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Validity and Reliability of Students’ Science and Technology Culture Instrument (BST-M) using Rasch Measurement Model

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Abstract
Students’ Science and Technology Culture Instrument (Budaya Sains dan Teknologi Murid, BST-M) was developed to measure the level of Science and Technology Culture among the students. A total of 800 Form Two students from several schools in Seremban, Negeri Sembilan have been selected as a sample study. This study was conducted to determine the reliability and construct validity of the instrument using Rasch Model via Winstep 3.73 software. The constructs consist of Value and Perception on Science and Technology (B); Perception on Science and Technology (C); Scientific Attitude and Common Practice (D); Scientific Mind Habits and Environmental Concerns (E); and Personality Traits (F). From the analysis, it is found that PTMEA Corr has a positive value, in which items are able to differentiate the capabilities of the respondents. Besides, the results of infit and outfit mean square are ranged between 0.60 and 1.4. The quality of items is high because the reliability value is also high. In addition, the separation of item and person is at the acceptable range. However, statistical data shows that 8 out of 110 items need to be modified.

Keywords: Validity and Reliability of Instrument, Rasch Measurement Model, Construct Validity

Introduction
The rapid development of science and technology (S&T) in the 21st century can be obviously seen. Likewise, the growth has a massive effect in human’s life. Nowadays, the use of technology and scientific equipments or devices in daily life is very important. Several examples are including telecommunication technologies such as smart phones, computers, and the Internet. In fact, the use of motor vehicles and other tools related to the basis of scientific knowledge are also very significant in this modern era. Recently, S&T knowledge has become the basis of development
and progress of most countries in this world. There is an increase in the number of professions that requires to be linked with science concepts and high technology tools. In addition, the future of society needs to be decided based on scientific knowledge (Lee & Luykx, 2007). Consequently, Malaysia Education plays a major role in developing scientific knowledge among the younger generation in line with Vision 2020’s goals. This is due to the fact that S&T field is very crucial. Thus, the development and enrichment of Science and Technology Culture among students in Malaysia are believed to be achievable and feasible (Curriculum Development Centre, 2003).

However, the decline in secondary-level students’ participation in S&T field needs to be taken into consideration. Even though the percentage of qualified students pursuing S&T field is higher, but the percentage of actual S&T students is lower than that. MOE statistics show that the participation of students in science field from 2001 to 2011 has never achieved the 60:40 target ratio of science to non-science students as aimed by national education policy (Ministry of Education Malaysia, 2012). Indirectly, this situation indicates that the number of students who are interested in S&T field is decreasing. These scenarios have raised concerns regarding the ability to shape S&T Culture community in the future, as proposed by The National Philosophy of Science Education (Curriculum Development Centre, 2003). Other than that, this situation needs to be improved in order to give good implication to the national development process (Halim, 2013). Hence, an instrument called Students’ Science and Technology Culture Instrument (BST-M) has been designed for this purpose.

Literature Review
The validity and reliability of instruments are very essential in order to ensure the accuracy and consistency of the instruments (Ariffin, Omar, Isa, & Sharif, 2010). The content validity should take precedence, followed by construct validity of the instrument in verifying whether the instrument is valid and reliable (Abdul Aziz, Masodi & Zaharim, 2013, m.s 67). On the other hand, construct validity is crucial to identify the credibility and quality of the instrument. According to Ariffin et al. (2010), reliability is the consistency of a decision on time, while validity refers to the extent to which a test can be tested in line with the test objectives. Therefore, Rasch measurement model is applied in this study to determine the validity and reliability of BST-M instruments.

