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### Measurement and Evaluation in a Junior High School Exploratory Typewriting Course

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MEASUREMENT AND EVALUATION  
IN A JUNIOR HIGH SCHOOL  
EXPLORATORY TYPEWRITING COURSE

for

Business Education 543

by

John D. Hall  
Eastern Illinois University  
Summer, 1962

### Purpose of this Paper

The purpose of this paper is to develop the basic aims of a junior high school exploratory typewriting course.

When the basic aims have been listed, objectives will be outlined to help in the construction of sample test items that will be valid for this course.

A discussion of the necessary attributes of an effective measuring device will then be undertaken.

The final item will be a summary of the processes utilized in constructing a proper measurement tool.

The junior high school, as originally developed, had several purposes. Among these reasons was an economy of time by improving the students' progress and forming a bridge between the elementary and senior high school. It serves as a means of breaking up the long period of elementary schooling.<sup>1</sup>

The period of time the adolescent spends in this institution is a period of rapid growth. Granting that all life is a period of transition from one situation to another, the period of adolescence is one of acute transition. The adolescent is not a young adult, nor is he an old child.<sup>2</sup> This is, instead, a separate stage of the maturation of the individual.

While the junior high school can hardly be expected to be exactly the same in any two communities, the following definition may be used generally:

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<sup>1</sup>Leonard V. Koos, The Junior High School in "A History of Business Education in the United States," (South-Western Monograph 25) 1935, p. 73.

<sup>2</sup>Herbert A. Tonne, Principles of Business Education (New York: Gregg Publishing Co., 1949), p. 372.

The junior high school is that portion of the public school system above the sixth elementary grade, including usually the seventh, eighth, and ninth grades, and admitting and making provision for all pupils who are in any respect so mature that they can profit more from junior high school environment than they would from continuing in the elementary school. It is essentially an exploratory, try-out, and information school. It is neither a sub-secondary school nor a vocational or trade school.<sup>3</sup>

These aims may be restated as follows:

- a. Exploratory: To enable the pupil to discover his capacities and aptitudes, and to explore the major areas of learning.
- b. Individual Differences: To enable the pupil to follow the lines of his ability and interest.
- c. Guidance: To bring pupils into contact with influences that should give direction and purpose to their lives.
- d. Mastery of Tools and Skills: To continue common, integrating education.<sup>4</sup>

The continuance in school for longer periods by our young people will remain a prime factor in deciding the curriculum of our schools. They will remain in school for two main reasons: (1) the community will insist on it, and (2) industry will have no place for these young people.<sup>5</sup> As the number of students in the

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<sup>3</sup>Koos, op. cit., p. 72.

<sup>4</sup>"The Business Curriculum," National Business Education Outlook, Sixth Yearbook of the National Commercial Teachers Federation (Bowling Green, Kentucky, 1940), p. 62.

<sup>5</sup>Tonne, op. cit., p. 373.

higher grades increases, it is extremely important that they develop emotional and social stability at some point.

The junior high schools should serve as a period of time in which the pupil grows in human understanding with specific knowledges being concomitant outcomes. This is not to say that learnings do not take place in the junior high school, but rather, that they are basically of an emotional type.

#### Objectives of Exploratory Typewriting

Congruent with the purposes of the junior high school as outlined above, the junior high schools of Mattoon, Illinois offer an exploratory course in typewriting. This is a compulsory course on the eighth-grade level for a period of six weeks.

The course is not exploratory in business life; however, it is exploratory in the manipulation of the typewriter. It is developed to help the student form manipulative skills that will be of use in later years.

The general objectives of this course can be listed in three general statements. These are:

First: To develop to the greatest possible extent a suitable typewriting skill.

Second: To contribute directly to the improvement of the communication skills of the students.

Third: To make the course an enjoyable and profitable exploratory experience, both emotionally and academically.

The specific objectives of the course must be developed to fit the individual course. The specific objectives for this course are:

1. To develop touch typewriting techniques.
2. To develop efficiency in using the typewriter.
3. To develop a typewriting skill commensurate with the time and ability available.
4. To improve the communication skills of the students.

