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Voice Characterstics and Acoustic Analysis in Students with and Witout Amplification

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ABSTRACT
Acoustic analysis of voice is a method to use to objectively measure and quantify various acoustic properties of person's voice. The present study aimed to analyse and compare the acoustic characteristics in engineering students when they talk in the class with and without amplification. 20 Malayalam speaking adult participants participated in the study. They were asked to attend a class and were recorded. The recorded Sample was analysed by PRAAT software to check various parameters f0, f1, f2, f3, jitter, and shimmer, HNR, SNR with and without amplification. Results obtained shows that students are showing less vocal load.
Key words: *Voice characteristics in students*

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I. INTRODUCTION

Voice is an integral part of unique human attribute known as speech. It is a powerful tool that not only delivers us messages but adds meaning to it. (Colton & Casper 1996).

Acoustic analysis of the voice signal may be one of the most attractive methods for assessing phonatory function or laryngeal pathology. It is non-invasive and provides objective and quantitative data. The technique of acoustic analysis has promising future as a diagnostic tool in the management of voice disorders. Many acoustic parameters derived by various methods have been reported to be useful.

There are various acoustic parameters in PRAAT such as, mean fundamental frequency of phonation, standard deviation of fundamental frequency, fundamental frequency of speech/reading, jitter, shimmer, signal to noise ratio and harmonic to noise ratio. It is a measure of frequency variability in comparison to the participants. Pathological voices often exhibit a higher percentage of jitter. Shimmer is the percentage irregularity in the amplitude of the voice note. It is often referred to as amplitude perturbation. Shimmer, therefore, measures the variability in the intensity of adjacent vibratory cycles of the vocal folds. As with jitter, pathological voices often exhibit a higher percentage of jitter.

Aronson (1980) has classified voice disorders as organic and psychogenic or functional. According to him voice disorder is organic, if it is caused by structural (anatomic) or physiologic diseases either a disease of larynx itself or remote systematic illness which impairs laryngeal structure or function. Psychogenic voice disorder includes disorders of quality, pitch loudness and flexibility caused by psychoneurosis personality disorders or faulty habits of voice usage.

Boominathan, Mahalingam, Samuel, Babu & Nallamuthu (2012) aimed to profile the voice characteristics of elderly teachers through comprehensive voice assessment & results found that Mean FO was 121 Hz (males) and 172 Hz (females). Mean 1 Orange 28.4 dB (A) in males and 24.2 dB in females was reduced and shimmer (5.80% in males and 4.84% in females) values were increased.

Leena & Maria (2001) studied Effects of sound amplification on teacher's speech while teaching voice problems are common among teachers. This study investigated one possible method to decrease the vocal load. The effects of amplification on classroom speech were studied on five Icelandic teachers (3 females,5 males). Classroom speech was recorded with a portable DAT recorder & a head-mounted microphone, first under ordinary conditions and in the next week while using electrical sound amplification.

Vocal misuse and abuse were predominant causative factors for voice problems in vocations involving high demands on vocal mechanism, alone or in combination with biologic and psychosomatic factors, which may result in chronic or acute symptoms of vocal attrition (overall reduction of vocal capabilities, wear and tear of vocal mechanism) such as vocal fatigue, hoarseness, throat discomfort or pain and benign mucosal lesions.(Sapir, 1993)

Studies on vocal characteristics have been attempted in western studies and are few in Indian studies.

Teachers form a serious group of vocal abuses and are studied frequently. It is difficult to isolate the factor of class room teaching, as responsible for voice changes. This happens as factors such as age, vocal hygiene habits, experience of talking in a variety of noise environments etc, complicate the results of voice analysis. To avoid such factors it is proposed to study attending engineering classes, when they are made to speak to the class in a teaching session. Their voices will be recorded and analysed, when they teach the class with and without amplification. Hence the study aims to record acoustically analysed voice of engineering students when they talk to their class with and without amplification.

Acoustic voice analysis provides normative or fundamental data for different voice realities. A significant amount of information gained in acoustic analysis is still little known, and its exploration has not generally been stimulated. Among acoustic measures that voice laboratories offer, those with clinical applications are: the fundamental frequency, voice intensity, noise measures, and frequency and in voice analysis provides normative or fundamental data for different voice realities. A significant amount of information gained in acoustic analysis is still little known, and its exploration has not generally been stimulated. Among acoustic measures that voice laboratories offer, those with clinical applications are: the fundamental frequency, voice intensity, noise measures, frequency and intensity perturbation measures.