According to Rasch measurement model, the validity of a questionnaire is identified by referring a positive value of point-measure correlation coefficient (PTMEA Corr). The value of PTMEA Corr shows the item is able to differentiate the ability of the respondent. Furthermore, a negative or zero value indicates a conflict between the responses and the construct. Wright and Masters (1982) stated that infit and outfit mean square (MNSQ) for each item should be within 0.6 to 1.5. On the other hand, Bond and Fox (2015) mentioned that MNSQ should be within 0.6 to 1.4. If MNSQ values are not within these ranges, the items need to be removed or modified. The description of MNSQ value range and measurement implications are shown in Table 1 below.
Table 1: Description of MNSQ range (Linacre, 2002b)

| Mean square value (MNSQ) | Measurement Implications |
|-------------------------|--------------------------|
| >2.0                    | Distorts or degrades the measurement system. It is probably caused by only one or two observations. |
| 1.5-2.0                 | Unproductive for measurement construction, but not degrading. |
| 0.5-1.5                 | Productive for measurement. |
| <0.5                    | Less productive for measurement, but not degrading. It may produce misleading reliability and separation coefficients. |

The reliability statistic used in Rasch model is referring to the person and item separation index. Bond and Fox (2015) mentioned that the accepted criterion for strong reliability is it has a value more than 0.8. Meanwhile for the separation index, the higher the separation value, the more precise the measurement is done (Wright & Masters, 1982). However, Linacre (2002) argues that isolation value of more than 2 is good. The study also refers to the quality of measurements stating that the separation index between 3 and 4 as good and more than 5 as excellent (Fisher, 2007).

Methodology
This study was conducted using the developed set of questionnaires. A total of 110 items were contained in this questionnaire in the form of 5-point Likert scale. The questionnaires were distributed to chosen 800 Form Two students (Male = 330, 41.3%; Female = 470, 58.8%) by stratified random sampling from 30 secondary schools in Seremban, Negeri Sembilan. After that, the collected data were analyzed using SPSS and Winstep 3.64.2 software. Construct validity was determined by several factors namely reliability and separation index, item polarity, fit and misfit items.

Research Findings
i. Item polarity and point-measure correlation
Table 2 shows the PTMEA Corr value for each item is positive, except E3, F15, E2, D3, D2 and E6 items which show non-compliance responses to the constructs. These items need to be reviewed.

Table 2: Correlation Order for Likert scale items

| ENTRY | TOTAL | TOTAL | MODEL | INFIT | OUTFIT | PT-MEASURE | EXACT MATCH | | NUMBER | SCORE | COUNT | MEASURE | S.E. | MNSQ | ZSTD | MNSQ | ZSTD | CORR. EXP. | OBS% | EXP% | ITEM |
|-------|-------|-------|-------|-------|-------|------------|-------------|-------|-------|---------|------|------|------|------|------|-------------|-------|------|-----|