The development of a method of evaluation and measurement will be the next step after the formulation of a course program. This will, of necessity, have to follow the philosophy of the course.

#### Speed and Accuracy Standards

It will be to the advantage of the teachers of all junior high school typewriting courses to have a visible objective for the students to attempt to attain. The establishment of a speed goal and an allowable amount of errors will furnish a valuable motivation device for such courses.

These standards, for the exploratory class, must be within easy reach of the student of average ability, yet high enough to challenge the talented and low enough to encompass the less talented.

Distributions of speed and accuracy scores for the students at Jefferson Junior High School in Mattoon, for the school year 1961-62, are shown in the appendix of this paper. These scores do not include the remedial section.

Ability grouping is used in the seventh and eighth grades at Jefferson. For this reason those students with low language abilities are included in one section. Evaluation of this section, based primarily on improvement, is somewhat different from the evaluation methods used with other sections.

Based on previous records, a table of weekly goals has decided advantages as a measuring device. One of these advantages is that students are drawn from similar social and economic backgrounds each year. This facilitates better comparison of achievement through the year. The development of the speed and accuracy tables has a more sound foundation for the same reason.

All scores are based on one-minute timed writings. Several timed writings are conducted each day. The student records his best writing daily, according to the table of weekly goals, on a record sheet. At the end of the week, an average score of gross words and errors is determined by averaging the best three days.

A weekly grade is then assigned each student after the third week.



TABLE I: WEEKLY GOALS

<u>Third Week</u>	<u>0-3 Errors</u>	<u>4-6 Errors</u>	<u>7-10 Errors</u>
A	26 / gwpm*	28 / gwpm	30 / gwpm
B	19-25	21-27	23-29
C	13-18	15-20	17-22
D	7-12	9-14	11-16
<u>Fourth Week</u>	<u>0-2 Errors</u>	<u>3-5 Errors</u>	<u>6-9 Errors</u>
A	28 /	30 /	32 /
B	21-27	23-29	25-31
C	15-20	15-22	17-24
D	9-14	9-14	11-16
<u>Fifth Week</u>	<u>0-2 Errors</u>	<u>3-5 Errors</u>	<u>6-9 Errors</u>
A	30 /	32 /	34 /
B	23-29	25-31	27-33
C	15-22	17-24	19-26
D	9-14	11-16	13-18
<u>Sixth Week</u>	<u>0-1 Error</u>	<u>2-3 Errors</u>	<u>4-5 Errors</u>
A	32 /	34 /	36 /
B	25-31	27-33	29-35
C	17-24	19-26	21-28
D	11-16	13-18	15-20

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\*All speeds are gross words per minute on one-minute timed writings

### Evaluation of Typewriting Techniques

Emphasis during the course is placed on the proper typewriting techniques and skills, including manipulation of the machine, stroking, posture, eye control, and a proper attitude.

The less defensible side of the evaluation of a student's progress in this course is the subjective aspect of the attitudes and skills while in actual practice. The teacher's role in this situation should be that of an impartial observer.

There will be, as in all situations, times when the teacher must shade his evaluation to the individual student but only to the advantage of the student. If, at any time there is a possibility of bias, the teacher as a professional person, must make the best evaluation he can being careful to avoid considering his personal feelings.

A list of the techniques to be checked should be formulated. The actual checking of these techniques should be accomplished with the aid of a check sheet that can be attached to a clipboard. This will allow the teacher to move around the room and make the evaluations.

A list of techniques and a sample check sheet are shown below.

TABLE II: TECHNIQUES OF TYPEWRITING<sup>6</sup>

1. Stroking
  - a. right fingering
  - b. quick key release
  - c. light finger weight on keys
2. Relaxation
  - a. absence of tenseness in shoulders and arms
  - b. back erect but not rigid
3. Quiet control
  - a. almost motionless forearms and elbows
  - b. minimum wrist movement
  - c. hands poised near keyboard--no bouncing in the air
4. Mental attitude (or mind-set)--works with confidence
5. Control of operative parts
  - a. carriage return
  - b. shift keys
  - c. space bar
  - d. inserting and removing paper
6. Eyes held on the copy
7. Reading the copy
  - a. appropriate use of letter-level reading
  - b. appropriate use of word-level reading

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<sup>6</sup>20th Century Typewriting Manual. (Seventh Edition)  
South-Western Publishing Co.; Chicago: 1957, p. 15.



