

# TAP

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Test Analysis Program (Version 4.2.5)

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| Web Site URL: <a href="http://oak.cats.ohiou.edu/~brooksg/tap.htm">http://oak.cats.ohiou.edu/~brooksg/tap.htm</a> |
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## User's Guide

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# 1 Introduction and Features

The Test Analysis Program (TAP) is designed as a powerful, easy-to-use (and free!) test analysis package for use by K-12 through graduate level instructors. The software's features also make it an excellent teaching tool for both undergraduate and graduate level test design courses. As a test analysis package, the user can insert test score data in text format or enter test data directly into the program. For teaching purposes, TAP generates sample sets of test data using a random seed. The user can set various parameters for the sample data, including the difficulty of the test, number of scores, number of test items and number of possible answers per item.

TAP output provides:

Examinee Analysis, including percentage correct, letter grade and confidence intervals for each student and aggregate descriptive statistics for the group. TAP also generates an instructor's list of scores and wrong answers by student, as well as a report for each student indicating his or her score, responses to each item and the correct answers to items missed.

Item and Test Analysis, including item difficulty, point biserial, discrimination index and various statistics if item deleted (KR20, scale mean and standard deviation, etc.). TAP also calculates the number of additional items needed to increase reliability.

Options Analysis, including high group and low group item difficulty for correct answer and distracters.

## 2 Installation and Setup

TAP operates in any Windows environment. To install TAP:

1. Insert the CD-ROM into the proper drive.
2. View contents the CD-ROM using Explore.
3. Click on the TAP icon. The program will launch and you are ready to begin.

### 3 Entering Test Data

TAP provides a simple method of entering test data for analysis. Scores can be entered directly into TAP or imported as text files from another program. Users can also choose to enter information on cognitive levels and content domain into the “Table of Specifications” feature.

#### Entering test data directly into TAP

1. Under INPUT, select Enter New Data and click on Go To Data Editor.

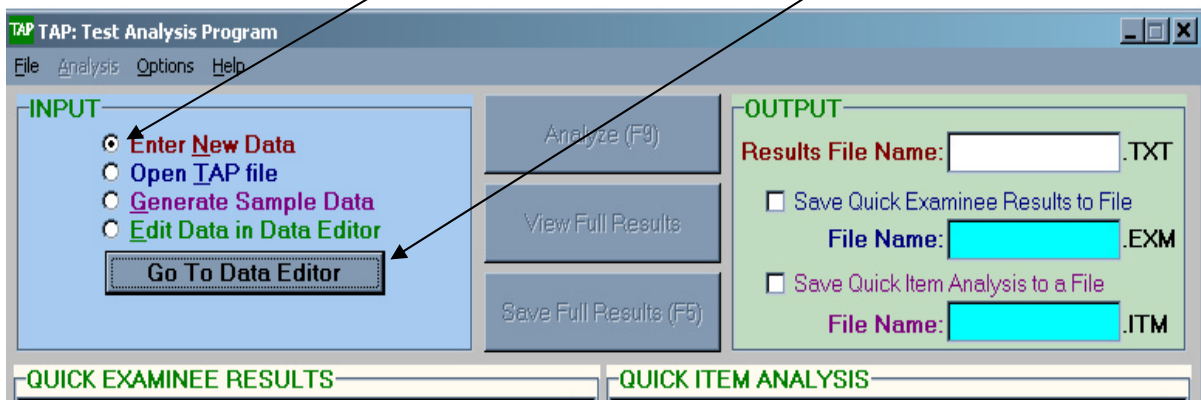


Figure 3.1. Procedure for accessing test score input screen.

1. In the Data Editor screen, enter any descriptive information in the Title and Comments sections (see Figure 3.2).
2. Input the number of examinees, number of items, missing data symbol and ID label (student name) length in the appropriate fields. The data entry screen will automatically adjust to the chosen parameters.
3. In the Answer Key field, enter the numbers corresponding to the correct answers as a string with no delimiters.
4. In the #Options field, enter the number of options corresponding to each question.
5. The Item Included field allows the user to eliminate items from the analysis or set alternative correct answers. For instance, if the teacher realizes that the item was incorrectly worded, he or she can enter an “N” under that item in the Item Included field. This will remove the item from the test analysis and will

calculate student scores without the item. This feature also allows the user to enter alternative answers for items. To set alternative correct answers:

- a) Flag that item by placing an A in the Item Included field in the Data Editor screen.
  - b) Under "Options" in the Data Editor screen, choose Set Alternative Correct Answers. Enter the alternatives.
6. In the Data screen, enter the student identification information and scores. Align the score data with the guide above the Data screen.
7. When all information is entered, click on either **Save File** or **Close and Analyze** at the bottom of the Data Entry screen. The Save File button will allow you to choose the location to save the entered data as a .tap file for future data entry or analysis. The Close and Analyze button will allow you to immediately view the test analysis data (see Section 6 for details on analysis).

