

A Critical Study of NPTEL

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Abstract— Indian economy is growing at a fast pace presently. Sustaining this growth requires technically trained professionals in large number. It requires providing education and training to population in increasing number. The technological advancement can be of great help in this regard. This paper studies and evaluates Technology Enhanced learning, with particular reference to NPTEL – a portal dedicated to technical e-content – across eight different Engineering Colleges of India located in Gujarat. Based on a comprehensive survey conducted across the Engineering Colleges with over 850 respondents, this study is a quantitative analysis of the findings and preferences articulated by students and faculty members. The questions pertain to the use and features of e content such as NPTEL used by students. Questions related to faculty quality, need for online educational services, content, technologies, pedagogies, research and extension are also posed to the sample. The responses of 287 NPTEL users out of the 875 respondents are compared across gender, institution, income level and such other factors. The responses are also tested for hypothesis analyses and other analysis such as factor analysis etc. The results and findings of the paper can be of use for further modifications and modeling of NPTEL for phase II.

Keywords-NPTEL, technical education, technology enhanced learning, virtual university

I. INTRODUCTION

Indian Economy is growing at a vast pace presently. If India is to become a leading knowledge economy in the world, one of the key factors that needs attention is the quantity and quality of its human resources. In fact, creation of knowledge, adoption of knowledge and becoming skilled in the assimilation, contextualization and application of knowledge are some of the key areas that need special thrust in the journey towards being a leading global knowledge economy (World Bank, 2002, Constructing Knowledge Societies: New challenges for Tertiary Education). This requires professionals in various disciplines corresponding to the different sectors of the economy such as scientists, administrators, technologists, teachers, lawyers, policy planners, health professionals, doctors, industrialists, among others. While all these professionals are needed, the importance of technical professionals and technologists is particularly high in a knowledge society, as they play the important role of transposing the knowledge, discoveries and innovations in the fields of Science onto their applications across various sectors of the economy, including the daily lives of people (*ibid*). These professionals from different fields of technology and engineering would be able to pave the way and create furrows in new, uncharted terrains by undertaking research, working at the cutting edge of emerging disciplines and fields. They would have to give

direction to the growth and development of knowledge and put in place mechanisms, processes, skills and human resources projected for future. This, in turn, requires a base of sound technical education as this leads to the development of skilled and competent professionals and work force as well as the teachers and instructors needed for further developing new professionals. India has witnessed a huge demand for engineering education and this has led to the setting up of a very large number of private engineering institutions across the country.

The Indian Institutes of Technology (IITs) have established themselves as premier institutions in technical education across the country and the world (The Times Higher Education Supplement international rankings of the top 200 Universities has only two Indian Institutions included in the top 200 ranking- IIT Bombay and IIT Delhi.

<http://www.timeshighereducation.co.uk/Rankings2009-Top200.html>). The Institutes of Technology Act, 1961 came to define the IITs

(<http://www.iitb.ac.in/legal/IITsAct.pdf> as on 12th March, 2011), although the IITs at Bombay, Kanpur, Kharagpur and Madras were established in the 1950s. Over the years, the Senate of each IIT has given the mandate for good quality of syllabus for the courses, contact hours, continuous evaluation methodology and examinations. Thus, IITs have developed excellent instructional material (“Engineering Education for Everyone- A Distance Education Experiment at IIT, Bombay” IEEE 2008 by Kannan M. Moudgalya, Deepak B. Phatak, R. K. Shevgaonkar). The instruction materials coupled with the absolutely top quality of students who make it to the IITs through a highly competitive examination have made the IITs have a very special brand name. The admission to the IITs is through a highly competitive examination called the JEE (Joint Entrance Examination). In April 2008, as many as 320,000 candidates took the JEE for about 7000 seats, which translates to a dismal 2.2%. So, while there is a tremendous need to join the IITs, given their excellent courseware, faculty quality and infrastructure, there is a huge unmet need which has, in recent years been addressed to some extent by the large number of new engineering colleges across the country. However, most of these colleges are plagued by problems of severe faculty shortage and poor quality of teaching staff hired. In fact, the post-graduate programs or Masters programs in engineering are very small and poor to be able to churn out the required quantity and quality of teachers that the colleges need. Added to this is the fact that the expansion of the IT sector has led to the huge expansion in the high paying jobs that both fuel and quench the aspirations of students studying in technical Institutions. With the result, very few of them opt to go for the teaching profession. This is also on account of the status and economic returns

that have traditionally been associated with the teaching profession. (M. Moudgalya et al, IEEE 2008).

