

# Expert Judgement Method to Determine Attribute Weights for Effectively teaching Mathematics in High Schools

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**Abstract** — *The present study gives a practical perspective of teaching mathematics for high school students based on analytical research conducted to improve the teaching and learning of mathematics. To develop the ability of problem solving and critical thinking, new pedagogy is implemented in mathematics curriculum. Teachers play an important role in developing new strategies and effectively implementing it in their classrooms. This article is mainly focused for developing teachers' methods of interaction in mathematics classroom. The output of the study is to create an awareness in teachers about the pedagogy and a paradigm shift from teacher-centric method to learner-centric method. According to the study more emphasis should be given to co-operative learning as it considers the students level of understanding, achievement, skill set, style of learning and it builds social harmony between students with different backgrounds. Teachers should develop pedagogy in a way that the students acquire the academic knowledge and develop the skill set to face any kind of challenge in their day-to-day lives.*

**Keywords** — *Mathematics, Teachers, Pedagogy, Learner-centric approach, Attribute Weight Calculation Method, Co-operative learning.*

## I. INTRODUCTION

In today's world, teachers play an important role for teaching mathematics effectively and efficiently mainly focusing on the student-centered approaches. Teachers should deliver the subject so efficiently that the student should develop the skill and values along with the academic knowledge. According to Adunola [1], to bring about desired changes in students, the teaching methods adopted by teachers should be the best. Student centered approach is used by teachers now-a-days as it creates interest, improves critical thinking, analytical research and enjoyment Hesson & Shad [8]. The Lecture method is dominant while explaining definitions, rules, and solving the problems Subahan [17]. In Co-operative learning small groups are formed to maximize their own as well as others learning according to Johnson et al., [10]. According to Johnson and Johnson [11] Co-operative learning is a form of collaborative learning. A co-operative learning is a structured way of learning things forming small groups to achieve the desired goal. In this approach students help each other, develop social skills, improve learning ability, increasing their self-confidence and enthusiasm Pressel [15]. In this method, the group is formed randomly choosing high and low ability students. A common goal is achieved by the students under the supervision of the teacher. Students share their knowledge and try to solve the mathematical problem. Cooperative learning comes under the umbrella of collaborative learning Godshell [7] and Ismail [9]. According to Alessi [2], the students should work in teams to complete a common task. According to Posamentier [14], teaching mathematics means not just to memorize definitions, rules and procedures but to involve students through teamwork, discussion and cooperation. In the present era to face any type of challenge students should be equipped with academic knowledge as well as skill. A practical collaborative research was carried out by Alphonse [3] to improve the teaching and learning of mathematics in Rwanda. According to Trouche [19] and Laborde [12] integration of tools affects the learning and teaching and involving technology into teaching is a lengthy process. Co-operative learning improves communication, leadership qualities, teamwork. These skills are required for employment by Tribe [18].

Now-a-days teachers employ the student-centered approaches to endorse interest, analytical research, critical thinking and delight among students according to Hesson & Shad, [8]. According to Elvis [6], a conducive atmosphere should be created by teachers to develop students learning experiences. Teachers must advance their familiarity about various instructional tactics to inspire the students. ICT integration in education, means technology-based instruction and learning method which closely tells the application of learning technologies in schools. Simon Ghavifekr & Athirah [16] believed that advanced technology and communication devices should be available to students either at home or at school. Teachers should be well

equipped with the knowledge of using ICT (Integration of Information, Communication, and Technology), to improve the teaching methods to promote effective learning. Edmundas et al., [5] applied attribute weight algorithm for determining peculiarities in MADM Methods. The role of collaborative and cooperative education for the progress of students in Malaysia is carried on by Anowar Hossain et al. [4] A self-study on learning to teach mathematics specialists using online course is carried out by Margret [13].

The aim of the current study is to find out the best method for teaching mathematics using weights of attributes obtained by limited number of experts. The main objective of the study is to study the influence of attributes based on expert's judgement and analyze the information. Analytical research method is used in the study.

## II. METHODOLOGY

In the present study highly qualified high school teachers specialized in mathematics having teaching experience ranging between 5-20 years were interviewed to find the best teaching methods implemented in the classroom. The most important attributes considered for effective teaching are

- Lecture method-  $x_1$
- Co-operative learning-  $x_2$
- Technology Based Teaching-  $x_3$
- Hand Holding-  $x_4$
- Others - $x_5$

Null Hypothesis ( $H_0$ ): Equal weightage is not given to all the methods.

