

Z-Test-Based Analysis for Validating the Effectiveness of NPTEL E-Learning Modules

Manoj Kumar Srivastava, University of Allahabad, India*

 <https://orcid.org/0000-0001-8957-2280>

Rajesh Kumar, University of Allahabad, India

 <https://orcid.org/0000-0002-4316-9936>

Ashish Khare, University of Allahabad, India

ABSTRACT

The article proposes use of a z-model to validate learning progress after experimenting on student performance. A statistical map of z-values is used to calculate the z-value. This paper is divided into two parts. First it examines the students' learning outcomes in various computer science and engineering (CSE) subjects during regular classroom instruction as well as examines the students by an interactive learning model in which traditional classroom instruction and e-learning modules are combined. Then the second part administers a related exam to the same group of students. Z-test is used as a tool for evaluating the results. Based on the findings, the authors found that student performance increased dramatically after incorporating an e-learning module into their classroom instruction. The e-learning module has now been introduced into the classroom. Each subject would have a separate test paper with a higher degree of difficulty. It has been found that there is a substantial increase in the learning outcome of the students after applying the proposed approach.

KEYWORDS

Confidence Level, E-Learning, ICT, NPTEL, Z-Value

INTRODUCTION

Any student's academic success is directly and indirectly linked by the teaching and learning methods employed in the classroom. Student's academic success is also directly proportional to the student's knowledge of various subject topics and research materials (Landan, 2017). Any scientific or engineering challenge necessitates a simple analytical interpretation of the problem and its solution, so it is critical that students comprehend each topic of science and engineering. The student must be taught in an imaginative and straightforward way so that logical interpretation of the subject and its real-world applications (Sarkar, 2012), (Mahmud, et al., 2012) become clearer. Earlier it

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*Corresponding Author

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was impossible due to two factors: first the limitations of formal teaching and second the lack of e-learning tools. Both of these arguments are no longer valid since a variety of e-learning modules are now available and being used by students at a variety of institutions. Students and teachers can use e-learning modules such as NPTEL, Course Era, W3School, Wikipedia, etc. (Sinha, et al., 2019), (Lee, et al., 2014), (Islam, 2016).

Now-a-days, the teaching and learning environment is not limited to a physical instruction in classroom because information and communication technology (ICT) provides accessibility to all types of people (learners or students as well as teachers). Now-a-days ‘learning on demand’ and ‘mobile learning’ (Park, et al., 2012) are the actual requirements where users can access any educational facilities wherever, anywhere, or wherever they need them. Previous researches have shown that by incorporating ICT into the classroom will improve both teaching content and student learning outcomes. The current study verifies the change in learning outcomes when e-learning is being used over the traditional learning, using pre-test and post-test tests with a cohort of postgraduate students in computer science and engineering (CSE) with the same level. Ten subjects of CSE have been selected for the experimentation, with two sets of question papers planned for each subject. The second series of questions are more challenging than the first. The pre-test is given after the students have been using traditional learning in each subject, and their success is evaluated. The post-test, on the other hand, is provided after the students have been taught using e-learning materials, and their success is assessed using the second set of papers. The z-values are calculated on solution scripts for each set of question papers, and it has been observed that using e-learning content to supplement conventional teaching yields a better result in learning outcome.

The remainder of the paper is divided into the following sections: Section two contains a short overview of the literature, accompanied by section three which contains the objective of the paper, and part four describes various materials and methods used to evaluate the performance of the student, Section five of this article provides outcomes of the paper; section six describes analysis of the experimental results finally section seven includes the concluding remarks of this article.

LITERATURE REVIEW

Author (Wang, 2014) created the GPAM-WATA EL evaluation-centered e-learning framework using a web-based two-tier diagnostic assessment. Teachers may use this e-learning framework to administer two-tier screening assessments, dynamic assessments, and e-learning assessments. The elements on the customized complex evaluation are linked to the questions that students don’t get right. Through responding to these chosen instructional objects and receiving prompts, students may learn more. This study discovered that customized dynamic evaluation, which is accessible in GPAM-WATA EL, is more successful in optimizing the student learning outcomes.

