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RESEARCH ARTICLE

Development of a Minimum Protocol for the Assessment of Communication Disorders within Moroccan Students

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Abstract:

Background:

The present paper aims at establishing a minimum assessment protocol to estimate the prevalence of communication disorders, their severity and the correlation between identified communication disorders and oral communication activities among students.

Material and Methods:

A questionnaire was built using assessments published in current literature, which consists of 14 sections.

The first section gathers demographic information such as age, gender, and level of education as well as history of speech therapy services (e.g. "do you consult a speech therapist?").

The second section asks about the ability to communicate verbally in public in social situations and the possible causes that impact a student's ability to communicate effectively.

The third section deals with the attitudes of the student before, during and after communicating, specifically focusing on questions related to stuttering.

The proposed assessment also identified the severity of stuttering as well as any secondary behaviours associated with stuttering (e.g. eye blinking, tics, face spasms, etc.).

Sections 4 through 13 are concerned with questions related to communication disorders such as: articulation disorders, language delays, dysphasia, swallowing disorders, hearing loss, cleft lip or palate, aphasia, attention disorders, dyslexia, and dysphonia.

The last section deals with acoustic analysis, using Praat Software, where a recording of the sustained vowel /a/ is performed by each participant in order to have an overview of the following acoustic parameters: pitch, harmonics to noise ratio, shimmer and jitter.

Participants included in this study were between 18 and 22 years of age who were in their 1st or 2nd year of department of science of the Ben M'Sik College -University Hassan II Mohammedia.

Results:

The questionnaire was completed by 170 students, which insures a confidence interval of 4 and confidence level of 95%.

Among the sample, 58% of students are male, and 42% are female.

The studied sample demonstrated that 75% of the students do not feel comfortable when engaging in verbal communication in social situation, which was highly correlated with stuttering.

Lack of self-confidence, stage fright, lack of experience, shyness and the presence of an important group are 80% of the causes students do not feel at ease when publicly speaking in front of an unfamiliar group.

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The study revealed that 20% of students had fluency disorders, 15% had articulation disorders, 21% had swallowing disorders, 19% had dysphasia, 1% of the students had hearing loss, 14% had attention disorders, 10% had dyslexia, and 6% had dysphonia.

The major finding of the present paper was that 54% of the students studied were identified as having a language delay.

Subjective assessments of the communication disorders are complemented with objective assessments based on acoustic analysis of the sustained vowel /a/ recorded from the studied sample.

Based on the conducted research, we found that communication disorders impact the oral communication activities with a percent of 27%.

By using objective assessments to analyse the threshold of acoustic parameters such as jitter, shimmer, mean harmonic to noise ratio and minimum and maximum pitch, we can determine the presence or absence of a voice disorder.

Conclusion:

The present paper proposes a ready-to-use assessment of communication disorders.

The proposed model can be used with large groups as well as with individual students.

Subjective assessment used in combination with objective assessments allow for a complete evaluation of communication disorders.

Keywords: Assessment of communication disorders, Acoustic analysis, Communication disorders, Oral communication in public, Stuttering assessment, Voice disorders.

1. INTRODUCTION

1.1. Communication Disorders

Communication disorder is “any disorder that affects an individual’s ability to communicate”.

There are two types of communication disorders: speech disorders and language disorders [1].

1.2. Speech Disorders

According to the U.S. Department of Education (1992), “Speech is the process that shapes sounds into meaningful units, such as words. A multitude of factors can interfere with the normal development of speech, resulting in articulation disorders, difficulty controlling the sounds produced verbally (dysarthria or apraxia), and controlling the rate and rhythm of speech (fluency)” [1].

R.D. Kent [2], reported that voice disorders occur in approximately 6% of all adults in US. R.H. Bahr *et al.* [1], revealed that in many developing countries, communication disorders are often unreported.

Disorders of speech include voice disorders, stuttering, and speech sound disorders [3].

