

# Quality Improvement in Higher Education through Normalization of Student Feedback data Using Evolutionary Algorithm

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## Abstract

Student Feedback is a vital information that helps not only to evaluate the existing academic practices but also to rectify the discrepancies if any, enabling continuous quality improvement. Often the educational institutions make decisions on the teaching and delivery strategies and requirements of the students based on the students' Feedback. Due to various factors like the composition of the class in terms of student background, personal relationship with the teacher and other factors, the Feedback generally remains so scattered that at times it may not be possible to arrive at a conclusion based on the feedback. Any decision, based on this already obscure feedback, can only be flawed. This underscores the necessity of normalizing the Feedback data so that one can elicit a clear numerical value for each item in questionnaire rather than quantifying the same in terms of number of responses 'for' and 'against' the item. Employing an artificial intelligence method, this paper aims at developing an efficient scheme for the analysis of students' Feedback taking into account the above mentioned factors. Because of its ease of use, the proposed feedback evaluation mechanism can be used on monthly basis in a given academic year, thus achieving continuous improvement of quality. It is hoped that this can serve as an effective tool in improving the learning and teaching methods, standards of education and ultimately the quality of higher education.

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## Keywords

*Higher Education, Normalization*

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## Introduction

Education encompasses various aspects like providing the students the required knowledge that is not only confined to text books, inculcating the culture of critical thinking and ultimately preparing the student for the real world scenario. In a teaching - learning system, the quality is weighed by how far the above mentioned objectives are met. Students feedback is the most common way of verifying the same. It is not uncommon to get a feedback which is so scattered

that one cannot rely on the feedback and hence is unable to decide on the required course of action. The open literature speaks less of quantifying the evaluation process. Wen et al [1] have used the grey relational grade for the same which involves the use of the Eigen vector method.

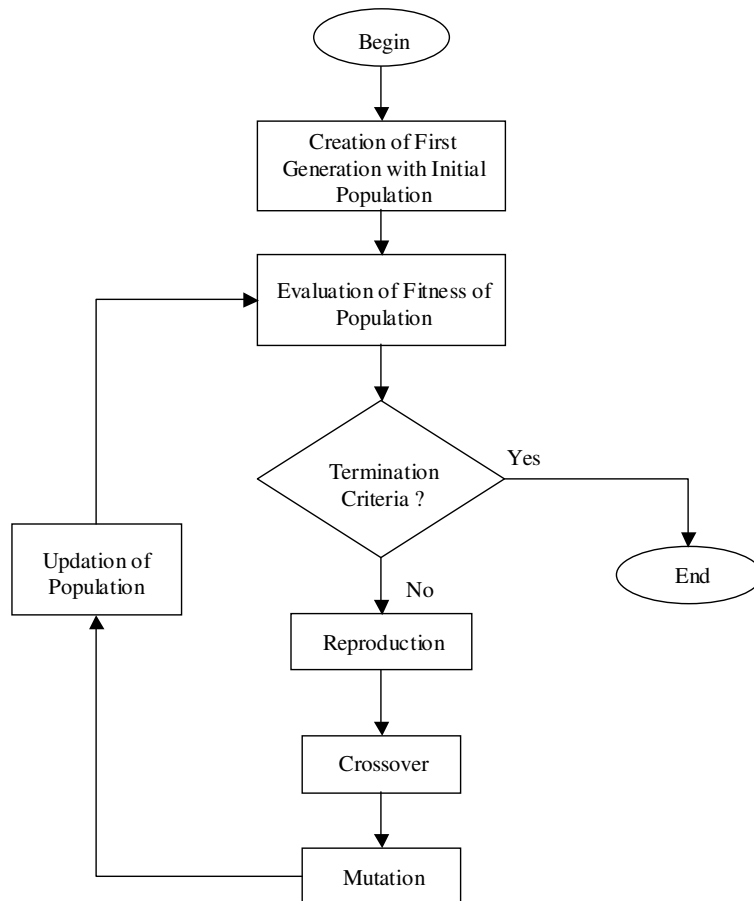
Robert and Mary Hogg [2] discussed the application of the corporate Total Quality Management culture in education where the evaluation of quality is discussed. Kifor and Oprean [3] proposed a generic process model for higher education institutions but again, a method of quantifying the system quality was not presented. Use of evolutionary techniques for quality improvement in education systems is scarce in the literature.

