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An Assessment of Quality of Higher Education Using Six Sigma – A Study in West Bengal, India

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Abstract: Education plays a very important role in the growth and prosperity of any nation. West Bengal, a well-known state of eastern India has witnessed a significant expansion in the recent years both in number of institutions and student enrolment. The present study aims to evaluate the effectiveness of the higher education institutions in providing quality education. Students' rating of teaching is world-wide acceptable method of measuring the quality of higher education. The overall experience gained by the students during their academic journey in their institutions is a key factor to determine the institutional quality. The study covers rural and urban areas of three districts in West Bengal namely Purba Medinipur, Paschim Medinipur and Purulia. A structured questionnaire containing 34 items on quality of higher education has been used for the purpose of the study. The respondents have been asked to rate the quality of education using the five point rating scale. The opinions of the students are analysed through six sigma analytical tool. Sigma rating for each teaching elements for rural and urban area has been measured. The results identify the important variables hindering the quality of higher education as perceived the students for both rural and urban areas.
Keywords: Higher education, Quality, Student perception, Six sigma, India.

INTRODUCTION

Higher education is the backbone of any society. It is the quality of higher education that decides the quality of human resources in a country [1].

No country can achieve sustainable development without sustainable investment in human capital. During the twentieth century, education, skill and the acquisition of knowledge have become crucial determinants of people and nations' productivity [2]. Higher education has been found to be significantly related to the human development index and greater for the disadvantaged groups [3]. The Higher education system in India is large and complex. India has the third largest higher education system in the world, behind China and the United States. The higher education system in India grew rapidly after independence [4]. But, the quality of Indian higher education system lags behind quantitative expansion. The overall quality scenario of higher education in India does not match with the global quality standards. Quality has become the defining element of education in the 21st century in the context of new social realities [5]. The higher education institutions in India are in need of infusion of quality and clarity on the approach of building world class educational institutions in the Indian context and environment. New benchmarks of quality need to be defined to help overall system to move up on the quality spectrum. Research assessment and national ranking of Indian educational institutions can play an important role in improving performance and quality of academic institutions. The British Standard Institution define quality as "the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs". Another analysis views the quality as culture and especially with its structural component, including the design and functioning of institutional governance and management [6]. In the present paper an attempt has been made to examine the quality of higher education in West Bengal, India, from the view point of students.

The process of improving the quality of higher education is a dynamic one and many higher education institutions continuously improve their teaching based on the students' perceptions [7]. In recent times, higher education institutions have paid increasing attention to the views of students and are obtaining feedback on

their experience of learning and teaching through internal surveys [8]. The approach of using students' evaluations to monitor the students experience has proved to an effective and essential component of the quality management process in higher education institutions [9]. Students evaluating teaching effectiveness are considered as an effective method of monitoring the quality of teaching and learning process in the higher education institutions [10]. The assessment of educational quality under the academic programme, through students' satisfaction, is one of the important aspects regarding quality management in higher education [11]. The information obtained through students' evaluating teaching effectiveness can be used to identify the strength and weakness of the teaching faculty, and it could help in making recommendations to improve existing teaching practices. They are also employed as an incentive for career growth [12]. Also, several studies indicate that the students rating are the widely accepted measures for evaluating teaching quality [13]. A more recent study investigated a general theoretical model linking students' demographic characteristics, perceptions and study behaviour with measures of outcome, and in particular, compared three accounts of the causal relationship between perceptions and study behaviour. They conclude that there exists a bidirectional causal relationship between variations in students' perceptions of the academic environment and variations in their study behaviour [14]. It is suggested that for improving quality, higher educational institution should try to engage themselves in the campus placement activities. Infrastructure should be improved and also be provided modern equipments and learning materials [15].A more recent study utilises a performance grading system to rate the teaching facilities offered at the higher education institutions using six sigma model [16].Six Sigma is both a philosophy and a methodology that improves quality by analysing data with statistics to find the root cause of quality problems and to implement controls [17]. A synergistic approach created by analysing and simultaneously using the benefits of Six Sigma plays an important role in the development and improving the quality of a higher education institution [18]. Using six sigma tools such as statistical process control lean manufacturing, failure mode and effects analysis can help in the development of sustainable higher quality educational process [19]. Six Sigma is the best strategy for quality education system for its quality improvement [20]. There exists a debate over the applicability of the six sigma concepts for the academic environment as they are only successful in manufacturing sector. Any business without a focus on customer satisfaction is at the mercy of the market [21]. As students assume the role both of "primary customer" and "end user" of the higher education sector, their opinion and satisfaction is vital in improving the quality of teaching and learning offered in a particular programmes. However, to accomplish this, a quality-rating scale which is entirely derived by students is necessary to gauge the teaching and learning process [22]. As a measure to fulfil this need, the present study utilises a six sigma model to arrive at a six-point quality-rating scale based on the number of "defects" (i.e. non-conformance) captured from the responses of the students. Each one of the "six" points in the rating scale is defined statistically based on the calculation of both "defects per opportunity" (DPO) and "defects per million opportunity" (DPMO).