Fluency disorders are defined as the abnormal flow of verbal expression, characterized by impaired rate and rhythm which may be accompanied by secondary behaviours such as tics, eye blinking and facial grimaces” [4].

1.3. Language Disorders

Language disorders are characterized by difficulties in learning and using language and can negatively impact the major areas of language including syntax, semantics, phonology and morphology [5].

1.4. Causes of Communication Disorders

A multitude of factors can interfere with the normal development of speech, language and hearing, these constitute communication disorders.

Many conditions can interfere with the communication process resulting in communication impairment, which includes both physical and behavioural conditions [3].

The causes of speech sound disorders can be divided into two categories; the first category are related to organic disorders resulting from structural, physiologic, sensory or neurologic deficits as reported by Gordon-Brannan *et al.* [6].

A large part of these disorders can be identified using acoustic analysis.

The second category relates to functional disorders as mentioned by Bernthal *et al.* [7] and behavioural disorders, which is not apparent in the first category.

1.5. Impact of Communication Disorders

Communication skills are necessary both in the academic and social atmosphere of the school environment [8].

Disordered communication can negatively affect a person's lifestyle.

Speech, language, and/or hearing disorders have the potential to affect a student communicatively, socially, psychologically and academically [3].

Santon-Chapman *et al.* [8], Thatcher *et al.* [9], van Kleeck [10], Logan *et al.* [11], Gillette *et al.* [12] and Pufpaff [13] discuss that there are barriers providing instruction to students with communication disorders in a regular classroom.

Roulstone *et al.* [14], Zascavage *et al.* [15], Weigel *et al.* [16, 17], demonstrate the relationship between speech and/or language and literacy acquisition.

Catts *et al.* [18, 19], Nation *et al.* [20] and Schuele *et al.* [21, 22] found that many of the individuals identified with speech and/or language disorders may also exhibit subsequent deficits in reading and writing. In addition to academics, students with communication disorders may experience difficulty in social and behavioral skills required in school.

Communication is a vital skill not only necessary to succeed academically, but also required to participate effectively in social situation.

Students with communication disorders find difficult engaging in many of the academic and social activities encountered in schools.

Olusanya *et al.* [23], reported that the economic and social consequences of disabilities, which includes communication disorders are staggering, especially when we consider that many communication disorders are not readily apparent (*e.g.* Language learning disability or word finding difficulties).

Allen [24] arrived at the conclusion that having confidence in oral communication can make graduates versatile in their personal, academic, professional and civic lives.

Horwitz *et al.* [25, 26], found that whenever such learners endeavour to learn and speak English either as a second or a foreign language, they experience a certain level of anxiety and claim to undergo a 'mental block' during oral communication. Researchers have found that this mental block or anxiety severely jeopardizes the language learners' communicative competence.

2. ASSESSMENT METHODS

Speech-language pathologists used a variety of assessment tools to assess both children and adults who have communication disorders;

Damico [3] Frassinelli *et al.* [27], Fujiki *et al.* [28], and Marvin [3], proposed collaborative models.

However, (Ferguson *et al.*) [3] exposed consultation models.

Standardized assessments that make an in depth evaluation of communication disorders usually yield a diagnosis. They also compare an individual's performance to the performance of individuals in the same age group and include a level of severity of the disorder. From a practical standpoint, tests that allow for in-depth and comprehensive assessment are often too long.

Some communication disorders tests may take up to 6 hours to administer and an additional amount of time for scoring and analysis.

Assessments that are short enough to be practical may not fully assess an individual's communication when compared to assessments that are longer in length and take longer to administer.

Hedge *et al.* [29] reported that tests have other limitations that may be more or less magnified in the case of individual tests.

2.1. Assessment of Stuttering

In the present paper, we follow the stuttering grading system based on Andrew's & Harris [30], which is a system used to evaluate stuttering. The grading system is described as follows:

Grade 0 (stuttering not observed during interview), grade 1-mild stuttering (0-5% words stuttered), grade 2-moderate stuttering (6-20% words of stuttered) and grade 3-severe stuttering (over 20% words stuttered).