Utilization of the check sheet will allow the teacher to place a check mark in the appropriate column. When all techniques have been checked the points are totaled and a grade assigned to each student.

Points assigned to each technique are:

3	.....	Fair
2	.....	Satisfactory
1	.....	Poor
0	.....	Unsatisfactory

Points necessary for weekly grades are:

14-15	.....	A
12-13	.....	B
9-10-11	.....	C
7- 8	.....	D

#### Construction of a Final Examination

The objective portion of the measurement of the students' achievement will be accomplished through the use of the speed and accuracy standards mentioned above, technique grades and a final examination.

The final examination can at best be only a crude measurement of readily apparent knowledges. It can attempt to measure only the skill portion of the course, pen and paper skill, which is secondary to emotional growth and understanding as the primary objective of all junior high school courses.

The construction of the final examination involves the development of test items drawn from material

covered during the course of study. It is using items that measure closely the amount of knowledge gained, in reference to the objectives of the course, that give a test validity.

Validity is the property of measuring knowledges which are the stated objectives of any given course. The closer a test comes to measuring the exact objectives, the more valid it becomes. This may be illustrated by the invalidity of administering a bookkeeping test to a class of shorthand students. This test will not measure the basic objectives of the shorthand course and is therefore invalid.

Validity, according to Cureton, has two aspects: relevance and reliability.<sup>7</sup> Relevance is "the closeness of agreement between what the test measures and the function that it is used to measure."<sup>8</sup> This is measuring the extent to which the objects of the course were met.

To develop validity, the test items must be constructed with the course objectives clear in the mind of the constructor. Most tests are developed on "face" validity, or the appearance of measuring course objectives.

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<sup>7</sup>Edward E. Cureton, "Validity," in Educational Measurement, ed. E. F. Lindquist (Washington: American Council on Education, 1951), p. 622.

<sup>8</sup>Ibid.

Face validity does not give any actual validity to the test. The actual validity, or ceiling of validity, may be determined after administering and scoring the test through statistical means.

Reliability is the ability of a test to measure the same knowledges consistently with a high degree of score similarity. This is to say that a reliable test should give scores for the same student in a narrow range regardless of when it is taken or how many times it has been taken.

The student will probably not receive the same scores on successive attempts. He will not accomplish the same score due to the many causes of variances. A list of the sources of variances is given below.

There remains the problem of estimating the reliability of a test. This can not be determined by appearance only. There are several methods of estimation, all based on the utilization of more than one set of test scores.

Possibly the more convenient and less time consuming of these is to use the split-half correlation. This involves dividing one test into two equal parts and then determining the whole-test reliability through the Spearman-Brown formula:<sup>9</sup>

$$r(1/2) = \frac{2r_{12}}{1 + r_{12}}$$

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<sup>9</sup>Robert L. Thorndike, "Reliability," in Educational Measurement, ed. E. F. Lindquist (Washington: American Council on Education, 1951), p. 580.

TABLE III:

POSSIBLE SOURCES OF VARIANCE IN SCORE ON A PARTICULAR TEST<sup>10</sup>

- I. Lasting and general characteristics of the individual
  - A. Level of ability on one or more general traits, which operate in a number of tests
  - B. General skills and techniques of taking tests
  - C. General ability to comprehend instructions
  
- II. Lasting but specific characteristics of the individual
  - A. Specific to the test as a whole (and to parallel forms of it)
    - 1. Individual level of ability on traits required in this test but not in others
    - 2. Knowledges and skills specific to particular form of test items
  - B. Specific to particular test items
    - 1. The "chance" element determining whether the individual does or does not know a particular fact. (Sampling variance in a finite number of items, not the probability of his guessing the answer.)
  
- III. Temporary but general characteristics of the individual  
(Factors affecting performance on many or all tests at a particular time.)
  - A. Health
  - B. Fatigue
  - C. Motivation
  - D. Emotional strain
  - E. General test-wiseness (partly lasting)
  - F. Understanding of mechanics of testing
  - G. External conditions of heat, light, ventilation, etc.
  