This papers aims at formulating a mathematical model that quantifies and optimizes the student Feedback using evolutionary algorithm ,an artificial intelligence technique. Quantifying also obviates the ambiguity caused by the starkly different answers for a given item of the questionnaire and makes the Feedback more ‘reliable’ and hence eases the decision making process. Genetic algorithm, a widely used evolutionary optimization technique is employed to optimize the system.

## **2 Genetic Algorithm**

Genetic algorithm (GA) is a kind of evolutionary technique that emulates biological theories that are useful in solving optimization problems. According to Darwin’s *survival of the fittest* evolutionary theory, only the most potential elements in a population are likely to survive and

generate offspring. The operation of GA begins with a population of random strings representing the design variable. Each string is evaluated to find the fitness function. The three main GA operators - reproduction, crossover and mutation are applied on the random population to create new population. The population is evaluated and tested until the termination criterion is met, iteratively altered by the GA operators. Generation in GA represents the cycle of operation by the genetic operators and the evaluation of the fitness function. **Figure 1** shows the principle of Genetic algorithm.



**Figure 1 Flowchart of Genetic algorithm**

## 2.1 Objective and Fitness Function

**An objective function is a measuring mechanism that is used to evaluate the status of a chromosome. Each chromosome is individually going through the evaluating exercise. To maintain uniformity, the objective function value is mapped into a fitness value.**

## 2.2 Selection Methods

Individuals for producing offspring are chosen using a selection strategy after evaluating the fitness value of each individual in the selection pool. Each individual in the selection pool receives a reproduction probability depending on its own fitness value and the fitness value of all other individuals in the selection pool.

## 2.3 Genetic Operators

There are two main genetic operators are used in genetic algorithm. They are crossover and mutation.

### *Crossover*

In the crossover operation, new strings are created by exchanging information among strings of the mating pool. The two strings participating in the crossover operation are known as *parent strings* and the resulting strings are known as *child strings*. The child strings produced may be good or not, which depends on the performance of crossover site. The effect of crossover may be beneficial or detrimental. In order to preserve some good strings that are already present in the mating pool, not all strings in the mating pool are used in crossover. A crossover operator is mainly responsible for the search of new strings even though a mutation operator is also used for the purpose sparingly.

### ***Mutation***

After crossover offspring undergo mutation. Offspring variables are mutated by the addition of small random values (size of the mutation step), with low probability. The need for mutation is to create a point in the neighborhood of the current point, thereby achieving local search around the current solution. Mutation is also used to maintain diversity in the population. The probability of mutating a variable is set to be inversely proportional to the number of variables (dimensions).

At each generation a new set of approximation is generated by the process of selecting individuals according to their level of fitness in the problem domain and breeding them together using reproduction, crossover and mutation operators borrowed from the natural genetics.

### 3 Problem Formulation and Analysis Procedure

The proposed Feedback evaluation procedure consists of two stages.

*Stage One:*

- Students' response to ten items in the questionnaire is obtained.
- These responses are optimized using genetic algorithm.

*Stage Two:*

- Obtaining weighing factors from teachers, for the same items in the questionnaire.
- Obtaining optimal weighing factor for each item.
- Using the optimized student response and the optimized weighing factor, a module evaluation quotient (MEQ) is obtained.

The questions are then categorized specific to *student*, *teacher* and *facilities* from which the respective factors and indices are arrived at. An evaluation band is proposed to serve as benchmark to evaluate the quality of the existing system. **Figure 2** shows the flow chart of the proposed analysis procedure.