The coding for symptoms was: A-simple repetitions, B-prolongations and blocks and C-associated facial and body movements (secondary behaviours).

2.2. Assessment and QOL (Quality of Life)

Hassan *et al.* [2], List *et al.* [2], Picarillo *et al.* [2] have all demonstrated that communication is an essential element in the perception of quality of life.

Rosen *et al.* [31] found that objective test batteries are useful to quantify communication disorder severity.

Hartl *et al.* [32], categorize acoustic / physiological profiles of the disorder.

Wolfe *et al.* [33], found the correlation between objective and subjective measures, which are included in the diagnosis of the voice disorder.

Assessment of QOL is driven by the realization that diseases and disorders alter the way individuals lead their lives.

Physical and communication problems may restrict their daily activities, social participation, job performance, hobbies, vacation plans, and their quality of life.

Consequently, individuals may feel less competent, depressed, and think of themselves negatively creating a “lower self-image.”

Paul *et al.* [34] proposed the quality of communication life scale (QCL) which is a quality of life assessment questionnaire that is specific to communication problems.

The present assessment included adapted items from QOL assessment such as:

“People understand me when I talk? Describe your current speech or language problem (with a focus on problems communicating verbally in public adapted to student participants), and what do you think caused the problem?”

2.3. Voice Handicap Index

The voice handicap index was designed to assess all types of voice disorders.

A detailed analysis of patient data using this test has been published by Benninger *et al.* [35], Since the VHI has been published, others have proposed similar tests.

Hogikian and Glicklich [2] have both demonstrated the validity and reliability of their assessments tools when assessing an individual’s perception of the severity of voice disorders.

Hogikian [2] presented a measure of voice-related quality of life ‘VR-QOL’.

2.4. Voice Activity and Participation Profile

Yiu *et al.* [36] demonstrated that the effects of voice disorders can limit an individual’s participation in activities that require use of the voice.

Five areas were examined: self-perceived severity of the voice disorder, how the voice disorder affected employment, daily communication, social communication and perceived feelings and emotions.

The VAPP has been found to be a reliable and valid assessment tool for assessing self-perceived voice severity as it relates to participation in daily activities and activities that require verbalization [2].

In the present assessment, some questions were adapted from an assessment created by Wall and Myers [37] which include psychosocial questions such as: “What situations appear to provoke or to ameliorate the fluency breakdowns? And how is the student’s adjustment to his/her speech and to the reactions of others?”

2.5. Wall & Myers Assessment of Communication Disorders

In the present assessment, some questions were adapted from an assessment created by Wall and Myers [37] which include psychosocial questions such as: “What situations appear to provoke or to ameliorate the fluency breakdowns? And how is the student’s adjustment to his/her speech and to the reactions of others?”

2.6. Assessment in Speech-language Pathology

The proposed assessment also some questions adapted from Eckelman-Taylor (Speech and Hearing clinic, Illinois state university) [38] speech and language adult case history such as including: Have you received speech therapy services in the past? Have you ever experienced any of the following: difficulty saying some syllables or/and recalling words you wish to say?

Other questions adapted from the neuro-adult case history form, which indicate oral weakness (in the mouth or lips), difficulty producing sounds in words, difficulty paying attention, difficulty eating or swallowing, and changes in vocal quality .

Other questions from the accent modification adult case history form, voice case history form and fluency adult case history form such as: Do you avoid speaking situations? Does the problem affect your job/school/social performance? List any situations where you find it easy to speak.

Do you substitute other words for those you expect to have difficulty saying? Do you ever use facial grimaces or body movements to help you get through a moment of stuttering? Do you ever pause, pretend to think, or recollect your thoughts in order to avoid a moment of stuttering?

All selected questions were adapted to the student context.

2.7. Assessment of the Acoustic Analysis

Acoustic analysis is an objective assessment used to analyse speech by devices capable of measuring several acoustic parameters.