- IV. Temporary and specific characteristics of the individual
  - A. Specific to a test as a whole
    - 1. Comprehension of the specific test task (insofar as this is distinct from I B)
    - 2. Specific tricks or techniques of dealing with the particular test materials (insofar as distinct from II A 2)
    - 3. Level of practice on the specific skills involved (especially in psychomotor tests)
    - 4. Momentary "set" for a particular test

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<sup>10</sup>Ibid., p. 568.



TABLE III: Continued

- B. Specific to particular test items
  - 1. Fluctuations and idiosyncrasies of human memory
  - 2. Unpredictable fluctuations in attention or accuracy, superimposed upon the general level of performance characteristic of the individual
  
- V. Systematic or chance factors affecting the administration of the test or the appraisal of test performance
  - A. Conditions of testing--adherence to time limits, freedom from distractions, clarity of instructions, etc.
  - B. Unreliability or bias in subjective rating of traits or performance
  
- VI. Variance not otherwise accounted for (chance)
  - A. "Luck" in selection of answers by "guessing"

The test is split into odd-even items to obtain two sets of test scores. This allows the student to have devoted approximately the same length of time to both parts, assuming the test is correctly constructed.

While reliability is of major importance to a test, the educator should never lose sight of the fact that validity is possibly more the prime requisite of any test. A test that does not measure the objectives of the course for which it is utilized is of no value for purposes of evaluation in that subject.

The basic purpose of a test is to measure some objective. For this reason, tests that are useful for evaluation must be valid as to specific course objectives.

With the problem of validity squarely in mind, there remains only the actual development of the final examination. Secondary points involved in test construction are: economy of time and material, selection of appropriate forms of test questions, formulation of directions, weighting of test sections, and wording of the test items.

Economy of time includes all time used in deciding all of the factors listed in the preceding paragraph in addition to the time occupied in administering, scoring, and evaluating the test.

Economy of material is self-evident. This includes all material used in duplicating, administering, scoring, and the placement of items on the question sheet in such a manner that the materials are used efficiently.

The selection of appropriate forms of test items is related directly to economy of time and material. The length and difficulty of the items will determine the amount of time needed by the student to comprehend the problem and to complete his answer. The length of time used by the scorer to score the test depends upon the ease with which the answers may be evaluated. The selection of appropriate test forms is needed to facilitate the use of material in the most efficient manner possible.

The formulation of directions is extremely important as variance in the reliability may be attributed to improperly-phrased directions. If the directions lack clarity, the students may experience difficulty in understanding the method of taking the test, the response called for, or the amount of time that may be devoted to each section of the test.

Wording of the test items must be clear and leave no room for ambiguity. There should, in an objective test, be no room for discussion of the meaning of any item.

Weighting of sections of the test is necessary to have it conform to the listed course objectives. To be a "fair" test, more weight should be given those items which were emphasized most through the duration of the course.

Shown later in this paper are sample questions that might be used on the final examination of the exploratory typewriting course which is the subject of this paper.

As extensive a sampling as possible of the various knowledges to be gained should be included in the test. With an increased sampling the reliability of the test increases. The simple errors of variance are more obvious when small samplings are used.

## SAMPLE TEST QUESTIONS

Part I. In the following section, if the statement is false, cross out the F (~~F~~). If the statement is true, cross out the T (~~T~~). If you wish to change an answer be sure you completely erase the first answer.

- Sample. All typewriters are blue. T ~~X~~
1. The typist does not lean toward the typewriter. T F
  2. The typist should sit 12 to 18 inches from his machine. T F
  3. There are 60 lines on a sheet of typing paper. T F
  4. In touch typing, the typist should look at the keys. T F
  5. The base of the palms should rest on the typing table. T F
  6. The carriage should always be thrown with the right hand. T F
  7. The paper release lever is used to insert paper in the typewriter. T F
  8. All typewriters have the same centering point. T F
  9. All material must be double-spaced. T F
  10. The tabulator key is used to center material vertically. T F
  11. Paragraphs are usually indented seven spaces. T F
  12. The space bar determines the number of blank lines left in the material we are typing. T F
  13. The shift key is used only with Roman numerals. T F
  14. Five strokes are counted as one word in typing. T F
  15. Gross words and net words are the same thing. T F