Author (Sahasrabudhe, et al., 2014) demonstrated that media selection should be based on the need and level of the student. Textual content is helpful in some cases, but richer media, such as film and animation, have proportionately higher learning efficacy in others. They proposed an applied research paradigm and empirically validated it to investigate this disparity of comprehension. Their findings suggest that the learning domain of the curriculum and the learners’ learning styles moderate the association between media preference in an e-learning programmers and its efficacy.

In an e-learning method, Authors (Dascalu, et al., 2014) suggested an intelligent solution that uses the Particle Swarm Optimization algorithm. They focused on forming optimal study communities of learners from various domains. This research was carried for adult education community building techniques. The proposed algorithm was implemented in an e-learning environment with the aim of forming self-contained educational groups and eventually becoming a trainer. According to the authors, various quantifying metrics, such as background variance and correlations between learners’ types of interests, within a society and between classes, can have a beneficial impact on the development of learning groups. Each participant involved in the study must create an account and

fill out a self-assessment survey. The results of this assessment enable the student to be placed in the most suitable learning community. Authors (Kurucay, et al., 2017) used a model to explore the impact of learner-to-learner engagement on satisfaction and learning in online undergraduate courses. They created a learning system for 77 students enrolled in online undergraduate courses. The students were randomly divided into two groups. Students of one group work alone and students of the other group perform their study using online training materials. By means of experiments it was identified that the students who were trained in communities with the aid of online learning materials do well in terms of topic comprehension and problem solving abilities.

Authors (Chao, et al., 2017) created and introduced a web-based integrated curriculum for nursing students. They splitted the students into two classes and required them to study two hours a week for each semester for two years. Students are divided into two groups: experimental and control. There were 51 students in the experimental group and 49 in the control group. The entire class took part in the e-learning curriculum. Students in the experimental group have shown a significant improvement in nursing ethics, self-learning, decision-making competence, recognizing differences, self-dialog, raising questions, and taking action in response to situations after completing each semester's course.

The authors (Hubalovsky, et al., 2019) developed a model for adaptive e-learning for primary school students. Some students were permitted to study course content using e-learning resources, while others were permitted to learn courses using conventional learning materials. Students who study e-contents as opposed to conventional learning contents provide a greater grasp of fundamentals and composition of questions through pedagogical education goal. The researchers were intended to work on improving the key e-learning adaptability in the future. The authors also conclude that this analysis can be used in conjunction with evolutionary algorithms such as particle swarm optimization strategies to improve learning outcomes.

Authors (Srivastava, et al., 2019) devised a framework for comparing the NPTEL (National Program on Technology Enhanced Learning (<https://nptel.ac.in>)) based e-learning to standard classroom learning. Final-year Master of Science students in Computer Science have been given the option of studying their subjects using NPTEL technique or the conventional learning approach. Following the learning of the subjects, a number of assessments were administered. Two mathematical matrices, F-test (<https://statisticshowto.com/probabilit-and-statistics/t-test/f-test>) and T-test (<https://statisticshowto.com/probabilit-and-statistics/t-test>), were used to compare the outcomes of two learning methodologies. The findings of the experiment suggest that the e-learning method helps students to better grasp their subjective experience. The above findings also suggest that learners were benefitted more from NPTEL video lectures than from conventional classroom teaching/learning.

The authors (Chika et al., 2020) presented - Stratified random sampling and selected 138 teachers and 39 administrators based on the three senatorial districts in Abia state. Data collection was done through a survey questionnaire which was self-constructed by the researcher in four point rating scale. It was validated by two research experts. The reliability coefficient of the questionnaire was estimated using Cronbach Alpha. The coefficient of the instrument obtained was 0.81, which indicate the reliability strength of the instrument. Mean and standard deviation were the statistical tools used to analyze the data gathered from the respondents on each of the research questions. The author had used the Z-test to test the null hypothesis at is 0.05 as level of significance. This work releases Z-test analysis on the effect of Information and communication Technology on school administration (students, personnel, financial and supervision of instruction) in secondary schools in Abia State. The results have shown that the Z-values obtained from the computation (0.65, 0.52, 0.41 and 1.28) were less than the Z-critical value 1.96. Hence, it was concluded that the opinion of teachers and school administrators on the influence of Information and communication Technology on school administration are not significantly different from each other.