II. NATIONAL PROGRAMME ON TECHNOLOGY ENHANCED LEARNING (NPTEL)

It is estimated that about 160,000 teachers are needed for engineering education for a student population of about two million. As against this, only about 4,000 teachers are trained by higher education institutions every year. Further, since the teaching profession is not one of the more attractive career options for students from the societal status and economic point of view, a large number do not take up teaching.

Against all of this, India is fairly ripe in terms of availability and deployment of technology for rolling out ICT and e learning initiatives on a large scale. Students are also very familiar with gadgets and ICT equipment and readily take to internet based content, chat etc. Efforts such as the Open Learning Initiative (OLI) of Carnegie Mellon University and the OpenCourseWare (OCW) effort of the Massachusetts Institute of Technology (MIT) are efforts in this direction that are also opening up education.

While there is a great deal of similarity between the OpenCourseWare effort of the Massachusetts Institute of Technology (MIT) and NPTEL, the differences are that the syllabi and curricula of the targeted client institutions are factored into the contents. This is generated by seven top Indian Institutes of Technology and the Indian Institute of Science. NPTEL also organizes a series of workshops for teachers and students of the client institutions to create awareness, collect feedback and facilitate the adoption and internalization of the contents created by NPTEL.

NPTEL also provides for course-specific web space which facilitates threaded discussions where students, teachers and other users anywhere in the world can participate. While there are 110 video (approximately 4500 hours) lecture courses from phase I, it is planned that about 500 video lecture courses (with about 20000 hours of lectures) would be readied at the end of phase II. NPTEL would, perhaps be the largest single repository of technical courses in the world in the streaming video format.

NPTEL is implemented through two committees – the National Program Committee (NPC) headed by the Joint Secretary, Higher Education, Ministry of Human Resource Development (MHRD) and the Program Implementation Committee (PIC), headed by Professor M. S. Ananth, Director IIT Madras. The NPC oversees policy matters and financial sanctions. The PIC has members from all IITs/IISc who are NPTEL Coordinators in each IIT/IISc and members from representative user institutions. It oversees implementation of the program.

The details of the Web courses and Video courses developed so far are given in the table below.

TABLE I. COURSE DETAILS

Discipline	Web	Video
Core Science	16	14
Civil Engineering	26	19
Computer Science & Engineering	23	17
Electrical Engineering	16	18
Electronics and Communication Engineering	22	21
Mechanical Engineering	26	21
Total	129	110

The Promotion of NPTEL has been done using many different methods. Posters and brochures have been sent by post to more than 3,500 institutes across the country. Emails and bulk sms have been sent to the available data of all principals and placement officers of various colleges across the country. Team from BodhBridge (a company incubated in IIT Madras) has visited nearly 350 engineering colleges across the country (Maharashtra, West Bengal, Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh, Kerala, Karnataka, etc.). This has been supplemented with online competitions and the selection of student ambassadors across different campuses.

Based on information available from NPTEL in the progress report sent to the Program Implementation Committee for the period ending March, 2010, students and faculty from 93 Universities across the country and 175 Companies of the Private and Public Sector are using NPTEL data. Here are some statistics on the use of NPTEL.

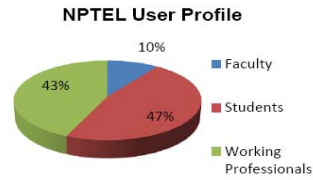


Figure 1. NPTEL user profile

Source for the tables and charts above: NPTEL Office from the progress report sent to the Program Implementation Committee for Period ending March 2010.

III. RESEARCH AGENDA

As explained in the previous sections, NPTEL has been recoding video lectures and packaging these for students and faculty of colleges outside the IITs. The present study addresses whether and to what extent NPTEL been able to fulfill its objectives.

The main objectives of the study were:

- To study the use and rating of NPTEL by engineering students of various Institutions and the differences and similarities in preferences and choices across different income groups, gender and castes.
- To assess NPTEL in knowledge enrichment and passing of examination.
- To know if a standalone Virtual University is preferred.

- To gauge the preferences of students for collaborative working with students, mentors, researchers, industry and local communities.

