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Construction, Validation And Application Of Agricultural Science Achievement Test With Rasch Measurement Model

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Abstract: *This research aimed at the development and validation of Agricultural Science Achievement Test using the Rasch model. Four research questions guided the study. The researcher used the instrumentation research design. The population of this study is made up of 20,494 Senior Secondary School three (SS3) students in both Delta and Edo states. A large sample of 1500 testees selected using multistage sampling technique. Agricultural Science Achievement Test (ASAT) was used for the collection of data. The researcher generated 100 questions/items using the table of specification which cut across all the topics required by WASSCE and NECO syllabi. The items were also vetted by experts. Factor analysis using the PCA for item analysis was carried out on the 100 items to select, review, re-write and edit the final test to be administered. The table of specification and the specialists in Agriculture and measurement and evaluation were used to establish the content validity and the face validity of the generated items. The KR-20 was used to establish the reliability of the test items. The 100 items were used to gather data from the field. The data gathered were then subjected to Rasch analysis. Results showed that ASAT was adequate in measuring the Achievement construct regarding the individual item provided enough contribution to the overall measurement of Agricultural Science Achievement Test items and equally established unidimensionality trait and local independence of the items*

Keywords: Development, Validation, Application, Agricultural Science

Introduction

Agricultural Science is one of the core subjects that is examined by West Africa Examination Council (WAEC) in the senior school certificate examination (SSCE). The original draft of the Agricultural Science curriculum content was developed by Comparative Education Study and Adaptation Centre (CESAC) and presented to a National Critique Workshop organized by the Federal Ministry of Education Science and Technology in December 1984 for review by specialists in Agricultural Education. The final draft was later studied at the Joint Consultative Committee (JCC) Reference Committee meeting held at Owerri in April, 1985. The curriculum also took cognizance of the existing WAEC Ordinary and Advanced level syllabuses. Specifically, the objectives of the Senior Secondary School Agricultural Education include: stimulate and sustain students' interest in Agriculture; enable students acquire basic knowledge and practical skills in Agriculture; prepare students for further studies in Agriculture and prepare students for occupation in Agriculture (Federal Republic of Nigeria, 2013)

In order to achieve these objectives, in 2004, the curriculum content has been structured around three major concepts of Production, Protection and Economics. Topics related to these concepts were organized into six units, viz: Basic Concepts, Crop Production, Animal Production, Agricultural Ecology and Systems, Agricultural Engineering, and Agricultural Economics and Extension. The Sparta approach was adopted in the presentation of topics across the Senior Secondary School years. Suffice to indicate that this Senior Secondary School (SSS) programme relates directly to the Junior Secondary School (JSS) programme such that concepts introduced at the JSS are further dealt with at the SSS to produce a graduated development of concepts and enhance the learning and comprehension of students.

Following the federal government's decision to launch the 9-Year Basic Education Programme, as well as the necessity to achieve the Millennium Development Goals (MDGs) and the critical targets of the National Economic Empowerment and Development Strategies (NEEDS), this can be summed up as: value re-orientation, poverty eradication, job creation, wealth generation, and using education to empower the people. The curriculum reflects the depth, suitability, and relationship between the curriculum's elements. Generally speaking, the curriculum places a focus on achieving the Millennium Development Goals (MDGs) and key components of National Economic Empowerment and Development Policies (NEEDS). Nigeria Educational Research and Development Council (NERDC) reviewed and realigned the secondary school curriculum to match the reform agenda as a result of this development (Nigeria Educational Research and Development Commission, 2012).

In order to lower the high percentage of youth unemployment, the new curriculum placed a strong emphasis on vocational education. Agricultural science is a crucial elective vocational course for senior secondary students since it imparts the knowledge, abilities, and attitudes needed for successful employment in agricultural occupations. According to the National Examination Council (2014), teaching agricultural science in secondary schools in Nigeria aims to increase students' interest in the subject, impact their functional knowledge and practical skills in the subject, and prepare them for further education and careers in the field. According to Shimave, Kesiki and Yami (2013), teaching agricultural science in secondary schools is a long-term strategy for boosting agricultural output. With these, it is envisaged that the educational system will provide effective and sufficient instruction in agricultural science so that universities and high schools can produce qualified and competent graduates who can guarantee the nation's food security.

Making the appropriate decisions in the complex and multifaceted realm of testing is really difficult. A variety of factors need to be taken into account for any evaluation to be reliable. In truth, decisions about people and events are frequently reached after review; hence, the decisions will have a number of effects. Some of these effects are psychological or social, altering people's motivation, objectives, and even social standing. Testing ought to help Nigeria in a systematic way to achieve this egalitarian society that is characterized by equal educational opportunities, political, social, economic stability balance advantage in employment irrespective of background and ethnic groups. By implication test items have to measure the same thing for individuals from different groups who have the same subject matter ability. Precisely, using test items that measure different things from different subgroups of testees who are of the same subject matter ability is contrary to the principle of an egalitarian society that emphasized no deprivation of any kind.

Although there are several instruments for evaluating education, tests appear to be the most frequently used one in classrooms. Tests are needed to determine whether students in Delta states had the desired aptitude as a result of learning the material from the SS1 Agricultural Science programme. According to Akpan (2002), a test consists of questions that test takers are required to answer and from which the examiners can deduce that the test takers possess the desirable traits that are inherent in the test. No one can visually perceive the level of agricultural science expertise a student possesses. It was only measurable using an agricultural science test. Denga (2003) is of the opinion standardised achievement tests and teacher-made achievement tests are intended to measure the effectiveness of a curriculum that has been implemented. According to Sakigo (2009), teacher-made tests can occasionally lack the ability to frame what they want, other times they know what they want but fail to convey it to the students, and it is possible that the items are either too difficult or too easy, as well as lacking validity and dependability. In spite of this, tests are still utilised in Nigeria as a tool for evaluation for placement, ongoing assessment, prediction, and educational counselling.

According to Abhuegbeude (2015), test construction is a crucial stage in any valid and reliable examination. The production of a high-quality test item, is a difficult task which require experience, concentration, a thorough knowledge of the subject matter. A good test requires careful organisation so that the objectives of education, the teaching approach, the textual materials, and the evaluation processes are all connected in a meaningful way. When test constructers examine students on technically valid and reliable Agricultural Science test items, large amount of performance data could be generated. Researcher such as Opasina, (2009) have based his studies on students' assessment on the Classical Test Theory which is considered not valid enough for ensuring objectivity in measurement. Hence, there is an urgent need to break into the process of constructing test items and new method of assessment of Agricultural Science test items for the SS111 students' final examination.

The validation of test items has benefited greatly from the adoption of the Rasch measurement model. The Rasch measurement model is a representation of the structure that the data must have in order for measurements to be made from them. It offers a standard for effective measuring. In the Rasch model, a logistic function of the difference between the person and item parameters is used to model the likelihood of a valid response. Items that may be difficult for each test subject have frequently been identified using the Rasch model. Item response theory or the Rasch model is the foundation of the psychometric technique that allows test takers' scores on several sets of items to be directly compared (Odili, Osadebe & Aliye, 2015). According to the Rasch model, a student's ability and the item's level of difficulty are the only factors that determine whether they will correctly respond to a question. Moreover, they can estimate from their individual responses to a group of questions with previously calculated difficulties (Aluya, 2015). This is thought to be especially helpful for creating a measurement of accuracy because the idea is made to encompass the full range of potential responses to an experience.

A value judgment in testing is the choice of step for estimating person and item parameter using Rasch Model. The method in which tests item are selected for administration should be given a serious thought before taking decision. The item difficulty is the only parameter used by the Rasch technique to evaluate an examinee's unobservable trace. Ahmad and Nordin (2012) claim that the type of exam questions and how they are scored determine the best model to use. The Rasch model is appealing to users due to a few unique characteristics, and it is also simpler to apply because there are fewer parameters involved (Aluya, 2015). Scholars have often recommended the use of Rasch model because of the advantages associated with it in terms of test item analysis, such as the known-correct assumption, local dependent and unidimensionality

To the best of the researcher's knowledge, of course, literature is scanty on construction and validation of Agricultural Science Achievement test used by SSS3 using Rasch Model. However, the fact remains that, if Agricultural Science test contains items that will directly or indirectly reduce the opportunity of some testees from gaining admission into such career like Agricultural Economic, Agricultural Engineering and even Agricultural science itself, which is the bed rock of National wealth and a self-reliant course for our future leaders, sure test is not fit to measure achievement test. Hence, there is the need for research on test items used in measurement of achievement in Agricultural Science in this direction. This necessitated the need for this study: Construction, Validation and Application of Agricultural Science Achievement Test with Rasch measurement model which may affect the achievement of natural endowed or inherited knowledge of the test takers. Thus, the study used Rasch model to construct, validate and apply Agricultural Science Achievement test.