**TAP Data Editor**

File Data Options Help

**Title:** Social Studies Test 2 (70 character maximum)

**Comments:** Chapters 3-5 (70 character maximum)

**Item#** 1 1 2 2 3  
 1...5...0...5...0...5...0

**Answer Key:** 12221112222221344333334442224

**# Options:** 2222222222222444444444444444

**Item Included:** YYYYYYYYYYYYYYYYYYYYYYYYYY

**DATA** # Examinees: 5 # Items: 30 Missing data symbol: 9 ID Label Length: 20

| Examinee ID | Item# | 1 | 1 | 2 | 2 | 3 |
|-------------|-------|---|---|---|---|---|
| -----       | Item# | 1 | 1 | 2 | 2 | 3 |
|             |       | 1 | 5 | 0 | 5 | 0 |
| student1    |       | 1 | 2 | 2 | 1 | 1 |
| student2    |       | 1 | 2 | 2 | 1 | 1 |
| student3    |       | 1 | 1 | 2 | 2 | 2 |
| student4    |       | 1 | 1 | 2 | 2 | 2 |
| student5    |       | 1 | 2 | 2 | 2 | 2 |

Buttons: Cancel Save File OK Close & Analyze

**Figure 3.2. TAP Data Editor screen.**

### Importing test data

Note: Under the **Data** menu in Data Editor, TAP also provides the option of entering data from an existing text (.txt) file.

### Entering a table of specifications

A table of specifications allows instructors to develop test questions based on: 1) the content domain covered, and 2) the cognitive skill level being tested. There are several methods for defining cognitive skill level. Bloom's Taxonomy is one common framework, classifying objectives into six levels (knowledge, comprehension, application, analysis, synthesis, evaluation).

Ideally, instructors want to mix the cognitive skill levels they are testing to ensure that they are not just asking questions that require memorization of facts (knowledge-level). Also, if more than one content domain is being covered on a test, instructors want to ensure that the questions reflect all the content. A table of specifications helps ensure that the instructor is testing across the appropriate content areas and at the appropriate cognitive levels.

**Table of Specifications for a 30 question General Business Test**

| Content Domain              | Cognitive Level |               |             |
|-----------------------------|-----------------|---------------|-------------|
|                             | knowledge       | comprehension | application |
| Factors of production       | 6               | 4             | 2           |
| Market/command economies    | 3               | 4             | 1           |
| Measuring economic activity | 2               | 5             | 4           |

In the Data Editor window the user can enter the table of specifications information by choosing that option from the **Options** menu. Figure 3.3 illustrates the Table of Specifications entry screen.

**Table of Specifications**  
File Options

**Number of Content Areas**  
☐ 0 ☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

**Number of Cognitive Skill Levels**  
☐ 0 ☐ 1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6

**Content Area Names**

|                |                             |
|----------------|-----------------------------|
| Content Area 1 | Factors of production       |
| Content Area 2 | Market/command economies    |
| Content Area 3 | Measuring economic activity |
| Content Area 4 |                             |
| Content Area 5 |                             |
| Content Area 6 |                             |

**Cognitive Skill Level Names**

|                   |               |
|-------------------|---------------|
| Cognitive Level 1 | knowledge     |
| Cognitive Level 2 | comprehension |
| Cognitive Level 3 | application   |
| Cognitive Level 4 |               |
| Cognitive Level 5 |               |
| Cognitive Level 6 |               |

**For each item, indicate its Content Area (1-6) and its Cognitive Level (1-6)**

| Item #          | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|-----------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Content Area    | 1 | 2 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1  | 1  | 2  | 2  | 3  | 1  | 3  | 3  | 2  | 3  | 3  | 1  | 1  | 1  | 1  | 1  | 1  | 2  | 3  | 3  | 3  |
| Cognitive Level | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1  | 1  | 2  | 2  | 2  | 2  | 3  | 3  | 1  | 1  | 3  | 3  | 1  | 2  | 2  | 1  | 2  | 3  | 3  | 3  |    |

Cancel OK

Figure 3.3. Table of Specifications entry screen.