Authors (Ukaigwe et al., 2020) have shown the planning of the integration of technologies in higher institutions as a strategy for effective implementation of blended learning in universities of Rivers State. The population of this study consisted of the 4,377 teaching staff in the three public

universities of Rivers State, comprising 2,348 male and 2,029 female teaching staff. The sample of the study was 590 elements, comprising 327 male and 263 female teaching staff that was drawn from the population using stratified random sampling technique. Data collection has been done through the questionnaire that yielded a reliability index of 0.84, using test-retest and Pearson Product Moment Correlation techniques. The generated data were analyzed to answer research questions. Z-test was used to test hypotheses at ($\alpha = 0.05$) level of significance. The authors recommended that university managers should take advantages of blended learning in the school system, with a planning to foster the integration of the learning innovation into the traditional face-to-face teaching and learning approach for improving students learning experiences and achievements.

Education system (Thiyagarajan, et al.,2021) has gone through great changes in past few years and its courses become very flexible and learner's centric. Our government is bringing a great number of technical institutes as well as the introduction of new courses has powered the expectation of the students. Introduction of NPTEL and SWAYAM have a higher dependence on technology. NPTEL courses were offered by premium institute from various parts of India. Most of these courses are developed by the professors of IIT and IIM. Due to the current pandemic situation more than 95% of educational institutions are conducting the regular classes in online mode. So at this time it is very important to measure the effectiveness of the online classes and the contents delivered during these period.

HYPOTHESIS AND METHODOLOGY

The traditional class room teaching is a way of teaching learning activities from the beginning of human civilization. Basically it is learning by example and methods, but from Last few decades the learning and teaching activities became more interesting and effective due to use of various learning aids like audio, video, text, graphics and animations. The blended mode of teaching became more relevant in after Pandemic era. The main hypothesis of this paper is to develop learning strategy and its outcome. The other purpose of this paper is to determine the effectiveness of students learning when studying in blended mode of learning by NPTEL e-learning resources with traditional class room teaching. Total 18 postgraduate students of Computer Sciences and Engineering are selected for experimentation and analysis. Since many of the study topics are totally new to all of the students, so each student has same level of understanding about subjects and their topics. The primary goal of this study is to compare the effectiveness of e-learning with conventional classroom teaching. Pre-test and post-test intervention approaches are used to accomplish this aim. A z-value and the students' trust level are used to compare the success of the e-learning outcomes.

Following steps are required to accomplish this work:

1. Student assessment through pre-test approach.
2. Student assessment through post-test approach.
3. Z-model: Mathematical study using z-value to achieve good confidence level.
4. Comparison of two assessments and checking the effectiveness of student's performance within certain confidence level.

STUDENT ASSESSMENT THROUGH PRE-TEST APPROACH

The students learning can be checked through pre-test intervention. This intervention can be done after traditional teaching methodology. Here, ten subjects of Computer Science & engineering (CSE) have been taken. These are mentioned along with subject code in Table-1.

Table 1. Details of subjects and Codes in which students have been examined

S.No.	Subject Code	Subject Name
1	PGCSE-1	C-Programming
2	PGCSE-2	Computer Networks
3	PGCSE-3	Data Base Management System
4	PGCSE-4	Data Structure
5	PGCSE-5	Operating System
6	PGCSE-6	Theory of Computation
7	PGCSE-7	Software Engineering
8	PGCSE-8	Computer Graphics
9	PGCSE-9	Artificial Intelligence
10	PGCSE-10	Design & Analysis of Algorithms

A unit of syllabus of all of the above subject codes is being taught to 18 students. An exam is conducted one by one for each of the subjects and their marks are recorded which has been shown in Table-2.

