.9713			
	b= 0.4036	b= 0.5857	3.62729	0.056	Not Significant
49	a= 1.9791	a= 2.1957			
	b= 0.6182	b= 0.9638	0.072583	0.787	Not Significant
50	a= 1.8892	a= 1.9244			
	b= 0.3446	b= 0.5544	1.70206	0.192	Not Significant

TABLE A.32

The Table showing the values of item parameters a and b of all items conditioned on item no. 32

Item	Item 32= 0	Item 32= 1	χ^2	p	Significance
1	a= 0.7753 b= -0.1969	a= 0.7843 b= -0.2035	14.1664	0.000	Significant
2	a= 1.1429 b= 0.046	a= 1.1668 b= 0.0672	32.5824	0.000	Significant
3	a= 0.8404 b= -0.1891	a= 0.8339 b= -0.1916	50.3019	0.000	Significant
4	a= 0.9243 b= -0.1274	a= 0.9498 b= -0.114	36.3006	0.000	Significant
5	a= 0.869 b= -0.1487	a= 0.8676 b= -0.1369	33.3503	0.000	Significant
6	a= 1.1996 b= -0.0286	a= 1.1258 b= 0.0464	26.1037	0.000	Significant
7	a= 1.1809 b= -0.0362	a= 1.0772 b= -0.0197	37.6975	0.000	Significant
8	a= 1.0335 b= -0.1333	a= 0.9734 b= -0.1436	39.5395	0.000	Significant
9	a= 1.472 b= 0.1906	a= 1.3416 b= 0.2055	33.8505	0.000	Significant
10	a= 1.0632 b= -0.0898	a= 0.9582 b= -0.0751	48.3220	0.000	Significant
11	a= 1.3545 b= 0.1175	a= 1.4468 b= 0.3736	4.13583	0.041	Not Significant
12	a= 0.7841 b= -0.1187	a= 0.8163 b= -0.178	31.1841	0.000	Significant
13	a= 1.0608 b= 0.0085	a= 1.0088 b= -0.0198	38.4593	0.000	Significant
14	a= 1.1426 b= -0.0483	a= 1.0594 b= 0.0254	34.1467	0.000	Significant
15	a= 1.2399 b= 0.08	a= 1.2188 b= 0.0958	25.8645	0.000	Significant
16	a= 0.8741 b= -0.1394	a= 0.8304 b= -0.1881	56.1264	0.000	Significant
17	a= 1.1034 b= -0.0935	a= 1.0176 b= -0.072	41.1860	0.000	Significant

Item	Item 32= 0	Item 32= 1	χ^2	p	Significance
18	a= 0.9386 b= -0.0429	a= 0.903 b= -0.0529	41.6346	0.000	Significant
19	a= 1.1558 b= -0.0311	a= 1.0589 b= -0.0528	46.5367	0.000	Significant
20	a= 0.9519 b= -0.0306	a= 0.9077 b= -0.0661	46.3026	0.000	Significant
21	a= 1.5068 b= 0.2836	a= 1.4173 b= 0.4236	24.1791	0.000	Significant
22	a= 1.5534 b= 0.3232	a= 1.4803 b= 0.4843	20.3168	0.000	Significant
23	a= 0.9939 b= -0.0973	a= 0.8722 b= -0.1232	69.8267	0.000	Significant
24	a= 1.2135 b= 0.11	a= 1.1575 b= 0.0915	36.4291	0.000	Significant
25	a= 1.0359 b= 0.1167	a= 1.0501 b= 0.117	24.8632	0.000	Significant
26	a= 1.1704 b= -0.0372	a= 1.0589 b= -0.0236	45.8023	0.000	Significant
27	a= 1.3918 b= 0.1001	a= 1.247 b= 0.1699	38.2435	0.000	Significant
28	a= 0.7471 b= 0.0159	a= 0.7776 b= -0.0771	33.685	0.000	Significant
29	a= 1.114 b= -0.0361	a= 0.9778 b= -0.0877	62.9850	0.000	Significant
30	a= 1.1991 b= 0.1486	a= 1.2083 b= 0.0993	29.1752	0.000	Significant
31	a= 1.816 b= 0.7661	a= 1.5834 b= 0.6088	60.6016	0.000	Significant
33	a= 1.9232 b= 0.6094	a= 1.7571 b= 0.7874	21.7137	0.000	Significant
34	a= 1.1219 b= 0.0258	a= 1.028 b= -0.0293	48.2786	0.000	Significant
35	a= 1.4271 b= 0.281	a= 1.3227 b= 0.3706	28.3315	0.000	Significant
36	a= 1.6055 b= 0.3549	a= 1.4995 b= 0.3615	32.6940	0.000	Significant
37	a= 1.6274 b= 0.014	a= 1.4365 b= 0.2099	24.0192,	0.000	Significant
38	a= 1.8534 b= 0.28	a= 1.5566 b= 0.3039	46.1107	0.000	Significant

Item	Item 32= 0	Item 32= 1	χ^2	p	Significance
39	a= 1.7698	a= 1.7177			
	b= 0.5417	b= 0.7475	12.4681	0.000	Significant
40	a= 0.8192	a= 0.8039			
	b= -0.025	b= -0.063	36.1066	0.000	Significant
41	a= 2.0503	a= 1.6859			
	b= 0.4318	b= 0.481	43.4486	0.000	Significant
42	a= 1.3315	a= 1.291			
	b= 0.0892	b= 0.2216	16.7835	0.000	Significant
43	a= 1.3384	a= 1.4333			
	b= 0.2104	b= 0.4318	3.85380	0.049	Not Significant
44	a= 1.3705	a= 1.3404			
	b= 0.1146	b= 0.3272	11.0341	0.000	Significant
45	a= 1.9467	a= 1.8348			
	b= 0.2019	b= 0.6679	2.41235	0.120	Not Significant
46	a= 1.3893	a= 1.3076			
	b= -0.1153	b= 0.0516	16.8138	0.000	Significant
47	a= 1.3963	a= 1.327			
	b= 0.064	b= 0.2037	17.5299	0.000	Significant
48	a= 2.2857	a= 1.8619			
	b= 0.2253	b= 0.5934	13.7205	0.000	Significant
49	a= 2.0529	a= 2.0887			
	b= 0.4643	b= 0.8722	1.23431	0.266	Not Significant
50	a= 2.0066	a= 1.8909			
	b= 0.1141	b= 0.6311	0.914941	0.338	Not Significant

TABLE A.33

The Table showing the values of item parameters a and b of all items conditioned on item no. 33

Item	Item 33= 0	Item 33= 1	χ^2	p	Significance
1	a= 0.7276	a= 0.7821			
	b= -0.1412	b= -0.2223	12.4988	0.000	Significant
2	a= 1.2845	a= 1.0448			
	b= 0.0969	b= 0.0023	47.6456	0.000	Significant
3	a= 0.8581	a= 0.8747			
	b= -0.1622	b= -0.1376	12.0768	0.000	Significant
4	a= 1.005	a= 0.8909			
	b= -0.162	b= -0.1376	36.2341	0.000	Significant
5	a= 0.8761	a= 0.894			
	b= -0.0915	b= -0.1215	10.1407	0.000	Significant
6	a= 1.2273	a= 0.9573			
	b= 0.0482	b= -0.0936	26.1037	0.000	Significant
7	a= 1.186	a= 0.9581			
	b= -0.0038	b= -0.0922	43.7079	0.000	Significant
8	a= 1.0535	a= 0.8591			
	b= -0.1235	b= -0.1768	50.6770	0.000	Significant
9	a= 1.4983	a= 1.1377			
	b= 0.2466	b= 0.1182	56.8890	0.000	Significant
10	a= 1.0404	a= 0.945			
	b= -0.0702	b= -0.1124	25.1730	0.000	Significant
11	a= 1.4301	a= 1.2051			
	b= 0.2613	b= 0.1793	32.9575	0.000	Significant
12	a= 0.791	a= 0.8844			
	b= -0.146	b= -0.1367	4.34750	0.037	Not Significant
13	a= 1.0552	a= 1.0351			
	b= 0.0131	b= 0.0568	17.8418	0.000	Significant
14	a= 1.1026	a= 1.1515			
	b= -0.0249	b= 0.0273	4.74881	0.029	Not Significant
15	a= 1.2684	a= 1.1423			
	b= 0.125	b= 0.0313	34.0034	0.000	Significant
16	a= 0.8596	a= 0.9003			
	b= -0.1601	b= -0.1594	10.9488	0.000	Significant
17	a= 1.1053	a= 0.9681			
	b= -0.0744	b= -0.0646	32.6715	0.000	Significant

115

Item	Item 33= 0	Item 33= 1	χ^2	p	Significance
18	a= 0.9224 b= -0.05	a= 1.0046 b= 0.0012	6.54620	0.010	Not Significant
19	a= 1.1573 b= -0.0281	a= 1.0035 b= -0.0408	32.9791	0.000	Significant
20	a= 0.9294 b= -0.042	a= 1.0262 b= -0.0284	5.63724	0.017	Not Significant
21	a= 1.4814 b= 0.334	a= 1.4511 b= 0.4783	8.93497	0.002	Significant
22	a= 1.571 b= 0.4223	a= 1.2931 b= 0.4021	28.5520	0.000	Significant
23	a= 0.9488 b= -0.1098	a= 0.9803 b= -0.0766	10.3344	0.001	Significant
24	a= 1.211 b= 0.0989	a= 1.156 b= 0.1131	13.4706	0.000	Significant
25	a= 1.0147 b= 0.0947	a= 1.2782 b= 0.2683	.024396	0.875	Not Significant
26	a= 1.1476 b= -0.0377	a= 1.1141 b= 0.0652	16.3130	0.000	Significant
27	a= 1.3859 b= 0.1393	a= 1.1301 b= 0.127	31.3895	0.000	Significant
28	a= 0.7612 b= -0.0134	a= 0.7859 b= -0.0414	11.7383	0.000	Significant
29	a= 1.0691 b= -0.0674	a= 1.0604 b= -0.0345	11.0673	0.000	Significant
30	a= 1.2437 b= 0.1888	a= 1.0678 b= 1.1301	45.5938	0.000	Significant
31	a= 1.7528 b= 0.6814	a= 1.631 b= 0.6691	13.4114	0.000	Significant
32	a= 1.3058 b= 0.1227	a= 1.1728 b= 0.144	.914941	0.000	Significant
34	a= 1.0888 b= -0.018	a= 1.1023 b= 0.4088	6.14988	0.013	Not Significant
35	a= 1.362 b= 0.3202	a= 1.4654 b= 0.6497	4.09648	0.042	Not Significant
36	a= 1.5591 b= 0.3024	a= 1.6263 b= 1.7629	1.07135	0.300	Not Significant
37	a= 1.6191 b= 0.1913	a= 1.1448 b= 0.0181	73.0583	0.000	Significant
38	a= 1.7257 b= 0.262	a= 1.7629 b= 0.4911	5.97460	0.014	Not Significant

116

Item	Item 33= 0	Item 33= 1	χ^2	p	Significance
39	a= 1.7128	a= 1.9445			
	b= 0.5488	b= -0.0887	.748615	0.386	Not Significant
40	a= 0.8056	a= 0.8773			
	b= -0.0338	b= 0.6733	6.44113	0.011	Not Significant
41	a= 1.8841	a= 1.9014			
	b= 0.4097	b= 0.3325	3.62690	0.056	Not Significant
42	a= 1.2859	a= 1.4231			
	b= 0.1176	b= 0.3325	.632165	0.426	Not Significant
43	a= 1.3415	a= 1.4746			
	b= 0.2876	b= 0.4593	1.11386	0.291	Not Significant
44	a= 1.3211	a= 1.4926			
	b= 0.1842	b= 0.7451	0.666218	0.414	Not Significant
45	a= 1.8275	a= 1.9142			
	b= 0.381	b= 0.0454	0.519243	0.471	Not Significant
46	a= 1.3927	a= 1.219			
	b= -0.0512	b= 0.2132	18.6171	0.000	Significant
47	a= 1.3498	a= 1.4278			
	b= 0.1151	b= 0.628	3.10715	0.077	Not Significant
48	a= 2.056	a= 1.9477			
	b= 0.3631	b= 0.628	2.70737	0.099	Not Significant
49	a= 2.0191	a= 2.1226			
	b= 0.587	b= 1.0667	0.0003	0.9844	Not Significant
50	a= 1.9141	a= 1.8875			
	b= 0.3343	b= 0.6252	4.24706	0.039	Not Significant

TABLE A.34

The Table showing the values of item parameters a and b of all items conditioned on item no. 34

Item	Item 34= 0	Item 34= 1	χ^2	p	Significance
1	a= 0.6895 b= -0.1072	a= 0.7753 b= -0.1969	19.8455	0.000	Significant
2	a= 1.3167 b= 0.0693	a= 1.1429 b= 0.046	53.5627	0.000	Significant
3	a= 0.8657 b= -0.1462	a= 0.8404 b= -0.1891	54.4368	0.000	Significant
4	a= 1.0262 b= -0.1462	a= 0.9243 b= -0.1274	65.3123	0.000	Significant
5	a= 0.8748 b= -0.0858	a= 0.869 b= -0.1487	40.7256	0.000	Significant
6	a= 1.2405 b= 0.0016	a= 1.0968 b= 0.0064	7.87064	0.000	Significant
7	a= 1.2092 b= -0.0455	a= 1.0713 b= -0.02	8.40113	0.000	Significant
8	a= 1.08 b= -0.1125	a= 0.9387 b= -0.164	77.7321	0.000	Significant
9	a= 1.5465 b= 0.2155	a= 1.3002 b= 0.1772	60.4686	0.000	Significant
10	a= 1.0716 b= -0.0562	a= 0.9619 b= -0.1059	65.8750	0.000	Significant
11	a= 1.4413 b= 0.1344	a= 1.3429 b= 0.2955	26.2456	0.000	Significant
12	a= 0.7914 b= -0.0856	a= 0.7957 b= -0.1941	59.5157	0.000	Significant
13	a= 1.0377 b= 0.0109	a= 1.0367 b= -0.0167	34.2275	0.000	Significant
14	a= 1.114 b= -0.0676	a= 1.0981 b= 0.0262	25.6069	0.000	Significant
15	a= 1.2986 b= 0.0944	a= 1.1654 b= 0.0732	53.6235	0.000	Significant
16	a= 0.8805 b= -0.1118	a= 0.8244 b= -0.2035	76.9235	0.000	Significant
17	a= 1.114 b= -0.0935	a= 1.0215 b= -0.0778	50.7343	0.000	Significant