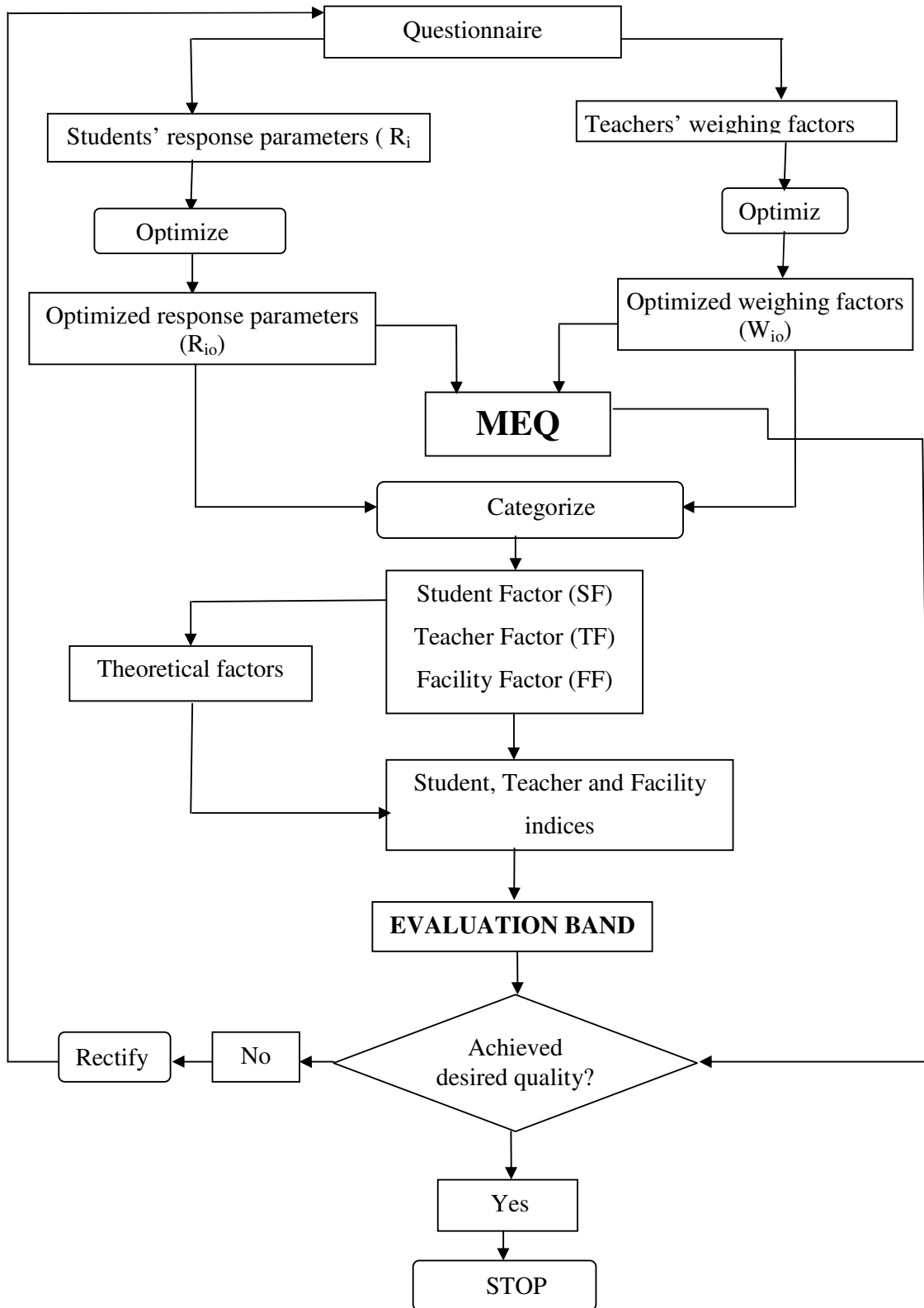


Figure 2 Flow Chart of the Analysis Procedure

#### 4 Mathematical Modeling

Let

'N' = number of students chosen a particular module

$N_s$  = number of students took part in the module evaluation questionnaire.