## 4 Using Random Score Generator

For users who are demonstrating the use of the software to colleagues or teaching test or item analysis, TAP generates sample sets of test score data using a random seed. The user can modify parameters such as item difficulty and number of items.

From the first TAP screen under INPUT, select **Generate Sample Data**, then click on **Go To Data Editor**.

The Data Generation Information options window appears (Figure 4.1). The user can choose the difficulty level, number of cases (examinees), number of test items, and the number of answer options per item. The seed for random data generation can also be changed. Once desired parameters are set, click **Generate** to create sample data set.

**Data Generation Information**

**Difficulty of Exam:**

- ☐ Extremely Easy Exam (a mean score near 95%)
- ☐ Very Easy Exam (a mean score near 90%)
- ☐ Relatively Easy Exam (a mean score near 80%)
- ☒ Moderately Difficult Exam (a mean score near 70%)
- ☐ Fairly Difficult Exam (a mean score near 60%)
- ☐ Very Difficult Exam (a mean score near 50%)
- ☐ Extremely Difficult Exam (a mean score near 40%)

**Number of Cases to Generate (max 200):**

**Number of Items on Test (max 90):**

**Seed for Data Generation:**

**# of Options per Item:** ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒ Mix It Up

**Cancel** **Generate**

Figure 4.1. Data Generation Information window.

Generated scores will appear in the Data Editor. Analyze data by clicking **Close and Analyze** in the Data Editor window or save for future analysis by clicking **Save** button in Data Editor window.



## 5 Saving Data Files

Test data created entered by the user or created by TAP's random data generator can be saved as TAP files for archival information, future modification or analysis.

Data files can be saved in TAP's data editor window.

1. Choose Save TAP file under the File menu.
2. Select the location and save the TAP file.
3. To open file later, choose Open TAP file under the File menu in the Data Editor Screen.

## 6 Analyzing Tests with TAP

Once you have a set of test scores in the Data Editor, either by entering your own test data (see section 3 for procedure) or generating sample scores for teaching purposes (see section 4 for procedure), you can generate the analysis by clicking **Analyze (F9)**. Quick examinee results and quick item analysis appear. The quick results provide summary information for the examinees as a group and the test as a whole.

To retrieve the full analysis click on the **View Full Results** box. The full results window will open. This window contains several pages of analysis on examinees, individual items, and the test as a whole.

|                           |       |         |       |              |              |           |
|---------------------------|-------|---------|-------|--------------|--------------|-----------|
| TITLE: Sample Data Set #1 |       |         |       |              |              |           |
| COMMENT:                  |       |         |       |              |              |           |
| *****                     |       |         |       |              |              |           |
| Examinee Analysis         |       |         |       |              |              |           |
| *****                     |       |         |       |              |              |           |
|                           |       |         | Ltr   | ~68% C.I.    | ~68% C.I.    | ~68% C.I. |
| Examinee                  | Score | Percent | Grade | (Raw Score)  | (Percents)   | (Letters) |
| -----                     |       |         |       |              |              |           |
| -----                     |       |         |       |              |              |           |
| Isaac Irt                 | 23    | 48.94%  | F     | (20.3- 25.7) | (43.3- 54.6) | (F , D )  |
| Valeria Validity          | 26    | 55.32%  | D     | (23.3- 28.7) | (49.6- 61.0) | (F , D )  |
| Nancy Nominal             | 26    | 55.32%  | D     | (23.3- 28.7) | (49.6- 61.0) | (F , D )  |
| James Judges              | 27    | 57.45%  | D     | (24.3- 29.7) | (51.8- 63.1) | (F , C )  |
| Oscar Option              | 27    | 57.45%  | D     | (24.3- 29.7) | (51.8- 63.1) | (F , C )  |
| Susan S.Brown             | 28    | 59.57%  | D     | (25.3- 30.7) | (53.9- 65.2) | (D , C )  |

Figure 6-1. View of first section of results from **View Full Results** command.