Statement of the Problem

The problem of poor performance in Agricultural Science at SSCE has been a recurring decimal despite research efforts made at improving students' achievement. The under achievement in Agricultural Science could result to lack of interest and also resulting to many of the students not being ready to take Agricultural Science as a subject, will affect the number of students taking agricultural science as a career or vocation in the future. Previous research has focused on the teaching methods, the subject curriculum, the student performance in Agricultural Science, factor that affect learning subject difficulty, refocusing Agricultural Science, factors militating against effective teaching of Agricultural Science, but none of these researches has looked at the problems of items construction used in measuring learning outcome. It is in this regard that the researcher intends to fill the gap thus created. The problem of this study therefore is question: Do the test items constructed in Agricultural Science fulfill the purpose of test construction and validation of Agricultural science achievement tests?

Purpose of the Study

The purpose of this study was the Construction, Validation and Application of Agricultural Science Achievement test using Rasch model in Delta and Edo states. Specifically, the study precisely aims at investigating the following:

1. Determining the Validity of Agricultural Science Achievement Test.
2. Establishing the Reliability of Agricultural Science Achievement Test.
3. Ascertaining the difficulty index of Agricultural Science Achievement Test.
4. Determine the performance index of Agricultural Science Achievement Test using the Rasch Model?

Research Questions

Four hypotheses guided this study:

1. What is the validity of the Agricultural Science Achievement Test?
2. What is the reliability of the Agricultural Science Achievement Test?
3. What are the difficulty indexes of the Agricultural Science Achievement Test?
4. What are the performance indexes of the Agricultural Science Achievement Test using the Rasch Model?

Methodology

This research aimed at the development and validation of Agricultural Science Achievement Test using the Rasch model. Four research questions guided the study. Literature relevant to the study were reviewed especially procedure for test development and validation using the Rasch model of item response theory. Messick's six facet construct validity were similarly reviewed and checked. Moreover, empirical studies on test development, validation and related factors affecting testees' Achievement in Agricultural Science were critically looked upon.

The researcher used the instrumentation research design. The population of this study is made up of 20,494 Senior Secondary School three (SS3) students in both Delta and Edo states. A large sample of 1500 testees selected using multistage sampling technique were used for the study. Agricultural Science Achievement Test (ASAT) was used for the collection of data. The researcher generated 100 questions/items using the table of specification which cut across all the topics required by WASSCE and NECO syllabi. The items were also vetted by experts. Factor analysis using the PCA for item analysis was carried out on the 100 items to select, review, re-write and edit the final test to be administered. The table of specification and the specialists in Agriculture and measurement and evaluation were used to establish the content validity and the face validity of the generated items. The KR-20 was used to establish the reliability of the test items. The 100 items were used to gather data from the field. The data gathered were then subjected to Rasch analysis.

Results

Preliminary Observations

Analyzing whether the data fit the model sufficiently well is necessary before interpreting the item and person (position) scores in logit/wit from a Rasch analysis. The purpose of this is to set the stage for data presentation. There are presented summary tables for the logit and wit-based Rasch model. Table 1-4 provides general information about the degree to which the data demonstrated satisfactory model fit.

Table 1 – level of item data fit to the Rasch model in wit

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	914.2	1500.0	49.1	0.55	0.98	0.09	0.99	.0
S.D.	232.8	.0	6.31	0.05	0.01	2.49	0.03	2.5
MAX.	1376.1	1500.0	63.62	0.93	1.08	9.89	1.1	9.7
MIN.	425.1	1500.0	29.63	0.5	0.91	-7.11	0.92	-7.0

REAL RMSE .59 TRUE SD 6.33 SEPARATION 11.21 Item RELIABILITY .92
MODEL RMSE .59 TRUE SD 6.33 SEPARATION 11.22 Item RELIABILITY .92
S.E. OF Item MEAN = .70

UMEAN=50.0000 USCALE=10.0000

Table 1 showed the level of item data fit to the Rasch model in wit. From the table, the mean square infit is 1.0 while the mean squares outfit is 1.0. On the other hand, the mean standardized scores for infit is 0.98 while that of the outfit is 0.99. For a fit to the model, mean squares for infit and outfit should be 1.0 respectively while the mean standardized scores (ZSTD) for infit and outfit should also be 0.0. The mean ZSTD scores for infit of 0.09 indicates that the data does not perfectly fit. It is an indication that some items in the test should be re-worked or dropped for a fit to the model based on the item individual MNSQ and ZSTD score.

The table also revealed that the separation statistics is 11.21 compared with 11.22 expected of the model. A value of 1.0 and below indicates a non-fit. In terms of separation factor, the data fit the model. The above statistics in wit is compared with similar statistics in logit.

Table 2 – level of item data fit to the Rasch model in logit

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	914.2	1500.0	.00	.04	0.98	0.09	0.99	.0
S.D.	232.8	.0	.69	.01	0.01	2.49	0.03	2.5
MAX.	1376.1	1500.0	1.34	.07	1.08	9.89	1.1	9.7
MIN.	425.1	1500.0	-1.82	.04	0.91	-7.11	0.92	-7.0

REAL RMSE .05 TRUE SD .62 SEPARATION 11.21 Item RELIABILITY .92
MODEL RMSE .05 TRUE SD .62 SEPARATION 11.22 Item RELIABILITY .92
S.E. OF Item MEAN = .03

The figure in table 2 revealed that they are the same with table 1. This reveals thatthe data can be analysed using the logit and wit data.

Table 3 – level of person data fit to the Rasch model in wit

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	62	100.0	56.12	2.13	1.00	.99	0.99	.0
S.D.	7.1	.0	3.97	.08	.09	0.08	0.11	1.0
MAX.	80	100.0	65.45	2.67	1.28	-1.27	1.41	3.9
MIN.	43	100.0	45.73	2.62	.71	0.7	0.64	-3.6

REAL RMSE 2.13 TRUE SD 1.87 SEPARATION 1.86 Person RELIABILITY .57
MODEL RMSE 2.31 TRUE SD 1.98 SEPARATION 1.89 Person RELIABILITY .59
S.E. OF Person MEAN = .07

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .59

The degree to which the Rasch model suited the person data was displayed in table 3. According to the table, the mean square infit and outfit are both 1.0. The mean standardised scores for infit are 0.99, but those for outfit are 0.0. In order for the model to be fit, the mean squares for the infit and outfit variables should be 1.0 and 0.0, respectively, for a fit to the model. The data do not properly match the model, as indicated by the mean MNSQ and ZSTD scores for infit and outfit of 0.0. The person mean in this case is 62.0, which shows that, on average, these questions were not challenging. If the individual mean is positive, the things would often be simple.

The separation statistics is an index of how the person spread across the latent scale. An index of 1.86 is closed enough to the maximum of 1.89. If separation is 1.0 or below, the test may not have sufficient breadth in position with the testees.

Table 4 – Level of person data fit to the Rasch model in logit

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	62	100.0	.51	.22	1.00	.99	0.99	.0
S.D.	7.1	.0	.29	.01	.09	0.08	0.11	1.0
MAX.	80	100.0	1.47	.26	1.28	-1.27	1.41	3.9
MIN.	43	100.0	-.36	.21	.71	0.7	0.64	-3.6

| REAL RMSE .21 TRUE SD 1.14 SEPARATION 1.86 Person RELIABILITY .57 |
|MODEL RMSE .21 TRUE SD 1.14 SEPARATION 1.89 Person RELIABILITY .59 |
| S.E. OF Person MEAN = .01 |

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .59

The figure in table 4 revealed that they are the same with table 3. This reveals that the data can be analyzed using the logit and wit data. Hence, it has been established that the data fit the Rasch model.

In the following section, the data is presented according to the research questions.

Research Question 1: What is the validity of the Agricultural Science Achievement Test?

Data in Tables 5, 6 and 7 was used to answer research question 1.

Table 5 – Validity of ASAT using the Principle Component Analysis for STANDARDIZED RESIDUAL variance (in Eigenvalue units) in Rasch

		Eigenvalue	Observed		Expected
Total raw variance in observations	=	110.400	100.0%		100.0%
Raw variance explained by measures	=	83.000	74.0%		74.0%
Raw variance explained by persons	=	9.2000	10.1%		10.1%
Raw Variance explained by items	=	18.200	15.9%		15.9%
Raw unexplained variance (total)	=	100.000	29.4%	100.0%	29.4%
Unexplned variance in 1st contrast	=	1.700	12.6%	3.2%	
Unexplned variance in 2nd contrast	=	1.500	12.8%	3.2%	
Unexplned variance in 3rd contrast	=	1.300	12.6%	3.2%	
Unexplned variance in 4th contrast	=	1.820	11.9%	3.3%	
Unexplned variance in 5th contrast	=	1.722	10.5%	2.9%	

The table 5 was interpreted by comparing the empirical values of the entries with the modeled value. It revealed that the total raw variance in observation agreed with the model value of 100%, raw variance explained by measures of 74.0% agreed with the model value of 74.0%, raw variance explained by persons of 10.1% agreed with the model value of 10.1%, and raw variance explained by items of 15.9% agreed with the model value of 15.9%. These values confirmed that the test has content and construct validity. The ratio of 12.6% of unexplained variance in 1st contrast to 15.9% of raw variance explained by items is 1.70. This seemed good since the 1st, 2nd and the 3rd were not supposed to be more than 2.0 if they were indicating unidimensionality (Linacre, 2009; Wright, 1997). This was further confirmed by a scree plot that is presented in Figure 1.