The analysis has been done on the above table. The marks scored by each student in any of the subjects are varying in nature and do not follow a definite trend. Also, one student may secure good marks in one subject while lesser marks in another subject. For example, the 9th student scored good marks in PGCSE-2, PGCSE-4, PGCSE-5 and PGCSE-10 whereas this student could not performed better in subjects PGCSE-3, PGCSE-6 and PGCSE-8.

STUDENT ASSESSMENT THROUGH POST-TEST APPROACH

The same unit has been taught again to the similar group of 18 students. This time NPTEL based e-learning material is incorporated. The e-learning material contains video lectures, practical aspects, application of that part of the syllabus, assignments and tutorial sheets.

For making the difference, we asked the teachers to make a different question paper in each of 10 subjects. The syllabus is same as we did for the first method. Therefore, this time, the questions in exam paper has been set a bit difficult than previous one and exams were conducted for each of the mentioned subjects. Since, the syllabus has been taught with some real life applications, on-line assignments and tutorial sheets have also been floated, so we were more concerned about the marks scored by the students in these papers. The marks scored by each student are mentioned in Table-3:

The comparison of marks shown in Table-2 and in Table-3 increases our thought process and it requires deep analysis. At many points and in few subjects, the marks scored by students are different. This shows that these two methodologies do the different impact on the student's learning and their performance.

Z-MODEL

The z-value is a measure of number of standard deviations below or above the population mean. A z-value is also known as a standard **score** and it can be placed on a normal distribution curve. In this paper z-model has been used to find the z-value (<https://www.staticshowtodatasciencecentral.com/z-test/>).

Table 2. Marks scored in 10 different subjects by 18 students using traditional teaching

Student S.N.	Subject wise Marks scored by students out of 30 marks									
	PGCSE-1	PGCSE-2	PGCSE-3	PGCSE-4	PGCSE-5	PGCSE-6	PGCSE-7	PGCSE-8	PGCSE-9	PGCSE-10
1	26	24	22	18	22	22	22	25	27	26
2	24	23	25	17	25	23	25	23	25	23
3	22	22	22	22	26	22	24	26	21	27
4	22	25	26	22	27	22	18	28	14	23
5	19	25	23	18	18	23	18	22	23	22
6	22	23	22	22	23	22	23	27	26	22
7	19	25	22	21	22	21	22	21	22	21
8	26	21	28	26	16	22	16	18	25	23
9	14	25	10	25	26	12	19	12	22	25
10	19	22	21	24	23	22	23	26	21	24
11	22	23	20	25	12	22	12	18	25	25
12	25	26	22	23	22	28	22	17	27	27
13	21	23	21	21	22	22	22	18	26	23
14	19	26	21	19	21	27	21	28	25	23
15	25	24	27	22	23	26	23	21	26	22
16	22	25	19	21	23	28	23	21	23	26
17	23	26	12	20	22	19	25	19	22	28
18	22	23	10	21	24	22	19	22	23	23
Median	21.77	23.94	20.72	21.50	22.06	22.50	20.94	21.77	23.50	24.05
SD	3.03	1.74	5.11	2.51	3.55	3.50	3.40	4.30	3.90	1.99

The z-scores or z-values are used to find confidence intervals for the true unknown mean \bar{x}_1 / \bar{x}_2 of a population. Z-value or Z-score is evaluated as:

$$z = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \tag{1}$$

where:

- \bar{x}_1 = Mean of group of student scores using traditional teaching.
- \bar{x}_2 = Mean of group of student scores using e-learning method.
- $n_1 = n_2 = 18$ is the size of groups .
- σ_1^2 = square of standard deviation on traditional learning method.
- σ_2^2 = square of standard deviation on e-learning method.