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| 43 1819 800 1.57 | .04 [1.55 9.9 1.68 9.9] -.19 | .46 | .35 35.1 | E3 |
| 68 1531 800 2.00 | .04 [1.83 9.9 2.00 9.9] -.14 | .45 | .33 34.7 | F15 |
| 42 2324 800 .92 | .04 [1.78 9.9 1.96 9.9] -.12 | .45 | 24.8 35.3 | E2 |
| 29 1575 800 1.93 | .04 [1.63 9.9 1.80 9.9] -.03 | .45 | .33 37.0 | D3 |
| 28 1385 800 2.26 | .04 [1.80 9.9 2.03 9.9] -.02 | .44 | 32.3 43.5 | D2 |
| 46 1870 800 1.50 | .04 [1.82 9.9 1.93 9.9] -.01 | .46 | 30.9 34.9 | E6 |
| 24 2395 800 .83 | .04 [1.63 9.9 1.77 9.9] -.04 | .45 | 29.4 35.8 | C24 |
| 27 1506 800 2.04 | .04 [1.52 9.1 1.61 9.8] -.04 | .45 | 38.8 38.2 | D1 |
| 3 3025 800 -.07 | .04 [1.25 4.5 1.32 5.7] .13 | .39 | 42.9 45.7 | C3 |
| 15 2489 800 .71 | .04 [1.38 7.8 1.48 9.3] .16 | .44 | 29.6 36.6 | C15 |
| 1 2825 800 .25 | .04 [1.10 1.9 1.17 3.2] .20 | .41 | 44.1 41.0 | C1 |
| 17 2729 800 .39 | .04 [1.27 5.3 1.33 6.2] .24 | .42 | 36.6 39.5 | C17 |
| 12 3044 800 -.10 | .04 [1.01 .3 1.08 1.5] .25 | .38 | 48.0 46.1 | C12 |
| 9 3245 800 -.48 | .05 [1.13 2.4 1.15 2.7] .26 | .35 | 51.1 48.9 | C9 |
| 8 3151 800 -.29 | .04 [1.07 1.4 1.13 2.4] .26 | .37 | 53.3 47.9 | C8 |
| 36 3078 800 -.16 | .04 [1.53 8.7 1.58 9.4] .26 | .38 | 41.0 46.8 | D10 |
| 19 3365 800 -.74 | .05 [1.18 3.1 1.20 3.5] .27 | .33 | 44.6 49.5 | C19 |
| 37 2911 800 .12 | .04 [1.34 6.1 1.41 7.3] .28 | .40 | 40.1 42.8 | D11 |
| 2 3164 800 -.32 | .04 [.93 -.13 .94 -.11] .29 | .37 | 52.6 48.1 | C2 |
| 11 3086 800 -.17 | .04 [.99 -.1 1.01 .3] .29 | .38 | 47.8 46.9 | C11 |
| 25 2728 800 .39 | .04 [1.27 5.3 1.30 5.8] .29 | .42 | 39.3 39.5 | C25 |
| 10 3439 800 -.92 | .05 [1.22 3.6 1.21 3.5] .30 | .32 | 49.1 50.3 | C10 |
| 97 2880 800 .17 | .04 [1.11 2.1 1.12 2.4] .30 | .40 | 42.5 42.2 | G16 |
| 5 3363 800 -.74 | .05 [1.05 1.0 1.04 .7] .31 | .33 | 52.1 49.5 | C5 |
| 30 3072 800 -.15 | .04 [.93 -.14 .97 -.6] .31 | .38 | 41.0 46.7 | D4 |
| 13 3059 800 -.12 | .04 [1.17 3.1 1.20 3.6] .31 | .38 | 42.5 46.3 | C13 |
| 32 2962 800 .04 | .04 [1.37 6.5 1.43 7.4] .32 | .39 | 37.5 44.1 | D6 |
| 35 3410 800 -.85 | .05 [1.47 7.3 1.45 7.1] .33 | .32 | 44.5 50.0 | D9 |
| 33 3298 800 -.59 | .05 [.96 -.6 .98 -.3] .33 | .34 | 52.3 49.2 | D7 |
| 4 3334 800 -.67 | .05 [.99 -.2 .96 -.7] .34 | .34 | 51.5 49.4 | C4 |
| 21 3184 800 -.35 | .04 [1.21 3.7 1.21 3.6] .34 | .36 | 42.9 48.3 | C21 |
| 34 3224 800 -.43 | .04 [1.10 1.8 1.12 2.1] .35 | .36 | 45.5 48.8 | D8 |