Figure 1 - Standardized Residual Variance Scree Plot for ASAT

```
                    VARIANCE COMPONENT SCREE PLOT
                  +--+--+--+--+--+--+--+--+--+--+--+
```

```
  100%+  T                             +
     |    M                          |
V 63%+                                 +
A    |                                 |
R 40%+                                 +
I    |            U   1                |
A 25%+                                 +
N    |                                 |
C 16%+                      2          +
E    |         I       1     3   4   5|
 10%+                                 +
L    |       P                         |
O  6%+                                 +
G    |                                 |
|  4%+                                 +
S    |                                 |
C  3%+                                 +
A    |                                 |
L  2%+                                 +
E    |                                 |
D  1%+                                 +
     |                               |
 0.5%+                                +
     +--+--+--+--+--+--+--+--+--+--+
       TV MV PV IV UV U1 U2 U3 U4 U5
        VARIANCE COMPONENTS
```

The T is referred to the total raw variance in observation, M is raw variance explained by measure, U is the raw unexplained variance (total), I is raw variance explained by item on the plot graph, P is raw variance explained by person while 1, 2, 3, 4, 5, represented the unexplained variance in 1st, 2nd, 3rd, 4th and 5th contrast on the plot graph. Therefore, this confirmed that the data has both content and construct validity which indicate unidimensionality trait. Information for the respected items in wit using the infit and outfit of MNSQ and ZSTD indices is also presented table 6.

Table 6- Validity of ASAT using infit and outfit of MNSQ and ZSTD indices in wit

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT ASATCH OBS%	EXACT ASATCH EXP%	Item
92	1056	1500	46.25	.57	1.03	1.1	1.04	1.5	A .03	.13	70.4	70.4	AG92
23	750	1500	55.09	.52	1.03	4.7	1.04	4.6	B .02	.14	49.8	55.8	AG23
31	889	1500	51.26	.53	1.03	2.6	1.04	2.8	C .03	.14	58.7	59.8	AG31
74	1040	1500	46.77	.57	1.02	.9	1.03	1.4	D .05	.13	69.4	69.4	AG74
35	626	1500	58.50	.53	1.03	2.5	1.03	2.8	E .04	.14	57.9	59.3	AG35
6	597	1500	59.31	.53	1.03	2.2	1.03	2.4	F .04	.14	60.1	60.8	AG06
17	587	1500	59.60	.53	1.03	2.0	1.03	2.2	G .05	.14	61.5	61.3	AG17
25	728	1500	55.69	.52	1.03	3.9	1.03	3.9	H .04	.14	51.8	55.9	AG25
28	578	1500	59.86	.54	1.03	2.0	1.03	2.0	I .04	.14	60.9	61.8	AG28
36	663	1500	57.47	.53	1.03	3.1	1.03	3.1	J .04	.14	53.5	57.6	AG36
16	780	1500	54.27	.52	1.0	3.5	1.0	3.4	K	.14	52.	55.9	AG16