Item	Item 34= 0	Item 34= 1	χ^2	p	Significance
18	a= 0.9333	a= 0.9092			
	b= -0.0267	b= -0.0671	48.5232	0.000	Significant
19	a= 1.1854	a= 1.0427			
	b= -0.0007	b= -0.0773	71.3639	0.000	Significant
20	a= 0.9659	a= 0.8993			
	b= -0.0286	b= -0.0644	61.5551	0.000	Significant
21	a= 1.5093	a= 1.4456			
	b= 0.2075	b= 0.437	20.3343	0.000	Significant
22	a= 1.6213	a= 1.4569			
	b= 0.2527	b= 0.483	28.9601	0.000	Significant
23	a= 0.9502	a= 0.9251			
	b= -0.0893	b= -0.1289	47.4890	0.000	Significant
24	a= 1.2635	a= 1.1386			
	b= 0.0182	b= 0.146	40.4100	0.000	Significant
25	a= 1.0309	a= 1.0513			
	b= 0.1155	b= 0.1121	31.1884	0.000	Significant
26	a= 1.1843	a= 1.0621			
	b= -0.06	b= -0.0226	53.6039	0.000	Significant
27	a= 1.4085	a= 1.2542			
	b= 0.0744	b= 0.1586	46.0233	0.000	Significant
28	a= 0.7019	a= 0.8201			
	b= 0.0243	b= -0.0624	11.4627	0.000	Significant
29	a= 1.0956	a= 1.0188			
	b= -0.0956	b= -0.0455	46.2685	0.000	Significant
30	a= 1.2802	a= 1.13			
	b= 0.1313	b= 0.1109	62.9297	0.000	Significant
31	a= 1.8455	a= 1.7556			
	b= 0.3588	b= 0.8139	9.80338	0.001	Significant
32	a= 1.3431	a= 1.2028			
	b= 0.0639	b= 0.1341	48.2786	0.000	Significant
33	a= 2.0951	a= 1.8283			
	b= 0.2217	b= 0.8847	6.14988	0.013	Not Significant
35	a= 1.4013	a= 1.3983			
	b= 0.1276	b= 0.4244	14.6286	0.000	Significant
36	a= 1.6743	a= 1.5293			
	b= 0.164	b= 0.4353	27.4332	0.000	Significant
37	a= 1.6746	a= 1.447			
	b= -0.0538	b= 0.1856	35.4373	0.000	Significant
38	a= 2.0162	a= 1.5419			
	b= 0.1805	b= 0.305	67.7755	0.000	Significant

Item	Item 34= 0	Item 34= 1	χ^2	p	Significance
39	a= 1.9261	a= 1.7459			
	b= 0.2806	b= 0.7854	11.9490	0.000	Significant
40	a= 0.802	a= 0.7998			
	b= 0.022	b= -0.0812	56.4985	0.000	Significant
41	a= 2.2274	a= 1.8083			
	b= 0.1017	b= 0.5913	20.5622	0.000	Significant
42	a= 1.3238	a= 1.2943			
	b= 0.0568	b= 0.197	28.0595	0.000	Significant
43	a= 1.4247	a= 1.3535			
	b= 0.1148	b= 0.4126	20.0106	0.000	Significant
44	a= 1.384	a= 1.3165			
	b= 0.0911	b= 0.2868	27.0855	0.000	Significant
45	a= 2.2644	a= 1.7387			
	b= 0.1158	b= 0.5751	27.7084	0.000	Significant
46	a= 1.4765	a= 1.2376			
	b= -0.0968	b= -0.0029	56.5551	0.000	Significant
47	a= 1.367	a= 1.3386			
	b= 0.0705	b= 0.1786	28.2605	0.000	Significant
48	a= 2.3794	a= 1.9635			
	b= 0.0559	b= 0.6207	10.1955	0.000	Significant
49	a= 2.408	a= 1.9072			
	b= 0.3639	b= 0.8168	22.7186	0.000	Significant
50	a= 2.1841	a= 1.8637			
	b= -0.0376	b= 0.618	4.25278	0.039	Significant

120

TABLE A.35

The Table showing the values of item parameters a and b of all items conditioned on item no. 35

Item	Item 35= 0	Item 35= 1	χ^2	p	Significance
1	a= 0.7158 b= -0.1436	a= 0.7762 b= -0.1841	2.25807	0.132	Not Significant
2	a= 1.2352 b= 0.0392	a= 1.2125 b= 0.1091	5.41176	0.020	Not Significant
3	a= 0.851 b= -0.1688	a= 0.8707 b= -0.1689	6.56548	0.010	Not Significant
4	a= 0.9701 b= -0.1688	a= 0.9928 b= -0.0896	4.64003	0.031	Not Significant
5	a= 0.8655 b= -0.1129	a= 0.8981 b= -0.1327	4.59716	0.032	Not Significant
6	a= 1.1808 b= -0.0118	a= 1.1416 b= 0.0499	7.87064	0.005	Significant
7	a= 1.1524 b= -0.0484	a= 1.1096 b= 0.0205	8.40113	0.003	Significant
8	a= 1.0092 b= -0.137	a= 1.0096 b= -0.1368	8.13491	0.004	Significant
9	a= 1.4299 b= 0.1738	a= 1.3868 b= 0.2526	6.81004	0.009	Significant
10	a= 1.052 b= -0.079	a= 0.9556 b= -0.0821	23.2643	0.000	Significant
11	a= 1.3868 b= 0.1838	a= 1.3798 b= 0.3391	3.32033	0.068	Not Significant
12	a= 0.801 b= -0.1398	a= 0.7964 b= -0.1579	15.5598	0.000	Significant
13	a= 1.0298 b= 0.018	a= 1.0624 b= -0.0445	7.57953	0.005	Significant
14	a= 1.131 b= -0.0126	a= 1.0533 b= -0.0052	16.7702	0.000	Significant
15	a= 1.219 b= 0.0319	a= 1.2699 b= 0.2025	1.28015	0.257	Not Significant
16	a= 0.8588 b= -0.1576	a= 0.8579 b= -0.1689	12.2419	0.000	Significant
17	a= 1.0873 b= -0.0901	a= 1.0345 b= -0.0589	13.1122	0.000	Significant

Item	Item 35= 0	Item 35= 1	χ^2	p	Significance
18	a= 0.9176 b= -0.0589	a= 0.9473 b= -0.0198	5.09385	0.024	Not Significant
19	a= 1.117 b= -0.0603	a= 1.122 b= 0.0025	5.95820	0.014	Not Significant
20	a= 0.9202 b= -0.0485	a= 0.9706 b= -0.0405	4.45392	0.034	Not Significant
21	a= 1.4691 b= 0.3095	a= 1.4463 b= 0.4555	4.64851	0.031	Not Significant
22	a= 1.5177 b= 0.3702	a= 1.5034 b= 0.4856	5.39830	0.020	Not Significant
23	a= 0.9546 b= -0.0957	a= 0.9206 b= -0.1282	17.4369	0.000	Significant
24	a= 1.1823 b= 0.0757	a= 1.2228 b= 0.1589	3.61277	0.057	Not Significant
25	a= 1.0329 b= 0.1125	a= 1.0676 b= 0.1365	5.76406	0.016	Not Significant
26	a= 1.1541 b= -0.0448	a= 1.0647 b= 0.0012	16.4961	0.000	Significant
27	a= 1.3726 b= 0.1588	a= 1.2235 b= 0.1133	23.5218	0.000	Significant
28	a= 0.7401 b= -0.0142	a= 0.8162 b= -0.0509	2.33083	0.126	Not Significant
29	a= 1.0922 b= -0.0939	a= 1.0054 b= -0.0045	46.2685,	0.000	Significant
30	a= 1.1914 b= 0.117	a= 1.2401 b= 0.1499	5.18772	0.022	Not Significant
31	a= 1.7503 b= 0.667	a= 1.683 b= 0.7039	9.79679	0.001	Significant
32	a= 1.339 b= 0.122	a= 1.1455 b= 0.1221	28.3315	0.000	Significant
33	a= 1.824 b= 0.6404	a= 1.819 b= 0.7772	4.09648	0.042	Not Significant
34	a= 1.0971 b= -0.0021	a= 1.0497 b= -0.004	14.6286	0.000	Significant
36	a= 1.5672 b= 0.3177	a= 1.5517 b= 0.4526	4.79275	0.028	Not Significant
37	a= 1.6225 b= 0.1181	a= 1.3385 b= 0.1383	27.6396	0.000	Significant
38	a= 1.7522 b= 0.263	a= 1.6404 b= 0.3559	9.95439	0.001	Significant

Item	Item 35= 0	Item 35= 1	χ^2	p	Significance
39	a= 1.7121	a= 1.7435			
	b= 0.6275	b= 0.711	4.94619	0.026	Not Significant
40	a= 0.8246	a= 0.7919			
	b= -0.0291	b= -0.0685	20.7123,	0.000	Significant
41	a= 1.929	a= 1.6976			
	b= 0.5208	b= 0.4176	26.3492	0.000	Significant
42	a= 1.3121	a= 1.2979			
	b= 0.1209	b= 0.2275	5.05785	0.024	Not Significant
43	a= 1.3932	a= 1.3124			
	b= 0.2768	b= 0.4132	7.64194	0.005	Significant
44	a= 1.3808	a= 1.2212			
	b= 0.3123	b= 0.1301	36.9832	0.000	Significant
45	a= 1.8881	a= 1.7301			
	b= 0.4096	b= 0.5523	7.41400	0.006	Significant
46	a= 1.4205	a= 1.216			
	b= -0.0372	b= -0.0127	23.7355	0.000	Significant
47	a= 1.3748	a= 1.3152			
	b= 0.1532	b= 0.1312	13.6139	0.000	Significant
48	a= 2.0713	a= 1.9298			
	b= 0.3778	b= 0.5491	5.58254	0.018	Not Significant
49	a= 1.9753	a= 1.949			
	b= 0.7693	b= 0.645	15.4649	0.000	Significant
50	a= 1.9788	a= 1.7058			
	b= 0.3876	b= 0.402	19.5650	0.000	Significant

TABLE A.36

The Table showing the values of item parameters a and b of all items conditioned on item no. 36

Item	Item 36= 0	Item 36= 1	χ^2	p	Significance
1	a= 0.7119 b= -0.1423	a= 0.8042 b= -0.1915	3.67996	0.055	Not Significant
2	a= 1.272 b= 0.0786	a= 1.13 b= 0.0393	30.1416	0.000	Significant
3	a= 0.8487 b= -0.1684	a= 0.8864 b= -0.1662	10.7870	0.000	Significant
4	a= 0.976 b= -0.1093	a= 0.9876 b= -0.0909	12.2637	0.000	Significant
5	a= 0.8869 b= -0.1304	a= 0.8522 b= -0.1592	29.6761	0.000	Significant
6	a= 1.1662 b= 0.0031	a= 1.1763 b= 0.0326	10.3549	0.000	Significant
7	a= 1.1541 b= -0.0305	a= 1.1081 b= -0.0011	16.3691	0.000	Significant
8	a= 1.0404 b= -0.131	a= 0.9422 b= -0.1483	34.1487	0.000	Significant
9	a= 1.4591 b= 0.208	a= 1.3212 b= 0.2003	23.5780	0.000	Significant
10	a= 1.0343 b= -0.0638	a= 0.9837 b= -0.111	25.4918	0.000	Significant
11	a= 1.379 b= 0.1709	a= 1.4227 b= 0.3996	3.18891	0.074	Not Significant
12	a= 0.7979 b= -0.1239	a= 0.8073 b= -0.1981	24.9314,	0.000	Significant
13	a= 1.068 b= 0.0089	a= 0.9907 b= -0.0202	28.5666	0.000	Significant
14	a= 1.1155 b= -0.0251	a= 1.0905 b= 0.0294	14.4701	0.000	Significant
15	a= 1.2461 b= 0.1025	a= 1.2057 b= 0.0764	18.5863	0.000	Significant
16	a= 0.8733 b= -0.1481	a= 0.8278 b= -0.1913	33.2695	0.000	Significant
17	a= 1.0776 b= -0.1047	a= 1.0617 b= -0.0216	12.6935	0.000	Significant

Item	Item 36= 0	Item 36= 1	χ^2	p	Significance
18	a= 0.9184 b= -0.0454	a= 0.9544 b= -0.0468	11.7227	0.000	Significant
19	a= 1.1426 b= -0.0278	a= 1.0638 b= -0.0557	26.5055	0.000	Significant
20	a= 0.9533 b= -0.0408	a= 0.9047 b= -0.0546	27.4157	0.000	Significant
21	a= 1.4707 b= 0.3131	a= 1.4486 b= 0.4598	9.32510	0.002	Significant
22	a= 1.5299 b= 0.34	a= 1.5062 b= 0.5572	6.91749	0.008	Significant
23	a= 0.9589 b= -0.1135	a= 0.9142 b= -0.0967	23.9718	0.000	Significant
24	a= 1.1924 b= 0.104	a= 1.2025 b= 0.1069	13.6756	0.000	Significant
25	a= 1.0291 b= 0.1161	a= 1.0957 b= 0.1333	8.81092	0.002	Significant
26	a= 1.1759 b= -0.0241	a= 1.0118 b= -0.0345	40.2067	0.000	Significant
27	a= 1.3387 b= 0.1241	a= 1.3021 b= 0.1784	14.7425	0.000	Significant
28	a= 0.7605 b= -0.004	a= 0.7713 b= -0.0843	24.2417	0.000	Significant
29	a= 1.0972 b= -0.0502	a= 0.9788 b= -0.0771	36.2238	0.000	Significant
30	a= 1.1981 b= 0.1315	a= 1.239 b= 0.125	11.9321	0.000	Significant
31	a= 1.7634 b= 0.6481	a= 1.6698 b= 0.751	14.6119	0.000	Significant
32	a= 1.3047 b= 0.1417	a= 1.176 b= 0.0838	32.6940	0.000	Significant
33	a= 1.8651 b= 0.5432	a= 1.832 b= 0.9776	1.07135	0.300	Not Significant
34	a= 1.0994 b= 0.0091	a= 1.0376 b= -0.0303	27.4332	0.000	Significant
35	a= 1.3632 b= 0.2612	a= 1.4202 b= 0.4448	4.79275	0.028	Not Significant
37	a= 1.6196 b= 0.089	a= 1.3385 b= 0.1954	30.0321	0.000	Significant
38	a= 1.8259 b= 0.3545	a= 1.4286 b= 0.2426	58.5373	0.000	Significant