Acoustic analysis reduces the degree of subjectivity of perceptual analysis (Teixeira *et al.* [39]).

Acoustic parameters commonly used in applications of acoustic analysis are fundamental frequency (F0), jitter, and shimmer, Harmonic to Noise Ratio (HNR) and frequency formants.

It is possible to distinguish between normal and pathological voices based on normative databases, which characterizes voice quality, or by comparing the data of the studied sample with the data of individuals considered to have a healthy voice.

Measurements of fundamental frequency disturbance, jitter and shimmer has proven to be useful in describing speech characteristics [18].

Dealing with acoustic analysis, adapted questions from CV-RQOL and Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) reported by Touri and Marquardt [40] are used, in addition to a recording of the sustained vowel /a/ for 3-5 seconds.

Jitter is defined as the parameter of frequency variation from cycle to cycle, and shimmer relates to the amplitude variation of the sound wave (Zwetsch *et al.* [41]).

Jitter is mainly affected by lack of control when the vocal cords are vibrating. The vocal quality of individuals with vocal pathologies often has a higher percentage of jitter. Most researchers consider a typical value variation between 0.5 and 1.0% during vowel phonation in young adults.

Values of less than 3% shimmer for adults and around 0.4 and 1% for children are described by Guimares as presence of pathological voice disorder [42].

The HNR is an assessment of the ratio between periodic and non-periodic components comprising a segment of voiced speech (Murphy and Akande [8]). The first component arises from the vibration of the vocal cords and the second arises from the glottal noise expressed in dB.

The evaluation between the two components reflects the efficiency of speech, *i.e.* the flow of air expelled from the lungs provides the energy to put the vocal folds into vibration. In these cases the HNR will be greater. A voice sound is thus characterized by a high HNR, which is associated with sonorant and harmonic voice. A low HNR denotes an asthenic voice and dysphonia. As described by Boersma [43, 44], a value of less than 7 dB on the HNR is considered pathological.

3. SIGNAL RECORD

The sample consisted of a 3-4 second recording of the sustained vowel /a/ for each student. The sample was obtained using the Praat program and digitally recorded in the .wav format. The sample was recorded inside a laboratory with minimal acoustic conditions. In this room, each speaker sat comfortably with a Dictaphone (Sony ICDPX240 4GB) 10cm away from the mouth.

The sampling frequency used for recording these signals was 22.05 kHz, with 16-bit resolution and mono.

Praat software was used to extract the acoustic parameters after transferring the recorded utterance from Dictaphone to a personal computer Dell (Intel® core™ i7 CPU M640 @ 2.8 GHz 2.8 Ghz, 4 Go memory) using audacity software.

A headphone with a 3.5 jack cable male/male was connected to the line input of the PC followed by activation of the audio recording using audacity software.

