PHYSIOLOGICAL CONSIDERATIONS IN LEARNING OF MUSICAL INSTRUMENTS.

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Abstract

Musical instruments come in various shapes, materials, and mechanisms of tone production. Some are tubular, some are conical, while some defy conventional shaping. Some are blown, some plucked, and some struck, while some are fingered to produce sound. These peculiarities present challenges in learning the instruments. By virtue of their varied shapes and varied mechanism of sound production, musical instruments demand certain physical and physiological soundness from the learners as criteria for learning and mastery. Through related literature review, interviews and personal experience of the researcher, this research highlights some of those peculiar physiological criteria such as 'long and thin fingers' for the piano and the strings; deep breath, firm lips, and strong tongue for the woodwinds and brasses etc. The findings further incicates that for a successful instrumental experience, the teacher and the learner must give attention to the peculiar physiological criteria demanded by a given orchestral musical instrument.

Introduction

The dynamic nature of musical instruments requires that the teacher and the learner adapt to the basic principles of instrumental pedagogy. The basic principles of grouping, mechanism of sound production, practice, and roles in orchestra have been well assimilated but not much attention has been given to the principle underlying the

choosing of musical instruments by a learner or the assigning of that by a teacher. Over the years, the practice has been 'as the learner chooses' or by 'rule of thumb by the teacher' and these haphazard procedures have stifled effective instrumental learning.

Musical instruments, by virtue of their build and dynamics of sound production demand certain physiological criteria. Just as the human physiological and physical build form the basic criteria in sportsmanship, music also presents a similar situation. Football demands people with strong limbs and the stamina for a ninety-minute active engagement, while swimming requires strong and flexible limbs with good lung power to attend to the energy-sapping sport. Musical instrument playing is even more complex owing to the fact that they are numerous and each one presents peculiar features and difficulties. As a result, the physiological and physical preconditions for learning them are many and these are what this paper has sought to highlight.

Statement of the Problem

Music educators and instrument tutors have handled the choosing, teaching, learning, and playing of musical instruments without recourse to proper criteria. Musical instruments come in various shapes and mechanisms of sound production and consequently pose various challenges to the learner. Over the years, instrumental music scholars, educators, and authors have focused on the obvious challenges of playing musical instruments such as, posture, fingering, intonation, embouchure, bowing, performance techniques, sight-reading, etc., without regarding the physical fitness and physiological soundness of the prospective learners.

Analogy with Football

Comparing instrumental pedagogy with sports helps to buttress the point of this paper. Football, for example, demands various criteria

for the players to qualify to play. Most of such preconditions are physiological and physical. Guarav (2015) reported that:

> *Physical and physiological characteristics that have been reported as essential for football players are aerobic fitness, muscle strength, high level of speed, explosive jumping power and agility. Generally football players are divided into four categories regarding playing position. There are goalkeepers, defenders, midfielders and attackers, and each has its own characteristics. Attackers appear to be the fastest players in the team. The greatest overall distances appear to be covered by midfield players who act as links between defense and attack. In a football game defenders perform more backward movement than attackers. Furthermore, different football related activities (i.e. tackling, heading and passing) provide an extra physiological stress to the player with different positions having to perform specific activities. The physical fitness of a player however can be a decisive determinant of success during competition. Previous studies have reported that each specific playing position may have unique physical and physiological requirements (p.1).*

The submission above captures some pertinent issues in this paper. If a footballer requires physical and physiological soundness of the limbs; speed and agility from the muscles; strong skull bones and strong legs for ball heading and tackling respectively, flexible legs for accurate passes, stamina, endurance, and balance for the entire match; then the playing of musical instruments should not be an exception because it places similar physiological and physical demands on the attendee. Although such qualities as 'speed' and 'agility' are

developed through exercise but diseased legs may never yield speed and agility no matter the amount of exposure to exercise.

The Nature of Musical Instruments and their Intrinsic Challenges

Musical instruments have been grouped and classified with regards to their material makeup and mechanism of sound production. Some cultures have come up with some type of classifications which highlight not just the material makeup of the instrument but also their roles in performance such as melody, harmony, male drums, female gongs, etc. For the sake of clarity, the scope of the research shall be narrowed to Western Musical instruments which have been classified under keyboards, strings, percussion, and winds even though occasional reference will be made to related instruments from other cultures.

Generally all musical instruments, by virtue of their nature, demand some physiological attention and adaptability from the learner. We shall look at some of those demands as they emanate from different musical instruments.

- **Keyboards**

Keyboard instruments are musical instruments sounded by means of keyboard- levers of black and white notes spread across a board. They are the piano, organ, piano-keyboard, etc.