Item	Item 36= 0	Item 36= 1	χ^2	p	Significance
39	a= 1.7695	a= 1.6667			
	b= 0.5915	b= 0.7893	11.0342	0.000	Significant
40	a= 0.8408	a= 0.7511			
	b= -0.02	b= -0.0918	52.6927	0.000	Significant
41	a= 1.9771	a= 1.6387			
	b= 0.4568	b= 0.505	33.8626	0.000	Significant
42	a= 1.3322	a= 1.2427			
	b= 0.1723	b= 0.1549	24.9165	0.000	Significant
43	a= 1.3804	a= 1.3376			
	b= 0.2944	b= 0.3913	13.8736	0.000	Significant
44	a= 1.358	a= 1.3301			
	b= 0.1851	b= 0.3088	11.2919	0.000	Significant
45	a= 1.9121	a= 1.7015			
	b= 0.4077	b= 0.5788	17.4250	0.000	Significant
46	a= 1.4313	a= 1.1867			
	b= -0.0552	b= 0.0198	34.1466	0.000	Significant
47	a= 1.3776	a= 1.3479			
	b= 0.103	b= 0.2194	11.1847	0.000	Significant
48	a= 2.2653	a= 1.7546			
	b= 0.2681	b= 0.7025	11.6203	0.000	Significant
49	a= 2.0658	a= 2.005			
	b= 0.5685	b= 0.9033	4.05439	0.044	Not Significant
50	a= 2.0107	a= 1.8502			
	b= 0.1734	b= 0.7819	0.180361	0.671	Not Significant

TABLE A.37

The Table showing the values of item parameters a and b of all items conditioned on item no. 37

Item	Item 37= 0	Item 37= 1	χ^2	p	Significance
1	a= 0.6994 b= -0.1222	a= 0.8113 b= -0.214	17.2049	0.000	Significant
2	a= 1:3237 b= 0.0843	a= 1.0748 b= 0.0289	80.2878,	0.000	Significant
3	a= 0.8625 b= -0.1545	a= 0.8465 b= -0.1915	55.4521	0.000	Significant
4	a= 1.0191 b= -0.0856	a= 0.9052 b= -0.1401	76.4293	0.000	Significant
5	a= 0.8668 b= -0.153	a= 0.8967 b= -0.1141	27.6785	0.000	Significant
6	a= 1.0827 b= -0.1288	a= 1.0185 b= -0.0419	89.5069	0.000	Significant
7	a= 1.2562 b= 0.0401	a= 1.0236 b= -0.0128	68.9356	0.000	Significant
8	a= 1.2105 b= -0.036	a= 0.891 b= -0.1567	100.379	0.000	Significant
9	a= 1.5261 b= 0.2256	a= 1.2393 b= 0.1635	75.8134	0.000	Significant
10	a= 1.0528 b= -0.0808	a= 0.9651 b= -0.0797	56.3276	0.000	Significant
11	a= 1.4791 b= 0.2597	a= 1.219 b= 0.1933	74.4272	0.000	Significant
12	a= 0.7831 b= -0.1232	a= 0.8335 b= -0.1801	35.4518	0.000	Significant
13	a= 1.0413 b= 0.0028	a= 1.0517 b= -0.008	32.8703,	0.000	Significant
14	a= 1.1327 b= -0.0523	a= 1.0758 b= 0.0563	34.7315	0.000	Significant
15	a= 1.2871 b= 0.0822	a= 1.1464 b= 0.0955	53.0855	0.000	Significant
16	a= 0.8524 b= -0.1532	a= 0.8724 b= -0.1691	38.9425	0.000	Significant
17	a= 1.1614 b= -0.0681	a= 0.9247 b= -0.1032	106.018	0.000	Significant

Item	Item 37= 0	Item 37= 1	χ^2	p	Significance
18	a= 0.9092	a= 0.9585			
	b= -0.0298	b= -0.0674	30.7501	0.000	Significant
19	a= 1.1565	a= 1.0519			
	b= -0.0336	b= -0.0493	57.2686	0.000	Significant
20	a= 0.9183	a= 0.9816			
	b= -0.0475	b= -0.0385	23.9944	0.000	Significant
21	a= 1.5509	a= 1.3268			
	b= 0.3391	b= 0.3738	58.9138	0.000	Significant
22	a= 1.5665	a= 1.4488			
	b= 0.3672	b= 0.4601	38.6075	0.000	Significant
23	a= 0.9808	a= 0.8852			
	b= -0.1043	b= -0.1158	70.1191	0.000	Significant
24	a= 1.1866	a= 1.2275			
	b= 0.0688	b= 0.1511	22.3417	0.000	Significant
25	a= 1.0168	a= 1.1222			
	b= 0.1013	b= 0.1469	16.5588	0.000	Significant
26	a= 1.1656	a= 1.0713			
	b= -0.0786	b= 0.0352	41.2141	0.000	Significant
27	a= 1.4096	a= 1.2051			
	b= 0.1167	b= 0.1602	61.5611	0.000	Significant
28	a= 0.7284	a= 0.8449			
	b= -0.0026	b= -0.0648	14.9740	0.000	Significant
29	a= 1.084	a= 1.0313			
	b= -0.0829	b= -0.0308	42.6037	0.000	Significant
30	a= 1.2364	a= 1.1311			
	b= 0.1855	b= 0.0495	68.4893	0.000	Significant
31	a= 1.7882	a= 1.7637			
	b= 0.509	b= 0.84	13.9871	0.000	Significant
32	a= 1.2918	a= 1.2792			
	b= 0.0384	b= 0.2115	24.0192	0.000	Significant
33	a= 1.9353	a= 1.6448			
	b= 0.7232	b= 0.6501	73.0583	0.000	Significant
34	a= 1.0773	a= 1.0897			
	b= 0.0041	b= -0.0191	35.4373	0.000	Significant
35	a= 1.4091	a= 1.3638			
	b= 0.236	b= 0.3968	27.6396	0.000	Significant
36	a= 1.655	a= 1.4919			
	b= 0.2213	b= 0.4686	30.0321	0.000	Significant
38	a= 1.8706	a= 1.4781			
	b= 0.2998	b= 0.292	80.1164	0.000	Significant

Item	Item 37= 0	Item 37= 1	χ^2	p	Significance
39	a= 1.7841	a= 1.8188			
	b= 0.4631	b= 0.833	9.95734	0.001	Significant
40	a= 0.8376	a= 0.7693			
	b= -0.0131	b= -0.0901	81.1965	0.000	Significant
41	a= 2.0903	a= 1.806			
	b= 0.2288	b= 0.6544	20.8889	0.000	Significant
42	a= 1.2974	a= 1.3762			
	b= 0.0798	b= 0.2482	15.8979	0.000	Significant
43	a= 1.349	a= 1.5087			
	b= 0.1777	b= 0.4878	5.87519	0.015	Not Significant
44	a= 1.3274	a= 1.4442			
	b= 0.1262	b= 0.3324	11.5612	0.000	Significant
45	a= 2.074	a= 1.7679			
	b= 0.1889	b= 0.6771	18.0833	0.000	Significant
46	a= 1.5386	a= 1.1026			
	b= -0.0874	b= 0.0256	96.6701	0.000	Significant
47	a= 1.4026	a= 1.3114			
	b= 0.0867	b= 0.2003	36.9400	0.000	Significant
48	a= 2.4251	a= 1.8551			
	b= 0.1585	b= 0.6615	24.4930	0.000	Significant
49	a= 2.2302	a= 2.0309			
	b= 0.4138	b= 0.9091	11.6449	0.000	Significant
50	a= 2.1685	a= 1.8612			
	b= 0.0585	b= 0.7217	6.06337	0.013	Not Significant

TABLE A.38

The Table showing the values of item parameters a and b of all items conditioned on item no. 38

Item	Item 38= 0	Item 38= 1	χ^2	p	Significance
1	a= 0.7063 b= -0.1367	a= 0.8336 b= -0.2045	4.96297	0.025	Not Significant
2	a= 1.2714 b= 0.0757	a= 1.1276 b= 0.0423	40.4171	0.000	Significant
3	a= 0.8507 b= -0.1624	a= 0.8822 b= -0.18	23.3821	0.000	Significant
4	a= 1.0044 b= -0.0919	a= 0.9158 b= -0.1354	49.6341	0.000	Significant
5	a= 0.8726 b= -0.1369	a= 0.8918 b= -0.141	25.3530	0.000	Significant
6	a= 1.2239 b= 0.0387	a= 1.0289 b= -0.0531	61.3517	0.000	Significant
7	a= 1.157 b= -0.0447	a= 1.0992 b= 0.026	24.9192	0.000	Significant
8	a= 1.0422 b= -0.1256	a= 0.9329 b= -0.1657	53.4829	0.000	Significant
9	a= 1.463 b= 0.1727	a= 1.3336 b= 0.2737	27.7463	0.000	Significant
10	a= 1.0431 b= -0.073	a= 0.9632 b= -0.0966	42.3322	0.000	Significant
11	a= 1.4095 b= 0.1883	a= 1.3534 b= 0.3563	18.9800	0.000	Significant
12	a= 0.7873 b= -0.1261	a= 0.8395 b= -0.193	26.0584	0.000	Significant
13	a= 1.0756 b= 0.0189	a= 0.9576 b= -0.0536	56.4309	0.000	Significant
14	a= 1.1319 b= -0.0277	a= 1.0533 b= 0.0368	33.5127	0.000	Significant
15	a= 1.2545 b= 0.0792	a= 1.1993 b= 0.125	27.8271	0.000	Significant
16	a= 0.8676 b= -0.1453	a= 0.8435 b= -0.199	45.4375	0.000	Significant
17	a= 1.1047 b= -0.0779	a= 0.9903 b= -0.0864	47.1303	0.000	Significant

Item	Item 38= 0	Item 38= 1	χ^2	p	Significance
18	a= 0.9186 b= -0.0291	a= 0.9524 b= -0.0806	26.3307	0.000	Significant
19	a= 1.1709 b= -0.0257	a= 0.9992 b= -0.0613	61.2783	0.000	Significant
20	a= 0.9408 b= -0.0551	a= 0.9403 b= -0.0211	27.6904	0.000	Significant
21	a= 1.4967 b= 0.2681	a= 1.4508 b= 0.5661	13.8493	0.000	Significant
22	a= 1.5311 b= 0.32	a= 1.5508 b= 0.6096	10.2003	0.000	Significant
23	a= 0.9531 b= -0.1144	a= 0.9287 b= -0.0904	32.0704	0.000	Significant
24	a= 1.2071 b= 0.0671	a= 1.1934 b= 0.1918	20.6634	0.000	Significant
25	a= 1.023 b= 0.1111	a= 1.117 b= 0.1517	13.1294,	0.000	Significant
26	a= 1.1785 b= -0.0222	a= 1.0031 b= -0.0405	60.9910	0.000	Significant
27	a= 1.3666 b= 0.1412	a= 1.2279 b= 0.1411	44.0255	0.000	Significant
28	a= 0.7356 b= -0.0133	a= 0.8636 b= -0.0577	7.38462	0.006	Significant
29	a= 1.1098 b= -0.0588	a= 0.9467 b= -0.0716	62.9030	0.000	Significant
30	a= 1.2507 b= 0.1483	a= 1.1075 b= 0.0877	55.4738	0.000	Significant
31	a= 1.7864 b= 0.5554	a= 1.7419 b= 0.8759	13.1717	0.000	Significant
32	a= 1.3226 b= 0.1045	a= 1.1667 b= 0.1446	46.1107	0.000	Significant
33	a= 1.8827 b= 0.5195	a= 1.885 b= 0.987	5.97460	0.014	Not Significant
34	a= 1.1189 b= 0.026	a= 0.9702 b= -0.069	67.7755	0.000	Significant
35	a= 1.3749 b= 0.2328	a= 1.4431 b= 0.4857	9.95439	0.001	Significant
36	a= 1.6567 b= 0.3303	a= 1.3698 b= 0.358	58.5373	0.000	Significant
37	a= 1.6601 b= 0.1051	a= 1.2341 b= 0.1167	80.1164	0.000	Significant

Item	Item 38= 0	Item 38= 1	χ^2	p	Significance
39	a= 1.7843 b= 0.591	a= 1.68 b= 0.7629	27.9711	0.000	Significant
40	a= 0.8398 b= -0.0052	a= 0.7447 b= -0.1268	86.4213	0.000	Significant
41	a= 1.9969 b= 0.3799	a= 1.712 b= 0.5936	35.2955	0.000	Significant
42	a= 1.3388 b= 0.1135	a= 1.2698 b= 0.2473	27.2244	0.000	Significant
43	a= 1.3473 b= 0.2436	a= 1.4999 b= 0.4837	6.81373	0.009	Significant
44	a= 1.388 b= 0.1652	a= 1.2935 b= 0.3269	29.4995	0.000	Significant
45	a= 2.05 b= 0.2957	a= 1.621 b= 0.6733	32.2661	0.000	Significant
46	a= 1.4626 b= -0.0727	a= 1.1399 b= 0.0435	61.4882	0.000	Significant
47	a= 1.3679 b= 0.1096	a= 1.3596 b= 0.2229	22.6006	0.000	Significant
48	a= 2.3479 b= 0.2545	a= 1.7408 b= 0.6654	34.5919	0.000	Significant
49	a= 2.1916 b= 0.5237	a= 1.9272 b= 0.8873	22.2776	0.000	Significant
50	a= 2.089 b= 0.1855	a= 1.8065 b= 0.6839	13.1462	0.000	Significant

TABLE A.39

The Table showing the values of item parameters a and b
of all items conditioned on item no. 39

Item	Item 39= 0	Item 39= 1	χ^2	p	Significance
1	a= 0.727 b= -0.1489	a= 0.7863 b= -0.1984	0.967594	0.325	Not Significant
2	a= 1.2142 b= 0:04	a= 1.307 b= 0.1981	0.000020	0.996	Not Significant
3	a= 0.8565 b= -0.1697	a= 0.8781 b= -0.1602	2.94279	0.086	Not Significant
4	a= 0.9791 b= -0.1082	a= 0.9926 b= -0.0786	3.13833	0.076	Not Significant
5	a= 0.8818 b= -0.136	a= 0.8704 b= -0.1467	7.71935	0.005	Significant
6	a= 1.1498 b= -0.0057	a= 1.2675 b= 0.1042	0.000379	0.984	Not Significant
7	a= 1.1261 b= -0.0365	a= 1.2063 b= 0.0529	0.257587	0.611	Not Significant
8	a= 1.0104 b= -0.1421	a= 1.0308 b= -0.1029	2.72678	0.098	Not Significant
9	a= 1.4263 b= 0.2062	a= 1.3709 b= 0.2145	5.33851	0.020	Not Significant
10	a= 1.0255 b= -0.0824	a= 1.007 b= -0.0524	4.98037	0.025	Not Significant
11	a= 1.3669 b= 0.2263	a= 1.4599 b= 0.3299	.421537	0.000	Significant
12	a= 0.7985 b= -0.1484	a= 0.8248 b= -0.1389	3.33089	0.067	Not Significant
13	a= 1.0392 b= -0.0144	a= 1.0833 b= 0.0653	1.15412	0.282	Not Significant
14	a= 1.1162 b= -0.0259	a= 1.0784 b= 0.0804	4.07328	0.043	Not Significant
15	a= 1.235 b= 0.0918	a= 1.2364 b= 0.117	3.62179	0.057	Not Significant
16	a= 0.868 b= -0.1577	a= 0.8391 b= -0.1761	10.4658	0.000	Significant
17	a= 1.0583 b= -0.1046	a= 1.152 b= 0.0545	0.001872	0.965	Not Significant