Figure 6-1 shows a portion of the first section of analysis, which provides score information for each examinee.

To continue viewing the full analysis, use the down arrow in the lower right portion of the TAP display window to scroll through the Full Results section. The examinee analysis subsection contains additional information on scores, including a bar graph and a stem-and-leaf display (Figure 6-2).

=====

```

Stem-and-Leaf Display
=====

Stem Leaves (width=10)
-----
 2 . 3
 2 . 6667789
 3 . 122334444
 3 . 58999
 4 . 0

```

Figure 6.2. Stem and leaf display under Examinee Analysis subsection of Full Results.

The stem and leaf display is one method of checking test scores for normality (when rotated to the left 90° the curve should approximate a normal one). The plot also provides a succinct look at each score. In a typical stem and leaf plot for a test score distribution, the tens place of each score is the stem and the units place of each score is the leaf. In Figure 6-2, for example, one person scored 23 and three people scored 26.

The Full Analysis section provides detailed information on individual items, including item difficulty, point biserial and discrimination index (Figure 6.3). The section also provides various statistics if item deleted (KR20, scale mean and standard deviation, etc.). The item information is helpful in determining how well an item functioned and can be used to revise or discard bad test items, while identifying good test items that can be used again.

| *****<br>Item and Test Analysis<br>***** |                   |               |                |                          |                         |                   |                      |
|--|-------------------|---------------|----------------|--------------------------|-------------------------|-------------------|----------------------|
| Item                                     | Number<br>Correct | Item<br>Diff. | Disc.<br>Index | # Correct<br>in High Grp | # Correct<br>in Low Grp | Point<br>Biserial | Adjusted<br>Pt. Bis. |
| Item 01                                  | 23                | 1.000         | 0.000          | 10 (1.00)                | 6 (1.00)                | *****             | *****                |
| Item 02                                  | 9                 | 0.391         | 0.500          | 5 (0.50)                 | 0 (0.00)                | 0.402             | 0.312                |
| Item 03                                  | 10                | 0.435         | 0.500          | 5 (0.50)                 | 0 (0.00)                | 0.393             | 0.302                |
| Item 04                                  | 20                | 0.870         | 0.233          | 9 (0.90)                 | 4 (0.67)                | 0.251             | 0.184                |
| Item 05                                  | 22                | 0.957         | 0.167          | 10 (1.00)                | 5 (0.83)                | 0.402             | 0.366                |

Figure 6.3. Example of item and test analysis information provided in Full Results

#### Item discrimination index

One example of a useful item analysis statistic is the item discrimination index. This index indicates how well each item discriminated between the more knowledgeable and less knowledgeable students. The item discrimination index is calculated by subtracting the item difficulty of the high group from the item difficulty of the low group.

The default item discrimination index calculation in TAP uses the top 27% of scores and the bottom 27% of scores as the high and low groups. The user can change this in the by choosing Set Percentages for Item Discrimination under the **Options** menu.

The Full Results section provides individual item information, including high group and low group item difficulty for correct answer and distracters (Figure 6.4). The correct answer should have a positive difference (more of the high group chose the answer than the low group). The incorrect answers (distracters) should have negative differences (more of the low group chose them than the high group). If no one chose a particular distracter, the teacher can examine that distracter to see if it could be improved.

| *****  |            |            |            |            |           |
|--|------------|------------|------------|------------|-----------|
| Options Analysis   |            |            |            |            |           |
| ~~~~~  |            |            |            |            |           |
| Item Frequencies and Percentages   |            |            |            |            | --        |
| page1  |            |            |            |            |           |
| ~~~~~  |            |            |            |            |           |
| * is keyed answer, # is option that discriminates better than keyed answer |            |            |            |            |           |
| Item   | Group      | Option 1   | Option 2   | Option 3   | Option 4  |
| -----  |            |            |            |            |           |
| 1  | TOTAL      | 1 (0.043)  | 0 (0.000)  | 22*(0.957) | 0 (0.000) |
|  | High Group | 0 (0.000)  | 0 (0.000)  | 10 (1.000) | 0 (0.000) |
|  | Low Group  | 1 (0.167)  | 0 (0.000)  | 5 (0.833)  | 0 (0.000) |
|  | Difference | -1(-0.167) | 0 (0.000)  | 5 (0.167)  | 0 (0.000) |
| 2  | TOTAL      | 3 (0.130)  | 5 (0.217)  | 6 (0.261)  | 9*(0.391) |
|  | High Group | 1 (0.100)  | 1 (0.100)  | 3 (0.300)  | 5 (0.500) |
|  | Low Group  | 2 (0.333)  | 3 (0.500)  | 1 (0.167)  | 0 (0.000) |
|  | Difference | -1(-0.233) | -2(-0.400) | 2 (0.133)  | 5 (0.500) |

Figure 6-4. Example of Options Analysis information provided in Full Results.