4. RESULTS AND DISCUSSION

4.1. Do you Feel Comfortable When Speaking in Front of a Large Group?

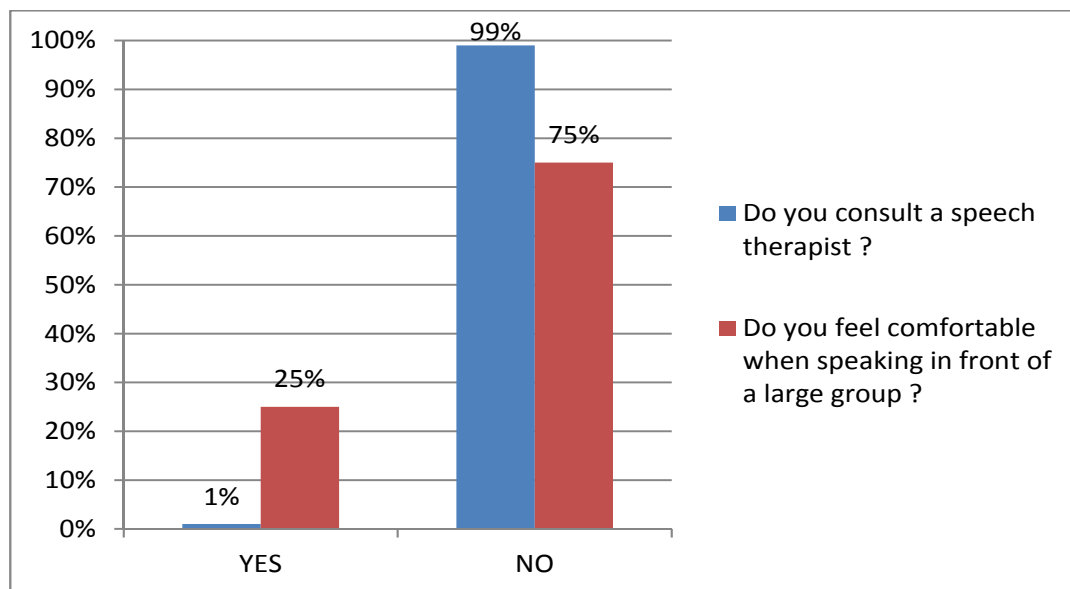


Fig. (1). Answers to the questions “do you consult a speech therapist” and “Do you feel comfortable when speaking in front of a large group”.

After collecting the data the results for each student was scored. Excel software was used to record the data.

The studied sample showed that 75% of the students do not feel comfortable when speaking in front of a large Group as shown in Fig. (1).

The first two questions that were asked “Do you feel comfortable when speaking in front of a large group” and “Do you consult a speech therapist?” gave us important information about the studied sample.

Pareto principle states that, for many events, roughly 80% of the effects come from 20% of the causes [2].

As shown in Table 1, lack of self-confidence, stage fright, lack of experience, shyness and presence of the important group constitute 80% of the causes.

As Friedl *et al.* [45] explained, the functional disorder is related to organic disorder. For example, the larynx can be a site of neuromuscular tension that is caused by stress, emotional inhibition, fear or threat of communication breakdown.

Table 1. Cited causes of not feeling at ease when speaking in front of a large group.

Causes of not feeling at ease in oral communication in public		%	80-20 rule
	Lack of self-confidence	27%	27%
	Stage fright	16%	43%
	Lack of experience	15%	58%
	Shyness	15%	73%
	Presence and eyes of others	9%	82%
	Fear of speaking in a bad way	7%	89%
	Afraid of criticism and public judgments	6%	95%
	Stress	5%	100%

Trevarthen [46] found that these disorders are impacting students' self-confidence.

Researchers like Devi *et al.* [47], found that most of the language learners have some form of anxiety that interferes with their level of confidence during their speech.

Anxiety shakes the language learners' confidence, which adversely impedes their oral performance in the target language.

Anxiety or low level of confidence restricts the chances of learning and speaking the target language posing serious threat to oral communication. Richmond and McCroskey [48], opined discussed that the high level of anxiety among language learners seriously hampers the interaction between teacher and learners, which is extremely crucial to productive teaching and learning of the target language.

Horwitz *et al.* [25], define this anxiety "as a type of shyness characterized by fear or apprehension about communicating [orally] with people."

McCroskey [26, 49], defines it simply as a fear related to oral communication.

Listeners' status and the context make the speaker uneasy and apprehensive to speak confidently Friedman [50]. Taylor [51] reveals that speech anxiety may be specific to just a few settings (*e.g.* public speaking) or may exist in most everyday situations.

Communication situations that cause general anxiety are present during many facets of an individual's life. Among all four language skills, speaking is supposed to be the most anxiety-provoking skill. MacIntyre and Gardner [52], point out that the skill producing most anxiety is oral communication.

Learners who demonstrate speech anxiety/communication apprehension feel uncomfortable when required to communicate verbally in the target language in front of other individuals. Tesioplakides explains that students who experience test anxiety consider verbal communication a test situation rather than a chance for improving communication skills.