In order to study the impact of NPTEL and understand the extent to which it is found useful by students from engineering colleges across the state, a critical study was undertaken. This study entailed soliciting the inputs of students using an online survey on various aspects and dimensions of NPTEL. For this study, students and faculty members from eight engineering colleges spread across Gujarat were selected. Various questions related to the use, features and contents of NPTEL were posed. Questions related to their preferences in terms of features of a proposed Virtual University or blended learning mechanisms were also asked.

The colleges selected included an IIT, a National Institute of Technology (Surat) and six other state engineering colleges representing different regions and backgrounds. While the IIT and NIT have students selected from an All India competitive examination, the students studying in Bhuj, Morbi, Bhavnagar, Modasa, Chandkheda and Dahod mostly represent students from far flung, rural, urban and tribal areas of Gujarat.

IV. ANALYSIS

In this research, a total 906 responses from eight colleges was received. However, 31 responses were rejected because it was observed that some of them had many questions unanswered. Hence, 875 responses were considered for final analysis. It was observed that as high as 767 respondents had used on-line e content. However, out of these 767 respondents, there were 287 respondents who had used NPTEL. Since this paper is aiming at the NPTEL users, detailed analysis has been carried out, in the following paragraphs, only on the basis of responses of these 287 NPTEL users.

An analysis of these NPTEL users reveals following facts:

- Respondents belong to eight engineering colleges – one from Kutch region, two from Saurashtra, three from North Gujarat, one from Central Gujarat and one from South Gujarat region – which have a spread throughout the State of Gujarat right from Bhuj to Surat.
- There are 61 faculty member respondents (48 males and 13 females) and 226 student respondents (190 males and 36 females).
- In this sample of 287 respondents, 158 (55.05 %) belong to General category, 83 (28.92 %) are from SEBC category, 13 (4.53 %) from SC category, 26 (9.06 %) from ST category and 7 (2.44 %) belong to other category.

Looking at the spread across the region, across the faculty and students, across the gender and across the caste, it may safely be presumed that the sample seems to be a fairly good representative of the population. Satisfied about the representativeness of the sample, further analysis has been carried out in two parts. In the first part, responses from the respondents have been analyzed to understand the quality dimensions of the NPTEL courseware and the same are analyzed in two different ways in the following paragraphs.

A. Analysis on the basis of percentages

- A total 107 (37.82 %) and 136 (47.39 %) respondents ‘strongly agree’ and ‘agree’ respectively to the statement ‘NPTEL leads to enrichment of the knowledge’. Thus, 85.21 percent of the respondents are of the opinion that NPTEL enriches the knowledge.
- Similarly 62 (21.60 %) and 128 (44.60 %) respondents ‘strongly agree’ and ‘agree’ respectively to the statement ‘NPTEL helps in passing examination’. Thus, 66.20 percent of the respondents have opined that NPTEL is helpful in clearing the examinations.
- For a statement related to ‘Overall rating of NPTEL in terms of quality, faculty, curriculum and presentation’; total 282 faculty members and students gave response. Out of these 282 respondents, 109 (38.65 %) rated NPTEL as ‘Excellent’, 149 (52.84 %) rated it as ‘Good’ and only 24 (8.51 %) rated it as ‘Fair’. *Another very important issue here is that no respondent rated NPTEL on this dimension as ‘Low’.*
- Again, all 282 respondents gave answers to a statement ‘NPTEL should become a standalone program of study offered by a Virtual University’. Here also 53 (18.79 %) and 129 (45.74 %) respondents ‘Strongly agreed’ and ‘Agreed’ respectively to the statement. Thus, 64.53 percent of the respondents are of the opinion that NPTEL should become a standalone program of study offered by a Virtual University.
- Also, 108 (Strongly agree) and 122 (Agree) want more choices of courses to be made available to choose from on NPTEL. Hence, 230 (81.56 %) wish to have more courses on NPTEL.
- Of the respondents, 90 (Strongly agree) and 119 (Agree) – total 209 (72.82 %) want that courses offered on NPTEL should be standardized according to National and International norms.
- 158 out of 282 respondents i.e. 56.03 percent want that NPTEL should not be priced.
- One more dimension is about the availability of NPTEL in local language. 41 (Strongly agree) and 83 (Agree) i.e., a total of 124 (43.97 %) out of 282 wish to have NPTEL in local language. About 70 (24.82 %) do not want it to be in local language, while 88 (31.21 %) seem to be neutral on this issue.