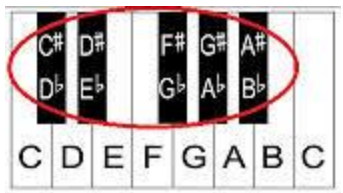

Image 1. Keyboard levers

The whole set of levers in pianos, organs, harpsichords, clavichords, and similar instruments are called keyboard, that is, a' board of keys' or 'keys on a board' and these are what actuate the tone production mechanism. Each octave consists of seven natural and five chromatic keys, arranged as in the accompanying figure above.

Keyboard instruments require learners who have strong, thin, and long fingers to attend to the notes of the instrument. Although some other playing techniques and strengths such as, wrist and finger flexibility can be mastered over time through practice, the learner with short, fat, and weak fingers is seriously disadvantaged. The impediments might not be noticeable at the initial stage of learning but later when he or she desires to ascend to the playing of more difficult and challenging passages.

Image 1a. Good fingers for keyboard instruments

The picture above shows long, strong, and slender fingers which are required for effective learning and playing of the instrument.

- **Strings**

Stringed instruments have cords made of metal or any other material that are tied to the body of the instrument and played by strumming,

plucking, striking, or bowing. Members of this family include the guitar, harp, banjo, mandolin, ukulele, violin, etc.

Image 2. Stringed musical instruments
(Credit: Shutterstack.com. 639444037)

Stringed musical instruments require long and thin fingers for effective learning and playing. Long fingers are necessary because notes run down the body of the instruments form the head to the tail or base, and only long fingers can contend with that. Thin fingers are also required because of the way the notes intertwine around the body or frets of the instrument. Thick fingers would be a disadvantage because it will not allow the learner to pick the notes with ease rather it would overlap the notes thereby producing undesired notes and chords. Another requirement for attending properly to the strings is long hands/arms. A relatively long hand would reach notes placed at the extremes more easily and faster than a short one.

Image 2a. Long and slender fingers required for playing stringed instruments (Credit 123RF)

- **Percussion**

These are musical instruments that produce sound by being struck or, less often, scraped, shaken, or plucked. In more formal classifications of musical instruments, they are usually divided between membranophones and idiophones, with both categories including instruments of definite as well as indefinite pitch. Some members of this family are, kettledrum, bass drum, wooden and metal gongs, cymbals, castanets, snare drum, conga, maracas, etc.

Image3. Some percussion instruments
(Credit: Encyclopaedia Britannica Inc (c) 2015)

Although the instrumentation of almost all percussions is actuated by the hands, such as tapping, scraping, shaking, or striking with beaters,

the actual energy that drives the activity comes from the biceps muscles located in the arms. Therefore strong arm bones and muscles are relevant qualifications for good percussion learning and playing.

Image 3a. Anterior arm muscles

Image 3b. Muscles of the forearm

The images above (3a and 3b) have helped to show the numerous muscles, tendons, and ligaments that are fused in the human arm. These muscles and their connectors power the entire hands. The implication is that the prospective percussionist must be imbued with healthy muscles and tendons and also be prepared to brace the physiological demands percussion instruments place on percussionists. Every other musical instrument demands some muscular activity from the arms but percussion instruments demand more.

Image 3c. Playing the jazz drum set

Playing the jazz drums, a percussion instrument, places even a greater physical and physiological demand on the player because of the involvement of the hands and legs. Both hands and both legs are active in playing the jazz drum as can be seen from the picture above and this involves serious muscular activity.

- **Woodwinds**

Woodwinds are wind instruments that have an enclosed, vibrating air column set into motion by a reed or by blowing across or through an aperture as distinct from brass instruments, in which the air column is set into motion by the vibration of the player's lips. Keyboard instruments sounded by the same means as woodwinds (e.g., the organ) are excluded. Despite the name 'woodwind', this group of instruments is no longer composed only of wooden-bodied instruments. Flutes, piccolos, and saxophones are now usually made of metal. Conversely, some early instruments made of wood, such as the cornet and the serpent, are not regarded as woodwinds because they are lip vibrated (The New Harvard Dictionary of Music, 1986). Examples of woodwind instruments are; the flute, recorder, clarinet, saxophone, oboe, bassoon, oja, ocarina, etc.

Image 4. Woodwinds

The basic technique for woodwind playing is the embouchure. Embouchure refers to the proper placement of the lips, facial muscles, and jaw in the playing of wind instruments (The New Harvard Dictionary of Music, 1986). Good intonation on a woodwind instruments demands correct embouchure. The basic lesson for woodwinds is simply embouchure and this must be learned before the student advances to other lessons and techniques of playing.

Image 4a. Correct embouchure for piccolo playing

Breathing Correctly: Use the corners of your mouth to breath. Maintain the correct embouchure biting pressure and flat chin.