Learners who exhibit fear of negative evaluations deem errors as a danger to their image and do not consider it an accepted part of the learning process. As a consequence, they are silent and do not participate in classroom activities (Ely [53]).

Some previous researchers on language anxiety have concluded that learners' apprehension may be aggravated by the learners' negative self perception as cited by Krashen [54].

Tobias [55] found that highly apprehensive learners think negatively about themselves and have low-perceived self-esteem about their own performance in the target language.

4.2. Stuttering Assessment

Determine the severity and frequency of the problem by answering each question on the voice quiz by using a 5 point rating scale where: 0 = None, not a problem, 1 = A mild 2 = moderate 3= moderate-severe, 4 = severe.

Each participant fills the form with the required answers to the questions.

As shown in Fig. (2), verbal communication was responsible for stuttering.

Stuttering assessment: 20% of students indicated they are severe persons who stutter.

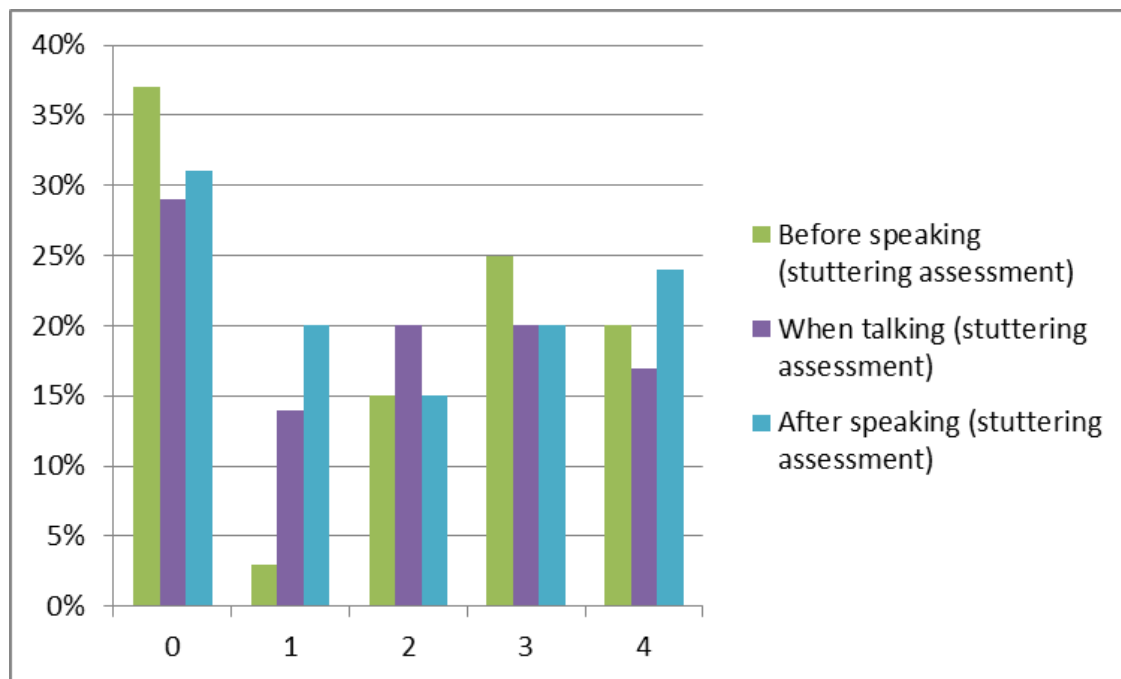


Fig. (2). Results of stuttering assessment: the degree of severity scaled from 0 to 4.

Before initiating communication: The feeling of being in front of a large group of people refrains students from talking, despite having the desire to speak. It also causes them to sweat, feel ashamed, and have an increase in heart rate.

During communication: The impression of having a rapid heartbeat, feeling the negative view of others, impression of a poor self-image, and fluency disorders are 80% of the reasons anxiety arises in students during communication.