From the above analysis, it may be concluded that the respondents are considering NPTEL at a high level in all the dimensions.

B. Analysis on the basis hypothesis testing through ‘t’ Tests

After carrying out simple analysis on the basis of percentages about the NPTEL users under A above, an advanced analysis for four important statements was performed and the details of the same are given in the following paragraphs.

Out of the eight statements discussed above, four important statements are chosen for hypothesis testing. An

	N	Mean	Std. Deviation	Std. Error Mean
Statement 3	282	3.30	0.618	0.037

attempt is made to test the following hypotheses:

- NPTEL leads to enrichment of knowledge.
- NPTEL helps in passing examination.
- Overall NPTEL rates high in terms of quality, faculty, curriculum and presentation.
- NPTEL should become a standalone program of

Test Value - 3.0	T	df	Sig.(2-tailed)	Mean Diff.	95% CI of the diff.	
					Lower	Upper
Stat. 3	8.188	281	0.00	0.301	0.23	0.37

study offered by a Virtual University.

For this purpose, one sample 't' test was carried out on the responses to the above four statements. On a five point Likert Scale used for statements 1, 2, and 4 above, the middle part was considered as 'Neutral'; and was given an equivalent number of 3. Hence, Test values of $\mu = 3.5$ were taken for these three hypotheses to show a positive approach towards agreeing to the statements. However, for statement 3 above, responses were taken on four points.

The middle part was given an equivalent number of

	N	Mean	Std. Deviation	Std. Error Mean
Statement 1	287	4.20	0.752	0.044
Statement 2	287	3.84	0.812	0.048
Statement 4	282	3.76	0.846	0.050

2.5 to consider it as 'Neutral'. Hence, a test value of $\mu = 3.0$ was taken for this hypothesis to show a positive approach towards agreeing to the statement.

	Test Value = 3.5					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Statement 1	15.741	286	0.000	0.699	0.61	0.79
Statement 2	7.087	286	0.000	0.340	0.25	0.43
Statement 4	5.209	281	0.000	0.262	0.16	0.36

(a) The results of the three hypotheses testing for statements 1, 2, and 4 (Test values of $\mu = 3.5$) are given in the following two tables:

TABLE II. ONE-SAMPLE STATISTICS ('T' TEST)

TABLE III. ONE-SAMPLE TEST

It can be observed from Table III, that for all the three statements, significance values are 0.000. Hence, hypothesis $H_0: \mu = 3.5$ is rejected at a confidence level = 0.95 for all the three statements. Mean values – as observed in table 1 – of 4.20, 3.84, and 3.76 respectively for statement numbers 1, 2, and 4 are much more than this positive approach assumed value of 3.5. Even, the standard deviations for these statements are comparatively low. These 't' tests are fortifying the results obtained under

points 1, 2, and 4 of I above. Therefore, it may safely be concluded that the respondents are of the opinion that:

- NPTEL leads to enrichment of knowledge.
 - NPTEL helps in passing examination.
 - NPTEL should become a standalone program of study offered by a Virtual University.
- (b) The results of hypothesis testing for Statements 3 (Test values of $\mu = 3.0$) are given in the following two tables.

TABLE IV. ONE-SAMPLE STATISTICS ('T' TEST)

TABLE V. ONE SAMPLE TEST

It can be observed from table V, that for statement 3, significance value is 0.000. Hence, hypothesis $H_0: \mu = 3.0$ is rejected at a confidence level = 0.95 for statement 3. The mean value of 3.30 for this statement is much more than this positive approach assumed value of 3.0. Even, the standard deviation for this statement is comparatively low. This 't' test is fortifying the results obtained under points 3 of I above.

Therefore, it may safely be concluded that the respondents are of the opinion that the overall NPTEL rates high in terms of quality, faculty, curriculum and presentation NPTEL leads to enrichment of knowledge.

In the second part, further detailed analysis of the responses of these 287 respondents has been carried out. In this part, responses of these respondents on 26 statements including some of the above statements have been considered for 'Factor Analysis'.

C. Factor Analysis

In the questionnaire, NPTEL users were asked to give their opinion on 26 statements related to NPTEL. All the 287 respondents had given their opinion on a five point Likert Scale on all these statements. In following paragraphs details of Factor Analysis are given. (Many theoretical details in this section are taken from the book of Naresh K. Malhotra. Malhotra Naresh K., *Marketing Research: an applied orientation*. Delhi: Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, 2001.)