The fundamental frequency (Fo) is determined by the number of cycles produced by the vocal folds per second. It is the result of the iterations among vocal fold length, mass & tension during speech (Parsa & Jamieson, 2001) Among acoustic parameters, Fo is the most uniform and less sensitive to voice recording characteristics (Ingrisano, 2003). The fundamental frequency is a measure of how high or low the frequency of a person's voice sounds. Its psychological correlate is pitch. It is the frequency of vocal fold vibration and correlates with changes in vocal fold tension and sub glottal air pressure. A bass voice has a lower fundamental frequency than a soprano voice. A typical adult male will have a fundamental frequency of from 85 to 155 Hz, and that of a typical adult female from 165 to 255 Hz. Children and babies have even higher fundamental frequencies. Infants show a range of 250 to 650 Hz, and in some cases go over 1000 Hz. A 10-year-old boy or girl might have a fundamental frequency around 400 Hz. When we speak, it is natural for our fundamental frequency to vary within a range of frequencies

Harmonic to Noise Ratio (HNR) characteristics the relationship between the two components of the acoustic wave of a sustained vowel: the periodic component, vocal fold regular sign and the additional noise coming from the vocal fold and vocal tract. It correlates with the perception of vocal roughness. Noise-to-Harmonic Ratio is an average ratio of energy of the in harmonic components in the range 1500-4500 Hz to the harmonic components energy in the range 70-4500 Hz

Western studies

Roy, Barbara & Stemple (2002) Voice problems are common among school teachers. This prospective, randomized clinical trial used patient-based treatment outcomes measures combined with acoustic analysis to evaluate the effectiveness of two treatment programs. 44 voice-disordered teachers were randomly assigned to one of three groups: voice amplification using the Chatter Vox portable amplifier (VA, n=15), vocal hygiene (VH, -15), and a non-treatment control group (n=14) Before and after a 6-week treatment phase, all teachers completed: (a) the Voice Handicap Index (VHI), an instrument designed to appraise the self-perceived psychosocial consequences of voice disorders; (b) a voice severity self-rating scale, and (c) an audio recording for later acoustic analysis. Based on pre and post-treatment comparisons, only the amplification group experienced significant reductions on mean VHI scores, voice severity self-ratings, and the acoustic measures of percent jitter and shimmer. The non-treatment control group reported a significant increase in level of vocal handicap as assessed by the VHI. Although most pre to post treatment changes were in the desired direction, no significant improvements were observed within the VH group on any of the dependent measures. Between-group comparisons involving the three possible pairings of the groups revealed a pattern of results to suggest that: (a) compared to the control group, both treatment groups (i.e., VA and VH) experienced significantly more improvement on specific outcomes measures and (b) there were no significant differences between the VA and

VH groups to indicate superiority of one treatment over another. Results, however, from a post treatment questionnaire regarding the perceived benefits of treatment revealed that, compared to the VH group, the VA group reported more clarity of their speaking and singing voice (p=.061), greater ease of voice production (p=.001), and greater compliance with the treatment program (p.045). These findings clearly support the clinical utility of voice amplification as an alternative for the treatment of voice problems in teachers.

Rachel & Jennifer (2009) explored whether acoustic and perceptual features could distinguish comfortable from maximally projected acting voice. 13 professional male actors read a passage. The first delivery used their comfortably projected voices, whereas the second used maximal projection. Acoustic measures, expert ratings, and self-ratings of projection and voice quality were investigated. Long-term average spectra (LTAS) and sound pressure level (SPL) analyses were conducted. Perceptual variables included projection, breathiness, roughness, and strain. When comparing the intensity difference between the higher (2-4 kHz) and lower (0-2 kHz) regions of the spectrum in voice samples from the maximal projected condition, LTAS analyses demonstrated increased acoustic energy in the higher part of the spectrum. This LTAS pattern was not as evident in the comfortable projected condition. These findings offered some preliminary support for the existence of an actor's formant (prominent peak in the upper part of the spectrum) during maximal projection.

Rantala, Vilkman & Bloigu (2002) studied voice changes during a working day in 33 female primary and secondary school teachers. Recording was made on first and last lessons during one school day. Estimation of fundamental frequency (FO), sound pressure level (SPL), the standard deviation of these values (FO SD, SPL SD) and FO time were made. The most obvious change noted, due to loading was the rise of FO that was 9.7 Hz between the first and last lesson (p=0.00) FO increased more (12.8. Hz, p=0.006) in the subgroup with few complaints.