| 6 3500 800 -.109 | .05 [1.10 1.8 1.04 .7] .35 | .30 | 54.0 51.4 | C6 |
| 20 3089 800 -.18 | .04 [.92 -.14 .94 -.10] .35 | .38 | 48.8 46.9 | C20 |
| 7 2981 800 .01 | .04 [.95 -.10 .96 -.7] .36 | .39 | 47.0 44.6 | C7 |
| 23 3238 800 -.46 | .05 [.94 -.10 .95 -.10] .37 | .35 | 51.1 48.8 | C23 |
| 16 3034 800 -.08 | .04 [.91 -.17 .92 -.16] .37 | .38 | 48.9 45.8 | C16 |
| 48 3123 800 -.24 | .04 [1.12 2.2 1.12 2.3] .37 | .37 | 44.9 47.4 | E8 |
| 14 2966 800 .03 | .04 [.92 -.15 .93 -.14] .38 | .38 | 48.9 44.2 | C14 |
| 40 3435 800 -.91 | .05 [1.15 2.6 1.11 1.9] .38 | .32 | 51.6 50.1 | D14 |
| 31 3389 800 -.80 | .05 [1.09 1.5 1.10 1.7] .38 | .33 | 53.5 49.7 | D5 |
| 47 3493 800 -.107 | .05 [1.24 3.9 1.16 2.8] .38 | .30 | 52.1 51.2 | E7 |
| 18 3123 800 -.24 | .04 [.77 -.46 .77 -.48] .38 | .37 | 56.0 47.4 | C18 |
|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 39 | 3182 | 800 | -35 | .04 | .95 | -.9 | .96 | -.7 |
| 57 | 2612 | 800 | .55 | .04 | 1.01 | .3 | 1.07 | 1.4 |
| 22 | 3297 | 800 | -.59 | .05 | 1.02 | .4 | .99 | -.1 |
| 62 | 2542 | 800 | .64 | .04 | 1.0 -2.3 | .94 | -1.3 | .40 | .44 | 39.3 | 37.2 | F9 |
| 49 | 3341 | 800 | -.68 | .05 | 1.00 | -.1 | .96 | -.8 | .41 | .34 | 50.3 | 49.4 | E9 |
| 51 | 2577 | 800 | .60 | .04 | 1.14 | 3.1 | 1.21 | 4.3 |
| 38 | 3247 | 800 | -.48 | .05 | .82 | -3.5 | .82 | -3.6 | .42 | .35 | 55.1 | 48.9 | D12 |
| 81 | 3111 | 800 | -.22 | .04 | .92 | -1.5 | .92 | -1.5 | .43 | .37 | 51.8 | 47.3 | F28 |
| 108 | 3269 | 800 | -.53 | .05 | 1.12 | 2.0 | 1.09 | 1.7 | .43 | .35 | 47.6 | 49.0 | G27 |
| 67 | 2749 | 800 | -.36 | .04 | 1.00 | 0 | 1.00 | .1 | .43 | .42 | 41.9 | 39.8 | F14 |
| 110 | 2994 | 800 | -.01 | .04 | 1.24 | 4.4 | 1.25 | 4.6 | .44 | .39 | 37.9 | 44.8 | G29 |
| 26 | 3094 | 800 | -.19 | .04 | .77 | -4.7 | .76 | -4.9 | .44 | .38 | 53.4 | 47.0 | C26 |
| 76 | 2647 | 800 | -.50 | .04 | .73 | -6.5 | .76 | -5.6 | .44 | .43 | 46.4 | 38.3 | F23 |
| 106 | 3112 | 800 | -.22 | .04 | .89 | -2.2 | .89 | -2.2 | .45 | .37 | 53.5 | 47.3 | G25 |
| 66 | 3218 | 800 | -.42 | .04 | .89 | -2.0 | .87 | -2.5 | .45 | .36 | 55.1 | 48.7 | F13 |
| 64 | 3211 | 800 | -.41 | .04 | .82 | -3.5 | .81 | -3.7 | .45 | .36 | 57.9 | 48.6 | F11 |
| 84 | 3346 | 800 | -.70 | .05 | .85 | -2.7 | .82 | -3.4 | .45 | .33 | 59.3 | 49.5 | G3 |
| 80 | 3141 | 800 | -.27 | .04 | .93 | -1.2 | .92 | -1.5 | .46 | .37 | 52.6 | 47.7 | F27 |