Analysis of multivariate data is very important. Factor analysis is one of the multivariate analytical techniques. Factor analysis is a generic name denoting a class of procedures primarily used for data reduction and summarization. When a research is carried out, it may contain a large number of variables. Most of these variables may be correlated. Factor analysis reduces a large number of variables to a small number of factors. This factor conveys all essential information about the original variables.

1) Determination of the method of Factor Analysis

To carry out the factor analysis there are about 6 to 7 methods available, out of which, two methods are generally used: (1) Principal Component Analysis, and (2) Common Factor Analysis. An appropriate method is to be selected for the analysis. If, however, the number of variables is large (greater than 15) both methods result in similar solutions. Since, the number of variables here are

26, either of the two methods can safely be used. From these two methods, 'Principal Component Analysis method' is selected to carry out factor analysis, as is usually done by different analysts.

2) *Appropriateness of Factor Analysis and number of Factors*

The decision for carrying out factor analysis is wholly dependent upon answers to following two questions:

1. Is factor analysis appropriate for the data?
2. How many factors should be extracted?

The answer to the first question is given by (1) Bartlett's test of sphericity and (2) Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy. Bartlett's test of sphericity is used to test the null hypothesis that variables are uncorrelated in the population. The second is an index to examine the appropriateness of factor analysis. Generally, the values of 'KMO measure of sampling adequacy', falling between 0.5 to 1.0 indicate that factor analysis is appropriate. Values below 0.5 indicate inappropriateness of the analysis.

Many procedures have been suggested to answer the second question. They include (1) a priori determination, (2) determination on the basis of eigenvalues, (3) determination on the basis of Scree plot etc.

3) *Factor Analysis using 'Principal Component Analysis' method:*

Factor analysis was carried out on all the responses to 26 statements using 'Principal Components Analysis' method. Details of Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity are given in the following table:

TABLE VI. KMO AND BARTLETT'S TEST

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.827
Bartlett's Test of Sphericity		
	Approx. Chi-Square	1996.272
	Df	325
	Sig.	0.000

The results showed the approximate Chi-Square value of 1996.272 at 325 degrees of freedom under the Bartlett's Test of Sphericity, which is significant at the 0.05 level. The null hypothesis (that the variables are uncorrelated in the population, or the correlation matrix is an identity matrix) is, therefore, rejected. The alternate hypothesis that the variables in the population are correlated is accepted. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.827, which is quite large. Thus, factor analysis may be considered appropriate for analyzing the data.

The factor matrix, therefore, is transformed into a simpler one through rotation. It is easier to interpret this rotated factor matrix. Again, many methods are available for rotation. Most commonly used method for rotation is the 'varimax' procedure. Other two popular methods are 'direct oblimin' and 'quartimax'.

Further analyses using Varimax rotation, therefore, were carried out. As per the approach based on

eigenvalues, only factors with eigenvalues greater than 1.00 are to be retained. The results given in Table VIII at the end of this document show that there are seven factors with eigenvalues greater than 1 and they account for 57.478 percent of the total variance.

An important output from factor analysis is the factor matrix, also called the factor pattern matrix. The factor matrix contains the coefficients used to express the standardized variables in terms of the factors. These coefficients, factor loadings, represent the correlation between the factors and the variables. A coefficient with a large absolute value indicates that the factor and the variable are closely related. Hence, to facilitate interpretation of factors, it is necessary to identify the variables that have large loadings on the same factor. Table IX at the end of this document gives the factor loadings under various factors.

In the factor matrix, the highest loading of 0.770 was found for statement NPTS9_4 on factor '3'. It was decided to consider factor loading of 0.500 as a cut off point for a statement to be associated with a factor. When 'factor matrix' of the above seven factors was referred to, and a cut off value of loading of 0.500 was considered; three statements were associated with factor '1', '4', '5' and '6'; five statements with factor '2', four statements with factor '3', and two statements were associated with factor '7'.

D. *Interpretations of factors*

1) *Factor Number 1*

Following three statements are associated with this factor:

Question 3.6: They would like more choices of courses to be available on NPTEL.

Question 3.7: The courses offered should be standardized according to National and International norms.