Table 3. Marks scored in 10 different subjects by 18 students using NPTEL video lectures based teaching

Student S.N.	Subject wise Marks scored by Students out of 30 Marks									
	PGCSE-1	PGCSE-2	PGCSE-3	PGCSE-4	PGCSE-5	PGCSE-6	PGCSE-7	PGCSE-8	PGCSE-9	PGCSE-10
1	22	26	27	22	22	28	30	27	26	24
2	23	28	22	23	26	25	27	26	28	25
3	22	25	22	22	23	27	22	25	23	27
4	23	29	22	22	26	27	23	24	28	25
5	26	25	26	21	25	23	22	21	26	23
6	24	23	22	22	23	22	10	23	21	28
7	25	25	27	21	27	26	28	23	26	26
8	26	21	20	26	29	25	28	30	27	22
9	26	28	21	25	23	24	22	22	23	28
10	23	29	27	26	22	22	28	23	25	29
11	22	27	24	23	27	23	28	28	27	23
12	22	24	28	23	25	24	23	22	25	29
13	23	22	23	21	27	21	25	23	21	23
14	23	21	21	19	25	29	27	25	23	23
15	21	22	22	22	18	22	20	28	25	26
16	26	28	20	28	19	23	19	22	26	27
17	22	26	20	27	21	23	21	21	28	26
18	22	28	28	23	29	27	23	22	27	25
Median	23.38	25.38	23.44	23.11	24.27	24.50	23.66	24.16	25.27	25.50
SD	1.69	2.67	2.86	2.30	3.06	2.73	4.63	2.59	2.19	2.19

The z-value has been calculated from table Table-2 and Table-3. The Results of detailed calculation of z- value is recorded in Table-4. Here in table N^r is ($\bar{x}_1 - \bar{x}_2$) and D^r is:

$$\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

A Z-score is a numerical estimation utilized in insights of esteem’s relationship to the mean (normal) of a gathering of qualities, estimated as far as standard deviations from the mean. On the off

Table 4. Observations through z-model

Attributes / Subjects	PGCSE-1	PGCSE-2	PGCSE-3	PGCSE-4	PGCSE-5	PGCSE-6	PGCSE-7	PGCSE-8	PGCSE-9	PGCSE-10
N ^r	1.61	1.44	2.72	1.61	2.22	2.00	2.72	2.39	1.78	1.44
D ^r	0.81	0.71	1.36	0.79	1.10	1.02	1.36	1.18	0.87	0.69
z-score	1.98	2.02	2.0	2.03	2.01	1.96	2.0	2.02	2.04	2.08

chance that a Z-score is 0, demonstrates that the information point's score is indistinguishable to the mean score. Z-scores might be positive or negative, with a positive esteem demonstrating the score is over the mean and a negative score showing it is beneath the mean. Z-scores are proportions of a perception's inconstancy and can be put to use by dealers in deciding business sector unpredictability.

From the table 4, we see the values of z-score for different subjects. This value falls in a specific range that is between 1.96 and 2.08. The above z-value denote that our hypothesis is valid at 95% confidence level. The confidence interval (Al Fattani,2014),(Gupta, 2012) table is given in Table-5 provides equivalent confidante level for the hypothesis corresponding to the z- value calculated in table 4.

The table-5 shows the confidence level that tells us how confident we are in our results. In any survey or experiment, we are never 100% sure that our results would be repeated. If the calculated confidence level is at the range of 95% sure or 96% sure, that's usually considered "good enough" in statistics.

COMPARISON OF TWO ASSESSMENTS AND CHECKING THE EFFECTIVENESS OF STUDENT'S PERFORMANCE

The marks scored by students shown in Table-2 and Table-3 have different values for different subjects. The individual student may have greater marks in traditional learning than NPTEL based e-learning methodology. The present paper takes all subjects for checking the effectiveness of NPTEL based e-learning methodology. From Table-4, we can see that the z-values are in between 1.96 to 2.08 in most of the cases. At 95% confidential level, it is found the similar values and at one place for a particular subject the confidence value is 96% where z-value is 2.08. Therefore, the marks scored by later methods have good impact over students in terms of students' learning and performance.

RESULTS

Figure-1 shows a plot between Ten Subjects (X-axis) and calculated z-value(Y axis) which indicate that ICT based e-learning methodology are greater impact with an average by 95% confidence level in each of the subjects.