| 100 | 2597 | 800 | .57 | .04 | .84 | -3.8 | .85 | -3.3 | .47 | .43 | 45.9 | 37.7 | G19 |
| 50 | 2799 | 800 | .29 | .04 | 1.02 | 5 | 1.04 | .9 | .47 | .41 | 42.9 | 40.6 | E10 |
| 109 | 2599 | 800 | .57 | .04 | .88 | -2.8 | .89 | -2.5 | .47 | .43 | 43.0 | 37.7 | G28 |
| 91 | 2985 | 800 | .00 | .04 | 1.15 | 2.7 | 1.16 | 2.9 | .47 | .39 | 42.6 | 44.7 | G10 |
| 94 | 2798 | 800 | .29 | .04 | .86 | -3.0 | .88 | -2.5 | .47 | .41 | 43.1 | 40.6 | G13 |
| 65 | 3171 | 800 | -.33 | .04 | .80 | -4.0 | .79 | -4.3 | .48 | .36 | 52.9 | 48.2 | F12 |
| 96 | 2760 | 800 | .34 | .04 | .91 | -1.9 | .92 | -1.6 | .48 | .42 | 45.0 | 40.0 | G15 |
| 60 | 3060 | 800 | -.13 | .04 | .95 | -9 | .96 | -8 | .48 | .38 | 52.1 | 46.4 | F7 |
| 45 | 3260 | 800 | -.51 | .05 | .91 | -1.7 | .90 | -1.9 | .48 | .35 | 52.4 | 48.9 | E5 |
| 53 | 2837 | 800 | .23 | .04 | .96 | -7 | .97 | -6 | .48 | .41 | 39.9 | 41.4 | E13 |
| 99 | 3053 | 800 | -.11 | .04 | 1.11 | 2.0 | 1.14 | 2.6 | .48 | .38 | 46.5 | 46.2 | G18 |
| 69 | 3024 | 800 | -.06 | .04 | .70 | -6.5 | .69 | -6.6 | .48 | .39 | 55.5 | 45.7 | F16 |
| 98 | 3153 | 800 | -.29 | .04 | .95 | -.9 | .93 | -1.3 | .48 | .37 | 48.4 | 47.9 | G17 |
| 70 | 2968 | 800 | .03 | .04 | .89 | -2.2 | .90 | -2.1 | .48 | .39 | 51.6 | 44.2 | F17 |
| 101 | 2723 | 800 | .40 | .04 | .85 | -3.3 | .87 | -2.7 | .49 | .42 | 42.6 | 39.4 | G20 |
| 59 | 2633 | 800 | .52 | .04 | .85 | -3.4 | .88 | -2.7 | .49 | .43 | 40.3 | 38.1 | F6 |
| 92 | 3083 | 800 | -.17 | .04 | 1.03 | 7 | 1.02 | 3 | .49 | .38 | 46.0 | 46.8 | G11 |
| 82 | 3100 | 800 | -.20 | .04 | .84 | -3.1 | .79 | -4.3 | .50 | .37 | 56.9 | 47.1 | G1 |
| 56 | 2990 | 800 | -.01 | .04 | .93 | -1.4 | .93 | -1.3 | .50 | .39 | 47.9 | 44.7 | F3 |
| 63 | 3225 | 800 | -.43 | .04 | .80 | -3.9 | .78 | -4.4 | .50 | .36 | 56.0 | 48.8 | F10 |
| 102 | 3128 | 800 | -.25 | .04 | .89 | -2.1 | .88 | -2.4 | .50 | .37 | 55.8 | 47.5 | G21 |
| 93 | 3062 | 800 | -.13 | .04 | .86 | -2.9 | .85 | -3.1 | .50 | .38 | 50.9 | 46.5 | G12 |
| 41 | 3286 | 800 | -.56 | .05 | 1.12 | 2.1 | 1.05 | 1.0 | .50 | .35 | 49.4 | 49.1 | E1 |
| 44 | 3237 | 800 | -.46 | .05 | .88 | -2.3 | .84 | -3.0 | .51 | .35 | 54.0 | 48.8 | E4 |
| 78 | 3059 | 800 | -.12 | .04 | .78 | -4.6 | .78 | -4.5 | .51 | .38 | 52.5 | 46.3 | F25 |
| 105 | 3187 | 800 | -.36 | .04 | .77 | -4.6 | .75 | -5.2 | .51 | .36 | 55.5 | 48.3 | G24 |
### ii. Fit and Misfit Items