Question 5.2: There is great value in NPTEL.

The three statements stated above can be summarized by stating that 'Respondents seem to expect more standardized choices of courses to add to the great value of NPTEL'.

2) *Factor Number 2*

Five statements given below are associated with this factor: These statements are extracted from the Questionnaire and reproduced below:

Question 4.4: On-line e-content should completely overlap with syllabus of degree course.

Question 4.6: Research topics and areas should be included in curriculum of virtual university.

Question 4.8: Virtual University should also make a provision for actual laboratory experience.

Question 4.11: Virtual University should also build in a provision for interaction with faculty or mentors.

Question 4.12: Industry related modules should be incorporated in the Virtual University.

The five statements stated above reflect that 'Respondents seem to prefer NPTEL as a Virtual University based on Industry linkage, faculty mentoring, laboratory experience and Research included in curriculum'.

3) *Factor Number 3*

There are four statements associated with this factor. They are reproduced below:

Question 8.4: Current system should provide platform for interaction with other students and share educational experiences, doubts and challenges.

Question 9.4: Current system should provide for quality interaction with future employers.

Question 9.5: Respondents interact regularly with the community in the neighborhood.

Question 10.1: IT is currently used in the college for various student applications.

It may be concluded that 'interactive NPTEL with students and employers is preferred'.

4) *Factor Number 4*

The three statements associated with this factor are given below:

Question 3.2: NPTEL helps in passing examination.

Question 5.3: NPTEL helps in GRE preparation.

Question 5.4: NPTEL helps in GATE preparation.

It may be concluded that 'Respondents want to have Examination oriented Facilities on NPTEL'.

5) *Factor Number 5*

Following statements are associated with this factor:

Question 8.3: Students could work as teaching fellows to coach junior students for some compensation.

Question 9.1: Students would like to take an online examination on a day of their choice.

Question 10.2: Students and faculty services management should be done using online services.

From these three statements, it may be concluded that 'Respondents want to have active participation in IT enabled teaching, exams and services on NPTEL'.

This factor can be labeled as 'Active educational and administrative services.'

6) *Factor Number 6*

Three statements given as under are associated with this Factor 6;

Question 4.7: Current system should provide simulated laboratory experiences.

Question 4.9: Provision of assessment, assignment and practice quiz should be made in the e-content.

Question 4.10: On line mode of examination and certification should be available on NPTEL.

These preferences can be summarized as 'Comprehensive educational facilities to be integrated in NPTEL'.

7) *Factor Number 7*

Factor 7 consists of following two statements:

Question 4.2: Respondents prefer online e-content in local language.

Question 4.3: Good quality e content should become a standalone program of study.

It seems that 'Respondents seem to demand standalone program of study in local language on NPTEL'.

The seven factors – depending upon the associated statements and inferences – can be named as given in the following table.

TABLE VII. FACTORS AND ASSOCIATED NAMES DEMANDED IN NPTEL.

Sr. No.	Factor	Name on the basis of Inference
1	Factor 1	More choices of standardized Courses
2	Factor 2	R&D, lab, industry and mentoring Experience
3	Factor 3	Interaction with Students & Employers

4	Factor 4	Examination Oriented Services
5	Factor 5	Active, Academic and Administrative Services
6	Factor 6	Comprehensive, integrated NPTEL
7	Factor 7	Standalone, local language based NPTEL

V. FINDINGS

Thus, as detailed in the previous sections, the findings of the analyses clearly give a high rating to the use of NPTEL in knowledge enrichment and passing of examination, a fairly high preference of students for collaborative working with other students, mentors, researchers, industry and local communities. There is a clear perception that NPTEL rates high in terms of quality, faculty, curriculum and presentation and helps in passing examinations. It is also perceived that NPTEL should become a standalone program of study offered by a Virtual University.

The factor analysis shows a preference of respondents for more choices of standardized courses, R&D, lab, industry and mentoring experience, interaction with students & employers, examination oriented services, active learning modes, academic and administrative services, comprehensive, integrated NPTEL as well as a standalone, local language based version of NPTEL.