'i' = number of questions

' $R_i$ ' = students response on question i

T' = number of teachers working in the institution

$T_s$ ' = number of teachers took part in the survey

$T_i$ . = response of the teacher on question i

$R_i^{Opt}$  = optimum student response factor for question i

The objective function  $OBJ_{SR}$  is given by

Minimize

$$OBJ_{SR} = \sum_{i=1}^i \sum_{j=1}^{N_s} \left| (R_1^{Opt} - R_1) + (R_2^{Opt} - R_2) + \dots + (R_{i-1}^{Opt} - R_{i-1}) + (R_i^{Opt} - R_i) \right| \quad (1)$$



The same questionnaire was given to the teachers and the weighing factor for each item is sought.

For optimization of the weighing factors, the objective function is given by

Minimize

$$OBJ_{TWF} = \sum_{i=1}^i \sum_{j=1}^{T_s} \left| (W_1^{Opt} - W_1) + (W_2^{Opt} - W_2) + \dots + (W_{i-1}^{Opt} - W_{i-1}) + (W_i^{Opt} - W_i) \right| \quad (2)$$

The MEQ is defined as the product of optimized student response terms and the corresponding optimum weighing factors, as given by equation 3.

$$MEQ = \sum_{i=1}^i \left[ W_1^{Opt} \times R_1^{Opt} + W_2^{Opt} \times R_2^{Opt} + \dots + W_i^{Opt} \times R_i^{Opt} \right] \quad (3)$$

Theoretical value of this MEQ is given as

$$TMEQ = \sum_{i=1}^i \left[ (W_1^{Opt} \times 100) + (W_2^{Opt} \times 100) + \dots + (W_{i-1}^{Opt} \times 100) + (W_i^{Opt} \times 100) \right] \quad (4)$$

Students' response and the corresponding optimum values given by GA are furnished in