MATERIALS AND METHODS

Objective

Though there are some studies on higher education in West Bengal, number of studies on the quality of higher education in the state is very limited [23-27].The major objective of the study is to assess the quality of higher education in the state of West Bengal in India. The specific objectives are as follows: (i) Assessing quality of higher education through 34 indicators of teaching and learning using student feedback. (ii) It has also been attempted whether there is any difference in the quality across regions i.e. rural and urban. (iii) An attempt has also been made to identify the major problem areas to facilitate policy formulation.

Methods

This study was conducted at 10 general degree colleges in the three districts namely PaschimMedinipur, PurbaMedinipur and Purulia in the state of West Bengal in India. The colleges under survey were: Dantan College, Hijli College, Raja N. L. Khan Women's College, SBSSM College, Sukumar Sengupta Mahavidyalay, Khejuri College, P K College, Arsha College, Bandwan College and J. K. College. The students of Bachelor in Arts (B.A.) and Science (B.Sc.) who are pursuing their 2nd and 3rd year of their 3-year degree programme participated in the survey and gave their objective responses. A total of 1311 students of different colleges gave their perceptions through responses in the designed questionnaires. Survey details by gender and region are presented in Table 1.

Table-1: Percentage of Respondents Selected for survey from different areas

	Female			Male			Grand Total
	Bachelor in Arts (B.A.)	Bachelor in Science (B.Sc.)	Total	Bachelor in Arts (B.A)	Bachelor in Science (B.Sc.)	Total	
Rural	22.6%	1.3%	23.9%	16.7%	1.8%	18.5%	42.3%
Urban	26.6%	24.6%	51.2%	3.7%	2.8%	6.5%	57.7%
Grand Total	49.2%	25.9%	75.1%	20.4%	4.6%	24.9%	100%

Source: Primary survey, own calculation

To facilitate this study, questionnaire was prepared by covering three important elements of the academic status with specific focus on Honours Education at the Bachelor Degree level. The three elements consist of (i) Teaching & Evaluation Method adopted in the college (ii) Effectiveness of the Teaching Faculty, which indicates the intellectual capital of the college (iii) Availability of Resources.

The questionnaires consist 34 items with five response options (1-5 scale) with a statement in ascending order: 1= Very Bad; 2= Bad; 3= Moderate; 4= Good; 5=Very Good. The Questionnaire contains three sections comprising 1.Teaching & Evaluation Method, 2.Effectiveness of the Teaching Faculty and 3.Availability of Resources as given in Table 2.

