

Simplified Formulae for Test Item Analysis of Multiple Choice Questions

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Abstract: The test item analysis of the question papers consisting of multiple choice questions has great importance. This analysis is quite useful in the identification of questions (test item) which need to be revised or removed. In the conventional formula used for the calculations of facilitation value and discrimination index, the numerator and denominator both contains the marks of each question. In this paper simplified formulae are derived for various test item analysis.

Keywords: Test items, facilitation valve, multiple choice questions, and discrimination index.

1. Introduction

Outcome Based Education (OBE) and Accreditation has become of utmost importance for all educational institutions. The accreditation is of prime importance for technical institutions since India became full signatory of Washington Accord on 13th June 2014. The OBE includes a very important subject called test item analysis. The test item analysis includes calculation of number of parameters viz, facilitation valve (FV), discrimination index and effectiveness of distractors (ED). This paper suggests some simplified formulae for the calculation of FV and DI. The application of three formulas will involve lesser calculations.

1) Facilitation Value

The facilitation value of a test item / questions tells about the easiness of the test items / questions. For calculating the value of facilitation value (FV), the marks obtained by the students of a particular subject of a particular class are tabulated. Then these marks are arranged in descending order. For calculating the facilitation value, the upper group and lower group are considered. Upper group consists of upper 30 percent students while the lower group consists of the lower 30 percent students.

The facilitation value (FV) is calculated as follows –

$$FV = (R_u + R_L) / (2 * n * m) \quad (1)$$

Where,

R_u = marks obtained by the upper group
= $n_1 * m$

R_L = marks obtained by the lower group
= $n_2 * m$

n = number of students in each group

n_1 = number of students in the upper group who answer correctly

n_2 = number of students in the lower group who answer correctly

m = number of marks of each question

2) Simplified Formula for Facilitation Value

It was observed by the author of this paper that the formula for the calculation of facilitation value includes the marks of test items (m) in both the numerator as well as denominator. Therefore, the marks of the test items have been removed from the numerator as well as denominator. This is explained as follows-

The facilitation value as per equation (1) is calculated as

$$\begin{aligned} FV &= (R_u + R_L) / (2 * n * m) \\ &= (n_1 * m + n_2 * m) / (2 * n * m) \\ &= (n_1 + n_2) / (2 * n) \end{aligned}$$

3) Discrimination Index (DI)

Discrimination index is used to see how good a test item is in separating the upper group students from the lower group students.

Discrimination index is given by the formula-

$$\begin{aligned} DI &= (R_u - R_L) / (n * m) \\ &= (n_1 * m - n_2 * m) / (n * m) \end{aligned} \quad (3)$$

Where,

R_u = marks obtained by upper group
= $n_1 * m$

R_L = marks obtained by the lower group
= $n_2 * m$

n_1 = number of students in the upper group who answer correctly

n_2 = number of students in the lower group who answer correctly

m = number of marks of each question.

2. Simplified Formula for Discrimination Index

It was observed by the author that the formula for the calculation of discrimination index includes the marks of test items (m) in both the numerator as well as denominator. Therefore, the marks of the test items have been removed from the numerator as well as denominator. This is explained as follows-

The conventional formula for calculating the Discrimination Index is given by

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$$DI = (Ru - RL) / (n * m) = 30/50$$

$$= (n1 * m - n2 * m) / (n * m) = 6/10$$

$$= (n1 - n2) / n = 0.6$$

The simplified formula for calculating the discrimination index is given by Eq. (4)

1) *Illustrative Example*

An example has been taken for calculating the facilitation value and discrimination index using conventional formula and simplified formula. It is assumed that a group of 15 students take an examination which consists of multiple choice questions having four options i.e., A, B, C and D. Out of these options only one option is correct. The marks obtained by the students along with the options chosen by them are given in the Table 1. The marks obtained by the students are arranged in descending order.

Table 1

Example for calculation of facilitation value and Discrimination Index

Item No.	1	2	3	4	5	Total Marks
Answer Key	C	C	B	C	D	25
Rank						
1	C	C	B	C	D	25
2	C	C	B	C	D	25
3	C	C	B	C	D	25
4	A	C	B	C	D	20
5	C	C	B	C	B	20
6	C	C	B	C	B	20
7	C	D	B	C	D	20
8	C	D	B	C	D	20
9	C	B	A	C	B	15
10	A	C	C	C	B	15
11	C	D	B	C	A	15
12	A	C	C	C	B	15
13	C	B	A	C	D	15
14	A	A	B	C	D	15
15	C	D	B	C	A	15

The upper group consists of 30 percent of total students.

The upper group = $30 * 15 / 100 = 4.5 = 5$ (next higher integer)

Thus, the upper group consists of students i.e., at S.No. 1, 2, 3, 4 and 5.

Similarly the lower group consists of 5 students i.e., at S. No. 11,12,13,14 and 15.