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                                3        3         .05          5      |
|   91  1043  1500   46.67     .57|1.0   .7|1.0   1.1|L     .13| 69.   69.6 AG91|
                                2        3         .07          6      |
|   24   612  1500   58.89     .53|1.0  2.1|1.0   2.0|M     .14| 56.   60.0 AG24|
                                3       2          .06          8      |
|   45   823  1500   53.10     .52|1.1  9.9|1.1   9.9|N-    .14| 48.   56.9 AG45|
                                0       1          .20          9      |
|   29  1217  1500   40.23     .66|1.0   .8|1.0   1.8|O-    .11| 81.   81.2 AG29|
                                3        8         .03          2      |
|  100  1123  1500   43.96     .60|1.0  1.3|1.0   2.2|P-    .12| 74.   74.9 AG100
                                4       7          .03          9      |     |
|   32  1034  1500   46.96     .56|1.0  2.5|1.0   2.9|Q-    .13| 68.   69.0 AG32|
                                6       7          .07          9      |
|   37   873  1500   51.71     .53|1.0  5.6|1.0   5.7|R-    .14| 54.   58.9 AG37|
                                6       7          .08          1      |
|   27   542  1500   60.90     .54|1.0  2.9|1.0   3.3|S-    .14| 62.   64.0 AG27|
                                5       6          .03          7      |
|   99  1155  1500   42.77     .62|1.0   .8|1.0   1.5|T     .12| 77.   77.0 AG99|
                                3        5         .00          1      |
|   26   493  1500   62.38     .55|1.0  2.2|1.0   2.5|U-    .14| 67.   67.1 AG26|
                                4       5          .02          1      |
|    7   427  1500   64.49     .58|1.0  1.5|1.0   1.9|V-    .13| 71.   71.5 AG07|
                                4       5          .01          6      |
|   93  1033  1500   46.99     .56|1.0  1.4|1.0   2.0|W     .13| 68.   68.9 AG93|
                                3       5          .01          8      |
|   50   805  1500   53.59     .52|1.0  5.1|1.0   5.2|X     .14| 53.   56.3 AG50|
                                4       5          .00          4      |
|   49   674  1500   57.17     .52|1.0  4.1|1.0   4.1|Y     .14| 53.   57.3 AG49|
                                4       4          .02          8      |
|    2  1002  1500   47.96     .55|1.0  1.8|1.0   1.8|Z     .13| 66.   66.8 AG02|
                                3       4          .01          8      |
|   43   662  1500   57.50     .53|1.0  2.4|1.0   2.3|      .14| 55.   57.7 AG43|
                                2       2          .07          0      |
|   21   725  1500   55.77     .52|1.0  2.4|1.0   2.4|      .14| 53.   56.0 AG21|
                                2       2          .08          0      |
|   39   774  1500   54.44     .52|1.0  2.8|1.0   3.1|      .14| 54.   55.8 AG39|
                                2       2          .07          4      |
|   15   792  1500   53.95     .52|1.0  3.0|1.0   2.8|      .14| 51.   56.1 AG15|
                                2       2          .06          8      |
|      BETTE FITTING               +----------+----------+    |          |     |
       R     OMITTED
|   77   619  1500   63.44    .55| .9    -   .99 -      .22 .13| 77.   56.5 AG18|
                                   9  3.2|      2.21|           4      |
|   69  1131  1500   43.67    .60| .9    -   .96 -      .22 .12| 75.   75.4 AG69|
                                   7   .9|      1.2|z           5      |
|   63  1103  1500   44.67    .59| .9    -   .96 -      .22 .12| 73.   73.6 AG63|
                                   7  1.0|      1.3|y           6      |
|   64  1163  1500   42.46    .62| .9    -   .94 -      .23 .12| 77.   77.6 AG64|
                                   7   .8|      1.6|x           6      |
|   38   652  1500   57.77    .53| .9    -   .96 -      .28 .14| 63.   58.1 AG38|
                                   6  4.2|      4.1|w           0      |
|   19   584  1500   59.68    .53| .9    -   .96 -      .28 .14| 64.   61.5 AG19|
                                   6  3.1|      3.0|v           6      |
|   20   974  1500   48.80    .55| .9    -   .95 -      .29 .14| 65.   65.0 AG20|
                                   6  2.5|      2.9|u           3      |
|   40   508  1500   61.92    .55| .9    -   .95 -      .28 .14| 66.   66.1 AG40|
                                   6  2.3|      2.5|t           2      |
|   47   775  1500   54.41    .52| .9    -   .95 -      .30 .14| 62.   55.8 AG47|
                                   5  6.1|      6.1|s           2      |
|   46   704  1500   56.34    .52| .9    -   .95 -      .30 .14| 63.   56.4 AG46|
                                   5  6.0|      6.0|r           4      |
|    4   753  1500   55.01    .52| .9    -   .95 -      .31 .14| 61.   55.7 AG04|
                                   5  6.8|      6.9|q           6      |
|   34   558  1500   60.43    .54| .9    -   .95 -      .31 .14| 66.   63.0 AG34|
                                   5  3.3|      3.3|p           0      |
```

41	666	1500	57.39	.53	.94	-7.1	.93	-7.1	o	.36	.14	66.4	57.5	AG41
33	631	1500	58.36	.53	.93	-6.4	.93	-6.4	n	.38	.14	66.0	59.0	AG33
60	1068	1500	45.86	.58	.98	-.7	.97	-1.0	m	.20	.13	71.2	71.2	AG60
30	712	1500	56.13	.52	.98	-2.4	.98	-2.4	l	.21	.14	59.3	56.2	AG30
65	1150	1500	42.96	.62	.98	-.6	.97	-.9	k	.19	.12	76.7	76.7	AG65
72	1145	1500	43.15	.61	.98	-.6	.96	-1.0	j	.20	.12	76.4	76.4	AG72
59	1055	1500	46.28	.57	.98	-.9	.97	-1.4	i	.21	.13	70.4	70.4	AG59
70	1122	1500	44.00	.60	.98	-.7	.97	-1.0	h	.20	.12	74.8	74.8	AG70
42	426	1500	64.52	.58	.98	-.9	.98	-.9	g	.21	.13	71.6	71.6	AG42
11	986	1500	48.44	.55	.98	-1.3	.98	-1.2	f	.21	.13	66.2	65.8	AG11
55	1200	1500	40.96	.65	.98	-.6	.95	-1.2	e	.21	.11	80.1	80.0	AG55
56	1143	1500	43.23	.61	.98	-.7	.96	-1.1	d	.21	.12	76.3	76.2	AG56
83	1048	1500	46.51	.57	.97	-1.1	.97	-1.4	c	.22	.13	70.0	69.9	AG83
62	1094	1500	44.98	.59	.97	-.9	.96	-1.3	b	.22	.13	73.0	73.0	AG62
68	1135	1500	43.52	.61	.97	-.8	.95	-1.5	a	.23	.12	75.7	75.7	AG68
MEAN	845.8	1500.0	52.25	.61	1.00	.2	1.00	.0				65.4	67.9	
S.D.	234.1	.0	7.00	.08	.06	1.9	.03	2.7				8.8	8.3	

Version 4.28 of the Winsteps Rasch software was used to analyse the data. Initially, fit indices were carefully scrutinised to ensure that the items were relevant as part of the content validity. The fit indices for some of the items are shown in tables 6 and 7. Table 7 has the items categorised from challenging to easy. The "entry number" column in the first row lists the numbers assigned to each test item (ranging from 1 to 100). The overall score for each item is shown in the second column, which is titled "total score" (i.e. the number of testees who have responded correctly to that item). The third column, titled "total count," contains the number of test takers who have attempted each item. The fourth column, under "measure," contains estimations of the items' degree of difficulty. The "model S.E." fifth column displays the item difficulty measures' standard error. The initials "MNSQ" and "ZSTD" stand for "mean square" and "z standardised distribution," respectively, and are given for both "infit" and "outfit" columns. Table 7 showed similar findings under the logit model.