## III. ALGORITHM

To calculate the importance of attributes, the expert's judgment which is presented by Kendall (1970) is applied.

This method was implemented in the following stages.

- calculate  $t_{jk}$
- calculate weights  $q_j$
- calculate S
- calculate  $T_k$
- calculate W
- calculate  $\chi^2$
- testing the statement  $\chi^2 > \chi^2_{tab}$

The values  $t_{jk}$  for testing were ranked from highest to lowest. The average attribute is calculated by using the formula

$$t_j = \frac{\sum_{k=1}^r t_{jk}}{r} \quad (1)$$

where  $t_{jk}$  is the ranking of the attributes

The weights of the attributes are the quotient of sum of attributes average by the average value of each attribute

$$q = \frac{\sum_{j=1}^n \bar{t}_j}{t_j} \quad (2)$$

The sum of weight should be equal to 1

$$\sum_{j=1}^n \frac{\sum_{j=1}^n \bar{t}_j}{\bar{t}_j} = 1 \quad (3)$$

Reliability is verified by the coefficient of concordance given by

$$W = \frac{12 S}{r^2 (n^3 - n) - r \sum T_k^2} \quad (4)$$

Where S is the total square deviation of the rankings of the attribute,  $T_k$  is the index of reiterated ranks in the r rank, r is the number of respondents and n is the number of evaluation attributes.

The deviation of the attribute ranking

$$S = \sum_{j=1}^n \left[ \sum_{k=1}^r t_{jk} - \frac{1}{n} \sum_{j=1}^n \sum_{k=1}^r t_{kj} \right]^2 \quad (5)$$

Where  $t_{jk}$  is the rank given by the k respondent to the j attribute.

However, the calculated value W is stochastic, and the coefficient concordance has to be calculated.

Kendall (1970) has shown that, when the value of  $n > 7$ , the value  $\chi^2 = WR(N-1)$  has a distribution with degrees of freedom  $v = n-1$ , where n is the number of the attributes and r is the opinion of no. of experts.

The significance  $\chi^2$  of the concordance coefficient is calculated as

$$\chi^2 = W.r.(n-1) = \frac{12 S}{rn(n+1) - \frac{1}{(n-1) \sum_{k=1}^r T_k^2}} \quad (6)$$

If the  $\chi^2$  calculated value is greater than the  $\chi^2$  tabulated value the opinion of the judges is accepted and if the  $\chi^2$  calculated value is lesser than the  $\chi^2$  tabulated value the opinion is rejected at 5% level of significance (i.e.  $\alpha = 0.05$ ).

Table 1: Values obtained by interviewing highly specialized high school mathematics teachers.

|                             | Efficiency attribute $x_j$ ; where $j=1,2,\dots,5$ |       |       |       |       |
|-----------------------------|--|-------|-------|-------|-------|
| Experts $k=1, 2, \dots, 30$ | $x_1$  | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
| 1                           | 3  | 5     | 4     | 2     | 1     |
| 2                           | 1  | 4     | 3     | 5     | 2     |
| 3                           | 2  | 5     | 3     | 4     | 1     |
| 4                           | 3  | 5     | 4     | 2     | 1     |
| 5                           | 2  | 5     | 3     | 4     | 1     |
| 6                           | 3  | 5     | 4     | 2     | 1     |
| 7                           | 1  | 3     | 5     | 4     | 2     |

|    |   |   |   |   |   |
|----|---|---|---|---|---|
| 8  | 2 | 5 | 3 | 4 | 1 |
| 9  | 5 | 4 | 2 | 3 | 1 |
| 10 | 1 | 3 | 5 | 4 | 2 |
| 11 | 1 | 5 | 4 | 3 | 2 |
| 12 | 1 | 5 | 4 | 2 | 3 |
| 13 | 3 | 5 | 4 | 2 | 1 |
| 14 | 3 | 5 | 4 | 1 | 2 |
| 15 | 1 | 5 | 3 | 4 | 2 |
| 16 | 2 | 5 | 3 | 4 | 1 |
| 17 | 2 | 5 | 4 | 3 | 1 |
| 18 | 1 | 5 | 3 | 4 | 2 |
| 19 | 4 | 2 | 3 | 1 | 5 |
| 20 | 2 | 4 | 3 | 1 | 5 |
| 21 | 3 | 4 | 5 | 2 | 1 |
| 22 | 5 | 4 | 3 | 1 | 2 |
| 23 | 2 | 4 | 5 | 3 | 1 |
| 24 | 3 | 5 | 4 | 1 | 2 |
| 25 | 4 | 3 | 5 | 2 | 1 |
| 26 | 5 | 4 | 1 | 2 | 3 |
| 27 | 3 | 4 | 2 | 5 | 1 |
| 28 | 3 | 2 | 5 | 4 | 1 |
| 29 | 4 | 3 | 2 | 5 | 1 |
| 30 | 5 | 3 | 1 | 4 | 2 |