Indian studies

Boominathan, Mahalingam, Samuel, Babu & Nallamuthu (2012) aimed to profile the voice characteristics of elderly teachers through comprehensive voice assessment and results found that Mean FO was 121 Hz (males) and 172 Hz (females). Mean I Orange 28.4 dB (A) in males and 24.2 dB in females was reduced and shimmer (5.80% in males and 4.84% in females) values were increased.

Leena & Maria (2001) studied Effects of sound amplification on teacher's speech while teaching voice problems are common among teachers. This study investigated one possible method to decrease the vocal load. The effects of amplification on classroom speech were studied on five Icelandic teachers (3 females,5 males). Classroom speech was recorded with a portable DAT recorder and a head-mounted microphone, first under ordinary conditions and in the next week while using electrical sound amplification.

Unnikrishnan (1999) acoustically analyzed voice of primary school teachers and college teachers and concluded that primary school teachers were more subjected to abusive voice.

Regishia & Yeshodha (2004) compared and correlated acoustic and aerodynamic parameters of voice across singers and non-singers during different phases of menstrual cycle. Participants included 10 female Karnatic singers and 10 non-singers in the age range of 20-27 years. Results obtained revealed no difference in acoustic parameters in singers for the two phases of menstrual cycle and decreased vital capacity measures across singers and non-singers sound pressure level (SPL) and phonation time were measured. According to the results, amplification significantly lowered both F0 (average 8.6 Hz for the females and 11.3 Hz for the males, p=0.002 and 0.0001, respectively) and SPL (about 1 dB for both genders, $p < 0.05$), while phonation time was not significantly affected. The results suggest that electric amplification is likely to reduce vocal load.

II. METHODOLOGY

Aim

The aim of the present study was to analyze and compare the acoustic characteristics in engineering students when they talk in the class with and without amplification.

Participants

Subjects consisted of 20 Malayalam speaking adult students (between the age ranges of 20-25) participated in the study. All the 20 subjects were attending engineering classes participants participated in the study was from Kerala.

Procedure

A standard Lenovo G580 laptop with a creative HS 150 microphone was used. The subjects were comfortably stood facing the class. The class was about 20m length and 10m width. The microphone connected to the laptop was placed at about 3 inches from the mouth of the subjects for audio recordings. Each of the subjects were supposed to address about a topic in which they are more sure about. And each voice recordings have 10 minutes of duration. The selected voice parameters included jitter (pitch- period perturbation), shimmer (amplitude perturbation), f 0 (fundamental frequency), f 1(formant frequency 1) f 2 (formant frequency2), f 3 (formant frequency3), HNR (harmonics to noise ratio).

Instruments

PRAAT(version 5,1.37) (Boersma & Weenick, 2009) was used to extract acoustic parameters of live voice acoustic parameters considered for the present study were jitter (pitch- period perturbation),shimmer (amplitude perturbation), f 0 (fundamental frequency),f 1(formant frequency1) f 2 (formant frequency2),f 3 (formant frequency3), HNR (harmonics to noise ratio)

Inclusion criteria

1. None of the subjects had a history of vocal pathology, upper respiratory tract infection, symptoms of allergies neurological diseases and respiratory dysfunctions.
2. No history of past or present speech, language or hearing problems.
3. Participants did not have psychological, ophthalmic problems.

Exclusion criteria

Subjects with any neurological involvement, articulatory deficits and any speech, language and hearing impairment.

Statistical analysis

Data were summarized using descriptive statistics: mean, median and SD. To explore the relationship between difference voice parameters. The mann-whitney test was used. The data were analysed using SPSS software.

III. RESULTS AND DISCUSSION

The aim of the study was to compare the acoustic features of student speech with and without amplification. The data obtained was statistically analysed using mann-whitney test and results are discussed below.

Fundamental frequency

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P Value
With amplification	20	315.443	122.035	267.978	1.718	.086 NS
Without amplification	20	270.459	122.025	222.260		

Table 1: Showing the mean, median, standard deviation of fundamental frequency for 20 subjects with and without amplification.

From the above table 1 it is clearly evident that there is no significant difference between the subjects with and without amplification. The comparison of fundamental frequency was carried out using mann-whitney test and p value is calculated as shown in table 1. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between subjects with and without amplification.