**Table 1.**

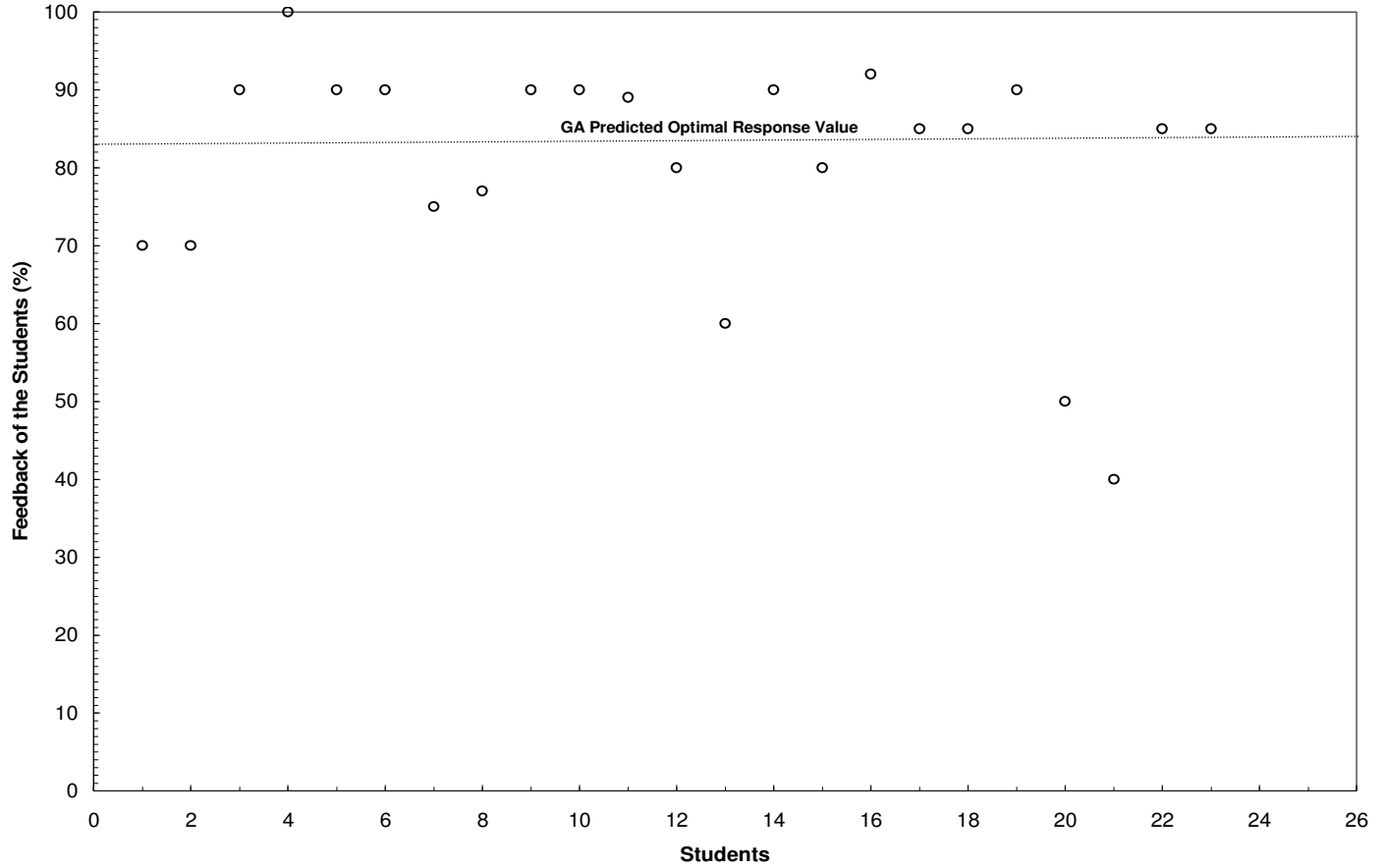
The GA also finds the optimum weighing factors that are shown in **Table 2.** A sample graph indicating the feedback of the students for Question No. 1 is shown in **Figure 3** for indicative purposes.

**Table 1 Response of the students and the corresponding optimum values obtained by genetic algorithm**

Q.No.	Student Number																							Opt.value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
<b>Students related factors</b>																								
<b>1</b>	70	70	90	100	90	90	75	77	90	90	89	80	60	90	80	92	85	85	90	50	40	85	85	<b>83.2918</b>
<b>2</b>	90	60	80	100	85	99	60	76	80	92	85	85	50	70	75	90	90	100	90	55	85	90	90	<b>83.7830</b>
<b>3</b>	100	61	80	90	85	100	60	67	70	98	91	65	44	85	79	85	84	90	70	55	73	80	85	<b>83.9346</b>
<b>Teaching related factors</b>																								
<b>4</b>	80	65	82	100	85	99	60	60	82	95	90	80	70	85	85	90	80	83	90	56	66	50	90	<b>79.9729</b>
<b>5</b>	90	66	84	100	90	100	65	66	84	98	78	60	50	90	90	90	82	90	85	80	59	75	88	<b>79.7036</b>
<b>6</b>	80	55	77	95	90	90	70	75	75	97	90	60	80	89	95	80	95	20	80	70	60	50	90	<b>78.1837</b>
<b>7</b>	90	54	85	100	90	100	70	78	95	90	90	75	40	90	88	95	78	80	80	73	95	50	95	<b>86.2322</b>
<b>8</b>	80	66	85	100	85	90	65	73	74	96	89	55	19	90	80	75	90	95	85	75	54	75	90	<b>78.8860</b>
<b>Facilities related factors</b>																								
<b>9</b>	75	29	75	80	90	100	65	58	78	90	70	70	44	85	87	95	93	100	88	60	53	50	85	<b>77.2800</b>
<b>10</b>	90	60	50	90	85	90	70	65	75	95	85	50	20	89	84	90	80	85	75	71	90	55	90	<b>84.1907</b>