If Table of Specifications information was entered (see Section 3 and Figure 3.2 for information on entering this information) the analysis includes information on the average item difficulty by content area and cognitive skill level. Figure 6-5 provides an example of the Table of Specifications analysis.

|       |  |  |  |  |  |
|-------|--|--|--|--|--|
| ***** |  |  |  |  |  |
|-------|--|--|--|--|--|

| Table of Specifications Analysis         |                       |                                   |               |
|--|-----------------------|-----------------------------------|---------------|
| *****                                    |                       |                                   |               |
| =====                                    |                       |                                   |               |
| CONTENT AREA ANALYSIS:                   |                       |                                   |               |
| =====                                    |                       |                                   |               |
| Content Area                             | Average<br>Difficulty | Items in Content Area             |               |
| -----                                    | -----                 | -----                             |               |
| Factors of productio                     | 0.691                 | 1,8,10,11,15,21,22,23,24,25,26    |               |
| Market/command econo                     | 0.750                 | 2,3,7,9,12,13,18,27               |               |
| Measuring economic a                     | 0.691                 | 4,5,6,14,16,17,19,20,28,29,30     |               |
| =====                                    |                       |                                   |               |
| COGNITIVE SKILL LEVEL ANALYSIS:          |                       |                                   |               |
| =====                                    |                       |                                   |               |
| Cognitive Level                          | Average<br>Difficulty | Items in Cognitive Level          |               |
| -----                                    | -----                 | -----                             |               |
| knowledge                                | 0.620                 | 1,2,3,9,10,11,19,20,23,26         |               |
| comprehension                            | 0.738                 | 4,5,6,7,8,12,13,14,15,16,24,25,27 |               |
| application                              | 0.771                 | 17,18,21,22,28,29,30              |               |
| =====                                    |                       |                                   |               |
| CONTENT AND COGNITIVE COMBINED ANALYSIS: |                       |                                   |               |
| =====                                    |                       |                                   |               |
| Content Area                             | Cognitive Level       | Avg.<br>Diff.                     | Items         |
| -----                                    | -----                 | -----                             | -----         |
| Factors of productio                     | knowledge             | 0.600                             | 1,10,11,23,26 |
| Factors of productio                     | comprehension         | 0.650                             | 8,15,24,25    |
| Factors of productio                     | application           | 1.000                             | 21,22         |
| Market/command econo                     | knowledge             | 0.733                             | 2,3,9         |
| Market/command econo                     | comprehension         | 0.700                             | 7,12,13,27    |
| Market/command econo                     | application           | 1.000                             | 18            |
| Measuring economic a                     | knowledge             | 0.500                             | 19,20         |
| Measuring economic a                     | comprehension         | 0.840                             | 4,5,6,14,16   |
| Measuring economic a                     | application           | 0.600                             | 17,28,29,30   |

Figure 6-5. Example of Table of Specifications Analysis

TAP provides information on test length and reliability using the Spearman-Brown Formula (see *Glossary*). The information is provided as part of the Full Results. To calculate test length for various reliability coefficients, click on Spearman-Brown Prophecy under the **Analysis** menu.

### Additional Options

Options for calculating and presenting information can be set under the **Options** menu.