Table 5.

Z-value for confidence levelS.NO	Z value	Confidence Level
1	1.04	0.70
2	1.15	0.75
3	1.28	0.80
4	1.44	0.85
5	1.645	0.90
6	1.75	0.92
7	1.96	0.95
8	2.03	0.96
9	2.33	0.98
10	2.58	0.99

Figure 1. Graph plotted over different z-values for 10 subjects



From Figure-1, for the subject C-Programming the experimental z-value occurs in the range of 1.98 and it provides about 95% confidence level according to z-value for confidence Interval from Table-5.

From Figure-1, for the subject Computer Networks the experimental z-value occurs in the range of 2.02 and it provides 95% and above confidence level according to z-value for confidence interval from Table-5.

From Figure-1, for the subject Database Management System the experimental z-value occurs in the range of 2.0 and it provides 95% and above confidence according to z-value for confidence interval from Table-5.

We can observe that from Figure-1 and z-value for confidence interval from Table 5, for the subject Data Structure the experimental z- value occurs in the range of 2.03 and it provides 96% and above confidence level.

We investigated that, from Figure 1 and z-value for confidence interval from Table 5, for the subject Operating System, the experimental z- value occurs in the range of 2.01 and it provides 95% and above confidence level.

From Figure-1 and z-value for confidence interval from Table 5 for the subject Theory of Computation the experimental z- value occurs in the range of 1.96 and it provides 95% and above confidence level.

From figure-1 for the subject Software Engineering the experimental z- value occurs in the range of 2.0 and it provides 95% and above confidence level z-value for confidence interval from Table-5.

According to figure-1 for the subject Computer Graphics the experimental z-value occurs in the range of 2.02 and it provides 95% and above confidence level z-value for confidence interval from Table 5.

From figure-1 and, z-value for confidence interval Table-5, for the subject Artificial Intelligence the experimental z-value occurs in the range of 2.04 and it provides 96% and above confidence level.

From figure-1 and z-value for confidence interval Table-5, for the subject Design & Analysis of Algorithms the z- value occurs in the range of 2.08 and it provides 96% confidence level.

Table-6 provides subject wise difference in the marks of students by normal teaching and NPTEL Based Teaching.

By Observing Table-6 one can see that, in subject PGCSE-1 there are 13 who are performing better in terms of marks obtained in that subject. For subject PGCSE-2 there are 14 students whose performance is better as compared to normal teaching. For subject PGCSE-3, 14 students are performing better in ICT based approach. In subject PGCSE-4, 17 students are performing better in

Table 6. Subject-wise difference in the marks of students by traditional teaching and NPTEL-based teaching

S.No	PGCSE-1	PGCSE-2	PGCSE-3	PGCSE-4	PGCSE-5	PGCSE-6	PGCSE-7	PGCSE-8	PGCSE-9	PGCSE-10
1	-4	2	5	4	0	6	8	5	0	0
2	-1	5	-3	6	1	2	2	4	1	5
3	0	3	0	0	-3	5	-2	-4	4	-4
4	1	4	-4	0	-1	5	5	-5	10	5
5	7	0	3	3	7	0	4	0	-2	4
6	2	0	0	0	0	0	-13	-17	-3	-1
7	6	0	5	0	5	5	6	7	1	5
8	0	0	-8	0	13	3	12	10	5	4
9	12	3	11	0	-3	12	3	10	0	-2
10	4	7	6	2	-1	0	5	2	2	1
11	0	4	4	-2	15	1	16	10	3	2
12	-3	-2	6	0	3	-4	1	6	-5	-2
13	2	-1	2	0	5	-1	3	7	-3	-2
14	4	-5	0	0	4	2	6	-1	0	0
15	-4	-2	-5	0	-5	-4	-3	-1	2	3
16	4	3	1	7	-4	-5	-4	-2	-1	0
17	-1	0	8	7	-1	4	-4	2	-1	0
18	0	5	18	2	5	5	4	1	-1	4