VI. ROAD AHEAD

Based on these findings, possible architecture for the ramp up, scaling up of NPTEL into a Virtual University model could be thought of by various stakeholders. Further studies can also be carried out to see the preferences articulated by respondents across different States of the country in respect of various features of NPTEL and their delivery. In fact, the offerings of different Institutions across the country and the globe may also be brought together as a Service Oriented Architecture and offered in a comprehensive manner with standardized scaffolding. Such a system may actually cover the full ground from offering of Open Educational Resources to e-assignments and finally testing and certification using a variety of technology enhanced learning models and methods.

VII. CONCLUSION

World over, governments, industry and academia are actively exploring ways to transform the method and manner of ensuring access, quality and equity in Higher and Technical Education. The new revolution that has started across the globe over the last decade includes efforts such as the OCW of MIT, OLI of Carnegie Mellon University and the NPTEL. This study shows that NPTEL gets high rating as an effort in disseminating e-content from students and faculty members across selected engineering institutions located in Gujarat. This study also throws light on the direction in which NPTEL could possibly go to make it more useful, accessible and preferable to the selected stakeholders.

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TABLE VIII. TOTAL VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.791	22.274	22.274	5.791	22.274	22.274	2.566	9.870	9.870
2	2.302	8.854	31.128	2.302	8.854	31.128	2.503	9.628	19.497
3	1.937	7.450	38.577	1.937	7.450	38.577	2.303	8.856	28.354
4	1.344	5.168	43.745	1.344	5.168	43.745	2.178	8.376	36.730
5	1.313	5.051	48.796	1.313	5.051	48.796	1.975	7.595	44.325
6	1.243	4.779	53.575	1.243	4.779	53.575	1.853	7.126	51.451
7	1.015	3.903	57.478	1.015	3.903	57.478	1.567	6.027	57.478
8	.893	3.433	60.911						
9	.881	3.389	64.300						
10	.834	3.207	67.508						
11	.786	3.024	70.532						
12	.771	2.967	73.499						
13	.706	2.715	76.214						
14	.661	2.542	78.756						
15	.607	2.333	81.090						
16	.579	2.227	83.317						
17	.566	2.176	85.493						
18	.551	2.118	87.611						
19	.505	1.941	89.552						
20	.455	1.750	91.302						
21	.445	1.713	93.014						
22	.412	1.583	94.597						
23	.395	1.518	96.115						
24	.369	1.418	97.533						
25	.341	1.312	98.846						
26	.300	1.154	100.000						

TABLE IX. ROTATED COMPONENT MATRIX

	Component						
	1	2	3	4	5	6	7
Q_Stat1	.410	.252	-.073	.428	.254	-.098	.124
Q_Stat2	.342	.079	.066	.696	.005	-.080	.155
Q_Stat6	.750	.128	-.028	.196	.098	.180	.003
Q_Stat7	.688	.268	.123	.023	.048	.040	.136
NoNPTL2	-.186	-.098	.153	.362	-.065	-.006	.674
NoNPTL3	.368	.065	-.025	.027	.219	.088	.653
NoNPTL4	.123	.544	.245	.048	-.073	-.023	.391
NoNPTL6	.135	.659	-.093	.128	.115	.281	-.071
NoNPTL7	.121	.383	.107	.366	-.071	.513	-.115
NoNPTL8	.007	.501	.146	.151	.252	.301	.083
NoNPTL9	.056	.333	.029	.121	.211	.644	-.117
NoNPTL10	.171	.127	.059	-.064	.166	.778	.192
NoNPTL11	.211	.518	-.047	-.104	.112	.361	.194
NoNPTL12	.209	.678	.089	.057	.008	.078	-.140
NPTLS5_2	.723	.064	.035	.289	.028	.155	-.064
NPTLS5_3	-.047	-.039	.265	.530	.033	.046	.366
NPTLS5_4	.252	.121	.047	.674	.112	.182	.020
NPTS8_3	.339	.042	.301	-.034	.566	.105	.084
NPTS8_4	-.031	.087	.665	-.012	.199	.013	.273
NPTS9_1	.101	-.080	.030	.018	.668	.200	.184
NPTS9_3	.330	.343	.135	.018	.430	-.094	-.178
NPTS9_4	.175	.053	.770	.155	-.104	.088	-.053
NPTS9_5	-.110	.173	.707	-.021	.287	-.115	.120
NPTS9_6	-.045	.285	.344	.007	.418	.119	-.014
NPTS10_1	.178	-.222	.549	.329	.037	.200	-.166
NPTS10_2	-.089	.181	.010	.420	.632	.099	-.112