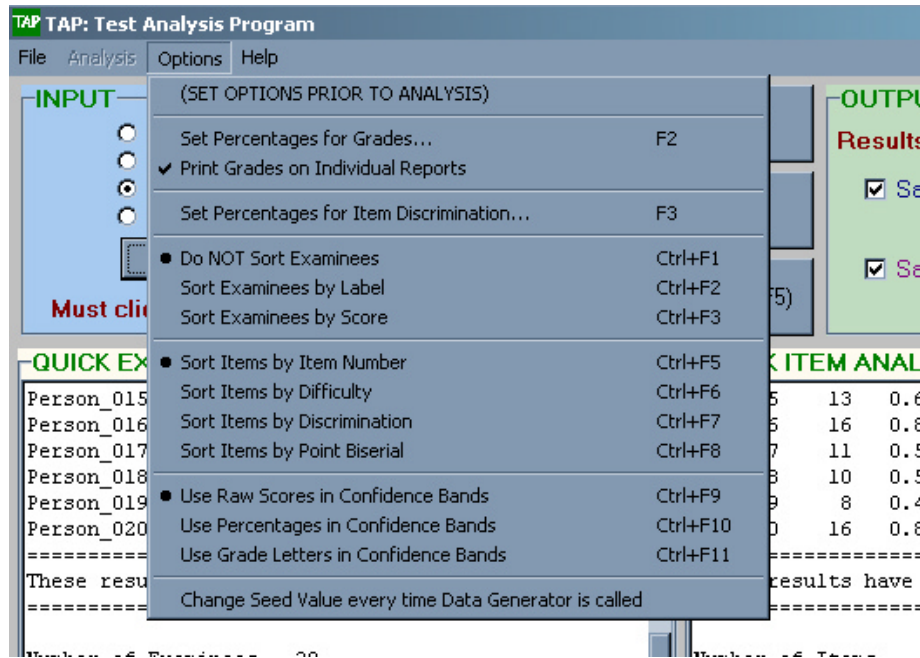


Figure 6.6. Options Menu.

Under Set Percentages for Grades, the user can choose the percentages that correspond to letter grades then save the scale as the default grading scale.

Under Use Letter Grades in Confidence Bands, TAP will indicate the range of letter grades corresponding to the confidence interval around the score.

TITLE: Sample Data Set #1  
COMMENT:  
\*\*\*\*\*  
Examinee Analysis  
\*\*\*\*\*

| Examinee         | Score | Percent | Ltr | ~68% C.I.<br>(Raw Score) | ~68% C.I.<br>(Percents) | ~68% C.I.<br>(Letters) |
|------------------|-------|---------|-----|--------------------------|-------------------------|------------------------|
| Isaac Irt        | 23    | 48.94%  | F   | (20.3- 25.7)             | (43.3- 54.6)            | (F , D )               |
| Valeria Validity | 26    | 55.32%  | D   | (23.3- 28.7)             | (49.6- 61.0)            | (F , D )               |
| Nancy Nominal    | 26    | 55.32%  | D   | (23.3- 28.7)             | (49.6- 61.0)            | (F , D )               |
| James Judges     | 27    | 57.45%  | D   | (24.3- 29.7)             | (51.8- 63.1)            | (F , C )               |
| Oscar Option     | 27    | 57.45%  | D   | (24.3- 29.7)             | (51.8- 63.1)            | (F , C )               |
| Susan S.Brown    | 28    | 59.57%  | D   | (25.3- 30.7)             | (53.9- 65.2)            | (D , C )               |

Figure 6-7. Example of Analysis when Use Letter Grades in Confidence Bands option is selected

## Saving Analysis

TAP provides options for saving the results of the analysis.

1. Under OUTPUT, type a file name in the white Results File Name box (the file name will automatically appear in the TAP File Name box, assigning the same file name to the .tap data file).
2. Click **Save Full Results** box, and then choose the location to save the text file.

The Results File Name will create a text (.txt) file containing the Full Results. This text file can be opened in a word processing program such as Microsoft Word, WordPad or Notepad. *Note: For best results, set the font to Courier or Courier New (10 point) and turn on the "word wrap" feature.*

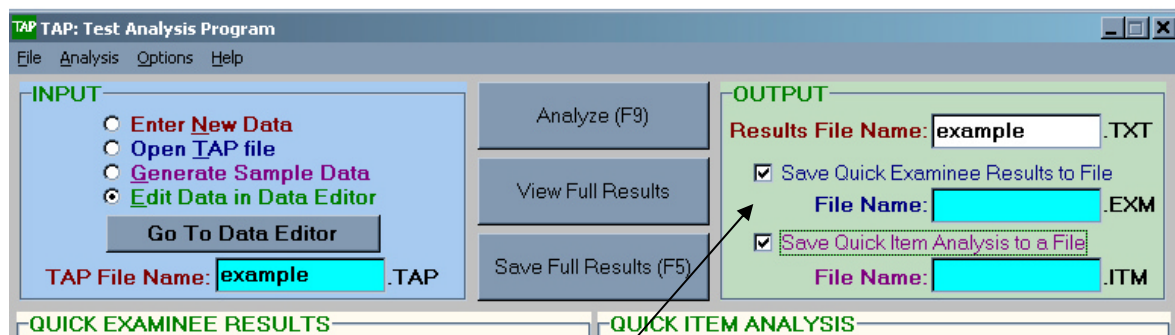


Figure 6.8. Saving Analysis.