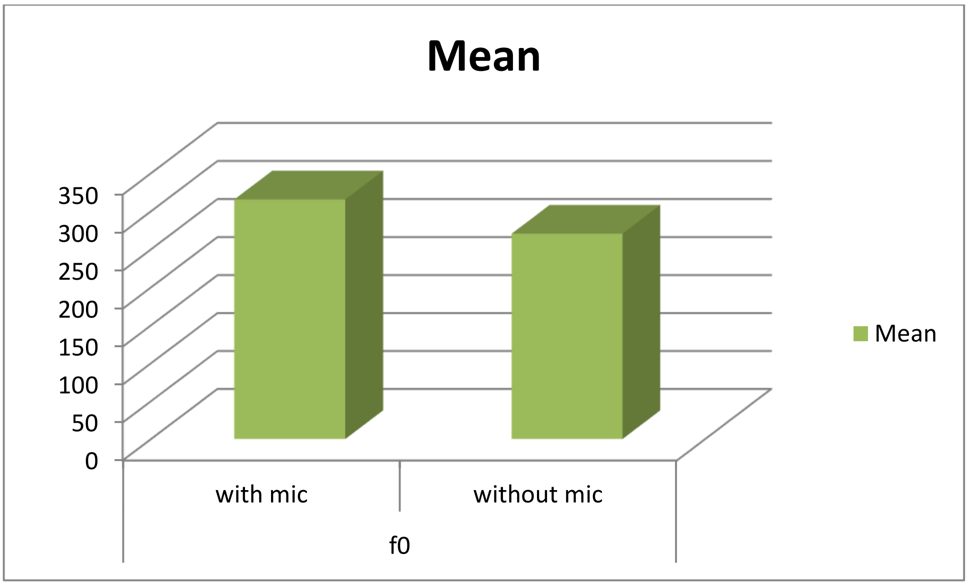

Figure 1: Showing the mean value of fundamental frequency for with and without amplification

Formant frequency 1

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	841.431	675.433	429.251	.325	.745 NS
Without amplification	20	759.188	700.034	215.077		

Table 2: Showing the mean, median, standard deviation of formant 1 for 20 subjects with and without amplification.

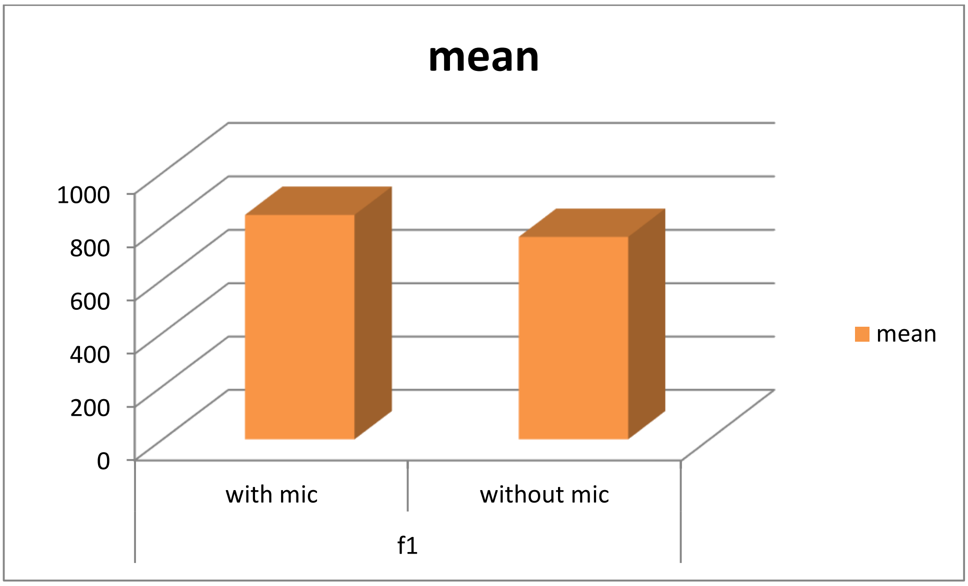

Figure 2: Showing the mean value of formant 1 plotted for with and without amplification

From the above table 2 and figure 2 it is clearly evident that there is no significant difference between the subjects using amplification and without amplification. The comparison of formant 1 was carried out using mann-whitney test and p value is calculated as shown in table 2. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between students using mic and without mic.

Formant frequency 2

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	2179.607	1963.413	488.774	.703	.482 NS
Without amplification	20	1924.423	1986.487	485.446		

Table 3: Showing the mean, median, standard deviation of formant 2 for 20 subjects with and without amplification.