Item	Item 39= 0	Item 39= 1	χ^2	p	Significance
18	a= 0.9197	a= 0.985			
	b= -0.052	b= -0.0079	0.851017	0.356	Not Significant
19	a= 1.1145	a= 1.1581			
	b= -0.0463	b= 0.0197	1.53779	0.214	Not Significant
20	a= 0.9389	a= 0.9475			
	b= -0.0492	b= -0.0234	4.19170	0.040	Not Significant
21	a= 1.478	a= 1.4069			
	b= 0.3239	b= 0.5603	1.96262	0.161	Not Significant
22	a= 1.5409	a= 1.4406			
	b= 0.3715	b= 0.6117	3.09992	0.078	Not Significant
23	a= 0.9455	a= 0.9648			
	b= -0.118	b= -0.0562	3.03126	0.081	Not Significant
24	a= 1.1935	a= 1.2238			
	b= 0.0914	b= 0.1879	2.03324	0.153	Not Significant
25	a= 1.043	a= 1.0722			
	b= 0.1221	b= 0.1325	3.76074	0.052	Not Significant
26	a= 1.1249	a= 1.1425			
	b= -0.0437	b= 0.0578	2.28842	0.130	Not Significant
27	a= 1.3185	a= 1.3943			
	b= 0.1022	b= 0.3383	.099042	0.752	Not Significant
28	a= 0.7652	a= 0.7767			
	b= -0.0059	b= -0.1236	11.2546	0.000	Significant
29	a= 1.0529	a= 1.133			
	b= -0.0641	b= -0.0337	1.47707	0.224	Not Significant
30	a= 1.1944	a= 1.296			
	b= 0.1178	b= 0.1997	0.641180	0.423	Not Significant
31	a= 1.7742	a= 1.5516			
	b= 0.7035	b= 0.6788	14.1216	0.000	Significant
32	a= 1.304	a= 1.1584			
	b= 0.1235	b= 0.1421	12.4681	0.000	Significant
33	a= 1.8265	a= 1.8574			
	b= 0.6036	b= 1.1228	0.748615	0.386	Not Significant
34	a= 1.0996	a= 1.0259			
	b= 0.0092	b= -0.0264	11.9490	0.000	Significant
35	a= 1.3742	a= 1.3802			
	b= 0.3275	b= 0.3324	4.94619	0.026	Not Significant
36	a= 1.5975	a= 1.4275			
	b= 0.3568	b= 0.3986	11.0342	0.000	Significant
37	a= 1.5513	a= 1.3933			
	b= 0.12	b= 0.1496	9.95734	0.001	Significant

Item	Item 39= 0	Item 39= 1	χ^2	p	Significance
38	a= 1.7717 b= 0.3373	a= 1.4349 b= 0.1978	27.9711	0.000	Significant
40	a= 0.8429 b= -0.0246	a= 0.7114 b= -0.108	38.9258	0.000	Significant
41	a= 1.8795 b= 0.5938	a= 1.6043 b= 0.227	37.9206	0.000	Significant
42	a= 1.3366 b= 0.2086	a= 1.1473 b= 0.0771	23.1667	0.000	Significant
43	a= 1.3687 b= 0.3627	a= 1.3022 b= 0.2767	10.6704	0.000	Significant
44	a= 1.4047 b= 0.2823	a= 1.0914 b= 0.1364	39.5299	0.000	Significant
45	a= 1.8609 b= 0.4689	a= 1.6732 b= 0.5772	7.07710	0.007	Significant
46	a= 1.4215 b= -0.01	a= 1.1029 b= -0.0483	30.3373	0.000	Significant
47	a= 1.3736 b= 0.183	a= 1.2711 b= 0.0646	14.1657	0.000	Significant
48	a= 2.125 b= 0.4221	a= 1.6249 b= 0.618	12.4342	0.000	Significant
49	a= 1.9955 b= 0.7068	a= 1.9436 b= 0.8161	3.65150	0.056	Not Significant
50	a= 1.944 b= 0.417	a= 1.5952 b= 0.427	17.8371	0.000	Significant

TABLE A.40

The Table showing the values of item parameters a and b of all items conditioned on item no. 40

Item	Item 40= 0	Item 40= 1	χ^2	p	Significance
1	a= 0.6486 b= -0.0714	a= 0.7794 b= -0.1933	11.2478	0.000	Significant
2	a= 1.2849 b= -0.0442	a= 1.1944 b= 0.09	32.5640	0.000	Significant
3	a= 0.8939 b= -0.1609	a= 0.8274 b= -0.1763	86.5345	0.000	Significant
4	a= 0.978 b= -0.1379	a= 0.9651 b= -0.0972	38.5100	0.000	Significant
5	a= 0.8809 b= -0.1477	a= 0.8605 b= -0.1383	55.0265	0.000	Significant
6	a= 1.1617 b= -0.1139	a= 1.1655 b= 0.0488	20.6467	0.000	Significant
7	a= 1.1709 b= -0.1303	a= 1.1144 b= 0.004	32.8695	0.000	Significant
8	a= 1.0448 b= -0.1804	a= 0.9792 b= -0.1256	50.6760	0.000	Significant
9	a= 1.4772 b= 0.0415	a= 1.391 b= 0.2425	25.2121	0.000	Significant
10	a= 1.0945 b= -0.1489	a= 0.9715 b= -0.0635	62.3273	0.000	Significant
11	a= 1.3249 b= 0.0485	a= 1.4119 b= 0.2909	10.0781	0.000	Significant
12	a= 0.7919 b= -0.1152	a= 0.7894 b= -0.1581	66.5172	0.000	Significant
13	a= 0.9697 b= -0.0785	a= 1.0726 b= 0.0253	12.7892	0.000	Significant
14	a= 1.2144 b= -0.102	a= 1.0447 b= 0.0089	62.2655	0.000	Significant
15	a= 1.1595 b= -0.0457	a= 1.2692 b= 0.1289	11.2146	0.000	Significant
16	a= 0.953 b= -0.1884	a= 0.8 b= -0.1539	119.415	0.000	Significant
17	a= 1.0607 b= -0.2024	a= 1.0613 b= -0.0407	25.0653	0.000	Significant

136

Item	Item 40= 0	Item 40= 1	χ^2	p	Significance
18	a= 0.8688 b= -0.0708	a= 0.943 b= -0.0382	22.0293	0.000	Significant
19	a= 1.0635 b= -0.1095	a= 1.1286 b= -0.0205	20.0753	0.000	Significant
20	a= 0.9348 b= -0.0857	a= 0.9205 b= -0.0349	42.7286	0.000	Significant
21	a= 1.4864 b= 0.0575	a= 1.4567 b= 0.4369	12.0341	0.000	Significant
22	a= 1.4067 b= 0.0611	a= 1.5885 b= 0.5174	1.28496	0.256	Not Significant
23	a= 0.9692 b= -0.1771	a= 0.9153 b= -0.0859	50.4251	0.000	Significant
24	a= 1.0956 b= -0.0642	a= 1.2445 b= 0.1596	6.13306	0.013	Not Significant
25	a= 0.9432 b= 0.1809	a= 1.0762 b= 0.0933	21.1357	0.000	Significant
26	a= 1.126 b= -0.1594	a= 1.1052 b= 0.011	27.4443	0.000	Significant
27	a= 1.2572 b= -0.0253	a= 1.3491 b= 0.1816	12.3844	0.000	Significant
28	a= 0.7597 b= 0.0054	a= 0.7442 b= -0.0322	67.0788	0.000	Significant
29	a= 1.0878 b= -0.1657	a= 1.0256 b= -0.0264	38.8006	0.000	Significant
30	a= 1.0018 b= 0.0555	a= 1.3279 b= 0.1513	0.842820	0.358	Not Significant
31	a= 1.6302 b= 0.4022	a= 1.8015 b= 0.7291	4.42337	0.035	Not Significant
32	a= 1.3188 b= 0.0107	a= 1.2253 b= 0.139	36.1066	0.000	Significant
33	a= 1.8024 b= 0.3774	a= 1.8665 b= 0.7424	6.44113	0.011	Not Significant
34	a= 1.0786 b= 0.0617	a= 1.0367 b= -0.0275	56.4985	0.000	Significant
35	a= 1.3141 b= 0.2381	a= 1.3751 b= 0.327	20.7123	0.000	Significant
36	a= 1.701 b= 0.3164	a= 1.4663 b= 0.3287	52.6927	0.000	Significant
37	a= 1.9718 b= -0.0225	a= 1.3515 b= 0.1149	81.1965	0.000	Significant

Item	Item 40= 0	Item 40= 1	χ^2	p	Significance
38	a= 2.1017	a= 1.5367			
	b= 0.3134	b= 0.2381	86.4213	0.000	Significant
39	a= 1.8254	a= 1.6704			
	b= 0.582	b= 0.6118	38.9258	0.000	Significant
41	a= 2.1043	a= 1.7752			
	b= 0.4021	b= 0.4316	48.5088	0.000	Significant
42	a= 1.6334	a= 1.1356			
	b= 0.2865	b= 0.1186	135.699	0.000	Significant
43	a= 1.4151	a= 1.315			
	b= 0.3265	b= 0.2898	48.6206	0.000	Significant
44	a= 1.5129	a= 1.2179			
	b= 0.359	b= 0.1855	95.2696	0.000	Significant
45	a= 2.2154	a= 1.7153			
	b= 0.3261	b= 0.4517	47.6443	0.000	Significant
46	a= 2.1854	a= 1.0751			
	b= 0.1097	b= -0.0356	215.000	0.000	Significant
47	a= 1.518	a= 1.2364			
	b= 0.2633	b= 0.107	86.9624	0.000	Significant
48	a= 2.4552	a= 1.8816			
	b= 0.3017	b= 0.4469	41.4461	0.000	Significant
49	a= 2.2964	a= 1.9673			
	b= 0.3541	b= 0.7528	12.7311	0.000	Significant
50	a= 2.3018	a= 1.7631			
	b= 0.1996	b= 0.4228	35.1988	0.000	Significant

139

TABLE A.41

The Table showing the values of item parameters a and b of all items conditioned on item no. 41

Item	Item 41= 0	Item 41= 1	χ^2	p	Significance
1	a= 0.7239 b= -0.1453	a= 0.7967 b= -0.2045	9.83046	0.001	Significant
2	a= 1.258 b= 0.0641	a= 1.1408 b= 0.0896	20.2976	0.000	Significant
3	a= 0.8578 b= -0.1668	a= 0.869 b= -0.174	14.9220	0.000	Significant
4	a= 0.9808 b= -0.1026	a= 0.9814 b= -0.1029	13.6205	0.000	Significant
5	a= 0.8777 b= -0.1425	a= 0.8881 b= -0.1216	14.2186	0.000	Significant
6	a= 1.1909 b= 0.0149	a= 1.0958 b= 0.0117	21.6209	0.000	Significant
7	a= 1.1535 b= -0.0279	a= 1.0967 b= 0.0099	15.0326	0.000	Significant
8	a= 1.0193 b= -0.1345	a= 0.991 b= -0.1346	17.2154	0.000	Significant
9	a= 1.4404 b= 0.1855	a= 1.3591 b= 0.2987	12.2091	0.000	Significant
10	a= 1.0299 b= -0.0799	a= 0.9971 b= -0.0638	17.2495	0.000	Significant
11	a= 1.3899 b= 0.2083	a= 1.3916 b= 0.3787	6.57466	0.010	Significant
12	a= 0.7852 b= -0.1444	a= 0.8874 b= -0.1469	3.42677	0.064	Significant
13	a= 1.0446 b= -0.0233	a= 1.0748 b= 0.098	6.85906	0.008	Significant
14	a= 1.126 b= -0.0267	a= 1.0564 b= 0.065	17.0733	0.000	Significant
15	a= 1.2436 b= 0.0683	a= 1.224 b= 0.1968	9.05922	0.002	Significant
16	a= 0.8594 b= -0.1592	a= 0.8813 b= -0.1617	14.2905	0.000	Significant
17	a= 1.082 b= -0.0907	a= 1.0391 b= -0.0346	15.8116	0.000	Significant

Item	Item 41= 0	Item 41= 1	χ^2	p	Significance
18	a= 0.9369 b= -0.0417	a= 0.8989 b= -0.0632	23.5651	0.000	Significant
19	a= 1.1305 b= -0.0403	a= 1.095 b= -0.0159	16.6282	0.000	Significant
20	a= 0.9392 b= -0.0612	a= 0.9589 b= 0.0204	10.6839	0.000	Significant
21	a= 1.4921 b= 0.3262	a= 1.3759 b= 0.4869	14.4760	0.000	Significant
22	a= 1.5408 b= 0.3544	a= 1.4625 b= 0.6184	8.45282	0.003	Significant
23	a= 0.9443 b= -0.1257	a= 0.9737 b= -0.0325	9.67788	0.001	Significant
24	a= 1.2184 b= 0.0921	a= 1.1348 b= 0.161	20.4032	0.000	Significant
25	a= 1.0155 b= 0.1081	a= 1.2031 b= 0.1833	1.48447	0.223	Not Significant
26	a= 1.1343 b= -0.0312	a= 1.1018 b= -0.0047	16.9021	0.000	Significant
27	a= 1.3193 b= 0.075	a= 1.4198 b= 0.3809	1.72548	0.188	Not Significant
28	a= 0.7472 b= -0.0124	a= 0.8538 b= -0.0826	6.53367	0.010	Not Significant
29	a= 1.0657 b= -0.0678	a= 1.0695 b= -0.0219	14.3720	0.000	Significant
30	a= 1.2146 b= 0.1379	a= 1.1991 b= 0.1177	19.3366	0.000	Significant
31	a= 1.7412 b= 0.6768	a= 1.7021 b= 0.7128	17.8839	0.000	Significant
32	a= 1.3212 b= 0.1287	a= 1.1076 b= 0.0972	43.4486	0.000	Not Significant
33	a= 1.8582 b= 0.5949	a= 1.8276 b= 0.9855	3.62690	0.056	Significant
34	a= 1.087 b= 0.0015	a= 1.0682 b= -0.0129	20.5622	0.000	Significant
35	a= 1.3967 b= 0.3212	a= 1.291 b= 0.3222	26.3492	0.000	Significant
36	a= 1.6194 b= 0.3392	a= 1.3713 b= 0.385	33.8626	0.000	Significant
37	a= 1.5788 b= 0.0686	a= 1.3743 b= 0.2421	20.8889	0.000	Significant