the terms of marks obtained in that subject by ICT based learning approach. For the subject PGCSE-5, 11 students performing better and about 61% students get good marks. In the subject PGCSE-6, there are 14 students are getting better marks as compared to normal teaching. For Subject PGCSE-7, 13 students are performing better in the terms of learning. For subject PGCSE-8 there are 12 students whose performance is better in terms of marks obtained by learning using NPTEL. For the subject PGCSE-9 there are 11 students which is about 61% of total students get better marks as compared to normal teaching .Finally for the subject PGCSE-10, 13 students have performed better in NPTEL based learning.

ANALYSIS OF THE RESULTS

From Table 6, column 1 with student numbers 1, 2, 12, 15 & 17 are getting below average improvements in the marks. For the subject PGCSE-1 with student numbers 3, 4, 6, 8, 10, 11, 13, 14 & 16 are getting average improvements in the marks while student numbers 5, 7 & 9 are getting above average improvements in the marks in the subject PGCSE-1.

From Table 6, column 2 student numbers 12, 13, 14 & 15 are getting below average improvements in the marks. For the subject PGCSE-2 with student numbers 1, 3, 4, 5, 6, 7, 8, 9, 11, 16 & 17 are getting average improvements in the marks while student numbers 2, 10 & 18 are getting above average improvements in the marks in subject PGDCS-2.

From Table 6, column 3 with student numbers 2, 4 & 15 are getting below average improvements in the marks. For the subject PGCSE-3 with student numbers 3, 5, 6, 11, 13, 14 & 16 are getting average improvements in the marks while student numbers 1, 7, 9, 10, 12, 17 & 18 are getting above average improvements in the marks in the subject PGCSE-3.

From Table 6, column 4 with student numbers 11 & 15 are getting below average improvements in the marks. For the subject PGCSE-4 with student numbers 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 & 18 are average improvements in the marks while student numbers 2, 16 & 17 are above average improvements in the marks in the subject PGCSE-4.

From Table 6, column 5 with student numbers 2, 4, 6, 9, 15, 16 & 17 are getting below average improvements in the marks. For the subject PGCSE-5 with student numbers 1, 6, 12, 13 & 14 are getting average improvements in the marks while student numbers 5, 7, 8, 11 & 18 are getting above average improvements in the marks of the subject PGCSE-5.

From the Table 6, column 6 with student numbers 12, 13, 15 & 16 are getting below average improvements in the marks. For the subject PGCSE-6 with student numbers 2, 5, 6, 8, 10, 11, 14 & 17 are getting average improvements in the marks while student numbers 1, 3, 4, 7, 9 & 18 are getting above average improvements in the marks of the subject PGCSE-6.

From the Table 6, column 7 with student numbers 3, 6, 15, 16 & 17 are getting below average improvements in the marks. For the subject PGCSE-7 with student numbers 2, 5, 9, 12, 13 & 18 are getting average improvements in the marks while student numbers 1, 4, 7, 8, 10, 11 & 14 are getting above average improvements in the marks of the subject PGCSE-7.

From the Table 6, I observed the column 8 with student numbers 3, 4, 6, 14, 15 & 16 are getting below average improvements in the marks. For the subject PGCSE-8 with student numbers 2, 5, 10, 17 & 18 are getting average improvements in the marks while student numbers 1, 7, 8, 9, 11, 12 & 13 are getting above average improvements in the marks in the subject PGCSE-8.

From the Table 6, column 9 with the student numbers 5, 6, 12, 13, 16, 17 & 18 are getting below average improvements in the marks. For the subject PGCSE-9 with student numbers 1, 2, 3, 7, 9, 10, 11, 14 & 15 are getting average improvements in the marks while the student numbers 4 & 8 are getting above average improvements in the marks of the subject PGCSE-9.

From the Table 6, it is observed the column 10 with student numbers 3, 6, 9, 12 & 13 are getting below average improvements in the marks. For the subject PGCSE-10 with student numbers 1, 5, 8, 10, 11, 14, 15, 16, 17 & 18 are getting average improvements in the marks while student numbers 2, 4 & 7 are getting above average improvements in the subject PGCSE-10.