Part II. If 40 is the centering point on your typewriter and allowing 5 extra spaces for the bell,

- |  | Left  | Right |
|--|-------|-------|
| 1. What are the margin settings for a 40-space line? | _____ | _____ |
| 2. What are the settings for a 70-space line?        | _____ | _____ |
| 3. What are the settings for a 50-space line?        | _____ | _____ |
| 4. What are the settings for a 60-space line?        | _____ | _____ |

## SAMPLE TEST QUESTIONS--Continued

Part III. In the following statements, indicate with a check mark errors in typewriting or punctuation. In the number column at the right, cross out the number of errors in the statement.

- Sample. Mike ran ✓ to the cars' ✓ door. 0 1 ~~3~~ 4
1. He called Mike ( his chum ) last night. 0 1 2 3 4
2. Here is the list: corn, apples, peas. 0 1 2 3 4
3. Both Mr. and Mrs. Phillips will be there. 0 1 2 3 4
4. Work begun about June 6-- perhaps June 8. 0 1 2 3 4
5. "Whose car is this"? asked Buzz. 0 1 2 3 4
6. "It takes this stuff a little while." 0 1 2 3 4
7. We had a good season in '61. 0 1 2 3 4
8. The boys' will be in pretty soon. 0 1 2 3 4
9. If bob calls, let me spak to him. 0 1 2 3 4
10. I tried, but I did not try enough. 0 1 2 3 4

Part IV. Proofread the following. Circle the errors and place the number of errors on the blank line at the right of each line.

- Sample. Night (baseball) will come to (are) town. S. 2
- The practice of holdin parties on Fridays, 1. \_\_\_\_\_
- Tuesdays, and Wedesndays will have to decease. 2. \_\_\_\_\_
- Parties are of little value to student's who 3. \_\_\_\_\_
- are hope-lessly lost in their studies. 4. \_\_\_\_\_
- Also, students who loose his shoes can clam 5. \_\_\_\_\_
- them at the office. We have won read shoe and 6. \_\_\_\_\_
- won blue shoe that can can not be found. 7. \_\_\_\_\_

The items should be arranged in order of difficulty on the test. Determination of difficulty must, in the first construction of a test, be the opinion of the test maker. For later tests, a statistical analysis of the test items will reveal their discriminating powers.

Discrimination shown by a test item is the ability to separate class groupings with the group of better ability giving more correct responses to an item than the group of lesser ability within the class.

Lastly, a good test will be easy to score. Objectivity enters into the construction of a test at this point. Here objectivity refers to the property of a test which will allow any number of scorers to check the test and arrive at the same score.

This is facilitated by deriving a key that includes all possible answers to each question in advance. Thus, any person can score the test objectively. The key should be constructed in a manner that will allow the scorer to work efficiently and economically with his time.

### Summary

The following actions must be taken to effectively measure and evaluate achievement in a course:

1. The philosophy of the course must be ascertained.
2. Course objectives must be determined.

3. The knowledges to be evaluated must be determined.
4. A plan for measuring achievement must be formed.
5. Objective measurements must be valid, reliable, economical, discriminating, and consistent with the objectives of the course.
6. Subjective ratings must be as impersonal as possible while having the same properties, as much as possible, as objective ratings.
7. Weighting of test sections must conform to the emphasis placed on them during the course.
8. Evaluation should be simplified as much as possible.

To show the use of weighting of test sections, all parts of the sample test items carry the same weight. However, the student's grade for the course is determined in the following manner:

Techniques . . . . .	60%
Speed and accuracy .	20%
Final test . . . . .	<u>20%</u>
Total	100%

Test construction and formulation of a valid evaluation procedure is far from simple if the method is to be a useful tool of measurement and evaluation. A professional person will continually strive to improve his measuring tools in all ways possible.

## Appendix

Shown in this appendix are distributions of speed and accuracy scores for the eighth-grade students at Jefferson Junior High School, Mattoon, Illinois for the school year 1961-62.