Marks of each question = 5

2) *Facilitation value of Test Item 1 using Conventional Formula*

$$FV = (Ru + RL) / (2n * m) = (n1 * m + n2 * m) / (2n * m)$$

$$= (4 * 5 + 3 * 5) / (2 * 5 * 5) = (20 + 15) / 50$$

$$= 35 / 50$$

$$= 7 / 10$$

$$= 0.7$$

3) *Facilitation Value of Test Item 1 using Simplified Formula*

$$FV = (n1 + n2) / (2 * n)$$

$$= (4 + 3) / 2 * 5$$

$$= 7 / 10$$

$$= 0.7$$

4) *Facilitation Value of Test Item 2 using Conventional Formula*

$$FV = (Ru + RL) / (2n * m) = (n1 * m + n2 * m) / (2 * n * m)$$

$$= (5 * 5 + 1 * 5) / (2 * 5 * 5)$$

$$= (25 + 5) / 50$$

5) *Facilitation Value of Test Item 2 using Simplified Formula*

$$FV = (n1 + n2) / (2 * n)$$

$$= (5 + 1) / 2 * 5$$

$$= 6 / 10$$

$$= 0.6$$

6) *Facilitation Value of Test Item 3 using Conventional Formula*

$$FV = (Ru + RL) / (2n * m)$$

$$= (n1 * m + n2 * m) / (2 * n * m)$$

$$= (5 * 5 + 3 * 5) / (2 * 5 * 5)$$

$$= (25 + 15) / 50$$

$$= 40 / 50$$

$$= 8 / 10$$

$$= 0.8$$

7) *Facilitation Value of Test Item 3 using Simplified Formula*

$$FV = (n1 + n2) / (2 * n)$$

$$= (5 + 3) / 2 * 5$$

$$= 8 / 10$$

$$= 0.8$$

8) *Facilitation Value of Test Item 4 using Conventional Formula*

$$FV = (Ru + RL) / (2 * n * m) = (n1 * m + n2 * m) / (2 * n * m)$$

$$= (5 * 5 + 5 * 5) / (2 * 5 * 5)$$

$$= (25 + 25) / 50$$

$$= 50 / 50$$

$$= 1.0$$

9) *Facilitation Value of Test Item 4 using Simplified Formula*

$$FV = (n1 + n2) / (2 * n)$$

$$= (5 + 5) / 2 * 5$$

$$= 10 / 10$$

$$= 1.0$$

10) *Facilitation Value of Test Item 5 using Conventional Formula*

$$FV = (Ru + RL) / (2 * n * m) = (n1 * m + n2 * m) / (2 * n * m)$$

$$= (4 * 5 + 2 * 5) / (2 * 5 * 5)$$

$$= (20 + 10) / 50$$

$$= 30 / 50$$

$$= 6 / 10$$

$$= 0.6$$

11) *Facilitation Value of Test Item 5 using Simplified Formula*

$$FV = (n1 + n2) / (2 * n)$$

$$= (4 + 2) / 2 * 5$$

$$= 6 / 10$$

$$= 0.6$$

12) *Discrimination Index of Test Item 1 using Conventional Formula*

$$DI = (n1 - n2) / n$$

$$= (4 * 5 - 3 * 5) / (5 * 5)$$

$$= (20 - 15) / 25$$

$$= 5 / 25$$

$$= 0.2$$

13) *Discrimination Index of Test Item 1 using Simplified Formula*

$$DI = (n1 - n2) / n$$

$$\begin{aligned}
 &= (4-3)/5 \\
 &= 1/5 \\
 &= 0.2
 \end{aligned}$$

14) *Discrimination Index of Test Item 2 using Conventional Formula*

$$\begin{aligned}
 DI &= (5*5-1*5)/ (5*5) \\
 &= (25-5)/25 \\
 &= 20/25 \\
 &= 0.8
 \end{aligned}$$

15) *Discrimination Index of Test Item 2 using Simplified Formula*

$$\begin{aligned}
 DI &= (n1 - n2)/n \\
 &= (5-1)/5 \\
 &= 4/5 \\
 &= 0.8
 \end{aligned}$$

16) *Discrimination Index of Test Item 3 using Conventional Formula*

$$\begin{aligned}
 DI &= (5*5-3*5)/ (5*5) \\
 &= (25-15)/25 \\
 &= 10/25 \\
 &= 0.4
 \end{aligned}$$

17) *Discrimination Index of Test Item 3 using Simplified Formula*

$$\begin{aligned}
 DI &= (n1 - n2)/n \\
 &= (5-3)/5 \\
 &= 2/5 \\
 &= 0.4
 \end{aligned}$$

18) *Discrimination Index of Test Item 4 using Conventional Formula*

$$\begin{aligned}
 DI &= (5*5-5*5)/ (5*5) \\
 &= (0)/25 \\
 &= 0.0
 \end{aligned}$$

19) *Discrimination Index of Test Item 4 using Simplified Formula*

$$DI = (n1 - n2)/n$$

$$\begin{aligned}
 &= (5-5)/5 \\
 &= 0.0 \\
 &= 0.4
 \end{aligned}$$

20) *Discrimination Index of Test Item 5 using Conventional Formula*

$$\begin{aligned}
 DI &= (4*5-2*5)/ (5*5) \\
 &= (20-10)/25 \\
 &= 10/25 \\
 &= 2/5 \\
 &= 0.4
 \end{aligned}$$

21) *Discrimination Index of Test Item 5 using Simplified Formula*

$$\begin{aligned}
 DI &= (n1 - n2)/n \\
 &= (4-2)/5 \\
 &= 2/5 \\
 &= 0.4
 \end{aligned}$$

3. Conclusion

In the conventional formula used for the calculations of facilitation value and discrimination index, the numerator and denominator both contains the marks of each question. Simplified formulae have been derived for the test item analysis. An illustrative example has been taken. The calculations for facilitation value and discrimination index have been carried out using both the Conventional Formulae and Simplified Formulae. It has been found that the proposed Simplified Formulae involves lesser calculations.

References

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