The Table-7 and Figure-2 show the percentage improvement in the marks of students in each subject. The percentage improvement in the PGCSE-2, PGCSE-3 and PGCSE-6 are equal and its numerical value is 77.7%. The improvement in the PGCSE-1, PGCSE-7 and PGCSE-10 are equal and its numerical value is 72.2%. The improvement in the PGCSE-5 and PGCSE-9 are equal and its numerical value is 61.1%. The subject PGCSE-4 has highest percentage improvement and its numerical value is 94.4%. The Subject PGCSE-8, having total 66.6% improvement. From the Table 7 and Figure 2, it is observed that for every subject percentage improvement by ICT method is always more than 60 percentages. When we closely analyze the performance of all students in each subject, and found good results (96% confidence level). The average marks of students in each subject are compared and it's improved by more than 74% student secured higher marks with NPTEL mode of teaching. Rests of students have equal marks in most of cases. We must say that in most of the subjects, the percentage improvement in subject teaching in online video lecture of NPTEL provides better way of learning and understanding of the subjects.

Table 7. Percentage of Improved in students in all subjects

Subjects	PGCS E-1	PGCS E-2	PGCS E-3	PGCS E-4	PGCS E-5	PGCS E-6	PGCS E-7	PGCS E-8	PGCS E-9	PGCS E-10
Improvement in % Marks of Students	72.2%	77.7%	77.7%	94.4%	61.1%	77.7%	72.2%	66.6%	61.1%	72.2%

CONCLUSION

The Z-value obtained from the experimental results shows that, in most of the cases, it is around 2.0. It gives the confidence level of 96% i.e. it provides better results in all the cases. This seems that teaching through NPTEL video largely affects in theoretical subjects also. From Table-7 it is clear that there are significant improvements in the terms of percentage marks of students. Finally, we have observed that on average 74% students are performing better in terms of NPTEL based approach. Hence we conclude that NPTEL based e-learning methodologies are significantly effective even in pandemic situations like COVID-19.

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Manoj Kumar Srivastava received the Master of Computer Application degree from Utter Pradesh Rajarshi Tandon Open University (UPRTOU) Allahabad (Prayagraj) in 2006 and M.Tech. in Software Engineering Motilal Nehru National Institute of Technology (MNNIT), Allahabad Prayagraj, U.P., India in 2012. He is perusing his Ph.D. degree in Computer Science from University of Allahabad, in the department of Electronics and Communication. His research interests include e-learning and computer networks.

Rajesh Kumar received the B.E. degree in Computer Science and Engineering from faculty of Engineering, HNB Garhwal university, Srinagar, U.K., India in 2003, and M.Tech. in Software Engineering from Motilal Nehru National Institute of Technology (MNNIT), Allahabad Prayagraj, U.P., India in 2012. He received his PhD. In Computer Science and Engineering on "Segmentation and Detection of Cancer from Microscopic Biopsy Images" from Indian Institute of Technology (IIT BHU) Varanasi, India, in the department of Computer Science and Engineering in 2015. Currently He is working as Assistant Professor in the University Of Allahabad Prayagraj, U.P., India. He has been working on computer vision and image processing. His research interests include image enhancement, analysis, registration, segmentation, and classifications of microscopic biopsy images. The current research includes Deep learning algorithms and Digital Image Forensic analysis and as well as application area of his work includes microscopic biopsy images for cancer research.

Ashish Khare received M.Sc. (Computer Science) and Ph.D. degree both from University of Allahabad, Allahabad, India, in 1999 and 2007 respectively. He did his post-doctoral research from Gwangju Institute of Science and Technology, Gwangju, Korea, in 2007–2008. Presently he is working as an Associate Professor in Computer Science at Department of Electronics and Communication, University of Allahabad, Prayagraj, India. His research interests include applications of wavelet transforms, computer vision, cyber security and human behavior understanding.