One timed writing is recorded each day. The scores for the best three days are averaged to determine a weekly average.

All formulas are from Hardaway and Maier's Tests and Measurements in Business Education.<sup>11</sup>

The legend used in the tables is as follows:

AsM = Assumed mean

M = Mean

c = Correction

Mdn = Median

d = Deviation

N = Number

f = Frequency

S<sub>b</sub> = Scores below mean

f<sub>m</sub> = Frequency at mean

Score = recorded gross words  
or errors

i = Interval

σ = Standard deviation

ll = lower limits of assumed  
mean

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<sup>11</sup>Mathilde Hardaway and Thomas B. Maier, Tests and Measurements in Business Education (Cincinnati: South-Western Publishing Co., 1952), pp. 291-325.



TABLE IV: SPEED IN GWPM FOR THE THIRD WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>a<sup>2</sup></u>
30-28	2	5	10	100	25
27-25	4	4	16	256	16
24-22	10	3	30	900	9
21-19	17	2	34	1156	4
18-16	30	1	30	900	1
<u>15-13</u>	<u>43</u>		<u>120</u>		
<u>12-10</u>	<u>30</u>	-1	-30	900	1
9-7	<u>5</u>	-2	<u>-10</u>	<u>100</u>	<u>4</u>
			<u>-40</u>		
	N = 141			4312	60

$$\text{Mdn} = 11 + \left( \frac{N/2 - S_b}{f_m} \right)$$

$$= 12.5 + \left( \frac{70.5 - 35}{43} \right)$$

$$= 12.5 + .82$$

$$= 13.32$$

$$\sum fd = 80$$

$$c = \sum fd / N = .56$$

$$i = 3$$

$$ci = 1.68$$

$$\overline{AsM} = 14$$

$$M = 15.68$$

$$\sigma = i \sqrt{\frac{fd^2}{N} - c^2}$$

$$= 3 \sqrt{\frac{4312}{141} - .56^2}$$

$$= 3 \sqrt{30.58 - .31}$$

$$= 3 \cdot 5.5$$

$$= 16.5$$

TABLE V: ERRORS IN THIRD WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
14	1	11	11	121	121
11	2	8	16	256	64
10	1	7	7	49	49
9	1	6	6	36	36
8	4	5	20	400	25
7	9	4	36	1296	16
6	9	3	27	729	9
5	15	2	30	900	4
4	16	1	16	256	1
<u>3</u>	30		<u>169</u>		
<u>2</u>	33	-1	-33	1089	1
1	12	-2	-24	576	4
0	8	-3	-24	576	9
			<u>-81</u>		
	N = 141			6284	

$$\begin{aligned}
 \text{Mdn} &= 11 \neq \left( \frac{N/2 - S_b}{f_m} \right) \\
 &= 2.5 \neq \left( \frac{70.5 - 53}{30} \right) \\
 &= 2.5 \neq .58 \\
 &= 3.08
 \end{aligned}$$

$$\begin{aligned}
 \sum fd &= 88 \\
 c &= \sum fd / N = .62 \\
 i &= 1 \\
 ci &= .62 \\
 \frac{ci}{AsM} &= 3 \\
 M &= 3.62
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= i \sqrt{\frac{fd^2}{N} - c^2} \\
 &= 1 \sqrt{\frac{6284}{141} - .62^2} \\
 &= \sqrt{44.56 - .38} \\
 &= \sqrt{44.18} \\
 &= 6.64
 \end{aligned}$$