After communication: The fear of being judged, reliving the conversation and focusing on the negative aspects (e.g., communication breakdowns), the feeling of not being able to say what “I want to say” and thinking that stuttering was distracting to the listener and negatively impacted communication are 80% of the causes of anxiety after communication.

Zheng [56] claims that anxiety influences both speed and accuracy and its arousal can impact the quality of communication output as the retrieval of information may be interrupted by the ‘freezing-up’ moments that students encounter when they get anxious, Richmond and Falcione [57] discovered that learners with high levels of speech anxiety were predisposed to have poorer self-esteem than students with low speech anxiety, which in turn negatively impacts academic success.

4.3. Other Communication Disorders Assessment

For each communication disorder, we focused on the severe degree (degree 4).

The weight of each question is examined, to select 20% that represent 80% of the causes.

As shown in Fig. (3), The speech delay was the most relevant disorder, with 54% of the students identifying themselves as having speech delay disorder.

Fifteen per cent of students have identified a degree of severity for the communication disorder.

Dealing with articulation disorders, 27% of the studied sample have difficulty producing the isolated phonemes A, B, C.

Twenty three per cent feel the inability to pronounce or to form a phoneme correctly?: i- u- -é è; Ch and R.

In the present study, the speech sound disorders were the most prevalent communication disorder, given that 54% of the studied sample had difficulty selecting and linking sounds in syllables, which according to Sabir *et al.* [58] is more prevalent than the other kinds of communication disorders.

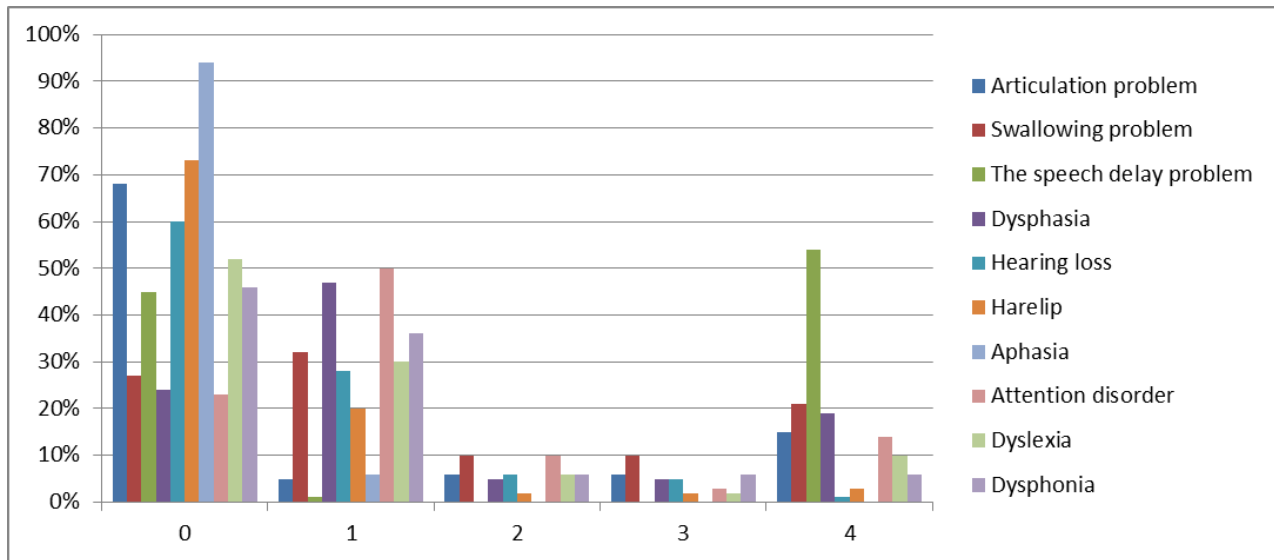


Fig. (3). Results of communication disorders assessment (except stuttering). : the degree of severity scaled from 0 to 4.

In regards to dysphasia, 27% of students feel they have word finding problems during oral presentations.