Item	Item 41= 0	Item 41= 1	χ^2	p	Significance
38	a= 1.7841	a= 1.4931			
	b= 0.2749	b= 0.3094	35.2955	0.000	Significant
39	a= 1.7308	a= 1.6188			
	b= 0.6927	b= 0.5656	37.9206	0.000	Significant
40	a= 0.824	a= 0.7637			
	b= -0.0119	b= -0.1506	48.5088	0.000	Significant
42	a= 1.3381	a= 1.2128			
	b= 0.1606	b= 0.2007	27.6461	0.000	Significant
43	a= 1.373	a= 1.3217			
	b= 0.3284	b= 0.3587	21.0700	0.000	Significant
44	a= 1.3796	a= 1.1961			
	b= 0.2531	b= 0.2022	41.8213	0.000	Significant
45	a= 1.8695	a= 1.708			
	b= 0.447	b= 0.587	21.4840	0.000	Significant
46	a= 1.4397	a= 1.0657			
	b= -0.0146	b= -0.0428	65.0675	0.000	Significant
47	a= 1.4005	a= 1.1942			
	b= 0.1846	b= 0.0773	48.0770	0.000	Significant
48	a= 2.1255	a= 1.7291			
	b= 0.4211	b= 0.5525	34.3738	0.000	Significant
49	a= 2.0194	a= 1.7612			
	b= 0.7812	b= 0.6572	49.7374	0.000	Significant
50	a= 2.0103	a= 1.5423			
	b= 0.3905	b= 0.4572	45.9537	0.000	Significant

TABLE A.42

The Table showing the values of item parameters *a* and *b* of all items conditioned on item no. 42

Item	Item 42= 0	Item 42= 1	χ^2	p	Significance
1	a= 0.7108	a= 0.778			
	b= -0.1339	b= -0.1954	6.97902	0.008	Significant
2	a= 1.2672	a= 1.1573			
	b= 0.0676	b= 0.0531	23.1194	0.000	Significant
3	a= 0.8431	a= 0.8816			
	b= -0.1636	b= -0.1773	.008040	0.002	Significant
4	a= 0.9685	a= 0.9916			
	b= -0.1101	b= -0.0974	9.39793	0.002	Significant
5	a= 0.8809	a= 0.8632			
	b= -0.123	b= -0.1679	24.6406	0.000	Significant
6	a= 1.1744	a= 1.1558			
	b= -0.0134	b= 0.0445	10.8405	0.000	Significant
7	a= 1.1435	a= 1.1302			
	b= -0.0583	b= 0.0282	9.57345	0.001	Significant
8	a= 1.0111	a= 1.0061			
	b= -0.1454	b= -0.1244	13.2025	0.000	Significant
9	a= 1.4592	a= 1.3553			
	b= 0.1561	b= 0.2701	13.6324	0.000	Significant
10	a= 1.0304	a= 0.9967			
	b= -0.0809	b= -0.0795	19.2838	0.000	Significant
11	a= 1.3902	a= 1.3693			
	b= 0.2002	b= 0.2858	10.0755	0.000	Significant
12	a= 0.7837	a= 0.8271			
	b= -0.1349	b= -0.1623	11.3561	0.000	Significant
13	a= 1.0268	a= 1.0719			
	b= -0.0189	b= 0.0256	7.13005	0.007	Significant
14	a= 1.1106	a= 1.095			
	b= -0.0264	b= 0.0128	13.4887	0.000	Significant
15	a= 1.2383	a= 1.2199			
	b= 0.0795	b= 0.1043	13.6287	0.000	Significant
16	a= 0.8661	a= 0.8397			
	b= -0.1333	b= -0.2047	31.4809	0.000	Significant
17	a= 1.0635	a= 1.08			
	b= -0.112	b= -0.0307	8.45094	0.003	Significant

Item	Item 42= 0	Item 42= 1	χ^2	p	Significance
18	a= 0.9241 b= -0.0455	a= 0.9262 b= -0.0495	16.3988	0.000	Significant
19	a= 1.1205 b= -0.0504	a= 1.1089 b= -0.0256	13.9143	0.000	Significant
20	a= 0.9392 b= -0.0453	a= 0.928 b= -0.0488	18.5733	0.000	Significant
21	a= 1.4523 b= 0.2828	a= 1.484 b= 0.469	4.74361	0.029	Not Significant
22	a= 1.5387 b= 0.3099	a= 1.4914 b= 0.5412	6.07081	0.013	Not Significant
23	a= 0.9474 b= -0.1249	a= 0.9381 b= -0.0828	15.3972	0.000	Significant
24	a= 1.174 b= 0.0826	a= 1.2315 b= 0.1342	7.04024	0.007	Significant
25	a= 1.0223 b= 0.1529	a= 1.0744 b= 0.0769	12.7661	0.000	Significant
26	a= 1.0991 b= -0.0648	a= 1.1697 b= 0.0293	4.35317	0.036	Not Significant
27	a= 1.3335 b= 0.07	a= 1.3218 b= 0.2345	7.40453	0.006	Significant
28	a= 0.7471 b= -0.0069	a= 0.7871 b= -0.0608	12.8248	0.000	Significant
29	a= 1.093 b= -0.0753	a= 1.0045 b= -0.0433	26.3124	0.000	Significant
30	a= 1.1716 b= 0.0943	a= 1.2818 b= 0.1793	3.30156	0.069	Not Significant
31	a= 1.7298 b= 0.505	a= 1.7883 b= 0.912	.156491	0.692	Not Significant
32	a= 1.3062 b= 0.075	a= 1.2159 b= 0.1786	16.7835	0.000	Significant
33	a= 1.8455 b= 0.5171	a= 1.8563 b= 0.9137	.632165	0.426	Not Significant
34	a= 1.0933 b= 0.0255	a= 1.0413 b= -0.0462	28.0595	0.000	Significant
35	a= 1.3711 b= 0.2386	a= 1.3876 b= 0.4281	5.05785	0.024	Not Significant
36	a= 1.5949 b= 0.359	a= 1.4779 b= 0.3292	24.9165	0.000	Significant
37	a= 1.5562 b= 0.074	a= 1.4616 b= 0.1539	15.8979	0.000	Significant

Item	Item 42= 0	Item 42= 1	χ^2	p	Significance
38	a= 1.8059	a= 1.5706			
	b= 0.2581	b= 0.2984	27.2244	0.000	Significant
39	a= 1.7406	a= 1.6627			
	b= 0.667	b= 0.6144	23.1667	0.000	Significant
40	a= 0.895	a= 0.6764			
	b= 0.0045	b= -0.1018	135.699	0.000	Significant
41	a= 1.9962	a= 1.6996			
	b= 0.4146	b= 0.4615	27.6461	0.000	Significant
43	a= 1.3935	a= 1.2937			
	b= 0.343	b= 0.2905	28.4847	0.000	Significant
44	a= 1.4918	a= 1.1431			
	b= 0.1919	b= 0.2422	51.9979	0.000	Significant
45	a= 2.0073	a= 1.669			
	b= 0.3367	b= 0.5699	18.1252	0.000	Significant
46	a= 1.6375	a= 1.0207			
	b= -0.0368	b= -0.0306	112.038	0.000	Significant
47	a= 1.4726	a= 1.1751			
	b= 0.1614	b= 0.1129	56.4145	0.000	Significant
48	a= 2.2645	a= 1.8209			
	b= 0.2768	b= 0.5925	14.9163	0.000	Significant
49	a= 2.2002	a= 1.8923			
	b= 0.4697	b= 0.9155	4.65154	0.000	Significant
50	a= 2.1919	a= 1.6411			
	b= 0.2352	b= 0.5277	24.5565	0.000	Significant

TABLE A.43

The Table showing the values of item parameters *a* and *b* of all items conditioned on item no. 43

Item	Item 43= 0	Item 43= 1	χ^2	p	Significance
1	a= 0.7319 b= -0.1496	a= 0.7417 b= -0.1741	5.36878	0.020	Not Significant
2	a= 1.2276 b= 0.0624	a= 1.2242 b= 0.0717	1.94906	0.162	Not Significant
3	a= 0.8431 b= -0.1791	a= 0.8948 b= -0.1427	0.008040	0.928	Not Significant
4	a= 0.9619 b= -0.1293	a= 1.0181 b= -0.0469	0.004002	0.949	Not Significant
5	a= 0.8629 b= -0.141	a= 0.9063 b= -0.1384	0.335770	0.562	Not Significant
6	a= 1.1682 b= 0.0001	a= 1.1594 b= 0.0336	1.82206	0.177	Not Significant
7	a= 1.1297 b= -0.0251	a= 1.1546 b= -0.0195	1.29176	0.255	Not Significant
8	a= 1.0004 b= -0.1403	a= 1.0331 b= -0.1289	0.905087	0.341	Not Significant
9	a= 1.4113 b= 0.1582	a= 1.4244 b= 0.3053	0.183354	0.668	Not Significant
10	a= 1.0173 b= -0.0833	a= 1.0242 b= -0.07	2.09731	0.147	Not Significant
11	a= 1.3776 b= 0.2138	a= 1.379 b= 0.2919	0.827085	0.363	Not Significant
12	a= 0.7936 b= -0.1496	a= 0.8177 b= -0.1404	1.49304	0.221	Not Significant
13	a= 0.9849 b= -0.0461	a= 1.2068 b= 0.1206	8.37426	0.003	Significant
14	a= 1.0771 b= -0.0401	a= 1.1792 b= 0.0648	0.282270	0.595	Not Significant
15	a= 1.1945 b= 0.0574	a= 1.3265 b= 0.1727	0.568412	0.450	Not Significant
16	a= 0.8437 b= -0.1581	a= 0.8992 b= -0.1685	0.357121	0.550	Not Significant
17	a= 1.0403 b= -0.1004	a= 1.1439 b= -0.0283	0.145737	0.702	Not Significant

Item	Item 43= 0	Item 43= 1	χ^2	p	Significance
18	a= 0.941	a= 0.895			
	b= -0.048	b= -0.0411	8.12144	0.004	Significant
19	a= 1.1083	a= 1.1378			
	b= -0.0396	b= -0.0306	1.53339	0.215	Not Significant
20	a= 0.9258	a= 0.9664			
	b= -0.0615	b= -0.0093	0.505940	0.476	Not Significant
21	a= 1.4459	a= 1.4776			
	b= 0.3231	b= 0.4562	0.262177	0.608	Not Significant
22	a= 1.484	a= 1.5733			
	b= 0.36	b= 0.543	.043831	0.834	Not Significant
23	a= 0.9163	a= 1.0219			
	b= -0.1365	b= -0.0348	0.635180	0.425	Not Significant
24	a= 1.2025	a= 1.1734			
	b= 0.0659	b= 0.1892	1.80094	0.179	Not Significant
25	a= 1.0516	a= 1.028			
	b= 0.1242	b= 0.1206	5.76531	0.016	Not Significant
26	a= 1.0782	a= 1.2407			
	b= -0.0649	b= 0.0656	1.46133	0.226	Not Significant
27	a= 1.316	a= 1.3493			
	b= 0.0932	b= 0.2513	0.257018	0.612	Not Significant
28	a= 0.7517	a= 0.7914			
	b= -0.001	b= -0.0829	3.13383	0.076	Not Significant
29	a= 1.0572	a= 1.0716			
	b= -0.0747	b= -0.0272	2.05482	0.151	Not Significant
30	a= 1.2011	a= 1.2227			
	b= 0.0894	b= 0.2169	0.581181	0.445	Not Significant
31	a= 1.7382	a= 1.686			
	b= 0.6889	b= 0.6804	5.36677	0.020	Not Significant
32	a= 1.2889	a= 1.2332			
	b= 0.091	b= 0.1818	3.85380	0.049	Not Significant
33	a= 1.8478	a= 1.7655			
	b= 0.6358	b= 0.8278	1.11386	0.291	Not Significant
34	a= 1.1264	a= 0.9858			
	b= 0.0084	b= -0.0247	20.0106	0.000	Significant
35	a= 1.4205	a= 1.2704			
	b= 0.2915	b= 0.3858	7.64194	0.005	Significant
36	a= 1.6096	a= 1.4241			
	b= 0.3701	b= 0.3321	13.8736	0.000	Significant
37	a= 1.5468	a= 1.4562			
	b= 0.099	b= 0.1433	5.87519	0.015	Not Significant

Item	Item 43= 0	Item 43= 1	χ^2	p	Significance
38	a= 1.7223	a= 1.6569			
	b= 0.2963	b= 0.2624	6.81373	0.009	Significant
39	a= 1.7281	a= 1.6603			
	b= 0.6966	b= 0.5844	10.6704	0.000	Significant
40	a= 0.8591	a= 0.7119			
	b= -0.0147	b= -0.0943	48.6206	0.000	Significant
41	a= 1.9227	a= 1.6815			
	b= 0.5251	b= 0.3568	21.0700	0.000	Significant
42	a= 1.3685	a= 1.1437			
	b= 0.2084	b= 0.0718	28.4847	0.000	Significant
44	a= 1.4396	a= 1.127			
	b= 0.2776	b= 0.169	36.5819	0.000	Significant
45	a= 1.8962	a= 1.6659			
	b= 0.4471	b= 0.5156	8.18298	0.004	Significant
46	a= 1.483	a= 1.0871			
	b= 0.0097	b= -0.0798	46.5114	0.000	Significant
47	a= 1.5144	a= 1.0611			
	b= 0.1999	b= 0.0825	60.4720	0.000	Significant
48	a= 2.0506	a= 1.8092			
	b= 0.5235	b= 0.3558	21.6301	0.000	Significant
49	a= 2.0903	a= 1.7901			
	b= 0.6816	b= 0.7773	9.01896	0.002	Significant
50	a= 1.9349	a= 1.7438			
	b= 0.3911	b= 0.4289	9.01896	0.004	Significant

TABLE A.44

The Table showing the values of item parameters a and b of all items conditioned on item no. 44