For "MNSQ," values between 0.7 and 1.1 are considered acceptable since the sample used was greater than (>) 1000 and -2 and +2 for 'ZSTD'. The table 7 shows that item 41 and 6 are the most difficulty item on the test. Out of 1500 testees who attempted these items, only 419 and 420 got it right respectively. This indicates that there is a 95% chance that the true value of this item's difficulty is between -1.96logit and 1.44logit, or two standard errors of the observed value, below and above. The MNSQ and ZSTD outfit and infit indices are both within the permitted range, thus there isn't a major issue. Table 7 indicates that 30 items should either be deleted or revised because of lack of fit to the model. Such items are 3, 5, 14, 15, 16, 17, 18, 19, 20, 22, 24, 25, 26, 29, 31, 32, 33, 34, 36, 37, 38, 39, 40, 44, 45, 46, 47, 48, 49, and 99. These metrics measure something different from the intended construct and content. They are construct irrelevant, in other words. The 70 items so exhibit construct validity and content validity. Therefore using the Rasch model, it was found that the ASAT items have content and construct validity.

Table 7- Validity of ASAT using infit and outfit of MNSQ and ZSTD indices inlogit

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT ASATCH OBS%	EXACT ASATCH EXP%	Item
41	419	1500	1.44	.07	.98	-.9	.98	-.9	0.2	.13	71.6	71.6	AG41
6	420	1500	1.44	.07	1.04	1.5	1.05	1.9	-0.02	.13	71.6	71.5	AG06
25	486	1500	1.23	.07	1.04	2.2	1.05	2.5	-0.03	.14	67.1	67.1	AG25
39	501	1500	1.18	.07	.96	-2.3	.95	-2.5	0.27	.14	66.2	66.1	AG39
26	535	1500	1.08	.06	1.05	2.9	1.06	3.3	-0.04	.14	62.7	64.0	AG26
2	548	1500	1.04	.06	.98	-1.2	.98	-1.2	0.19	.14	64.4	63.2	AG02
33	551	1500	1.03	.06	.95	-3.3	.95	-3.3	0.3	.14	66.0	63.0	AG33
21	559	1500	1.01	.06	1.00	.1	1.00	.2	0.12	.14	63.1	62.5	AG21
27	571	1500	0.98	.06	1.03	2.0	1.03	2.0	0.03	.14	60.9	61.8	AG27
7	572	1500	0.97	.06	1.00	.3	1.01	.4	0.11	.14	61.6	61.8	AG07
18	577	1500	0.96	.06	.96	-3.1	.96	-3.0	0.27	.14	64.6	61.5	AG18
16	580	1500	0.95	.06	1.03	2.0	1.03	2.2	0.04	.14	61.5	61.3	AG16
5	590	1500	0.92	.06	1.03	2.2	1.03	2.4	0.03	.14	60.1	60.8	AG05
23	605	1500	0.88	.06	1.03	2.1	1.02	2.0	0.05	.14	56.8	60.0	AG23
34	619	1500	0.84	.06	1.03	2.5	1.03	2.8	0.03	.14	57.9	59.3	AG34
32	624	1500	0.83	.06	.93	-6.4	.93	-6.4	0.37	.14	66.0	59.0	AG32
37	645	1500	0.77	.06	.96	-4.2	.96	-4.1	0.27	.14	63.0	58.1	AG37
42	655	1500	0.74	.06	1.02	2.4	1.02	2.3	0.06	.14	55.0	57.7	AG42
35	656	1500	0.74	.06	1.03	3.1	1.03	3.1	0.03	.14	53.5	57.6	AG37
40	659	1500	0.73	.06	.94	-7.1	.93	-7.1	0.35	.14	66.4	57.5	AG42
8	667	1500	0.71	.06	.99	-1.0	.99	-1.0	0.16	.14	57.6	57.3	AG08
48	667	1500	0.71	.06	1.04	4.1	1.04	4.1	0.01	.14	53.8	57.3	AG48
13	691	1500	0.64	.06	1.00	.5	1.00	.6	0.12	.14	55.6	56.5	AG13
17	693	1500	0.64	.06	.98	-2.3	.98	-2.1	0.19	.14	61.9	56.5	AG17
11	695	1500	0.63	.06	.99	-1.7	.99	-1.6	0.18	.14	58.9	56.4	AG11
45	697	1500	0.62	.06	.95	-6.0	.95	-6.0	0.29	.14	63.4	56.4	AG45
29	705	1500	0.6	.06	.98	-2.4	.98	-2.4	0.2	.14	59.3	56.2	AG29
20	718	1500	0.57	.06	1.02	2.4	1.02	2.4	0.07	.14	53.0	56.0	AG20
24	721	1500	0.56	.06	1.03	3.9	1.03	3.9	0.03	.14	51.	55.9	AG24

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											8		
4	731	1500	0.53	.06	.99	-1.1	.99	-1.0	0.16	.14	59.0	55.8	AG06
100	739	1500	0.51	.06	.99	-.9	.99	-1.1	0.16	.14	54.2	55.8	AG100
22	743	1500	0.5	.06	1.03	4.7	1.04	4.6	0.01	.14	49.8	55.8	AG22
3	746	1500	0.49	.06	.95	-6.8	.95	-6.9	0.3	.14	61.6	55.7	AG03
38	767	1500	0.43	.06	1.02	2.8	1.02	3.1	0.06	.14	54.4	55.8	AG38
46	768	1500	0.43	.06	.95	-6.1	.95	-6.1	0.29	.14	62.2	55.8	AG46
15	773	1500	0.42	.06	1.03	3.5	1.03	3.4	0.04	.14	52.5	55.9	AG15
9	778	1500	0.4	.06	1.01	1.2	1.01	1.0	0.1	.14	54.4	56.0	AG09
14	785	1500	0.38	.06	1.02	3.0	1.02	2.8	0.05	.14	51.8	56.1	AG14
43	785	1500	0.38	.06	.99	-1.6	.99	-1.6	0.18	.14	57.4	56.1	AG43
12	797	1500	0.35	.06	1.00	-.4	1.00	-.5	0.14	.14	56.0	56.3	AG12
49	798	1500	0.35	.06	1.04	5.1	1.05	5.2	-0.01	.14	53.4	56.3	AG49
44	816	1500	0.3	.06	1.10	9.9	1.11	9.9	-0.21	.14	48.9	56.9	AG44
36	866	1500	0.16	.06	1.06	5.6	1.07	5.7	-0.09	.14	54.1	58.9	AG36
30	882	1500	0.12	.06	1.03	2.6	1.04	2.8	0.02	.14	58.7	59.8	AG30
47	951	1500	-0.08	.06	.99	-.3	.99	-.4	0.15	.14	63.6	64.0	AG47
19	967	1500	-0.13	.06	.96	-2.5	.95	-2.9	0.28	.14	65.3	65.0	AG19
10	979	1500	-0.17	.06	.98	-1.3	.98	-1.2	0.2	.13	66.2	65.8	AG10
79	988	1500	-0.19	.07	1.00	.1	1.01	.3	0.11	.13	66.4	66.4	AG79
1	995	1500	-0.21	.07	1.03	1.8	1.04	1.8	0	.13	66.8	66.8	AG01
78	995	1500	-0.21	.07	.99	-.7	.98	-.9	0.18	.13	67.0	66.8	AG78
75	1020	1500	-0.29	.07	1.00	.0	1.00	-.1	0.13	.13	68.6	68.5	AG75
92	1026	1500	-0.31	.07	1.03	1.4	1.05	2.0	0	.13	68.8	68.9	AG92
31	1027	1500	-0.31	.07	1.06	2.5	1.07	2.9	-0.08	.13	68.9	69.0	AG31
73	1033	1500	-0.33	.07	1.02	.9	1.03	1.4	0.04	.13	69.4	69.4	AG73
93	1035	1500	-0.34	.07	1.02	.8	1.02	1.0	0.05	.13	69.6	69.5	AG93
80	1036	1500	-0.34	.07	1.00	-.2	1.00	-.2	0.13	.13	69.5	69.6	AG80
90	1036	1500	-0.34	.07	1.02	.7	1.03	1.1	0.06	.13	69.6	69.6	AG90
82	1041	1500	-0.36	.07	.97	-1.1	.97	-1.4	0.21	.13	70.0	69.9	AG82
87	1042	1500	-0.36	.07	.99	-.3	.99	-.4	0.14	.13	69.9	70.0	AG87
97	1046	1500	-0.38	.07	1.02	.7	1.02	.9	0.06	.13	70.2	70.2	AG97

58	1048	1500	-0.38	.07	.98	-.9	.97	-1.4	0.2	.13	70.4	70.4	AG58
91	1049	1500	-0.38	.07	1.03	1.1	1.04	1.5	0.02	.13	70.4	70.4	AG91
72	1050	1500	-0.39	.07	1.00	.2	1.01	.2	0.1	.13	70.5	70.5	AG72
94	1058	1500	-0.41	.07	1.00	.0	1.00	.0	0.12	.13	71.0	71.0	AG94
59	1061	1500	-0.42	.07	.98	-.7	.97	-1.0	0.19	.13	71.2	71.2	AG59
85	1063	1500	-0.43	.07	.99	-.2	.99	-.4	0.14	.13	71.4	71.4	AG85
57	1065	1500	-0.44	.07	.99	-.5	.98	-.7	0.17	.13	71.5	71.5	AG57
86	1066	1500	-0.44	.07	.99	-.5	.98	-.6	0.16	.13	71.6	71.6	AG86
74	1074	1500	-0.47	.07	.99	-.4	.99	-.4	0.15	.13	72.1	72.1	AG74
81	1074	1500	-0.47	.07	.99	-.3	.99	-.3	0.15	.13	72.1	72.1	AG81
60	1075	1500	-0.47	.07	.99	-.6	.97	-1.0	0.18	.13	72.2	72.2	AG60
77	1083	1500	-0.5	.07	1.00	-.1	.99	-.2	0.13	.13	72.7	72.7	AG77
84	1083	1500	-0.5	.07	.98	-.6	.98	-.8	0.17	.13	72.7	72.7	AG84
61	1087	1500	-0.51	.07	.97	-.9	.96	-1.3	0.21	.13	73.0	73.0	AG61
56	1088	1500	-0.52	.07	.99	-.3	.98	-.6	0.15	.13	73.0	73.0	AG56
76	1092	1500	-0.53	.07	1.01	.4	1.02	.6	0.07	.12	73.3	73.3	AG76
62	1096	1500	-0.54	.07	.97	-1.0	.96	-1.3	0.21	.12	73.6	73.6	AG62
89	1098	1500	-0.55	.07	1.01	.2	1.01	.3	0.09	.12	73.7	73.7	AG89
96	1103	1500	-0.57	.07	1.01	.4	1.01	.4	0.08	.12	74.0	74.0	AG96
83	1109	1500	-0.59	.07	.99	-.2	.99	-.4	0.14	.12	74.4	74.4	AG83
69	1115	1500	-0.61	.07	.98	-.7	.97	-1.0	0.19	.12	74.8	74.8	AG69
99	1116	1500	-0.61	.07	1.04	1.3	1.07	2.2	-0.04	.12	74.9	74.9	AG99
68	1124	1500	-0.64	.07	.97	-.9	.96	-1.2	0.21	.12	75.5	75.4	AG68
95	1126	1500	-0.65	.07	1.01	.5	1.02	.6	0.06	.12	75.6	75.6	AG95
67	1128	1500	-0.66	.07	.97	-.8	.95	-1.5	0.22	.12	75.7	75.7	AG67
88	1130	1500	-0.67	.07	1.00	.1	1.01	.2	0.1	.12	75.9	75.8	AG88
55	1136	1500	-0.69	.07	.98	-.7	.96	-1.1	0.2	.12	76.3	76.2	AG55