With respect to the dyslexia assessment, 22% of students have reading comprehension difficulty, and 13% confuse sounds fv, sz, hp-j, td, cg, mn and pbqd.

With respect to the dysphonia assessment, 14% of students feel a change in voice characteristics (more or less intensive, height too low or too high) when they are talking, and 6% have even altered their vocal cords.

4.4. Acoustic Analysis

Record of sustained vowel /a/ (duration 3 to 5 seconds).

The acoustic parameters jitter, shimmer, HNR, and pitch will be evaluated using normative data from the literature as shown in Table 2.

Table 2. For the sample studied in this paper.

	Mean Pitch	Minimum pitch	Maximum pitch
Female signal recommended value	225 Hz for adult females [39],	155 for adult females [39],	334Hz for adult [39],
Male signal recommended value	adult males 128 Hz [39],	adult males 85 Hz [39],	adult males 196 Hz [39],

Table 2. Recommended values of pitch for male and female signals.

The classification pathological/healthy was based on the extracted values of acoustic parameter upon the defined threshold in the literature.

For jitter, recommended values of praat (jitter ddp% <= 1.04%) [44], for female signal: <=0.66% [39] and for male signal: <=0.44% [39].

For shimmer, recommended values of praat (shimmer dda%): <= 3.810% [44], and female signal: <=2.7458% [39], and male signal <=: 2.2873% [39],

For harmonic-to-noise-ratio (HNR), recommended value of praat <=: <20 dB [44], for female signal recommended value <=: 15.3dB [39], and for male signal recommended value <=: 17.3 dB [39].

4.5. Synthesis Results

For each communication disorder, students use the following 0-4 scale to rate the severity of the problem: 0 = None, not a problem, 1 = A mild 2 = moderate 3= moderate-severe, 4 = severe.

The synthesis results are shown in Table 3.

Table 3. Synthesis results form.

	Type of communication disorder	0	1	2	3	4
Communication disorders assessment	Before communication (stuttering assessment)	37%	3%	15%	25%	20%
	During communication (stuttering assessment)	29%	14%	20%	20%	17%
	After communication (stuttering assessment)	31%	20%	15%	20%	24%
	Articulation disorder	68%	5%	6%	6%	15%
	Swallowing problem	27%	32%	10%	10%	21%
	The speech delay problem	45%	1%	0%	0	54%
	Dysphasia	24%	47%	5%	5%	19%
	Hearing loss	60%	28%	6%	5%	1%
	Cleft lip or plate	73%	20%	2%	2%	3%
	Aphasia	94%	6%	0	0	0
	Attention disorder	23%	50%	10%	3%	14%
	Dyslexia	52%	30%	6%	2%	10%
	Dysphonia	46%	36%	6%	6%	6%
	Overall score	47%	22%	8%	8%	15%
	Stuttering grade	88%	9%	2%	1%	
	Coding symptoms of stuttering	A	B		C	
97%		2%		1%		
Acoustic parameters	Jitter ddp % for /a/ utterance	<0.52%		Healthy or Pathological		
	Shimmer local % (for /a/ utterance)	<2.51%		Healthy or Pathological		
	Mean harmonic to noise ratio in dB for /a/ utterance	26 dB		Healthy or Pathological		
	Mean pitch	223 HZ		Healthy or Pathological		
	Minimum pitch	219HZ		Healthy or Pathological		
	Maximum pitch	226HZ		Healthy or Pathological		

CONCLUSION

The proposed minimum protocol assessment can assess communication disorders within students.

It covers all aspects related to the communication disorders utilizing both subjective and objective assessment related to acoustic analysis of students sustained vowel /a/.

By focusing on student's verbal communication activities we identified a possible correlation between their activities and communication disorder severity.

SUPPLEMENTARY MATERIAL

The question survey link on the web is:

https://docs.google.com/forms/d/1J9_nxF5FAqdiCIaksz8XrgjPnkEZylLcgYNYwICSU4Y/viewform?c=0&w=1&usp=mail_form_link

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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Declared none.

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