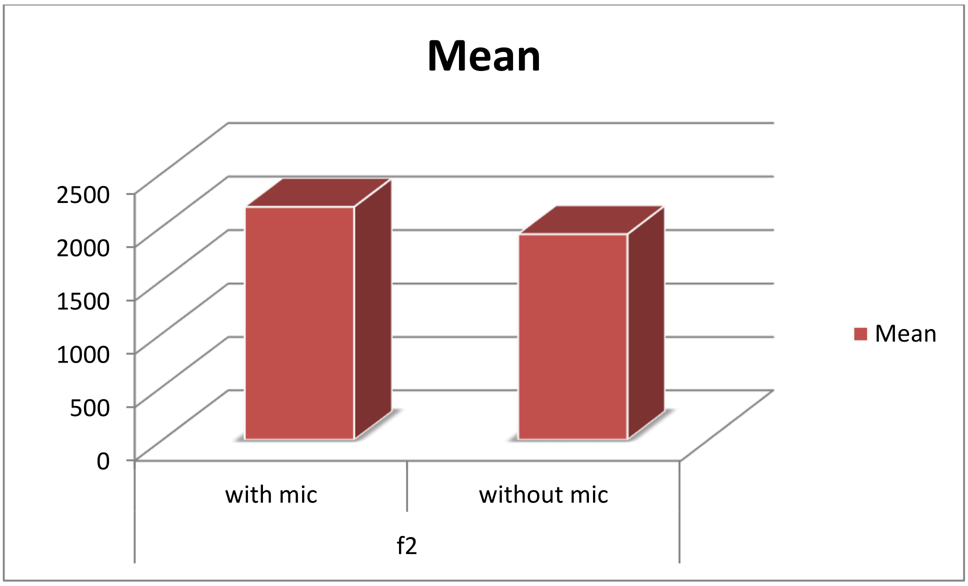

Figure 3: Showing the mean value of formant 2 plotted for with and without amplification

From the above table 3 and figure 3 it is clearly evident that there is no significant difference between the subjects with and without amplification. The comparison of formant 2 was carried out using mann-whitney test and p value is calculated as shown in table 3. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between students with amplification and without amplification.

Formant frequency 3

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	3103.592	3059.960	511.320	.081	.935 NS
Without amplification	20	3101.821	3075.870	258.266		

Table 4: Showing the mean, median, standard deviation of formant 3 for 20 subjects with and without amplification.

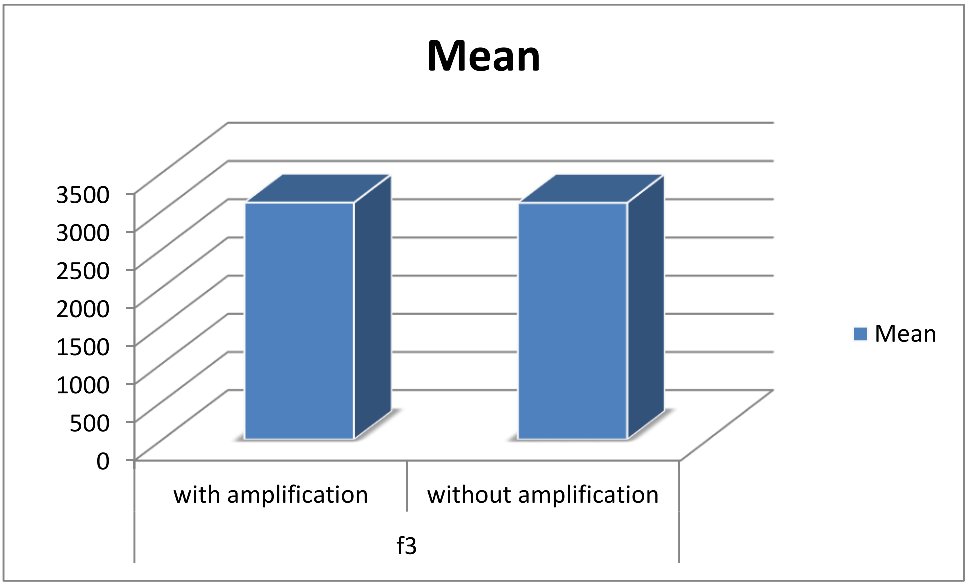

Figure 4: Showing the mean value of formant 3 plotted for with and without amplification

From the table 4 and figure 4 it is clearly evident that there is no significant difference between the subjects using amplification and without amplification. The comparison of formant 3 was carried out using mann-whitney test and p value is calculated as shown in table 4. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between students using amplification and without amplification.