71	1138	1500	-0.69	.07	.98	-.6	.96	-1.0	0.19	.12	76.4	76.4	AG71
64	1143	1500	-0.71	.07	.98	-.6	.97	-.9	0.18	.12	76.7	76.7	AG64
98	1148	1500	-0.73	.07	1.03	.8	1.05	1.5	-0.01	.12	77.1	77.0	AG98
66	1153	1500	-0.75	.07	.98	-.5	.97	-.9	0.18	.12	77.4	77.4	AG66
63	1156	1500	-0.76	.07	.97	-.8	.94	-	0.22	.12	77.	77.6	AG63

								1.6			6		
70	1158	1500	-0.77	.07	.99	-.2	.99	-.2	0.13	.12	77.7	77.7	AG70
54	1193	1500	-0.91	.07	.98	-.6	.95	-1.2	0.2	.11	80.1	80.0	AG54
65	1198	1500	-0.93	.08	.98	-.4	.96	-.9	0.17	.11	80.4	80.4	AG65
28	1210	1500	-0.99	.08	1.03	.8	1.08	1.8	-0.04	.11	81.2	81.2	AG28
53	1273	1500	-1.29	.08	.98	-.3	.96	-.8	0.17	.10	85.4	85.4	AG53
52	1312	1500	-1.52	.10	.99	-.2	.96	-.7	0.14	.09	88.0	88.0	AG52
51	1344	1500	-1.74	.10	1.00	.0	1.00	.0	0.08	.08	90.1	90.1	AG51
50	1370	1500	-1.96	.10	.99	-.1	.95	-.5	0.11	.08	91.9	91.9	AG50
MEAN	908.1	1500.0	.00	.06	1.00	.1	1.00	.0			67.3	67.2	
S.D.	234.9	.0	.73	.01	.03	2.5	.04	2.6			9.1	8.8	

Research Question 2

What is the reliability of the Agricultural Science Achievement Test?

To answer the research question, the level of item data fit to the Rasch model of 1500 measured person with that of 100 and 70 measured items were both considered here. The person [Cronbach's alpha (KR-20)] reliability estimates of the 100 test was 0.59 (table 3 & 4) which was slightly moderate. The small range of the individual's abilities in the analysis was the cause of this moderate reliability. Table 3 displayed the sample's raw score standard deviation as 7.1 out of 100, which was a relatively small range of individuals. The reliability increased to 0.88 for 70 test items when the item with negative point-measure correlation indices was removed (table 8). The items with negative PT measure correlation indices are ten in numbers. They are 6, 25, 26, 28, 31, 36, 44, 49, 98 and 99. The table 7 showed the items with negative PTMC while the reliability table 8 & 9 showed the increased in the person reliability when the negative PTMC were removed.

Table 8 – Reliability table of 70 ASAT ITEMS (Person – units in wit)

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	41.17	70.0	51.08	2.77	0.98	.0	0.99	.0
S.D.	33.87	.0	4.78	0.17	0.08	.7	0.14	0.9
MAX.	60.97	70.0	66.16	4.74	1.32	4.2	1.85	5.1
MIN.	25.97	70.0	39.56	2.54	0.68	-1.6	0.54	-3.4

REAL RMSE 2.88 TRUE SD 2.42 SEPARATION 2.11 Person RELIABILITY .86
MODEL RMSE 2.77 TRUE SD 2.48 SEPARATION 2.15 Person RELIABILITY .88
S.E. OF Person MEAN = .10

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .88

The person's separation index is 2.15, which equals a person strata index of 4.20. The person stratum index shows how many different skill levels the test is able to distinguish between. The test can discriminate between at least two person strata, specifically high- and low-ability individuals, according to the minimum person strata index of 2, which is 2. A separation index of at least 1.0 is required for a stratum index of 2. For a separation index of 1.0, a reliability index of at least 0.00logit or 50.0wit is needed.

Table 9 – Reliability table of 70 ASAT Items (Person – units in logit)

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD

MEAN	41.17	70.0	.56	.22	0.98	.0	0.99	.0
S.D.	33.87	.0	.39	.02	.08	.7	.14	0.9
MAX.	60.97	70.0	2.54	.38	1.32	4.2	1.85	5.1
MIN.	25.97	70.0	-.34	.27	.68	-1.6	.54	-3.4

REAL RMSE .24 TRUE SD 2.24 SEPARATION 2.11 Person RELIABILITY .86
MODEL RMSE .24 TRUE SD 2.26 SEPARATION 2.15 Person RELIABILITY .88
S.E. OF Person MEAN = .10

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .88

It should be noted that while the moderate reliability, separation, and strata indices for the 100 test items were caused by the low standard deviation of people's abilities (3.97wit or 0.29logit), the high reliability, separation, and strata indices for the 70 test items were caused by the high standard deviation of people's abilities (4.78wit or .39logit). These numbers would be much better if a different sample with a wider range of talents were evaluated. Also, the result presented in logit form in table 9 shows the same with the one presented in table 8 in wit.

Table 10 – Reliability table of the 70 ASAT items (item – units in wit)

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	1219.2	1500.0	49.79	0.56	1.00	.0	1.00	.0
S.D.	207	0.06	7.21	.07	.02	2.4	.05	1.5
MAX.	64.31	0.94	64.52	.95	1.20	6.9	1.01	6.9
MIN.	30.32	0.51	30.53	.52	.89	-8.3	.89	-6.2

REAL RMSE .71 TRUE SD 7.63 SEPARATION 12.82 ItemRELIABILITY .98
MODEL RMSE .71TRUE SD 7.63 SEPARATION 12.89 ItemRELIABILITY .98
S.E. OF Item MEAN = .82

The table 10 showed the summary statistics of the 70 measured items. This examined the value supplied for item stratification, item separation, and item reliability to determine whether the items were representative. The item strata is 6.9, item separation is 12.89 while item reliability is 0.98. The products' reliability was excellent. That is, if the test items were sent to a different group, there is a very high likelihood that the difficulties ordering of the things would occur again.. Thus, one can rely on the representativeness and reliability of the test items. Therefore, the reliability of the ASAT items using the Rasch model was 0.98.

Table 11 – Reliability table of the 70 ASAT items (items – units in logit

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	1219.2	1500.0	.00	.06	1.00	.0	1.00	.0
S.D.	207	.0	.64	.01	.03	1.3	.05	1.6
MAX.	64.31	1500.0	1.37	.09	1.03	6.9	1.01	6.9
MIN.	30.32	1500.0	-1.67	.05	.92	-6.6	.90	-6.6

REAL RMSE .05 TRUE SD .65 SEPARATION 12.82 Item RELIABILITY .98
MODEL RMSE .05 TRUE SD .65 SEPARATION 12.89 Item RELIABILITY .98
S.E. OF Item MEAN = .89

The table 11 has equally reported the same value of result for the 70 items in logit asreported in table 10 and there are correspondence of information between the two tables.

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Research Question 3

What are the difficulty indices of the Agricultural Science achievement Test?

To answer the Research question, the table 12 and 13 are considered. Table 12 was expressed in wit while table 13 was expressed in logit. The difficulty ASAT or indices for the 65 items of ASAT were given in the fourth column labeled as **"measure"**.

Table 12- Difficulty Indices of 70 ASAT Items (Measure Order- unit in wit)

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD		PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT ASATCH OBS%	EXACT ASATCH EXP%	Item
94	1166	1500	41.41	.43	1.01	.7	1.04	1.4	G	.00	.10	88.1	77.0	I0099
88	1044	1500	43.52	.44	1.02	1.2	1.04	2.1	J	.01	.14	79.8	68.9	I0093
13	1013	1500	44.33	.42	1.02	1.4	1.03	1.2	M	.01	.12	77.8	66.8	I0002
87	1067	1500	43.22	.43	1.01	1.2	1.03	1.3	N	.03	.13	81.4	70.4	I0092
69	1051	1500	45.41	.56	1.02	.3	1.02	1.2	Q	.05	.13	80.4	69.4	I0074
23	589	1500	56.22	.22	1.01	2.4	1.02	2.1	V	.04	.14	71.9	61.8	I0028
86	1054	1500	44.11	.33	1.02	.1	1.2	1.2	Y	.07	.14	80.6	69.6	I0091
BETTER FITTING OMITTED														
55	1079	1500	44.45	.33	.94	-.2	.95	-1.0	z	.20	.14	82.2	71.2	I0060