Based on Table 2, there were 8 items (E3, F15, E2, D3, D2, E6, C24 and D1) which were unproductive for measurement construction, but not degrading. These items need to be reviewed and modified.

### iii. Reliability and Separation Index

According to Table 3, Rasch analysis for Likert scale items shows a high reliability value for *person*, with 0.94 and 0.99 for each item. It indicates that the items are adequate to measure what should be measured. Moreover, the separation index for *person* is 4.06 while the separation index for the item is 13.77.
Table 3: Statistical summary of Likert scale items

| TABLE 3.1 data murid primary800.sav | ZOU441WS.TXT | Apr 18 9:02 2018 |
|-------------------------------------|-------------|-----------------|
| INPUT: 800 PERSON 110 ITEM REPORTED: 800 PERSON 110 ITEM 5 CATS | WINSTEPS 3.73 | |

### SUMMARY OF 800 MEASURED PERSON

| TOTAL | MODEL | INFIT | OUTFIT |
|-------|-------|-------|--------|
| SCORE | COUNT | MEASURE | ERROR | MNSQ | ZSTD | MNSQ | ZSTD |--------|
| MEAN  | 405.7 | .72 | .11 | 1.04 | -.3 | 1.02 | -.4 |--------|
| S.D.  | 40.3 | .0 | .54 | .01 | .52 | 3.6 | .50 | 3.6 |--------|
| MAX.  | 528.0 | 110.0 | 3.31 | .23 | 3.13 | 9.9 | 3.25 | 9.9 |--------|
| MIN.  | 287.0 | 110.0 | -5.4 | .10 | .13 | -9.9 | .14 | -9.9 |--------|

| REAL RMSE | .13 | TRUE SD | .52 | SEPARATION | 4.06 | PERSON RELIABILITY | .94 |
| MODEL RMSE | .11 | TRUE SD | .53 | SEPARATION | 4.59 | PERSON RELIABILITY | .95 |
| S.E. OF PERSON MEAN = .02 | |

PERSON RAW SCORE-TO-MEASURE CORRELATION = .98
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .95

### SUMMARY OF 110 MEASURED ITEM

| TOTAL | MODEL | INFIT | OUTFIT |
|-------|-------|-------|--------|
| SCORE | COUNT | MEASURE | ERROR | MNSQ | ZSTD | MNSQ | ZSTD |--------|
| MEAN  | 2950.7 | 800.0 | .00 | .04 | 1.01 | -.3 | 1.02 | -.2 |--------|
| S.D.  | 401.5 | .0 | .61 | .00 | .26 | 4.5 | .30 | 4.7 |--------|
| MAX.  | 3500.0 | 800.0 | 2.26 | .05 | 1.83 | 9.9 | 2.03 | 9.9 |--------|
| MIN.  | 1385.0 | 800.0 | -1.09 | .04 | .67 | -7.8 | .65 | -7.6 |--------|

| REAL RMSE | .04 | TRUE SD | .61 | SEPARATION | 13.77 | ITEM RELIABILITY | .99 |
| MODEL RMSE | .04 | TRUE SD | .61 | SEPARATION | 14.45 | ITEM RELIABILITY | 1.00 |
| S.E. OF ITEM MEAN = .06 | |

UMEAN=.0000 USCALE=1.0000

By detailing or specifying the reliability and separation index, constructs (B), (E) and (F) are more capable in measuring respondent’s capabilities through items in the constructs (Table 4).
Table 4: Reliability and isolation index according to the constructs

| Construct                                              | Isolation | Reliability | Measured dimension (%) |
|--------------------------------------------------------|-----------|-------------|------------------------|
|                                                        | Item      | Person      | Item                  | Person     |            |
| Value and Perception on Science and Technology (B)    | 10.27     | 2.01        | 0.99                  | 0.80       | 24.9       |
| Perception on Science and Technology (C)              | 22.10     | 1.12        | 1.00                  | 0.56       | 57.2       |
| Scientific Attitude and Common Practice (D)           | 17.85     | 1.29        | 1.00                  | 0.62       | 44.2       |
| Scientific Mind Habits and Environmental Concerns (E) | 12.87     | 2.78        | 0.99                  | 0.89       | 40.1       |
| Personality Traits (F)                                | 7.98      | 3.15        | 0.98                  | 0.91       | 35.9       |

Conclusion
In conclusion, item analysis is the best method to control the quality of applied measuring tools. Across all constructs, individual separation index are good and the item separation index are excellent. Overall items were found moving towards the constructs except few need to be revised. The next step in this research will be improving the items in this instrument. The data collected using this validated instrument will then be analysed using Hierarchy Linear Modelling (HLM) analysis to determine the relationship between the student’s S&T Culture and teacher’s productive pedagogy.

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