Item	Item 44= 0	Item 44= 1	χ^2	p	Significance
1	a= 0.71 b= -0.154	a= 0.7926 b= -0.1609	0.0067	0.934	Not Significant
2	a= 1.2177 b= 0.041	a= 1.2469 b= 0.1092	2.310	0.128	Not Significant
3	a= 0.8348 b= -0.174	a= 0.9095 b= -0.1551	0.6222	0.430	Not Significant
4	a= 0.9743 b= -0.117	a= 0.9827 b= -0.0815	5.18344	0.022	Not Significant
5	a= 0.8652 b= -0.1403	a= 0.8962 b= -0.1367	4.59716	0.032	Not Significant
6	a= 1.1401 b= -0.0134	a= 1.2237 b= 0.0589	0.7078	0.400	Not Significant
7	a= 1.112 b= -0.0565	a= 1.1922 b= 0.0415	0.4838	0.486	Not Significant
8	a= 0.9857 b= -0.1467	a= 1.0591 b= -0.1171	1.10540	0.293	Not Significant
9	a= 1.435 b= 0.1935	a= 1.3747 b= 0.2189	8.75112	0.003	Significant
10	a= 1.0145 b= -0.0827	a= 1.0246 b= -0.0756	6.03288	0.014	Not Significant
11	a= 1.3743 b= 0.2074	a= 1.3906 b= 0.2908	3.32033	0.068	Not Significant
12	a= 0.7968 b= -0.1513	a= 0.8062 b= -0.1366	8.96241	0.002	Significant
13	a= 0.9974 b= -0.0357	a= 1.1465 b= 0.0725	0.2551	0.613	Not Significant
14	a= 1.082 b= -0.0232	a= 1.155 b= 0.0161	1.7559	0.185	Not Significant
15	a= 1.195 b= 0.0392	a= 1.3222 b= 0.1969	0.0928	0.923	Not Significant
16	a= 0.8376 b= -0.1554	a= 0.9041 b= -0.1728	2.192	0.138	Not Significant
17	a= 1.0385 b= -0.1006	a= 1.1306 b= -0.0383	0.5252	0.525	Not Significant

Item	Item 44= 0	Item 44= 1	χ^2	p	Significance
18	a= 0.9228 b= -0.0584	a= 0.9321 b= -0.0235	6.2237	0.012	Not Significant
19	a= 1.0994 b= -0.0573	a= 1.1484 b= -0.0027	2.312	0.128	Not Significant
20	a= 0.928 b= -0.0643	a= 0.9538 b= -0.0093	3.970	0.046	Not Significant
21	a= 1.4348 b= 0.2695	a= 1.5184 b= 0.5314	.04399	0.833	Not Significant
22	a= 1.5013 b= 0.3022	a= 1.5472 b= 0.6205	.04553	0.831	Not Significant
23	a= 0.9156 b= -0.1225	a= 1.0089 b= -0.076	0.579	0.446	Not Significant
24	a= 1.1813 b= 0.0234	a= 1.2287 b= 0.2596	0.3976	0.528	Not Significant
25	a= 1.0538 b= 0.1077	a= 1.0236 b= 0.1449	10.271	0.001	Significant
26	a= 1.117 b= -0.0674	a= 1.1339 b= 0.0458	3.1118	0.077	Not Significant
27	a= 1.3404 b= 0.0803	a= 1.2951 b= 0.246	4.57978	0.032	Not Significant
28	a= 0.7465 b= -0.0107	a= 0.797 b= -0.0573	5.1880	0.022	Not Significant
29	a= 1.0493 b= -0.0977	a= 1.0814 b= 0.0104	2.6803	0.101	Not Significant
30	a= 1.198 b= 0.0789	a= 1.2327 b= 0.2203	2.4909	0.114	Not Significant
31	a= 1.7199 b= 0.5863	a= 1.7655 b= 0.8387	0.91669	0.338	Not Significant
32	a= 1.3216 b= 0.0531	a= 1.1803 b= 0.228	11.0341	0.000	Not Significant
33	a= 1.8412 b= 0.5675	a= 1.8167 b= 0.9067	0.6662	0.414	Not Significant
34	a= 1.118 b= 0.0103	a= 0.9987 b= -0.0272	27.085	0.000	Significant
35	a= 1.4144 b= 0.3979	a= 1.2442 b= 0.2224	36.983	0.000	Significant
36	a= 1.6015 b= 0.3135	a= 1.4748 b= 0.4074	11.291	0.000	Significant
37	a= 1.5524 b= 0.0886	a= 1.4433 b= 0.149	11.5612	0.000	Significant

Item	Item 44= 0	Item 44= 1	χ^2	p	Significance
38	a= 1.8328 b= 0.2797	a= 1.4969 b= 0.2778	29.4995	0.000	Significant
39	a= 1.8106 b= 0.7147	a= 1.5289 b= 0.5671	39.5299	0.000	Significant
40	a= 0.8793 b= -0.0042	a= 0.6892 b= -0.1084	95.2696	0.000	Significant
41	a= 1.9809 b= 0.5182	a= 1.6219 b= 0.3702	41.8213	0.000	Significant
42	a= 1.4584 b= 0.1353	a= 1.0712 b= 0.1622	51.9979	0.000	Significant
43	a= 1.4539 b= 0.3254	a= 1.1953 b= 0.2874	36.5819	0.000	Significant
45	a= 1.981 b= 0.4575	a= 1.5862 b= 0.4587	32.7559	0.000	Significant
46	a= 1.5678 b= 0.0125	a= 1.0331 b= -0.0946	95.7099	0.000	Significant
47	a= 1.545 b= 0.2168	a= 1.0544 b= 0.0546	94.8288	0.000	Significant
48	a= 2.2221 b= 0.4145	a= 1.7235 b= 0.4582	32.7338	0.000	Significant
49	a= 2.1777 b= 0.6906	a= 1.7446 b= 0.7056	32.9670	0.000	Significant
50	a= 2.0838 b= 0.428	a= 1.5603 b= 0.3553	51.4994	0.000	Significant

TABLE A.45

The Table showing the values of item parameters a and b of all items conditioned on item no. 45

Item	Item 45= 0	Item 45= 1	χ^2	p	Significance
1	a= 0.7215	a= 0.8152			
	b= -0.1502	b= -0.1886	1.06439	0.302	Not Significant
2	a= 1.2383	a= 1.2011			
	b= 0.0654	b= 0.0821	8.56753	0.003	Significant
3	a= 0.8584	a= 0.8719			
	b= -0.1702	b= -0.1549	8.66755	0.003	Significant
4	a= 0.9615	a= 1.0793			
	b= -0.1224	b= -0.0141	0.141077	0.707	Not Significant
5	a= 0.8891	a= 0.8389			
	b= -0.1358	b= -0.1488	21.1700	0.000	Significant
6	a= 1.1761	a= 1.1464			
	b= 0.0167	b= 0.0082	9.52429	0.002	Significant
7	a= 1.1372	a= 1.1683			
	b= -0.0472	b= 0.0957	2.59673	0.107	Not Significant
8	a= 1.0234	a= 0.9734			
	b= -0.1331	b= -0.1409	14.3426	0.000	Significant
9	a= 1.4531	a= 1.2748			
	b= 0.2255	b= 0.1567	20.9667	0.000	Significant
10	a= 1.0225	a= 1.0295			
	b= -0.0831	b= -0.0518	6.86759	0.008	Significant
11	a= 1.4166	a= 1.2729			
	b= 0.2226	b= 0.3263	12.1968	0.000	Significant
12	a= 0.7986	a= 0.8268			
	b= -0.1451	b= -0.1521	8.31925	0.003	Significant
13	a= 1.0525	a= 1.0307			
	b= -0.0076	b= 0.0357	9.14210	0.002	Significant
14	a= 1.1129	a= 1.1022			
	b= -0.022	b= 0.0612	6.54355	0.010	Not Significant
15	a= 1.2471	a= 1.1984			
	b= 0.0909	b= 0.1212	9.97885	0.001	Significant
16	a= 0.8569	a= 0.8878			
	b= -0.1601	b= -0.1677	6.50325	0.010	Not Significant
17	a= 1.0734	a= 1.0768			
	b= -0.0824	b= -0.0525	7.25592	0.007	Significant

Item	Item 45= 0	Item 45= 1	χ^2	p	Significance
18	a= 0.9265 b= -0.0436	a= 0.9503 b= -0.0486	7.59771	0.005	Significant
19	a= 1.1209 b= -0.027	a= 1.123 b= -0.0632	9.25292	0.002	Significant
20	a= 0.9494 b= -0.0446	a= 0.9091 b= -0.0437	14.9573	0.000	Significant
21	a= 1.4624 b= 0.3363	a= 1.4707 b= 0.4927	3.56280	0.059	Not Significant
22	a= 1.5056 b= 0.345	a= 1.5943 b= 0.7197	.024585	0.875	Not Significant
23	a= 0.945 b= -0.1097	a= 0.9657 b= -0.0918	6.55763	0.010	Not Significant
24	a= 1.1723 b= 0.0528	a= 1.3398 b= 0.3457	0.147662	0.700	Not Significant
25	a= 1.0536 b= 0.1393	a= 1.0256 b= 0.0716	15.0724	0.000	Significant
26	a= 1.1297 b= -0.0368	a= 1.1224 b= 0.0254	6.88398	0.008	Significant
27	a= 1.3073 b= 0.1154	a= 1.4389 b= 0.2703	.840714	0.359	Not Significant
28	a= 0.7509 b= -0.0217	a= 0.8456 b= -0.0561	1.71891	0.189	Not Significant
29	a= 1.0765 b= -0.0689	a= 1.0233 b= -0.0205	11.8107	0.000	Significant
30	a= 1.2108 b= 0.1384	a= 1.2106 b= 0.1183	9.50758	0.002	Significant
31	a= 1.734 b= 0.6679	a= 1.7259 b= 0.7772	5.99383	0.014	Not Significant
32	a= 1.2685 b= 0.0891	a= 1.3197 b= 0.2554	2.41235	0.120	Not Significant
33	a= 1.825 b= 0.6293	a= 1.8709 b= 0.9735	.519243	0.471	Not Significant
34	a= 1.1079 b= 0.0202	a= 0.9915 b= -0.0704	27.7084	0.000	Significant
35	a= 1.3882 b= 0.3012	a= 1.3351 b= 0.4294	7.41400	0.006	Significant
36	a= 1.5943 b= 0.3572	a= 1.4372 b= 0.3792	17.4250	0.000	Significant
37	a= 1.5679 b= 0.1065	a= 1.3561 b= 0.1631	18.0833	0.000	Significant

Item	Item 45= 0	Item 45= 1	χ^2	p	Significance
38	a= 1.8	a= 1.4131			
	b= 0.2935	b= 0.2911	32.2661	0.000	Significant
39	a= 1.7492	a= 1.6702			
	b= 0.6154	b= 0.7785	7.07710	0.007	Significant
40	a= 0.8374	a= 0.719			
	b= -0.0235	b= -0.117	47.6443	0.000	Significant
41	a= 1.8937	a= 1.7057			
	b= 0.4829	b= 0.4283	21.4840	0.000	Significant
42	a= 1.3407	a= 1.1911			
	b= 0.145	b= 0.1896	18.1252	0.000	Significant
43	a= 1.3774	a= 1.3392			
	b= 0.2934	b= 0.3982	8.18298	0.004	Significant
44	a= 1.3905	a= 1.1618			
	b= 0.2364	b= 0.1809	32.7559	0.000	Significant
46	a= 1.4691	a= 0.9682			
	b= 0.0135	b= -0.0932	83.9551	0.000	Significant
47	a= 1.3926	a= 1.1963			
	b= 0.1858	b= 0.0733	33.0885	0.000	Significant
48	a= 2.0709	a= 1.741			
	b= 0.4615	b= 0.4862	25.0746	0.000	Significant
49	a= 2.0033	a= 1.8761			
	b= 0.7374	b= 0.7262	18.2145	0.000	Significant
50	a= 1.9092	a= 1.7178			
	b= 0.4219	b= 0.4107	20.4128	0.000	Significant

TABLE A.46 The Table showing the values of item parameters a and b of all items conditioned on item no. 46

Item	Item 46= 0	Item 46= 1	χ^2	p	Significance
1	a= 0.6939 b= -0.1162	a= 0.8042 b= -0.2125	18.2079	0.000	Significant
2	a= 1.2859 b= 0.0353	a= 1.1519 b= 0.0917	44.5325	0.000	Significant
3	a= 0.8533 b= -0.1592	a= 0.8616 b= -0.1821	45.4723	0.000	Significant
4	a= 0.986 b= -0.1055	a= 0.9608 b= -0.1061	42.1816	0.000	Significant
5	a= 0.8651 b= -0.1537	a= 0.8932 b= -0.1179	21.1700	0.000	Significant
6	a= 1.2148 b= 0.0021	a= 1.0988 b= 0.0147	51.1704	0.000	Significant
7	a= 1.1893 b= -0.0484	a= 1.0687 b= -0.0004	51.2664	0.000	Significant
8	a= 1.0838 b= -0.1236	a= 0.905 b= -0.1616	99.3135	0.000	Significant
9	a= 1.5045 b= 0.1589	a= 1.3154 b= 0.2468	47.3246	0.000	Significant
10	a= 1.0511 b= -0.0866	a= 0.9708 b= -0.0749	55.9521	0.000	Significant
11	a= 1.4637 b= 0.2052	a= 1.2789 b= 0.2643	51.4492	0.000	Significant
12	a= 0.7695 b= -0.1235	a= 0.8499 b= -0.1716	25.6225	0.000	Significant
13	a= 0.9996 b= -0.0502	a= 1.1249 b= 0.0682	8.38307	0.003	Significant
14	a= 1.1311 b= -0.0494	a= 1.0769 b= 0.0378	38.4039	0.000	Significant
15	a= 1.2415 b= 0.0417	a= 1.236 b= 0.1488	26.6400	0.000	Significant
16	a= 0.8669 b= -0.1476	a= 0.8421 b= -0.1788	60.9504	0.000	Significant
17	a= 1.1025 b= -0.1119	a= 1.0227 b= -0.0457	47.1506	0.000	Significant

Item	Item 46= 0	Item 46= 1	χ^2	p	Significance
18	a= 0.898	a= 0.9737			
	b= -0.0489	b= -0.0396	22.2537	0.000	Significant
19	a= 1.1322	a= 1.1003			
	b= -0.0824	b= 0.0128	32.977	0.000	Significant
20	a= 0.9251	a= 0.9571			
	b= -0.0628	b= -0.0241	29.8678	0.000	Significant
21	a= 1.5031	a= 1.4441			
	b= 0.2343	b= 0.4868	22.1059	0.000	Significant
22	a= 1.572	a= 1.4891			
	b= 0.2585	b= 0.5665	20.2632	0.000	Significant
23	a= 0.952	a= 0.934			
	b= -0.137	b= -0.0712	40.2476	0.000	Significant
24	a= 1.1695	a= 1.2599			
	b= 0.0131	b= 0.2116	12.4867	0.000	Significant
25	a= 0.9915	a= 1.1338			
	b= 0.1168	b= 0.1296	14.9301	0.000	Significant
26	a= 1.1162	a= 1.1432			
	b= -0.0918	b= 0.0478	21.4920	0.000	Significant
27	a= 1.3249	a= 1.3469			
	b= 0.0455	b= 0.2347	18.8456,	0.000	Significant
28	a= 0.7443	a= 0.787			
	b= 0	b= -0.0586	39.5234	0.000	Significant
29	a= 1.0613	a= 1.0629			
	b= -0.1141	b= 0.0026	27.6909	0.000	Significant
30	a= 1.1827	a= 1.2579			
	b= 0.0806	b= 0.181	20.1766	0.000	Significant
31	a= 1.7622	a= 1.7996			
	b= 0.4534	b= 0.8666	7.47002	0.006	Significant
32	a= 1.2687	a= 1.3009			
	b= 0.0085	b= 0.2293	16.8138	0.000	Significant
33	a= 1.9353	a= 1.7928			
	b= 0.4811	b= 0.8368	18.6171	0.000	Significant
34	a= 1.0834	a= 1.0397			
	b= 0.0334	b= -0.0455	56.5551	0.000	Significant
35	a= 1.375	a= 1.3936			
	b= 0.2269	b= 0.3859	23.7355	0.000	Significant
36	a= 1.6449	a= 1.507			
	b= 0.2151	b= 0.4217	34.1466	0.000	Significant
37	a= 1.7886	a= 1.2528			
	b= 0.0189	b= 0.1439	96.6701	0.000	Significant