60	1161	1500	42.26	.43	.93	-.6	.95	-.3	x	.19	.14	87.7	76.7	I0065
67	1156	1500	44.43	.22	.92	-.2	.93	-1.2	w	.20	.14	87.4	76.4	I0072
54	1066	1500	42.54	.21	.92	-.3	.95	-1.3	v	.21	.14	81.4	70.4	I0059
65	1133	1500	44.06	.35	.92	-.1	.95	-1.2	u	.20	.12	85.8	74.8	I0070
97	437	1500	62.32	.52	.94	-.1	.94	-.1	t	.21	.13	82.6	71.6	I0042
6	997	1500	44.11	.22	.91	-1.3	.92	-1.6	s	.21	.13	77.2	65.8	I0011
50	1211	1500	41.43	.46	.93	-.4	.96	-1.4	r	.21	.11	91.1	80.0	I0055
51	1154	1500	44.62	.53	.91	-.2	.94	-1.3	q	.21	.12	87.3	76.2	I0056
78	1059	1500	46.73	.44	.94	-1.1	.92	-1.5	p	.22	.13	81	69.9	I0083
57	1105	1500	44.54	.44	.93	-.3	.94	-13	o	.22	.13	84	73.0	I0062
63	1146	1500	47.52	.24	.92	-.1	.92	-1.3	n	.23	.12	86.7	75.7	I0068
64	1142	1500	45.61	.64	.91	-.2	.94	-1.1	m	.22	.12	86.5	75.4	I0069
58	1114	1500	44.73	.42	.93	-1.1	.91	-1.3	l	.22	.12	84.6	73.6	I0063
59	1174	1500	42.31	.14	.9	-	.94	-		.23	.12	88.6	77.6	I0064

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				1	.1	1.1	k				
MEAN	1219.2	1500.0	50.11	.58	1.00	.0	1.01	.0		68.3	68.3
S.D.	207	.0	8.21	.06	.03	2.4	.03	2.5		9.0	8.8

Table 13 showed the difficulty indices of 70 ASAT items (measure order) in logit unit. The difficulty estimates or indices for the items ASAT were given in the fourth column labeled as "measure" too. The ASAT items were arranged from difficult to easy in table 13.

Table 13- Difficulty Indices of 70 ASAT Items (MEASURE ORDER- unit in logit)

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT OBS%	ASATCH EXP%	Item
41	419	1500	1.44	.07	.98	-.8	.98	-.9	0.2	.13	71.6	71.6	AG41
6	420	1500	1.44	.07	1.04	1.5	1.05	1.9	-0.02	.13	71.6	71.5	AG06
2	548	1500	1.04	.06	.98	-1.2	.98	-1.2	0.19	.14	64.4	63.2	AG02
21	559	1500	1.01	.06	1.00	.1	1.00	.2	0.12	.14	63.1	62.5	AG21
27	571	1500	0.98	.06	1.03	2.0	1.03	2.0	0.03	.14	60.9	61.8	AG27
7	572	1500	0.97	.06	1.00	.3	1.01	.4	0.11	.14	61.6	61.8	AG07
23	605	1500	0.88	.06	1.03	2.1	1.02	2.0	0.05	.14	56.8	60.0	AG23
42	655	1500	0.74	.06	1.02	2.4	1.02	2.3	0.06	.14	55.0	57.7	AG42
35	656	1500	0.74	.06	1.03	3.1	1.03	3.1	0.03	.14	53.5	57.6	AG37
8	667	1500	0.71	.06	.99	-1.0	.99	-1.0	0.16	.14	57.6	57.3	AG08
13	691	1500	0.64	.06	1.00	.5	1.00	.6	0.12	.14	55.6	56.5	AG13
11	695	1500	0.63	.06	.99	-1.7	.99	-1.6	0.18	.14	58.9	56.4	AG11
4	731	1500	0.53	.06	.99	-1.1	.99	-1.0	0.16	.14	59.0	55.8	AG06
100	739	1500	0.51	.06	.99	-.9	.99	-1.1	0.16	.14	54.2	55.8	AG100
9	778	1500	0.4	.06	1.01	1.2	1.01	1.0	0.1	.14	54.4	56.0	AG09
43	785	1500	0.38	.06	.99	-1.6	.99	-1.6	0.18	.14	57.4	56.1	AG43
12	797	1500	0.35	.06	1.00	-.4	1.00	-.5	0.14	.14	56.0	56.3	AG12
30	882	1500	0.12	.06	1.03	2.6	1.04	2.8	0.02	.14	58.7	59.8	AG30
10	979	1500	-0.17	.06	.98	-1.3	.98	-1.2	0.2	.13	66.2	65.8	AG10
79	988	1500	-0.19	.07	1.00	.1	1.01	.3	0.11	.13	66.4	66.4	AG79
1	995	1500	-0.21	.07	1.03	1.8	1.04	1.8	0	.13	66.8	66.8	AG01
78	995	1500	-0.21	.07	.99	-.7	.98	-.9	0.18	.13	67.0	66.8	AG78
75	1020	1500	-0.29	.07	1.00	.0	1.00	-.1	0.13	.13	68.6	68.5	AG75
92	1026	1500	-0.31	.07	1.03	1.4	1.05	2.0	0	.13	68.8	68.9	AG92

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73	1033	1500	-0.33	.07	1.02	.9	1.03	1.4	0.04	.13	69.4	69.4	AG73
93	1035	1500	-0.34	.07	1.02	.8	1.02	1.0	0.05	.13	69.6	69.5	AG93
80	1036	1500	-0.34	.07	1.00	-.2	1.00	-.2	0.13	.13	69.5	69.6	AG80
90	1036	1500	-0.34	.07	1.02	.7	1.03	1.1	0.06	.13	69.6	69.6	AG90
82	1041	1500	-0.36	.07	.97	-1.1	.97	-1.4	0.21	.13	70.0	69.9	AG82
87	1042	1500	-0.36	.07	.99	-.3	.99	-.4	0.14	.13	69.9	70.0	AG87
97	1046	1500	-0.38	.07	1.02	.7	1.02	.9	0.06	.13	70.2	70.2	AG97
58	1048	1500	-0.38	.07	.98	-.9	.97	-1.4	0.2	.13	70.4	70.4	AG58
91	1049	1500	-0.38	.07	1.03	1.1	1.04	1.5	0.02	.13	70.4	70.4	AG91
72	1050	1500	-0.39	.07	1.00	.2	1.01	.2	0.1	.13	70.5	70.5	AG72
94	1058	1500	-0.41	.07	1.00	.0	1.00	.0	0.12	.13	71.0	71.0	AG94
59	1061	1500	-0.42	.07	.98	-.7	.97	-1.0	0.19	.13	71.2	71.2	AG59
85	1063	1500	-0.43	.07	.99	-.2	.99	-.4	0.14	.13	71.4	71.4	AG85
57	1065	1500	-0.44	.07	.99	-.5	.98	-.7	0.17	.13	71.5	71.5	AG57
86	1066	1500	-0.44	.07	.99	-.5	.98	-.6	0.16	.13	71.6	71.6	AG86
74	1074	1500	-0.47	.07	.99	-.4	.99	-.4	0.15	.13	72.1	72.1	AG74
81	1074	1500	-0.47	.07	.99	-.3	.99	-.3	0.15	.13	72.1	72.1	AG81
60	1075	1500	-0.47	.07	.99	-.6	.97	-1.0	0.18	.13	72.2	72.2	AG60
77	1083	1500	-0.5	.07	1.00	-.1	.99	-.2	0.13	.13	72.7	72.7	AG77
84	1083	1500	-0.5	.07	.98	-.6	.98	-.8	0.17	.13	72.7	72.7	AG84
61	1087	1500	-0.51	.07	.97	-.9	.96	-1.3	0.21	.13	73.0	73.0	AG61
56	1088	1500	-0.52	.07	.99	-.3	.98	-.6	0.15	.13	73.0	73.0	AG56
76	1092	1500	-0.53	.07	1.01	.4	1.02	.6	0.07	.12	73.3	73.3	AG76
62	1096	1500	-0.54	.07	.97	-1.0	.96	-1.3	0.21	.12	73.6	73.6	AG62
89	1098	1500	-0.55	.07	1.01	.2	1.01	.3	0.09	.12	73.7	73.7	AG89
96	1103	1500	-0.57	.07	1.01	.4	1.01	.4	0.08	.12	74.0	74.0	AG96
83	1109	1500	-0.59	.07	.99	-.2	.99	-.4	0.14	.12	74.4	74.4	AG83
69	1115	1500	-0.61	.07	.98	-.7	.97	-1.0	0.19	.12	74.8	74.8	AG69
68	1124	1500	-0.64	.07	.97	-.9	.96	-1.2	0.21	.12	75.5	75.4	AG68
95	1126	1500	-0.65	.07	1.01	.5	1.02	.6	0.06	.12	75.6	75.6	AG95
67	1128	1500	-0.66	.07	.97	-.8	.95	-1.5	0.22	.12	75.7	75.7	AG67
88	1130	1500	-0.67	.07	1.00	.1	1.01	.2	0.1	.12	75.9	75.8	AG88

55	1136	1500	-0.69	.07	.98	-.7	.96	-1.1	0.2	.12	76.3	76.2	AG55
71	1138	1500	-0.69	.07	.98	-.6	.96	-1.0	0.19	.12	76.4	76.4	AG71
64	1143	1500	-0.71	.07	.98	-.6	.97	-.9	0.18	.12	76.7	76.7	AG64
98	1148	1500	-0.73	.07	1.03	.8	1.05	1.5	-0.01	.12	77.1	77.0	AG98
66	1153	1500	-0.75	.07	.98	-.5	.97	-.9	0.18	.12	77.4	77.4	AG66
63	1156	1500	-0.76	.07	.97	-.8	.94	-1.6	0.22	.12	77.6	77.6	AG63
70	1158	1500	-0.77	.07	.99	-.2	.99	-.2	0.13	.12	77.7	77.7	AG70
54	1193	1500	-0.91	.07	.98	-.6	.95	-1.2	0.2	.11	80.1	80.0	AG54
65	1198	1500	-0.93	.08	.98	-.4	.96	-.9	0.17	.11	80.4	80.4	AG65
28	1210	1500	-0.99	.08	1.03	.8	1.08	1.8	-0.04	.11	81.2	81.2	AG28
53	1273	1500	-1.29	.08	.98	-.3	.96	-.8	0.17	.10	85.4	85.4	AG53
52	1312	1500	-1.52	.10	.99	-.2	.96	-.7	0.14	.09	88.0	88.0	AG52
51	1344	1500	-1.74	.10	1.00	.0	1.00	.0	0.08	.08	90.1	90.1	AG51
50	1370	1500	-1.96	.10	.99	-.1	.95	-.5	0.11	.08	91.9	91.9	AG50
MEAN	908.1	1500.0	.00	.06	1.00	.1	1.00	.0			69.3	76.8	
S.D.	234.9	.0	.73	.01	.03	2.5	.04	2.9			10.0	9.6	

Therefore, using the Rasch model, the difficulty index ranges between the value of - 1.95logits to 1.45logits.

Research Question 4

What are the performance indices of the Agricultural Science Achievement Test using Rasch Model?

The person-item-map in Logit was shown in Figure 2. In order to determine whether the test adequately covers every aspect of the construct, the person-item-map served as evidence for the representativeness of the test items. It also meant that the objects were evenly distributed over the full scale, demonstrating that the test adequately examined every aspect of the construct. The numbers on the right represented objects, while the numbers on the left represented people. Rasch item difficulty and person ability measures were therefore computed. This figure plotted person ability against item difficulty. The distribution of persons was consistent, making a curve- like shape which peaked around the mean.

Figure 2 – Person-item-Map