3. To save the Quick Examinee Results and/or Quick Item Analysis as separate files for quick reference, check these boxes before clicking on **Save Full Results**. These files will be saved with the same name and .EXM and .ITM extensions, and can also be opened in a word processing program.
4. In addition to the information provided in Full Results, TAP provides the option of retrieving detailed test information on individual students. From the TAP File menu, click on **Save Grade Reports**. Choose the location to save the data.

Social Studies Test 2

~~~~~

```

Individual Grade Report for: Susan Spearman-Brown
~~~~~
Total Number of Items Correct = 20
Percentage Correct           = 66.67%

*****

Item    Student  Correct
Number  Response  Response
-----
1        1
2        1        2
3        2
4        2
5        1

```

Figure 6.9. Example of output from Save Grade Reports option under **File** menu.

To view and print grade reports, open the Grade Report file in a word processing program such as Microsoft Word, WordPad or Notepad. *Note: For best results, set the font to Courier or Courier New (10 point) and turn on the word wrap feature.*



## Glossary

**Confidence Interval** An interval that consists of those values of a statistic that have a given probability of including the population value. In terms of test scores, when confidence intervals are constructed for a number of examinees, a specified percentage (for instance, 95%) of these intervals are expected to contain the examinees' actual scores.

**Item Difficulty** The proportion of examinees answering the item correctly (the lower the proportion, the more difficult the item).

**Item Discrimination Index** A number (ranging from 1.00 to -1.00) representing the ability of an item to distinguish between more and less knowledgeable students. The index is commonly calculated as the difference in proportion of students in the high group (i.e. top quartile of scores) and the low group (i.e. bottom quartile of scores). An item discriminates if a larger proportion of students from the upper group correctly answered the item than in the lower group.

**KR20 (Kuder-Richardson Formula 20)** A method of calculating the internal consistency reliability of a test by dividing the test into components and calculating a reliability coefficient.

**KR21 (Kuder-Richardson Formula 21)** A method of calculating the internal consistency reliability of a test using the mean and standard deviation of the scores.

**Kurtosis** The relative steepness or flatness of a distribution—one measure of normality. A relatively flat distribution is described as platikurtic; a relatively steep distribution is described as leptokurtic. In general, kurtosis between -1 and 1 is considered normal (but only one measure of normality).

**Mean Score** The arithmetic average of actual scores on a test.

**Median Score** The score below which 50 percent of the scores on a test fall.

**Point Biserial Correlation** A method of calculating a correlation between the number of correct answers on a particular item and the number of correct answers on the entire test.

**Reliability** The degree to which a test measures something consistently (calculated in this program using the Kuder-Richardson Formula KR20). In general, for teacher-made tests that take approximately 50 minutes to complete, the KR20 reliability should be between .60 and .80. Shorter tests will likely have lower reliabilities. If the KR20 reliability is below .50, the test does not adequately differentiate the performance of a student from the average performance of the class as a whole.

**Skewness** A measure of symmetry of a distribution, used as one measure of normality. A positively skewed distribution has many low scores and relatively few high scores; a negatively skewed distribution has many high scores and relatively few low scores. In general, a skewness between -1 and 1 is considered normal (but only one measure of normality).

**Spearman-Brown Formula**    A method of estimating the effects that changes in test length will have on the reliability of the test.

**Standard Deviation**    An estimate of how far a set of scores deviates from the Mean.

**Standard Error of Measurement**    The standard deviation of the distribution of observed scores for any individual.

**Stem and Leaf Display**    A bar plot that provides a visual picture of the distribution as well as much or all of the actual data. In a typical stem and leaf plot for a test score distribution, the tens place of each score as the stem and the units place of each score as the leaf.

## References for formulas and terms

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