Table-2: Different indicators of teaching and learning facilities in the college

Category	Variable	Variable name
1.Teaching & Evaluation Method	X_1	Completion of syllabus in academic year
	X_2	The extra coaching and revision
	X_3	Regularity & evaluation of internal assessment
	X_4	Practical classes in the laboratory
	X_5	Distribution of syllabus load in different years
2.Effectiveness of the Teaching Faculty	X_6	Teaching technique
	X_7	The quality of lectures provided
	X_8	The communication skills of teachers
	X_9	Teachers' attitude in the class room
	X_{10}	The knowledge of the teachers
	X_{11}	Teachers come in class with preparation
	X_{12}	Regularity and punctuality of the teachers
	X_{13}	Accessibility of teachers outside in the class
	X_{14}	Examples used by the teachers are appropriate
	X_{15}	The opportunity of asking questions to teachers
	X_{16}	The focus of a teachers on the topic
	X_{17}	Student-teacher relation
3.Availability of Resources	X_{18}	Student-principal relation
	X_{19}	Availability of books & Journals in library
	X_{20}	Quality of books and Journals in library
	X_{21}	The availability of laboratory equipments
	X_{22}	Availability of sports equipment
	X_{23}	Hostel availability of long distance student
	X_{24}	Role of Student Union in academic development
	x_{25}	The discipline in College
	X_{26}	Overall academic environment of the colleges
	X_{27}	Distribution of free studentship
	X_{28}	Toilet facility
	X_{29}	Canteen facility
	X_{30}	Common room facility
	X_{31}	Sufficiency of permanent teachers
	X_{32}	Sports activities in college
	X_{33}	Quality of office services
	X_{34}	Drinking water facility

The analysis was carried out to study the perception of the students about all the items included in the Questionnaire. From the response of the students, using Six Sigma methodology, the opportunities and defects were calculated for each item in the questionnaire. A "defect" is defined as anything that could lead to dissatisfaction among the students about their academic programme. Six Sigma is most effective methodology available for quality judgement and improving the performance of any organization minimizing the defects in its products or services. Every error committed, has a cost associated to it in form of losing efficiency.

Understanding the Six Sigma scale

The six sigma scale is universal measure of the performance of any business or organisation [28]. Higher sigma score indicates batter performance or more precise result. In other words, if the output is defective sixty-nine percent of the time, it implies that performance is one Sigma compliant. On the other hand if it is defective thirty-one percent of the time, it means that the performance is demonstrating two sigma compliance.

Table-3: Six Sigma Scale

The Sigma Scale		
Sigma level	Percent Defective	Defects per Million opportunity
1	69%	691462
2	31%	308538
3	6.70%	66807
4	0.62%	6210
5	0.02%	233
6	0.00%	3.4

As mentioned in the Table 3, Six Sigma implies almost perfect output resulting in only 3.4 defects per million opportunities (DPMO). The term 'DPMO' can be explained as the non-conformities present in the output that falls beyond the satisfactory customer (here students) limits. The number of defects present per million opportunities is used to determine as to which Sigma scale a particular process corresponds to. DPMO is represented by the following expression.

DPMO= (Total number of defects found in sample/sample size number of opportunities per unit in the sample) ×1000000

RESULTLS

The non-conformance level captured through the responses of the students about the various important elements of the teaching and learning process including the academic facilities prevailing in the college was analysed through Six Sigma analytical tool. The choices of the Questions will range from score 1 to 5 for every item in questionnaire. Score 4 & 5 were considered as conformance and score 1, 2 and 3 were considered as non-conformance. The description of Quality rating adopted to classify the student's feedback about the teaching methodology adopted and the facilities prevailing in the selected college in rural and urban areas is depicted in table 4. The Quality of each teaching element studied was rated on six point scale ranging from 1 to 6. The higher score indicates better quality. The six point rating scale was prepared based on the Six Sigma Model.

Table-4: Quality rating for the student feedback about the status of education in the college

Quality Rating Scale	Quality Rating Range	Description of the quality rating
6	Above 5 and up to 6	"Healthy and Excellent world class teaching and learning facilities" provided to the students
5	Above 4 and up to 5	"Benchmarked and stimulating teaching and learning facilities" offered to the students
4	Above 3 and up to 4	Teaching and learning facilities provided to the students are "adequate" with medium necessary provisions needs to be carried out to accomplish the objective of the programme in an efficient way and also gain complete satisfaction from the students.
3	Above 2 and up to 3	Teaching and learning facilities provided in the programme are "adaptable" and are just sufficient to accomplish the objective of the programme without hindering performance.
2	Above 1 and up to 2	"Highly compromised teaching and learning facilities" that have the possibility to hinder the academic performance of the students.
1	Less than or equal to 1	Totally inappropriate for the students to learn and gain knowledge through the existing Academic Atmosphere.