Jitter

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	5.333	2.570	4.064	.122	.903 NS
Without amplification	20	4.748	2.645	4.525		

Table 5: Showing the mean, median, standard deviation of formant 4 for 20 subjects with and without amplification.

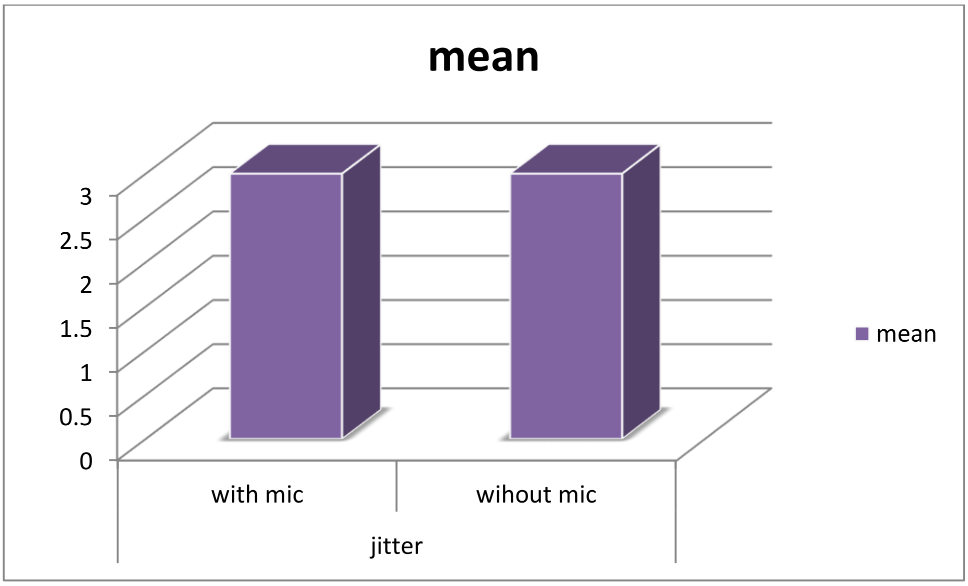

Figure 5: Showing the mean value of formant 4 plotted for with and without amplification

From the table 5 and figure 5 it is clearly evident that there is no significant difference between the subjects using amplification and without amplification. The comparison of jitter was carried out using mann-whitney test and p value is calculated as shown in table 5. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between students using amplification and without amplification.

Shimmer

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	2.619	1.107	4.977	1.528	.126 NS
Without amplification	20	7.745	1.193	11.412		

Table 6: Showing the mean, median, standard deviation of shimmer for 20 subjects with and without amplification.

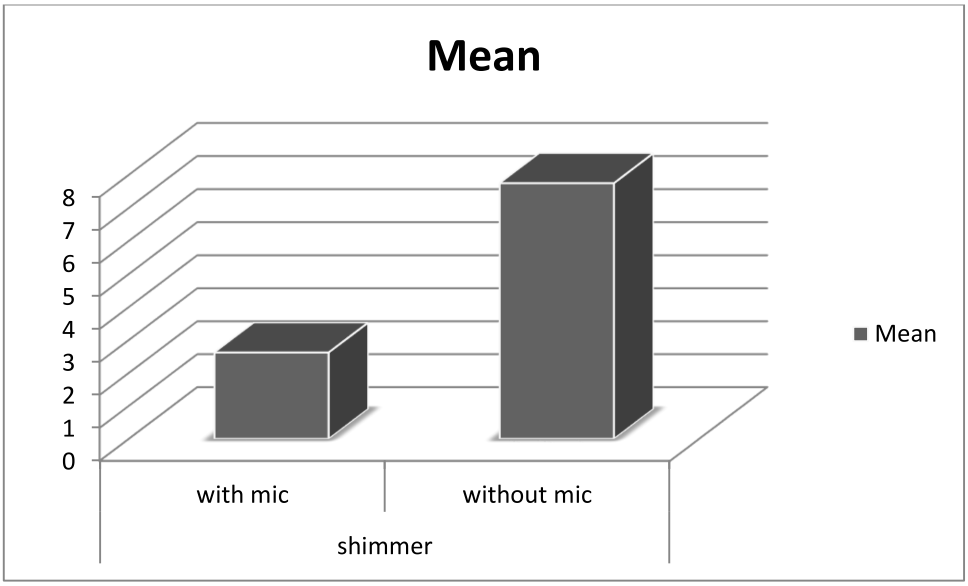

Figure 6: Showing the mean value of shimmer plotted for with and without amplification