TABLE VI: SPEED IN GWPM FOR THE FOURTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
33-31	1	5	5	25	25
30-28	4	4	16	256	16
27-25	10	3	30	900	9
24-22	22	2	44	1936	4
21-19	25	1	25	625	1
<u>18-16</u>	28		<u>120</u>		
<u>15-13</u>	38	-1	-38	1444	1
12-10	9	-2	-18	324	4
9-7	<u>4</u>	-3	<u>-12</u>	<u>144</u>	9
			<u>-68</u>		
	N = 141			5654	

$$\text{Mdn} = 11 \neq \left( \frac{N/2 - S_b}{f_m} \right)$$

$$= 15.5 \neq \left( \frac{70.5 - 51}{28} \right)$$

$$= 15.5 \neq .69$$

$$= 16.19$$

$$\begin{aligned} \sum fd &= 52 \\ c &= \sum fd / N = .36 \\ i &= 3 \\ ci &= 1.08 \\ \frac{AsM}{M} &= 17 \\ &= 18.08 \end{aligned}$$

$$\begin{aligned} \sigma &= i \sqrt{\frac{fd^2}{N} - c^2} \\ &= 3 \sqrt{\frac{5654}{141} - .36^2} \\ &= 3 \sqrt{40.09 - .12} \\ &= 3 \cdot 6.31 \\ &= 18.93 \end{aligned}$$

TABLE VII: ERRORS IN FOURTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
14	1	13	13	169	169
11	1	8	8	64	64
10	1	7	7	49	49
9	4	6	24	576	36
8	4	5	20	400	25
7	4	4	16	256	16
6	3	3	9	81	9
5	13	2	26	676	4
4	21	1	21	441	1
<u>3</u>	<u>33</u>		<u>144</u>		
2	40	-1	-40	1600	1
1	13	-2	-26	676	4
0	<u>3</u>	-3	<u>-9</u>	<u>81</u>	<u>9</u>
	N = 141		<u>-75</u>	5049	

$$\begin{aligned}
 \text{Mdn} &= 11 \neq \left( \frac{N/2 - S_b}{f_m} \right) \\
 &= 2.5 \neq \left( \frac{70.5 - 56}{33} \right) \\
 &= 2.5 \neq .43 \\
 &= 2.93
 \end{aligned}$$

$$\begin{aligned}
 zfd &= 69 \\
 c &= zfd/N = .48 \\
 i &= 1 \\
 ci &= .48 \\
 \frac{AsM}{M} &= 3 \\
 M &= 3.48
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= i \sqrt{\frac{fd^2}{N} - c^2} \\
 &= 1 \sqrt{\frac{5049}{141} - .48^2} \\
 &= \sqrt{35.80 - .43} \\
 &= \sqrt{35.37} \\
 &= 5.94
 \end{aligned}$$

TABLE VIII: SPEED IN GWPM FOR THE FIFTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
39-37	1	6	6	36	36
36-34	6	5	30	900	25
33-31	7	4	28	784	16
30-28	15	3	45	2025	9
27-25	17	2	34	1156	4
24-22	19	1	19	361	1
<u>21-19</u>	18		<u>162</u>		
18-16	28	-1	-28	784	1
15-13	22	-2	-44	1936	4
12-10	6	-3	-18	324	9
9-7	<u>1</u>	<u>-4</u>	<u>-4</u>	<u>16</u>	<u>16</u>
			<u>-94</u>		
	N = 141			8322	

$$\begin{aligned}
 \text{Mdn} &= 11 + \left( \frac{N/2 - S_b}{f_m} \right) \\
 &= 18.5 + \left( \frac{70.5 - 57}{18} \right) \\
 &= 18.5 + .75 \\
 &= 19.25
 \end{aligned}$$

$$\begin{aligned}
 \sum fd &= 68 \\
 c &= \sum fd / N = .48 \\
 i &= 3 \\
 ci &= 1.44 \\
 \frac{ci}{AsM} &= 20 \\
 M &= 21.44
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= 1 \sqrt{\frac{\sum fd^2}{N} - c^2} \\
 &= 3 \sqrt{\frac{8322}{141} - .48^2} \\
 &= 3 \sqrt{59.02 - .23} \\
 &= 3 \cdot 7.66 \\
 &= 22.98
 \end{aligned}$$