```
MEASURE ITEM - MAP - PERSON
          <rare>|<more>
   2            +  2P    10P    11P    12P    20P    21P
29P
                   35P   36P    42P    50P    51P    52P
60P
                   61P   67P    69P    73P
                |
                |
                |
                |T
                |
                |  4P    44P
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                             |  1P      41P
                             |
                             |
                             |
                             |
                             |  3P      15P     16P     17P     43P     55P
          56P
                             |S
                             |
                             |
                   1         +  57P
                          X  |
                            T|
                             |
                          X  |
                             |  6P      22P     23P     25P     30P     31P
          39P
                                40P     46P     63P     68P     74P
                             |
                          X  |
                             |  5P      19P     24P     28P     33P     45P
          59P
                                62P     64P     66P     70P     72P
                             |
                             |
                         XX  |M
                          X S|  27P
                             |
                          X  |
                             |
                          X  |  7P      14P     47P
                             |
                             |
                          X  |  8P      48P     54P
                             |
                   0     XX M+
                             |
                             |  9P      49P
                      XXXXX  |S
                             |
                             |  18P     26P     58P
                             |
                     XXXXXX  |
                             |
                            S|  13P
                             |
                          X  |
                             |
                             |  53P     65P     71P
                             |
                         XX  |
                             |
                             |T 34P     37P     38P     75P
                             |
                            T|
                             |
                  -1         +  32P
                       <freq>|<less>
```

The map shows that some of the items on the right lower part did not match to the persons on the left, indicating that the items were not appropriate for this group of testees, though they indicated good fit to the model. Four (4) of these items at the lower part may be omitted since they were too easy for the testees and in fact useless since there were no testees at that ability level.

Items and persons placed on top of the scale were more difficulty and more competent respectively. As one can see, all testees were clustered towards the centre of the scale and the items were spread all over the scale. The map indicated that the area of the scale

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where testees are located had a sufficient number of objects and that this area of the scale was largely covered with things. The low root mean square standard error of the participants indicated that the person abilities were thus measured pretty properly. Consequently, the actual homogeneity in the subjects with regard to item difficulty was what caused the test's accuracy and dependability. The items' overall level of representativeness was adequate. The person-item-map of ASAT items using the Rasch model showed the items were spread all over the scale with the testees ability clustered towards the centre of the scale.

Discussion of Findings

The findings of this study are discussed under the followingsubheadings:

Validity of the ASAT items using the Rasch model

The means of the infit and outfit MNSQ was 0.98 and 0.99, and The infit and outfit ZSTD means, which were 0.09 and 0.0, respectively, were nearly in line with the model's prediction (1.00 for MNSQ and .0 for ZSTD). This may indicate that there was little measurement distortion. Although there was little or no difference between the standard deviations of the infit and outfit MNSQ (.01 and.03, respectively) and the predicted value, these differences were too minor to be significant, and thus indicated that the data exhibited fitness from the Rasch Model expectation. Also, to assess the fit of the Rasch model to the data, we equally examined infit mean-square (information-weighted mean- square statistics which is more sensitive to the unexpected behaviour of items closer to persons' measures) and outfit (unweighted mean-square sensitive to outliers). Mean-square (MNSQ) is computed as the chi-square value divided by the degree of freedom. MNSQ fit indices show useful, as opposed to perfect, fit of the data to the model. An infit MNSQ of, say, 1.2 means 1 unit of modeled information is observed and 0.2 units of unmodeled noise sneaks in (Linacre, 2004). The t-test significance (ZSTD) is used to investigate the perfect fit of the data to the model (acceptable range:|2|). Therefore, individual items demonstrated infit MNSQ values from 0.97 to 1.03, while outfit MNSQ were between 0.94 to 1.08, which were within the acceptable range of 0.7–1.1 for a sample greater than 1000 while the items demonstrated infit ZSTD values from -1.7 to 2.0, while outfit ZSTD were between -1.6 to 2.0, which were within the acceptable range of -2.0 to +2.0. This was in congruent with Green and Frantom (2002); and Bond and Fox (2001) who suggested 0.7-1.1 and -2+2 for both infit and outfit of MNSQ and ZSTD respectively. This established the structural aspect of construct validity.

The range of item difficulty measures was about.00 logits (from -1.95 logit to +1.45 logit), whereas the range of test taker ability measures was about.51 logits (from -.36 logit to +1.47 logit). Whereas the mean test taker ability was 62.0 (standard error =.01logit), the mean item difficulty was 915.1 (standard error =.07 logit). The ASAT effectively targeted the test subjects as seen by the minor discrepancy in the means of the test subjects and the items.

Although the standardised residual coefficient was less than 2.0, indicating unidimensionality, the Principle Component Analysis of Rasch (PCAR) of factor analysis was found to be statistically significant and of practical value (Green & Frantom, 2002). This was in congruent with Tennants' (2000) findings whose PCAR standardized residual coefficients were not also greater than 2.0. This was used to establish substantive and content aspect of the construct validity of the six facet Messick's principle.

Reliability of the ASAT items Using the Rasch model

The item difficulty measures' reliability was very high (.98), indicating that the order of item difficulty was highly replicable with a different sample of test takers in a similar situation. This was in support of the findings of Ahmad and Nordin (2012) with reliability that ranges between 0.97-0.99. This established both structural and content validity.

When the items with negative point measure correlation were removed, the student ability measure's internal consistency was also high (.88), indicating that it was likely that the test subjects' ability rankings could be replicated because the majority of the variance in the measured scores was attributed to the true variance of the Agricultural Science Achievement Test (ASAT) construct. The standard error of measurement (SEM) associated with the b- parameter of each of the ASAT item is used to estimate its reliability. The SE of the item of ASAT ranged from 0.1 for item 59 to 0.4 for item 94. Low SE (0.50 and below) indicate high reliability whereas high SE (0.5 and above) indicate low reliability (Nworgu & Agah, 2012). Therefore, all items had SE within the range of 0.1 and 0.4 and the mean SE of the ASAT was 0.48 with SD of 0.06. This accounted for the high item reliability of 0.98. This supported Ahmad and Nordin (2012) whose item reliability ranges between 0.97-0.99. Therefore, it may be said that the TEST was suitable for assessing the Agricultural Science Achievement construct. This established the content validity.

The point measure correlation (PTMEA CORR.) ranged from -.01 to.38, with eleven items having negative values, as shown in tables 6 and 7. When these unfavourable factors were eliminated, the reliability of the person increased from 0.57 to 0.88. This association showed that almost all of the things were defining the Agricultural Science Achievement Test items in a similar manner. This was in consonant with the findings of Bond and Fox (2007) that when negative point measure correlation values were removed, they helped the items to work together in the same way thereby enhancing the reliability of the test. This established content aspect of the six facet Messick's constructs validity.

Difficulty indices of the ASAT items using the Rasch model

The difficulty level of the items ranges from -1.95logit to 1.45logit. The PCA of the Rasch residuals (PCAR) results showed that the largest factor retrieved from the residuals was 1.4 units, which has the strength of around 2 items and is significantly less than the 5 items required for consideration as a second factor (Linacre, 2007). Moreover, no gaps in the item distributions on the Achievement scale (Linacre, 2004) of .5logits or higher indicated that the items were insufficient for accessing significant characteristics of the Agricultural Science Achievement Test construct.

The spread of the ASAT items using person-item-map of the Rasch model

Initial data on the ASAT's suitability came from the results of item difficulty and student ability tests. The test subjects and the items were positioned along the achievement scale in figure 4.2. The top exam takers demonstrated greater aptitude, while the top items were more challenging. The items got easier and the test takers showed less skill as we moved down the line. This backed up what Bagheai and Amrahi (2011) claimed: a closer look at the person-item-map indicated the quantity of information on the basis of which decisions for action might be made. This gave decision-makers useful information to consider when determining the external and consequential part of a test's construct validity and the test subjects.

Another important finding was that all items SD - .70logit, model error - .01, S.E of item mean = .03, separation = 11.22 on person-map-item graph spread over the entire range of the scale which indicate that all parts of the construct are well covered by the test - spread of item and person (standard deviations SD of 0.70logit and 0.29logit respectively). Person had a smaller spread (SD = 0.29logit, separation = 1.86) compared with item SD = .70logit, separation = 11.22. This supported Green and Frantom (2002) and Bond and Fox (2007), findings. They were of the opinion that for a test item to spread across the continuum indicated the coverage in content of such test. This established the external, content and substantive validity.

One significant finding from examining each item in the person-item-map was that the test subjects in this study were able to respond to questions about comprehending information that was explicitly provided. This degree of comprehension was expected because the items only asked test takers to discover the material that is openly presented, which is a lower level of knowledge. Similar to this, some test takers were able to respond to questions that called for the application of simple techniques. Yet, test takers struggled with questions that asked them to apply existing knowledge to solve brand-new issues, in particular, creating connections between concepts. This is problematic because effective agricultural science learning and instruction depend on the ability to integrate different types of information, particularly between concept and process and between agricultural science and real-life experience (Ahmad & Nordin, 2012).

Conclusion

It is clear from these research results and the Rasch Model framework that the ASAT was suitable for measuring the Achievement construct in light of the following findings: (a) Each item adequately contributed to the measuring of the Agricultural Science Achievement Test items as a whole and equally established the items' unidimensionality attribute and local independence, (b) The calibrated items were effective at gauging students' proficiency in agricultural science because the ASAT items met the requirements of the Rasch measurement model and showed the six aspects of Messick's construct validity, including content, substantive, structural, generalizability, external, and consequential evidences of construct validity, (c) Agricultural Science Achievement test used to measure the construct did confuse with others., and (d) Threats to construct validity were maintained to a minimum, including construct-irrelevant variations and construct underrepresentation. The study also discovered that there was substantial agreement between the model put out and all indicators used in the creation and validation of the test items hypothesised in some prior investigations. Also, the study followed the principles of invariance because there was no discernible change in the mean difficulty index (b-parameter values) across gender, school type, geography, and socioeconomic status.

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