From the table 6 and figure 6 it is clearly evident that there is no significant difference between the subjects using amplification and without amplification. The comparison of shimmer was carried out using mann-whitney test and p value is calculated as shown in table 6. Since the p value is greater than 0.001 the hypothesis is accepted. This implicates that there is no any significant difference between students using amplification and without amplification.

HNR

	N	Mean	Median	Standard deviation	Mann-whitney test Z value	P value
With amplification	20	10.823	11.588	8.455	1.244	.213
Without amplification	20	7.946	8.829	5.612		NS

Table 7: Showing the mean, median, standard deviation of HNR for 20 subjects with and without amplification.

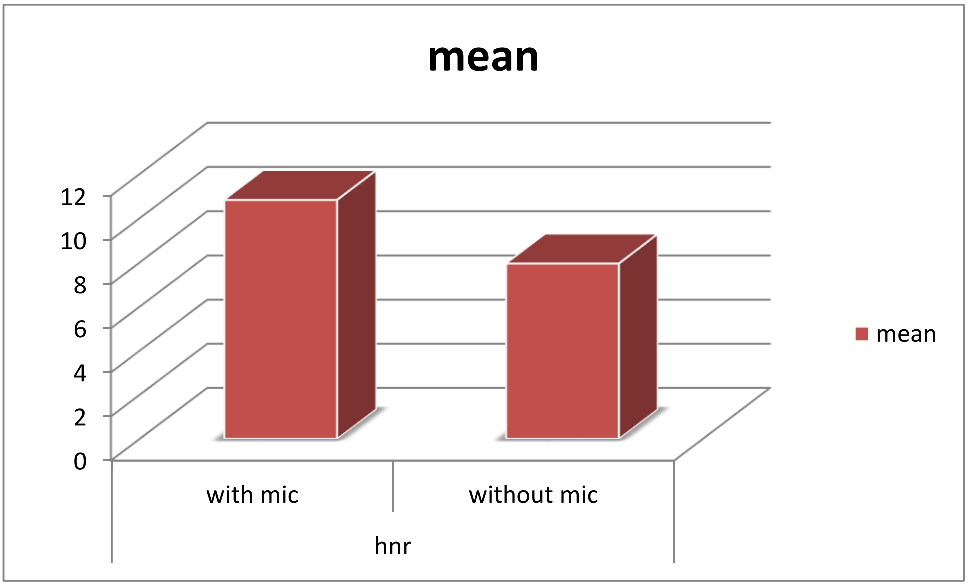

Figure 7: Showing the mean value of HNR plotted for with and without amplification

From the above table 7 and figure 7 it is clearly evident that there is no significant difference between the subjects with and without amplification. The comparison of HNR was carried out using a statistical test known as mann-whitney test and p value is calculated as shown in table 7. Since the p value is greater than

0.001 the hypothesis is accepted. This implicates that there is no significant difference between subjects with and without amplification

IV. Discussion

The aim of the study was to analyse the acoustic features with and without amplification in student's age range with 20-25. Result obtained shows that students are showing less vocal load.

The present study is in accordance with Leena & Maria (2001) studied Effects of sound amplification on teacher's speech while teaching this study investigated method to decrease the vocal load. The effects of amplification on classroom speech were studied on 5 teachers (3 females, 5 males). Classroom speech was recorded with a recorder and microphone, first under ordinary conditions and in the next week. The average fundamental frequency (F0), sound pressure level (SPL) and phonation time were measured. According to the results, amplification significantly lowered both F0 (average 8.6 Hz for the females and 11.3 Hz for the males, $p=0.002$ and 0.001, respectively) and SPL (about 1 dB for both genders, $p <0.05$), while phonation time was not significantly affected. The results suggest that electric amplification is likely to reduce vocal load.

V. Summary & conclusion

Voice is a potent, effective & artistic tool for communication. The voices can not only sophisticated scholarly concepts, but also fine emotional nuances.

Voice is the primary instrument through which an individual's personality is projected and compatriots are influenced. (Sataloff 2006)

The present study analyses the acoustic features with and without amplification of student's in the age of 20-25.