#### IV. RESULTS AND DISCUSSION

The values obtained by interviewing highly specialized high school mathematics teachers is presented in table 1. Algorithm for weight establishment is shown in table 2. The values of attributes obtained using the algorithm are  $w_1 = 0.18$ ,  $w_2 = 0.28$ ,  $w_3 = 0.23$ ,  $w_4 = 0.20$ ,  $w_5 = 0.12$ . Maximum importance (weight) is given to the second attribute, which is co-operative learning.

Generally, the teachers of Mathematics explain the concepts on the chalk board and the students copy these concepts in their notebooks. The techniques taught are practiced as exercise questions by the students. In our society 'Chalk and talk' concept has deeper roots. In the present situation new teaching strategies should be developed by teachers. There should be a shift from teacher-centric method to learner-centric method. Students

enjoy these methods; it improves their interest in the subject and develops critical thinking. Co-operative learning improves communication, leadership qualities, teamwork.

Table 2: Algorithm for weight establishment

| Experts k=1, 2,...30   | $x_1$  | $x_2$ | $x_3$ | $x_4$ | $x_5$ |
|--|--|-------|-------|-------|-------|
| Sum of Ranks<br>$t_j = \sum_{k=1}^{30} t_{jk}$   | 80   | 126   | 104   | 88    | 52    |
| Average attribute rank value<br>$t_j = \frac{\sum_{k=1}^r t_{jk}}{r}$                  | 2.67   | 4.20  | 3.47  | 2.93  | 1.73  |
| Attribute rank   | 1  | 2     | 3     | 4     | 5     |
| Attribute weight<br>$q = \frac{\sum_{j=1}^n \bar{t}_j}{t_j}$                           | 0.18   | 0.28  | 0.23  | 0.20  | 0.12  |
| $\sum_{k=1}^{30} (t_{jk} - t_j)^2$   | 50.67  | 26.8  | 37.47 | 49.87 | 33.87 |
| Dispersion (variance)<br>$\sigma^2 = \frac{1}{r-1} \sum_{k=1}^{30} (t_{jk} - t_j)^2$   | 1.75   | 0.92  | 1.29  | 1.72  | 1.17  |
| Standard deviation $\sigma$  | 1.32   | 0.96  | 1.14  | 1.31  | 1.08  |
| Variation $\beta_j = \frac{\sigma}{t_j}$   | 0.49   | 0.23  | 0.33  | 0.45  | 0.62  |
| Ranking sum average<br>$V = \frac{1}{r} \sum_{j=1}^5 \sum_{k=1}^{30} (t_{jk} - t_j)^2$ | $0.2(80+126+104+88+52) = 90$   |       |       |       |       |
| Total square ranking deviation<br>$S = \sum_{j=1}^5 (\sum_{k=1}^{30} t_{jk} - V)^2$    | $(80-90)^2 + (126-90)^2 + (104-90)^2 + (88-90)^2 + (52-90)^2 = 3040$ |       |       |       |       |
| Coefficient of concordance   | 0.34   |       |       |       |       |

|   |  |
|---|--|
| $W = \frac{12 S}{r^2 (n^3 - n) - r \sum T_k}$   |  |
| Significance of concordance Coefficient<br>$\chi^2 = W.r.(n-1) = \frac{12 S}{rn(n+1) - \frac{1}{(n-1) \sum_{k=1}^r T_k}}$ | $\chi^2_{\text{Cal}} = 40.53$  |
| Tab value at 4 df   | $v = n - 1 = 5 - 1 = 4; \chi^2_{\text{tab}} = 13.3$                      |
| Compatibility of expert judgement   | 40.53 > 13.3, The hypothesis about agreement of the experts is accepted. |

## V. CONCLUSION

The best method according to this algorithm is co-operative learning method. According to the study more emphasis should be given to co-operative learning as it considers the students level of understanding, achievement, skill set, style of learning and it builds social harmony between students with different backgrounds. Teachers should develop pedagogy in such a way that the students learn the academic knowledge and develop the skill set to face any kind of challenge in their day-to-day lives.

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