**Table 2 Weighing factors given by teachers and the corresponding optimum values by genetic algorithm**

Q.No	Teacher number														Opt.value
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<b>1</b>	10	10	15	5	20	5	5	5	5	13	20	10	5	5	<b>09</b>
<b>2</b>	20	12	15	10	10	10	5	10	20	14	10	11	15	15	<b>12</b>
<b>3</b>	10	6	5	10	10	5	5	20	30	10	5	10	15	10	<b>07</b>
<b>4</b>	10	12	5	5	10	25	15	7	5	8	10	13	20	25	<b>08</b>
<b>5</b>	10	12	15	30	10	30	30	15	10	13	20	11	5	10	<b>23</b>
<b>6</b>	5	8	8	10	10	10	10	10	5	8	10	9	5	5	<b>08</b>
<b>7</b>	10	8	5	5	10	5	10	10	5	8	5	7	10	5	<b>07</b>
<b>8</b>	10	8	10	5	5	0	5	8	5	4	5	7	5	10	<b>06</b>
<b>9</b>	10	12	10	15	10	5	5	10	5	10	5	13	15	10	<b>11</b>
<b>10</b>	5	12	12	5	5	5	10	5	10	12	10	9	5	5	<b>09</b>



**Figure 3 Graph indicating the feedback of the students for the questionnaire (Corresponds to question No: 1) and GA based optimum value**

The total number of items (ten) in the questionnaire are categorized into student, teacher and facility specific.

Let

s = Number of student specific questions, 3 in this case

t = Number of teacher specific questions, 5 in this case

f = Number of facility specific questions, 2 in this case

Then,

**a.** The student factor is given by  $SF = \sum_{s=1}^3 W_{os} \times R_{os}$

(5)

The theoretical value of student factor is given by  $TSF = \sum_{s=1}^3 W_{os} \times 100$

(6)

**b.** The teacher factor is given by  $TF = \sum_{t=4}^8 W_{ot} \times R_{ot}$

(7)

The theoretical value of teacher factor is given by  $TTF = \sum_{t=4}^8 W_{ot} \times 100$

(8)

**c.** The facility factor is given by  $FF = \sum_{f=9}^{10} W_{of} \times R_{of}$

(9)

The theoretical value of facility factor is given by  $TFF = \sum_{q=9}^{10} W_{of} \times 100$

(10)

Based on these values the Module, Student, Teacher and Facility indices are defined as follows.

$$\text{Module Index } MI = \frac{MEQ}{TMEQ}$$

(11)

$$\text{Student Index } SI = \frac{SF}{TSF}$$

(12)

$$\text{Teacher Index } TI = \frac{TF}{TTF}$$

(13)

$$\text{Facility Index } FI = \frac{FF}{TFF}$$

(14)

#### 4.1 Evaluation band

To make the interpretation of the whole exercise easier and to enable one 'visualize' the scenario, a unique banding scheme is proposed. It is to be mentioned, however that this banding is only an indicative and a different scheme can be adopted based on how strict one wants the quality system should be. Table 3 shows the proposed banding.

**Table 3 Proposed Banding**

<b>Index value</b>	0-40	41-60	61-75	76-100
<b>Color of the band</b>	Red	Yellow	Blue	Green

## 4.2 Illustration

As mentioned earlier, the questions are categorized specific to student, teacher and facilities. Referring to the sample questionnaire in the Appendix, questions 1-3 are students related, 4-8 are teacher related and 9-10 are facilities related.