Item	Item 46= 0	Item 46= 1	χ^2	p	Significance
38	a= 1.9521	a= 1.5278			
	b= 0.1387	b= 0.3295	61.4882	0.000	Significant
39	a= 1.8577	a= 1.6939			
	b= 0.4414	b= 0.7178	30.3373	0.000	Significant
40	a= 0.8838	a= 0.6805			
	b= 0.0421	b= -0.1373	215.000	0.000	Significant
41	a= 2.1593	a= 1.6715			
	b= 0.3013	b= 0.4709	65.0675	0.000	Significant
42	a= 1.4925	a= 1.0914			
	b= 0.0968	b= 0.1347	112.038	0.000	Significant
43	a= 1.4124	a= 1.3141			
	b= 0.2374	b= 0.3215	46.5114	0.000	Significant
44	a= 1.4618	a= 1.1825			
	b= 0.2069	b= 0.1719	95.7099	0.000	Significant
45	a= 2.2814	a= 1.5697			
	b= 0.2702	b= 0.4665	83.9551	0.000	Significant
47	a= 1.5034	a= 1.1202			
	b= 0.2322	b= 0.0575	143.475	0.000	Significant
48	a= 2.7683	a= 1.6804			
	b= 0.1973	b= 0.5203	81.6003	0.000	Significant
49	a= 2.3596	a= 1.9355			
	b= 0.393	b= 0.8255	27.0332	0.000	Significant
50	a= 2.6282	a= 0.5813			
	b= 0.1065	b= 0.4959	72.2048	0.000	Significant

TABLE A.47

The Table showing the values of item parameters a and b of all items conditioned on item no. 47

Item	Item 47= 0	Item 47= 1	χ^2	p	Significance
1	a= 0.7163 b= -0.1449	a= 0.7717 b= -0.1789	5.25214	0.000	Significant
2	a= 1.2228 b= 0.0603	a= 1.2335 b= 0.0686	5.84732	0.015	Not Significant
3	a= 0.8438 b= -0.1687	a= 0.8844 b= -0.1677	5.16740	0.023	Not Significant
4	a= 0.9862 b= -0.111	a= 0.9586 b= -0.0914	12.4699	0.000	Significant
5	a= 0.8629 b= -0.1584	a= 0.9037 b= -0.1011	3.54113	0.059	Not Significant
6	a= 1.1817 b= -0.0058	a= 1.1389 b= 0.0422	9.73249	0.001	Significant
7	a= 1.1252 b= -0.0415	a= 1.1623 b= 0.0102	3.74327	0.053	Not Significant
8	a= 1.0039 b= -0.1395	a= 1.0194 b= -0.1311	7.05366	0.007	Significant
9	a= 1.4109 b= 0.1677	a= 1.4285 b= 0.2667	3.77454	0.052	Not Significant
10	a= 1.0158 b= -0.0798	a= 1.0236 b= -0.0793	8.21176	0.004	Significant
11	a= 1.4083 b= 0.2338	a= 1.3261 b= 0.2416	12.9377	0.000	Significant
12	a= 0.7886 b= -0.1336	a= 0.8211 b= -0.1686	8.86443	0.002	Significant
13	a= 1.0013 b= -0.0379	a= 1.1368 b= 0.0704	0.005887	0.938	Not Significant
14	a= 1.1158 b= -0.0183	a= 1.0842 b= 0.006	10.6069	0.000	Significant
15	a= 1.2076 b= 0.0441	a= 1.289 b= 0.1915	0.8289	0.362	Not Significant
16	a= 0.8549 b= -0.1564	a= 0.8656 b= -0.17	10.6317	0.000	Significant
17	a= 1.0548 b= -0.0991	a= 1.0989 b= -0.0411	3.41754	0.064	Not Significant

Item	Item 47= 0	Item 47= 1	χ^2	p	Significance
18	a= 0.9337 b= -0.0449	a= 0.9097 b= -0.0489	14.8284	0.000	Significant
19	a= 1.079 b= -0.0561	a= 1.2005 b= -0.0017	0.666251	0.414	Not Significant
20	a= 0.9222 b= -0.054	a= 0.9651 b= -0.027	4.70725	0.030	Not Significant
21	a= 1.4851 b= 0.3033	a= 1.423 b= 0.4599	6.73259	0.009	Significant
22	a= 1.4864 b= 0.2631	a= 1.5997 b= 0.7085	0.467667	0.494	Not Significant
23	a= 0.9236 b= -0.124	a= 0.989 b= -0.0742	2.71398	0.099	Not Significant
24	a= 1.2043 b= 0.0508	a= 1.1787 b= 0.2016	6.22736	0.012	Not Significant
25	a= 1.0275 b= 0.1229	a= 1.0734 b= 0.1217	6.88048	0.008	Significant
26	a= 1.1178 b= -0.0589	a= 1.1344 b= 0.0339	5.45309	0.019	Not Significant
27	a= 1.3066 b= 0.0785	a= 1.3678 b= 0.2487	1.86158	0.172	Not Significant
28	a= 0.7417 b= -0.0178	a= 0.8073 b= -0.04	4.19482	0.040	Not Significant
29	a= 1.0436 b= -0.0868	a= 1.0967 b= -0.0105	3.88142	0.048	Not Significant
30	a= 1.2184 b= 0.1167	a= 1.1822 b= 0.1514	12.8933	0.000	Significant
31	a= 1.7253 b= 0.5234	a= 1.8003 b= 0.9324	.069813	0.791	Not Significant
32	a= 1.3299 b= 0.0608	a= 1.1756 b= 0.2075	17.5299	0.000	Significant
33	a= 1.8928 b= 0.5392	a= 1.7614 b= 0.9194	3.10715	0.077	Not Significant
34	a= 1.1046 b= 0.0198	a= 1.0223 b= -0.0463	28.2605	0.000	Significant
35	a= 1.4005 b= 0.28	a= 1.3282 b= 0.3745	13.6139	0.000	Significant
36	a= 1.6035 b= 0.2782	a= 1.5044 b= 0.4405	11.1847	0.000	Significant
37	a= 1.651 b= 0.0805	a= 1.3127 b= 0.1311	36.9400	0.000	Significant

Item	Item 47= 0	Item 47= 1	χ^2	p	Significance
38	a= 1.7957	a= 1.5792			
	b= 0.2432	b= 0.3155	22.6006	0.000	Significant
39	a= 1.75	a= 1.696			
	b= 0.5972	b= 0.6792	14.1657	0.000	Significant
40	a= 0.8606	a= 0.7102			
	b= 0.0018	b= -0.1189	86.9624	0.000	Significant
41	a= 1.9943	a= 1.6362			
	b= 0.481	b= 0.3774	48.0770	0.000	Significant
42	a= 1.4221	a= 1.1091			
	b= 0.1549	b= 0.1106	56.4145	0.000	Significant
43	a= 1.5091	a= 1.1466			
	b= 0.3014	b= 0.2875	60.4720	0.000	Significant
44	a= 1.5171	a= 1.0694			
	b= 0.2565	b= 0.135	94.8288	0.000	Significant
45	a= 2.0235	a= 1.6205			
	b= 0.3655	b= 0.4738	33.0885	0.000	Significant
46	a= 1.6101	a= 0.9828			
	b= 0.0242	b= -0.1294	143.475	0.000	Significant
48	a= 2.2361	a= 1.7481			
	b= 0.4056	b= 0.4352	45.2555	0.000	Significant
49	a= 2.2817	a= 1.7114			
	b= 0.63	b= 0.716	47.7343	0.000	Significant
50	a= 2.1917	a= 1.5737			
	b= 0.3365	b= 0.3769	56.4447	0.000	Significant

TABLE A.48

The Table showing the values of item parameters a and b
of all items conditioned on item no. 48

Item	Item 48= 0	Item 48= 1	χ^2	p	Significance
1	a= 0.7246	a= 0.8109			
	b= -0.1474	b= -0.2083	3.71760	0.053	Not Significant
2	a= 1.2499	a= 1.1413			
	b= 0.0764	b= 0.0377	17.2135	0.000	Significant
3	a= 0.8539	a= 0.8993			
	b= -0.1669	b= -0.1691	6.33971	0.011	Not Significant
4	a= 0.9779	a= 1.0016			
	b= -0.2554	b= -0.0824	6.84836	0.008	Significant
5	a= 1.1846	a= 0.9692			
	b= 0.0201	b= -0.0711	0.826586	0.363	Not Significant
6	a= 1.1573	a= 1.1053			
	b= -0.0128	b= -0.007	15.6809	0.000	Significant
7	a= 1.0342	a= 1.0636			
	b= -0.126	b= -0.0474	18.2095	0.000	Significant
8	a= 1.4405	a= 0.9189			
	b= 0.1844	b= -0.1747	27.6659	0.000	Significant
9	a= 1.024	a= 1.3435			
	b= -0.0812	b= 0.3337	9.20446	0.002	Significant
10	a= 1.3941	a= 1.0244			
	b= 0.2389	b= -0.0492	8.64494	0.003	Significant
11	a= 0.7925	a= 1.3443			
	b= -0.1447	b= 0.282	10.2330	0.000	Significant
12	a= 1.0435	a= 0.8698			
	b= -0.0066	b= -0.1532	3.65431	0.055	Not Significant
13	a= 1.0435	a= 1.0726			
	b= -0.0066	b= 0.0336	5.71150	0.016	Not Significant
14	a= 1.1124	a= 1.1121			
	b= -0.0242	b= 0.0928	6.11897	0.013	Not Significant
15	a= 1.264	a= 1.1169			
	b= 0.1021	b= 0.0838	21.5760	0.000	Significant
16	a= 0.8572	a= 0.9004			
	b= -0.1599	b= -0.1611	6.64784	0.009	Significant
17	a= 1.0827	a= 1.0325			
	b= -0.0736	b= -0.0811	14.1083	0.000	Significant

Item	Item 48= 0	Item 48= 1	χ^2	p	Significance
18	a= 0.9203 b= -0.0399	a= 0.9921 b= -0.0591	4.89333	0.026	Not Significant
19	a= 1.1221 b= -0.0841	a= 1.1295 b= -0.0232	8.23165	0.004	Significant
20	a= 0.9329 b= -0.0486	a= 0.9966 b= -0.0183	4.38762	0.036	Not Significant
21	a= 1.4807 b= 0.3421	a= 1.4086 b= 0.5065	8.19808	0.004	Significant
22	a= 1.5237 b= 0.3727	a= 1.532 b= 0.6374	2.85589	0.091	Not Significant
23	a= 0.9437 b= -0.118	a= 0.9938 b= -0.044	4.22187	0.039	Not Significant
24	a= 1.2051 b= 0.0923	a= 1.1867 b= 0.1912	7.93559	0.004	Significant
25	a= 1.0394 b= 0.128	a= 1.1098 b= 0.1148	5.97826	0.014	Not Significant
26	a= 1.1243 b= -0.0402	a= 1.1678 b= 0.0652	4.40852	0.035	Not Significant
27	a= 1.331 b= 0.1356	a= 1.3344 b= 0.191	7.35080	0.006	Significant
38	a= 0.7644 b= -0.0237	a= 0.7857 b= -0.0636	10.9888	0.000	Significant
29	a= 1.0788 b= -0.0607	a= 1.0146 b= -0.0434	15.7653	0.000	Significant
30	a= 1.2101 b= 0.1194	a= 1.2515 b= 0.2042	5.93928	0.014	Not Significant
31	a= 1.7415 b= 0.6397	a= 1.7495 b= 0.8771	3.62729	0.056	Not Significant
32	a= 1.3042 b= 0.0961	a= 1.178 b= 0.241	13.7205	0.000	Significant
33	a= 1.8537 b= 0.629	a= 1.786 b= 0.98	2.70737	0.099	Not Significant
34	a= 1.0841 b= 0.0019	a= 1.0989 b= -0.0018	10.1955	0.000	Significant
35	a= 1.3779 b= 0.2986	a= 1.4013 b= 0.4496	5.58254	0.018	Not Significant
36	a= 1.6153 b= 0.3021	a= 1.4002 b= 0.5583	11.6203	0.000	Significant
37	a= 1.579 b= 0.1022	a= 1.2987 b= 0.1779	24.4930	0.000	Significant

Item	Item 48= 0	Item 48= 1	χ^2	p	Significance
38	a= 1.7921	a= 1.4172			
	b= 0.2858	b= 0.3052	34.5919	0.000	Significant
39	a= 1.7922	a= 1.5523			
	b= 0.5881	b= 0.8263	12.4342	0.000	Significant
40	a= 0.8276	a= 0.7397			
	b= -0.0224	b= -0.1314	41.4461	0.000	Significant
41	a= 1.931	a= 1.5947			
	b= 0.4663	b= 0.4054	34.3738	0.000	Significant
42	a= 1.3321	a= 1.2244			
	b= 0.1289	b= 0.2309	14.9163	0.000	Significant
43	a= 1.3752	a= 1.3123			
	b= 0.329	b= 0.2689	21.6301	0.000	Significant
44	a= 1.3858	a= 1.1705			
	b= 0.2204	b= 0.1878	32.7338	0.000	Significant
45	a= 1.9109	a= 1.6165			
	b= 0.4182	b= 0.51	25.0746	0.000	Significant
46	a= 1.4637	a= 0.9585			
	b= -0.0268	b= -0.0682	81.6003	0.000	Significant
47	a= 1.3958	a= 1.1711			
	b= 0.1726	b= 0.0116	45.2555	0.000	Significant
49	a= 2.0486	a= 1.7787			
	b= 0.7099	b= 0.739	28.0889	0.000	Significant
50	a= 2.0722	a= 1.3427			
	b= 0.391	b= 0.4377	67.7945	0.000	Significant

TABLE A.49

The Table showing the values of item parameters a and b of all items conditioned on item no. 49