TABLE IX: ERRORS IN FIFTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
11	1	8	8	64	64
9	3	6	18	324	36
8	3	5	15	225	25
7	5	4	20	400	16
6	8	3	24	576	9
5	13	2	26	676	4
4	24	1	24	576	1
<u>3</u>	30		<u>735</u>		
2	28	-1	-28	784	1
1	22	-2	-44	1936	4
0	<u>2</u>	-3	<u>-6</u>	<u>36</u>	<u>9</u>
			<u>-78</u>		
				5597	

$$N = 141$$

$$\begin{aligned} \text{Mdn} &= 11 \neq \left( \frac{N/2 - S_b}{f_m} \right) \\ &= 2.5 \neq \left( \frac{70.5 - 52}{30} \right) \\ &= 2.5 \neq .61 \\ &= 3.11 \end{aligned}$$

$$\begin{aligned} \sum fd &= 57 \\ c &= \sum fd / N = .40 \\ i &= 1 \\ \frac{ci}{AsM} &= .40 \\ \frac{M}{M} &= 3.40 \end{aligned}$$

$$\begin{aligned} \sigma &= 1 \sqrt{\frac{fd^2}{N} - c^2} \\ &= 1 \sqrt{\frac{5597}{141} - .40^2} \\ &= \sqrt{39.69 - .16} \\ &= \sqrt{39.53} \\ &= 6.28 \end{aligned}$$

TABLE X: SPEED IN GWPM FOR THE SIXTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
48-46	1	8	8	64	64
45-43	1	7	7	49	49
42-40	5	6	30	900	36
39-37	3	5	15	225	25
36-34	12	4	48	2304	16
33-31	17	3	51	2601	9
30-28	14	2	28	784	4
27-25	19	1	19	361	1
<u>24-22</u>	19		<u>106</u>		
21-19	28	-1	-28	784	1
18-16	19	-2	-38	1444	4
15-13	5	-3	-15	225	9
12-10	<u>4</u>	-4	<u>-16</u>	<u>256</u>	16
			<u>-97</u>		
	N = 147			9997	

$$\begin{aligned} \text{Mdn} &= 11 + \left( \frac{N/2 - S_b}{f_m} \right) \\ &= 21.5 + \left( \frac{73.5 - 56}{19} \right) \\ &= 21.5 + .92 \\ &= 22.42 \end{aligned}$$

$$\begin{aligned} \sum fd &= 109 \\ c &= \frac{\sum fd}{N} = .74 \\ i &= 3 \\ \frac{ci}{M} &= 2.22 \\ \frac{AsM}{M} &= 23 \end{aligned}$$

$$\begin{aligned} &= i \sqrt{\frac{fd^2}{N} - c^2} \\ &= 3 \sqrt{\frac{9997}{147} - .74^2} \\ &= 3 \sqrt{68 - .54} \\ &= 3 \cdot 8.21 \\ &= 24.63 \end{aligned}$$

TABLE XI: ERRORS IN SIXTH WEEK

<u>Score</u>	<u>f</u>	<u>d</u>	<u>fd</u>	<u>fd<sup>2</sup></u>	<u>d<sup>2</sup></u>
15	1	12	12	124	144
14	1	11	11	121	121
11	1	8	8	64	64
9	6	6	36	216	36
7	5	4	20	400	16
6	11	3	33	1089	9
5	18	2	36	1296	4
4	27	1	27	729	1
<u>3</u>	26		<u>183</u>		
<u>2</u>	20	-1	-20	400	1
1	24	-2	-48	2304	4
0	<u>7</u>	-3	<u>-21</u>	<u>441</u>	9
			<u>-97</u>		
	N = 147			7184	

$$\begin{aligned}
 \text{Mdn} &= 11 + \left( \frac{N/2 - S_b}{f_m} \right) \\
 &= 2.5 + \left( \frac{73.5 - 51}{26} \right) \\
 &= 2.5 + .86 \\
 &= 3.36
 \end{aligned}$$

$$\begin{aligned}
 \sum fd &= 94 \\
 c &= \sum fd / N = .63 \\
 i &= 1 \\
 ci &= .63 \\
 \frac{\text{AsM}}{M} &= 3 \\
 M &= 3.63
 \end{aligned}$$

$$\begin{aligned}
 \sigma &= i \sqrt{\frac{\sum fd^2}{N} - c^2} \\
 &= 1 \sqrt{\frac{7184}{147} - .63^2} \\
 &= \sqrt{48.87 - .39} \\
 &= \sqrt{48.48} \\
 &= 6.96
 \end{aligned}$$



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