Source: Adapted from Kuwaiti and Subbarayaul, 2015

The analysis was carried out on the students opinion with respect to all variables included in each of the three specific areas incorporated in the Questionnaire tool. From the response of the students, the 'Opportunities' and 'defects' were calculated for each item. An 'opportunity' is the availability of each of the teaching and learning facility in the college and a 'defect' is defined as that could lead to students' dissatisfaction on the teaching and learning elements prevailing in the college. Accordingly, the DPMO (defects per million opportunities), chance for a student to be totally satisfied and the Sigma rating for each item and each category was measured for rural and urban areas.

Table 5 depicts the quality rating expressed in sigma level for the student feedback on the different indicator in rural areas. The sigma level shows that the variables X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17} andX_{18} are above 2 but less than equal to 3, i.e. were rated by the students as "adaptable" and are just sufficient to accomplish the objective of the programme

without hindering performance of the students. The sigma level of indicators X_1, X_3, X_5, X_{12}, X_{20}, X_{25}, X_{26}, X_{32}, X_{33} andX_{34} are above 1 but less than equal to 2, i.e. were rated by the student as "Highly compromised" and it have the possibility to hinder the academic performance of the students. The sigma level of indicators X_2, X_4, X_{19}, X_{21}, X_{22}, X_{23}, X_{24}, X_{27}, X_{28}, X_{29}, X_{30} andX_{31} are less than equal to 1, i.e. were rated by the student as "totally inappropriate for the students to learn and gain knowledge".

Table- 5: Quality rating for the students' feedback (555 Students) about the undergraduate programme offered by the general degree colleges in rural areas in West Bengal

Variables	DPO	Chance for a student to be totally satisfied	Non-conformance per student	DPMO	Sigma level*
X_1	0.372973	0.63	0.37	372973	1.8
X_2	0.837838	0.16	0.84	837837.8	0.5
X_3	0.484685	0.52	0.48	484684.7	1.5
X_4	0.872072	0.13	0.87	872072.1	0.4
X_5	0.587387	0.41	0.59	587387.4	1.3
X_6	0.171171	0.83	0.17	171171.2	2.4
X_7	0.281081	0.72	0.28	281081.1	2.1
X_8	0.176577	0.82	0.18	176576.6	2.4
X_9	0.068468	0.93	0.07	68468.4	3.0
X_{10}	0.097297	0.90	0.10	97297.3	2.8
X_{11}	0.187387	0.81	0.19	187387.4	2.4
X_{12}	0.353153	0.65	0.35	353153.2	1.9
X_{13}	0.248649	0.75	0.25	248648.6	2.2
X_{14}	0.163964	0.84	0.16	163964.0	2.5
X_{15}	0.158559	0.84	0.16	158558.6	2.5
X_{16}	0.198198	0.80	0.20	198198.2	2.3
X_{17}	0.09009	0.91	0.09	90090.09	2.8
X_{18}	0.135135	0.86	0.14	135135.1	2.6
X_{19}	0.677477	0.32	0.68	677477.5	1.0
X_{20}	0.515315	0.48	0.52	515315.3	1.5
X_{21}	0.855856	0.14	0.86	855855.9	0.4
X_{22}	0.778378	0.22	0.78	778378.4	0.7
X_{23}	0.805405	0.19	0.81	805405.4	0.6
X_{24}	0.805405	0.19	0.81	805405.4	0.6
X_{25}	0.331532	0.67	0.33	331531.5	1.9
X_{26}	0.427027	0.57	0.43	427027.0	1.7
X_{27}	0.864865	0.14	0.86	864864.9	0.4
X_{28}	0.857658	0.14	0.86	857657.7	0.4
X_{29}	0.915315	0.08	0.92	915315.3	0.1
X_{30}	0.866667	0.13	0.87	866666.7	0.4
X_{31}	0.747748	0.25	0.75	747747.7	0.8
X_{32}	0.600000	0.40	0.60	600000.0	1.2
X_{33}	0.412613	0.59	0.41	412612.6	1.7
X_{34}	0.50991	0.49	0.51	509909.9	1.5

Source: Primary survey, Authors' own calculation, *Sigma level (considering 1.5σ shift)