Using equations (5) to (10) given above the various indices are calculated as given below:

$$\begin{aligned} SF &= \sum_{s=1}^3 W_{os} \times R_{os} \\ &= [(9 \times 83.2918) + (12 \times 83.783) + (7 \times 83.9346)] \\ &= 2342.564 \end{aligned}$$

and

$$\begin{aligned} TSF &= \sum_{s=1}^3 W_{os} \times 100 \\ &= (9 + 12 + 7)100 = 2800 \\ \text{Student Index} &= \frac{2342}{2800} \times 100 = 83.6 \end{aligned}$$

$$\begin{aligned} TF &= \sum_{t=4}^8 W_{ot} \times R_{ot} \\ &= [(8 \times 79.9729) + (23 \times 79.7036) + (8 \times 78.1837) + (7 \times 86.2322) + (6 \times 78.886)] \\ &= 4175.377 \end{aligned}$$

Similarly for teacher,

For facilities,

$$\begin{aligned} TTF &= \sum_{t=4}^8 W_{ot} \times 100 \\ &= (8 + 23 + 8 + 7 + 6)100 = 5200 \\ \text{Teacher Index} &= \frac{4175.377}{5200} \times 100 = 80.28 \end{aligned}$$

$$FF = \sum_{f=9}^{10} W_{of} \times R_{of}$$

$$= (9 \times 77.28) + (11 \times 84.1907) = 1621.617$$

and

$$TFF = \sum_{f=9}^{10} W_{of} \times 100 = (9 + 11)100 = 2000$$

$$Facility\ Index = \frac{1621.617}{2000} \times 100 = 81.05$$

Finally, the module index  $MI = \frac{MEQ}{TMEQ} = \frac{8139.6}{10000} \times 100 = 81.39$

Following the banding scheme, it is observed that all the indices are falling in the 'Green' banding. From this it is clear that the existing quality condition for this particular module-student- teacher-facilities combination is 'good'.

## 5 Advantages of the proposed method

The proposed method has the following advantages:

- i.* Influence of responses that deviate very much from other 'majority' is considered. But it does not affect the response of the rest of the masses.
- ii.* Teachers' opinion is included in the model. Hence this does not suffer from the 'lack of exposure' or 'biasness' factor that may prevail among the students.
- iii.* Some mathematical models emphasize restriction on type or spread of data used for analysis. This method obviates that pre requisite.



## 6 Conclusion

A novel method of genetic algorithm based normalized students' feedback evaluation scheme is presented. Since the proposed scheme numerically quantifies the quality parameters, looks simple to assess the feedback. This helps to initiate corrective actions in the right direction rather than focusing attention at a wrong point. Due its simplicity the proposed method can be applied at desired intervals in a given academic year, thereby enabling corrective action so that the end results will be fruitful This can be seen in contrast to a traditional Feedback system which is normally considered only at the end of the semester/year and does not serve the purpose for the present students. It is hoped that the proposed methodology could prove to be an effective means of determining and enhancing the quality of higher education institutions.

## 7 References

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**Appendix**  
**MODULE EVALUATION QUESTIONNAIRE\***

*Please furnish the weighing factors in percentages for the following according to your opinion:*

S.No	Questions	Scale: 0-100 Total=100%
1	Understanding of the learning outcomes of the module (Have you understood the learning outcomes of the module)	
2	Class room interaction/discussion (Discussion with tutor and clarification of doubts)	
3	Rate your 'out of the class' learning of this module (Home work, study, discussion with your class mates, seminars and self study)	
4	Teaching methodology (Use of teaching aids and teaching methods)	
5	Delivery of the lecture by the tutor (Clarity, flow and conduct of the classes)	
6	Relevance of the tutorials and assignments to practical situation (Application of the tutorial/assignment problem in solving the real time problems)	
7	Feedback on the assessments (Tutor discussed your performances and guided you for betterment)	
8	Level of usefulness of earlier modules you have studied	
9	Library facilities with respect to this module (Availability of text books, hand books and references materials related to the module)	
10	Class room environment (Class room facility, arrangements and comfort)	

\*  
*This questionnaire is used*

*purely for the academic purposes and this is conducted as a part of the research work.*