Item	Item 49= 0	Item 49= 1	χ^2	p	Significance
1	a= 0.7375 b= -0.1571	a= 0.749 b= -0.1625	3.294	0.069	Not Significant
2	a= 1.2264 b= 0.0652	a= 1.2598 b= 0.1205	0.2412	0.623	Not Significant
3	a= 0.8496 b= -0.169	a= 0.957 b= -0.157	0.6870	0.407	Not Significant
4	a= 0.9789 b= -0.101	a= 0.9978 b= -0.1068	0.793	0.372	Not Significant
5	a= 0.8699 b= -0.1414	a= 0.9705 b= -0.1095	0.2499	0.617	Not Significant
6	a= 1.1637 b= 0.0108	a= 1.2217 b= 0.0696	0.0570	0.811	Not Significant
7	a= 1.1354 b= -0.0314	a= 1.185 b= 0.0997	0.0005	0.981	Not Significant
8	a= 1.008 b= -0.1322	a= 1.0582 b= -0.1446	0.2321	0.629	Not Significant
9	a= 1.4362 b= 0.2191	a= 1.2833 b= 0.1704	5.7483	0.016	Not Significant
10	a= 1.0214 b= -0.0735	a= 1.038 b= -0.0893	0.98148	0.321	Not Significant
11	a= 1.3835 b= 0.2305	a= 1.3925 b= 0.3832	0.24472	0.620	Not Significant
12	a= 0.7996 b= -0.14	a= 0.8425 b= -0.2022	0.7290	0.393	Not Significant
13	a= 1.0427 b= -0.0038	a= 1.0944 b= 0.0479	.1409	0.707	Not Significant
14	a= 1.1143 b= -0.0117	a= 1.0966 b= 0.0573	1.480	0.223	Not Significant
15	a= 1.2512 b= 0.091	a= 1.1455 b= 0.1674	3.3737	0.066	Significant
16	a= 0.859 b= -0.157	a= 0.9057 b= -0.193	0.5346	0.464	Not Significant
17	a= 1.0812 b= -0.0729	a= 1.0387 b= -0.0949	3.857	0.049	Not Significant

Item	Item 49= 0	Item 49= 1	χ^2	p	Significance
18	a= 0.936	a= 0.9047			
	b= -0.0465	b= -0.0303	3.2436	0.071	Not Significant
19	a= 1.1251	a= 1.1045			
	b= -0.028	b= -0.0685	2.6812	0.101	Not Significant
20	a= 0.933	a= 1.0225			
	b= -0.0484	b= -0.0035	0.0005	0.981	Not Significant
21	a= 1.4719	a= 1.3982			
	b= 0.3567	b= 0.5094	1.6975	0.192	Not Significant
22	a= 1.5113	a= 1.5897			
	b= 0.3726	b= 0.8437	0.72577	0.394	Not Significant
23	a= 0.9438	a= 1.0085			
	b= -0.113	b= -0.0404	0.0606	0.805	Not Significant
24	a= 1.184	a= 1.3283			
	b= 0.0975	b= 0.2414	0.09958	0.752	Not Significant
25	a= 1.0548	a= 1.0217			
	b= 0.1194	b= 0.186	2.6007	0.106	Not Significant
26	a= 1.1373	a= 1.0713			
	b= -0.0155	b= -0.058	5.4137	0.019	Not Significant
27	a= 1.3213	a= 1.4117			
	b= 0.1304	b= 0.313	.01883	0.890	Not Significant
28	a= 0.7518	a= 0.9322			
	b= -0.0286	b= -0.0293	2.5843	0.107	Not Significant
29	a= 1.0644	a= 1.0995			
	b= -0.0668	b= 0.0278	0.58582	0.444	Not Significant
30	a= 1.2139	a= 1.2561			
	b= 0.1175	b= 0.2702	0.61172	0.434	Not Significant
31	a= 1.7188	a= 1.9334			
	b= 0.6538	b= 1.0131	0.07258	0.787	Not Significant
32	a= 1.2736	a= 1.3274			
	b= 0.1186	b= 0.1966	1.2343	0.266	Not Significant
33	a= 1.8344	a= 1.8379			
	b= 0.6523	b= 1.0937	0.0003	0.9844	Not Significant
34	a= 1.1191	a= 0.8976			
	b= 0.0088	b= -0.0532	22.718	0.000	Significant
35	a= 1.3974	a= 1.2184			
	b= 0.3538	b= 0.2169	15.464	0.000	Significant
36	a= 1.5764	a= 1.4757			
	b= 0.3499	b= 0.4685	4.0543	0.044	Not Significant
37	a= 1.5576	a= 1.313			
	b= 0.1241	b= 0.1262	11.644	0.000	Significant

Item	Item 49= 0	Item 49= 1	χ^2	p	Significance
38	a= 1.763	a= 1.3827			
	b= 0.3169	b= 0.2095	22.277	0.000	Significant
39	a= 1.738	a= 1.6934			
	b= 0.6434	b= 0.7775	3.6515	0.056	Not Significant
40	a= 0.8265	a= 0.7594			
	b= -0.0417	b= -0.0816	12.731	0.000	Significant
41	a= 1.9182	a= 1.4188			
	b= 0.5459	b= 0.1871	49.737	0.000	Significant
42	a= 1.3354	a= 1.2108			
	b= 0.1352	b= 0.328	4.6515	0.031	Not Significant
43	a= 1.4047	a= 1.1889			
	b= 0.3024	b= 0.4529	9.0189	0.002	Significant
44	a= 1.4059	a= 1.0328			
	b= 0.2378	b= 0.1615	32.967	0.000	Significant
45	a= 1.876	a= 1.5257			
	b= 0.4755	b= 0.4621	18.214	0.000	Significant
46	a= 1.4038	a= 1.0596			
	b= -0.0152	b= -0.0832	27.033	0.000	Significant
47	a= 1.4397	a= 0.9881			
	b= 0.1633	b= 0.0426	47.734	0.000	Significant
48	a= 2.0948	a= 1.5517			
	b= 0.4597	b= 0.4178	28.088	0.000	Significant
50	a= 1.9333	a= 1.5486			
	b= 0.4157	b= 0.4416	17.716	0.000	Significant

TABLE A.50

The Table showing the values of item parameters a and b of all items conditioned on item no. 50

Item	Item 50= 0	Item 50= 1	χ^2	p	Significance
1	a= 0.7291 b= -0.1489	a= 0.781 b= -0.199	5.1790	0.022	Not Significant
2	a= 1.2566 b= 0.0873	a= 1.1158 b= 0.0032	18.7555	0.000	Significant
3	a= 0.8552 b= -0.1703	a= 0.8895 b= -0.1501	4.1195	0.042	Not Significant
4	a= 0.9823 b= -0.1081	a= 0.9795 b= -0.0788	6.3547	0.011	Not Significant
5	a= 0.8745 b= -0.1426	a= 0.9067 b= -0.1196	4.3268	0.037	Not Significant
6	a= 1.1821 b= 0.0274	a= 1.115 b= -0.0298	12.418	0.000	Significant
7	a= 1.1501 b= -0.0288	a= 1.1066 b= 0.0214	7.6332	0.005	Significant
8	a= 1.0159 b= -0.1348	a= 1.0053 b= -0.1321	7.7525	0.005	Significant
9	a= 1.4206 b= 0.1966	a= 1.4154 b= 0.262	4.3926	0.036	Not Significant
10	a= 1.0226 b= -0.0849	a= 1.0297 b= -0.0403	5.2810	0.021	Not Significant
11	a= 1.3985 b= 0.2357	a= 1.3259 b= 0.2817	8.0985	0.004	Not Significant
12	a= 0.7955 b= -0.1425	a= 0.8437 b= -0.1615	4.5585	0.032	Not Significant
13	a= 1.0308 b= -0.0228	a= 1.1412 b= 0.1092	0.23780	0.625	Not Significant
14	a= 1.1055 b= -0.0244	a= 1.1352 b= 0.0791	2.8650	0.090	Not Significant
15	a= 1.2325 b= 0.0802	a= 1.2652 b= 0.1702	3.0875	0.078	Not Significant
16	a= 0.8734 b= -0.1585	a= 0.8199 b= -0.1728	19.266	0.000	Significant
17	a= 1.0862 b= -0.0857	a= 1.0234 b= -0.0387	10.808	0.000	Significant

Item	Item 50= 0	Item 50= 1	χ^2	p	Significance
18	a= 0.9225	a= 0.9749			
	b= -0.0534	b= -0.0074	2.9412	0.086	Not Significant
19	a= 1.1145	a= 1.1679			
	b= -0.055	b= 0.0503	2.0747	0.149	Not Significant
20	a= 0.9254	a= 1.0274			
	b= -0.0623	b= 0.0386	0.41269	0.412	Not Significant
21	a= 1.4709	a= 1.4444			
	b= 0.331	b= 0.5301	3.1608	0.075	Not Significant
22	a= 1.5251	a= 1.4978			
	b= 0.3691	b= 0.628	1.8100	0.178	Not Significant
23	a= 0.9456	a= 0.9746			
	b= -0.1228	b= -0.0343	3.722	0.053	Not Significant
24	a= 1.1859	a= 1.274			
	b= 0.0733	b= 0.2681	0.0995	0.420	Not Significant
25	a= 1.0519	a= 1.0401			
	b= 0.1181	b= 0.1539	7.988	0.004	Significant
26	a= 1.1272	a= 1.1374			
	b= -0.0319	b= 0.0126	5.67329	0.017	Not Significant
27	a= 1.3197	a= 1.3951			
	b= 0.1092	b= 0.3087	1.064	0.302	Not Significant
28	a= 0.7605	a= 0.7976			
	b= -0.0152	b= -0.0952	7.776	0.005	Significant
29	a= 1.0591	a= 1.1038			
	b= -0.0713	b= 0.0047	3.331	0.068	Not Significant
30	a= 1.1933	a= 1.3172			
	b= 0.1179	b= 0.2052	0.611	0.261	Not Significant
31	a= 1.7269	a= 1.7823			
	b= 0.6483	b= 0.8495	1.702	0.192	Not Significant
32	a= 1.27	a= 1.3249			
	b= 0.0783	b= 0.3198	0.9149	0.338	Not Significant
33	a= 1.8447	a= 1.7699			
	b= 0.6658	b= 0.8516	4.247	0.039	Not Significant
34	a= 1.0768	a= 1.1316			
	b= -0.0037	b= 0.019	4.252	0.039	Not Significant
35	a= 1.4002	a= 1.258			
	b= 0.3458	b= 0.2718	19.560	0.000	Significant
36	a= 1.5579	a= 1.6089			
	b= 0.2919	b= 0.6352	0.180	0.671	Not Significant

Item	Item 50= 0	Item 50= 1	χ^2	p	Significance
37	a= 1.5411	a= 1.4607			
	b= 0.0898	b= 0.2483	6.063	0.014	Not Significant
38	a= 1.7374	a= 1.5867			
	b= 0.294	b= 0.3202	13.146	0.000	Significant
39	a= 1.7557	a= 1.5816			
	b= 0.6728	b= 0.6261	17.837	0.000	Significant
40	a= 0.833	a= 0.7388			
	b= -0.0253	b= -0.1182	35.198	0.000	Significant
41	a= 1.9239	a= 1.5312			
	b= 0.5444	b= 0.2833	45.953	0.000	Significant
42	a= 1.3525	a= 1.1358			
	b= 0.1646	b= 0.1567	24.556	0.000	Significant
43	a= 1.362	a= 1.3762			
	b= 0.3308	b= 0.3135	9.018	0.000	Significant
44	a= 1.3946	a= 1.0902			
	b= 0.2901	b= 0.0579	51.499	0.000	Significant
45	a= 1.8369	a= 1.6777			
	b= 0.5087	b= 0.3919	20.412	0.000	Significant
46	a= 1.4712	a= 0.9613			
	b= -0.0056	b= -0.0797	72.204	0.000	Significant
47	a= 1.4137	a= 1.0935			
	b= 0.2168	b= -0.0474	56.444	0.000	Significant
48	a= 2.1675	a= 1.4401			
	b= 0.5099	b= 0.3486	67.794	0.000	Significant
49	a= 2.0046	a= 1.8716			
	b= 0.7447	b= 0.6309	17.716	0.000	Significant

167

Appendix B

MATLAB Programme

for the estimation of item parameters of

2PL model using EM algorithm

```
clear all;
close all;
clc;
n=1407;
m=49;
yof=zeros([n m]);
xo=ones([2 m]);
xfinal=ones([2 m]);
yo=zeros([n 1]);
yof = xlsread('spelling',1,'c2:cw995');
 q=[-3;-2;-1;0;1;2;3];
 for j=1:m
    for i=1:n
       yo(i)=yof(i,j);
    end
    pio=(1/7)*ones(7,1);
    ro=pfn(yof,xo,pio,q,n,m)*ones(n,1);
    qfn=q'*pfn(yof,xo,pio,q,n,m)*yo;
    for i=1:10
       x0=[1;.5];
       yd=yo'*ones(n,1);
       [x,Fval,exitflag] = fsolve(@(x)eqns(yo,x,ro,yd,q,qfn),x0);
       eqns(yo,x,ro,yd,q,qfn);
       ros=ro'*ones(7,1);
       pio=ro/ros;
       xo(1,j)=x(1);
       xo(2,j)=x(2);
       ro=pfn(yof,xo,pio,q,n,m)*ones(n,1);
       qfn=q'*pfn(yof,xo,pio,q,n,m)*yo;
    end
    xfinal(1,j)=x(1);
    xfinal(2,j)=x(2);
end
xfinal
pio
```

```
function p=eqns(y,x,ro,yd,q,qfn);
s1=zeros([7 1]);
s2=zeros([7 1]);
 for k=1:7
   r=double(exp(x(1)*(q(k)-x(2))));
   s1(k)=double(q(k)*r/(1+r));
   s2(k)=double(r/(1+r));
 end
 value(1)=(ro'*s1)-x(2)* yd-qfn;
 value(2)=(ro'*s2)-x(1)* yd;
p=value;
```

```
function p=pfn(y,x,pi,q,n,m);
s=ones([7 n]);
nr=zeros([7 n]);
dr=zeros([n 1]);
value=zeros([7 n]);
for k=1:1:7
   for i=1:1:n
        for j=1:m
         p=double(exp(x(1,j)*(q(k)-x(2,j))));
         if y(i,j)==0;
            s(k,i)=double(s(k,i)/(1+p));
         else
            s(k,i)=double(s(k,i)*p/(1+p));
         end
         nr(k,i)=pi(k)*s(k,i);
      end
   end
end
for i=1:1:n
   for k=1:1:7
      dr(i)=dr(i)+nr(k,i);
   end
end
for k=1:7
   for i=1:n
      value(k,i)=double(nr(k,i)/dr(i));
   end
end
p=value;
```