Table 6 depicts the quality rating expressed in sigma level for the student feedback on the different indicator in urban areas. The sigma level shows that X_9, X_{10} andX_{15} are above 3 but less than equal to 4, i.e. were rated by the students as "adequate" with medium necessary provisions needs to be carried out to accomplish the objective of the programme in an efficient way and also gain complete satisfaction from the students. The sigma level shows that X_1, X_3, X_6, X_7, X_{18}, X_{11}, X_{12}, X_{13}, X_{14}, X_{16}, X_{17}, X_{18}, X_{25}, X_{26} andX_{34} are above 2 but less than equal to 3, i.e. were rated by the students as "adaptable" and are just sufficient to accomplish the objective of the programme without hindering performance of the students. The sigma level of indicators X_2, X_4, X_{19}, X_{20}, X_{21}, X_{22}, X_{23}, X_{24}, X_{27}, X_{29}, X_{31}, X_{32} and$X_{33}$are above 1 but less than equal to 2, i.e. were rated by the student as "Highly compromised" and it have the possibility to hinder the academic performance of the students. The sigma level of indicators X_5, X_{28} and $X_{30}$are less than equal to 1, i.e. were rated by the student as "totally inappropriate for the students to learn and gain knowledge".

Table-6: Quality rating for the students' feedback (756 Students) about the undergraduate programme offered by the general degree colleges in urban areas in West Bengal.

Variables	DPO	Chance for a student to be totally satisfied	Non-conformance per student	DPMO	Sigma level*
X_1	0.133598	0.87	0.13	133597.9	2.6
X_2	0.588624	0.41	0.59	588624.3	1.3
X_3	0.117725	0.88	0.12	117724.9	2.7
X_4	0.436508	0.56	0.44	436507.9	1.7
X_5	0.753968	0.25	0.75	753968.3	0.8
X_6	0.071429	0.93	0.07	71428.57	3.0
X_7	0.093915	0.91	0.09	93915.34	2.8
X_8	0.101852	0.90	0.10	101851.9	2.8
X_9	0.059524	0.94	0.06	59523.81	3.1
X_{10}	0.026455	0.97	0.03	26455.03	3.4
X_{11}	0.080688	0.92	0.08	80687.83	2.9
X_{12}	0.111111	0.89	0.11	111111.1	2.7
X_{13}	0.100529	0.90	0.10	100529.1	2.8
X_{14}	0.064815	0.94	0.06	64814.81	3.0
X_{15}	0.054233	0.95	0.05	54232.8	3.1
X_{16}	0.074074	0.93	0.07	74074.07	2.9
X_{17}	0.066138	0.93	0.07	66137.57	3.0
X_{18}	0.271164	0.73	0.27	271164	2.1
X_{19}	0.349206	0.65	0.35	349206.3	1.9
X_{20}	0.332011	0.67	0.33	332010.6	1.9
X_{21}	0.472222	0.53	0.47	472222.2	1.6
X_{22}	0.30291	0.70	0.30	302910.1	2.0
X_{23}	0.361111	0.64	0.36	361111.1	1.9
X_{24}	0.582011	0.42	0.58	582010.6	1.3
X_{25}	0.088624	0.91	0.09	88624.34	2.8
X_{26}	0.099206	0.90	0.10	99206.35	2.8
X_{27}	0.568783	0.43	0.57	568783.1	1.3
X_{28}	0.708995	0.29	0.71	708994.7	0.9
X_{29}	0.67328	0.33	0.67	673280.4	1.1
X_{30}	0.698413	0.30	0.70	698412.7	1.0
X_{31}	0.554233	0.45	0.55	554232.8	1.4
X_{32}	0.34127	0.66	0.34	341269.8	1.9
X_{33}	0.551587	0.45	0.55	551587.3	1.4
X_{34}	0.279101	0.72	0.28	279100.5	2.1

Source: Primary survey, Authors' own calculation, *Sigma level (considering 1.5σ shift)

DISCUSSION

The study is the documentation of the students' perception about the existing teaching and learning facilities prevailing in the selected colleges in rural and urban areas in West Bengal, India. For this purpose a sample of 10 colleges offering 3 years bachelor degree programme were chosen. Second and third year students were chosen to capture their experience about the overall quality of higher education institution. Questionnaire consists of 34 questions by covering all the three important elements of the academic environment, (i) teaching and evaluation method (ii) effectiveness of the teaching faculty (iii) availability of the resources in the college. For the purpose of rating the students experience on various aspects of teaching and learning facilities offered by the college, a five point rating scale (Table 2) used. The rating scale consists of six points ranging from 1 to 6. Each point has specific range of description indicating quality. Higher rating better is the quality of higher education facility.