Subjects were asked to take a class for students on the given topic and recorded. PRAAT software 5.1.35 version was used to extract voice related parameters. Specifically various parameters of voice were determined. F0, F1, F2, F3, Jitter, Shimmer HNR, SNR was determined and compared with and without amplification.

Mann Whitney test was used to compare the acoustical parameters of voice among the students (with and without). And result shows that there is no significant difference in F0, F1, F2, F3, Jitter, Shimmer HNR, and SNR using with and without amplification. Result obtained shows that students are showing less vocal load.

Limitation of the study

1. The study was limited to only male subjects
2. Effect of smoking in students is not taken to consideration
3. Ambient noise and SNR was not calculated.

Further recommendation

1. Study can be performed in female subjects also.
2. Ambient noise and SNR have to be calculated.

REFERENCES

[1]. Amir, O., Amir, N., & Wolf, M., (2005). A clinical comparison between two acoustic analysis softwares: MDVP and Praat. Biomedical Signal Processing and Control,4,202-205.doi:10.1016/j.bspc.2008.11.002.

[2]. Aronson, E.A., & Bless, M.D.,(1981).Clinical Voice Disorders: (pp.18) Fourth Edition. Thieme Publications.

[3]. Babu, M., Boominathan. P., Mahalingam, S., Nallamuthu, A., & Samuel, S. (2012). Voice characteristics of elderly college teachers: A pilot study. Journal of Laryngology and Voice, 2, 21-25. DOI: 10.4103/2230-9748.94729.

[4]. Baken, J.R., & Orlikoff, F.R., (2000). Clinical measurement of speech and voice (pp.444) Second Edition, Singular Thomson Learning, San Diego, CA.

[5]. Boersama, P., & Weenink, D. (1992). Doing phonetics by computer software Available.

[6]. Boersma.P., & Weenink, D. (2007).Praat., Doing Phonetics by Computer (5.1.35)., Computer Software Retrieved from: http//www.praat.org

[7]. Burdick, J., (2013).Colour of Sound: race Religion and Music in Brazil: (pp.207)

[8]. Colton, H.R., Casper, K (1996). Understanding Voice Problems: A Psychological Perspective For Diagnosis and Treatment (second Edition).

[9]. Ingrisano, D. R. (1998). Environmental noise: A threat to automatic voice analysis. American Journal of Speech-Language Pathology, 7, 91-96. doi:10.1044/1058-0360.0701.91.

[10]. Jennifer, P.M and Depoe, S(2009). Voice and Environmental Communication: (pp.114)

[11]. Kent, R.D.,Lowit,A(2010). Assessment of Motor Speech Disorders: (pp.86). Plural publishers.

[12]. Manfredi, C. (2011). Models and Analysis of Vocal Emissions for Biomedical Applications: (pp.160)

[13]. Parsa, V., & Jamieson, D, G. (2001). Acoustic discrimination of pathological voice: Sustained vowels versus continuous speech. Journal of Speech Language and Hearing Research, 44, 327-339.doi:10.1044/1092-4388.

[14]. Regishia, A., Yeshodha, K. (2004). Influence of Menstrual Cycle on Clinical Measures of Voice: A Comparison of Singers and Non singers. Unpublished Dissertation, Mysore University

[15]. Sataloff, R,T,.(2006) Vocal Health & Pedagogy Signs & Assessment Second Edition Volumel Plural Publications

[16]. Stemple, L.,C.(2002). Clinical voice pathology Theory and management, Mosby-year Book Inc.Mo. USA 155-171.

[17]. Sulica. L., Blitzer, A.,(2006). Vocal Fold Paralysis: (pp.64). Springer. Publishers.
[18]. Sapir, S. (1993). Vocal attrition in voice students: Survey findings. Journal of voice 7,69-74
[19]. Unnikrishnan, K.J.(1999).Acoustic Analysis of Voice-Quality in School-Teachers and College-teachers. Unpublished dissertation, Mangalore University.
[20]. Wang., Huang, (2011). Neurologic Disorders of the larynx: (pp.76) Thieme. Publishers.
[21]. htpp://www.deepdyve.com/lp/informa-healthcare/effect-of-sound-amplification- on-teachers-speech-while-teaching.
[22]. http://www.ncbi.nlm.nih.gov/pubmed/14740934
[23]. http://www.scielo.br/pdf/bjorl/v75n3/v75n3a20.pdf