The analysis of the feedback of students by the six sigma tool indicates that the overall score of the different colleges in the rural areas score was 1.5 i.e. were rated by students as "Highly compromised teaching and learning facilities" that have the possibility to hinder the academic performance of the students. Overall status of the different colleges in urban areas as indicated by the sigma score of 2.03 in Table 8 reveals teaching and learning facilities provided in the programme by the colleges are "adaptable" and are just sufficient to accomplish the objective of the programme without hindering performance.

The study is quality rating of facilities adopted at the higher education institutions in West Bengal, India. Through this rating scale, the academicians can monitor quality improvements in the educational process and also observe what teaching and learning element need to be improved to attain six sigma level of quality (i.e. 3.4 DPMO).

For improving the quality of rural and urban colleges institutional authority more concentrate on some itemsas presented in Table 9.

Table-7: Quality rating for the students' feedback about the undergraduate programme offered by the general degree colleges in rural areas in West Bengal (Different categories).

	No. of Respondent	No. of Questions	Opportunities	Defects (Non Conformance)	DPO	Chance for a student to be totally satisfied	Non-conformance per student	DPMO	Sigma level*
Teaching & Evaluation Method	555	5	2775	1751	0.630991	0.37	0.63	630991	1.2
Effectiveness of the Teaching Faculty	555	12	6660	1218	0.182883	0.82	0.18	182882.9	2.4
Availability of Resources	555	17	9435	6164	0.653312	0.35	0.65	653312.1	1.1
All	555	34	18870	9133	0.483996	0.52	0.48	483995.8	1.5

Source: Primary survey, Authors' own calculation, *Sigma level (considering 1.5σ shift)

Table-8: Quality rating for the students' feedback about the undergraduate programme offered by the general degree colleges in urban areas in West Bengal (Different categories).

	No. of Respondent	No. of Questions	Opportunities	Defects (Non Conformance)	DPO	Chance for a student to be totally satisfied	Non-conformance per student	DPMO	Sigma level *
Teaching &Evaluation Method	756	5	3780	1535	0.406085	0.59	0.41	406084.7	1.7
Effectiveness of the Teaching Faculty	756	12	9072	684	0.075397	0.92	0.08	75396.83	2.9
Availability of Resources	756	17	12852	5469	0.425537	0.57	0.43	425536.9	1.7
All	756	34	25704	7688	0.299097	0.70	0.30	299097.4	2.03

Source: Primary survey, Authors' own calculation, *Sigma level (considering 1.5σ shift)

Table-9: For attaining higher sigma level (increase in quality) the variables needing more concentration

College	Teaching & Evaluation Method	Effectiveness of the Teaching Faculty	Availability of Resources
Rural college	X_2, X_4	X_{12}	X_{29}, X_{21}, X_{27}, X_{28}, X_{29}, X_{22}, X_{23}, X_{24}, X_{30}, X_{31}
Urban College	X_5, X_2	X_{12}	X_{28}, X_{30}, X_{29}, X_{24}, X_{31}

Source: primary survey, own estimation

CONCLUSION

The six sigma tool is a stringent criterion for quality assessment. The present study is a student-driven quality rating system for the teaching and learning facilities adopted in the higher education institutions in West Bengal, India. From the sigma value, it has been possible to identify the problems of the selected higher education institutions in West Bengal. In this study the basic problems of higher education institutions as perceived by the students are lack of availability of resources (like toilet facility), sufficiency of permanent teachers, canteen and common room facilities and lack of teaching and evaluation methods like practical classes in the laboratory and the extra coaching, revision of department. This study will help the policy planners or academicians of the higher education sector to understand the students' views in improving the quality of higher education.

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