Breathing Incorrectly: Many people completely open the mouth to breath, losing the embouchure and having to RESET many times over.

Images 4c & 4d. Correct embouchure and incorrect one for the clarinet respectively.

The nature of woodwinds requires a player with firm lips and strong tongue muscles for embouchure and tonguing.

- **Brass musical instruments.**

This is a family of tubular wind instruments or aerophones most often made of brass and sounded by the buzzing of the player's lips. Each consists of a more or less expanding length of tube with a mouthpiece at one end and a rapidly enlarging or flared opening called a bell at the other end. Common members of this family are the trumpet, cornet, horn, trombone, euphonium, and tuba (The New Harvard Dictionary of Music, 1986).

Image5. Instruments of the Brass family

Image 5a. Holding and playing the trumpet

Brass instruments, by virtue of their material makeup, are relatively heavy. The potential trumpet player, for example, should have strong hands for proper carrying of the instrument. Just as the case with woodwinds, firm lips and good tongue muscles are also required for buzzing on the mouthpiece and tonguing. Without these physiological prerequisites, good intonation on the instrument would be difficult.

Regarding the physiological requirements for playing the brasses, Hunt and Bachelder (1994) advise that:

> *Before pursuing the performance of a brass instrument or selecting appropriate candidates for an instrument, consider certain requirements: (i) proper lower and upper jaw alignment, (2) straight teeth, (3) lip formation conducive to vibration, and, (4) adequate muscular development of the lips. If any one of these four requirements is not met, performance on a brass instrument will be difficult, if not impossible (p.17).*

Some Theoretical Considerations

Child (2004) observes that, "Because learning takes place as part and parcel of body-mechanisms, any learning theory should be capable of incorporating physiological and ethological findings".

Charles Hoffer's Guide on Choosing Musical Instruments

On physiological considerations for learning and assigning musical instruments, Hoffer (1991) advises that:

> *Only general guides can be offered regarding what instruments should be assigned to individual students. If a youngster faces a lengthy session with braces on his or her teeth or has an underbite (lower teeth in front of upper) or crooked teeth, the student should be guided away from brasses (cornet, trumpet, trombone,*

French horn, euphonium, tuba). Generally, small students should not try large instruments. Students who have thick fingers should be encouraged to try instruments other than violin, because notes in the higher positions are too close together to allow for thick fingers without some kind of compensatory movement, which is difficult. Students whose pitch sense is below average should especially avoid strings, French horn, and trombone. (pp. 239-240).

The string bass, as a rule, is usually discouraged for people with shorter arms and smaller hands due to the big note gaps and the thick strings (Hoffer, 1991).

Leonhard & House (1972) appear to have a different view as above. They argue that:

Teachers should not recruit, in the sense that they select students on the basis of some test and prescribe the instruments which will later assure for proper instrumentation later… The choice of instruments should be on the basis of student preference… (p. 254).

This argument is fair if it is allowed at the preliminary stages of learning (nursery, primary, and even secondary school levels) to serve for music appreciation so that the learner is not scared away by the prescriptive nature of some physiological criteria involved in the exercise. Hoffer (1991) even agrees to this regarding to secondary school pupils:

The most important point to consider in assigning an instrument is the student's desire. Teenagers can accomplish wonders- when they want to. They can become proficient on an instrument while appearing to defy all the physical qualifications. Teachers should guide students in instrument selection but should not

require that a student take a particular instrument or none at all. There is a higher-than-expected incidence of dropping out among students who begin on an instrument other than their first choice (p.240).

Hoffer's submission above appears to be contradictory to his first submission but a deeper look disproves that. The point is this, for the purpose of music appreciation, pupils and students should be given the freedom to make their choices on instruments but at the same time, they should be guided in doing so. The guiding should take the form of explaining the nature of every instrument, their respective mechanisms of sound production, their respective roles in orchestra and physical and physiological demands of the instruments. The teacher guides by explaining.

Although there is no rule of thumb or generally accepted procedure in prescribing Western orchestral instruments to students, but Hoffer's suggestion on physiological considerations for choosing and learning Western orchestral instruments appears more tenable than Leonhard & House's recommendation that selection of orchestral instruments by students should be by choice. Obviously Leonhard & House seem to neglect the intricacies and complexities of human physiological make-up as a sensitive factor in learning musical instruments. For instance, allowing a student with thick fingers to learn the violin or ignoring the choice of the trumpet or trombone by a student with under-bite may amount to misguided learning, wasted efforts, frustration and apathy towards Western orchestral instruments.

The Case of Vocal Music

Musicologists have developed an empirical parameter for grouping the human voice. The four basic vocal groups or parts named soprano, alto, tenor, and bass, along with the variants, mezzo-soprano and

baritone, are distinguished by specific ranges. The ranges are illustrated below:

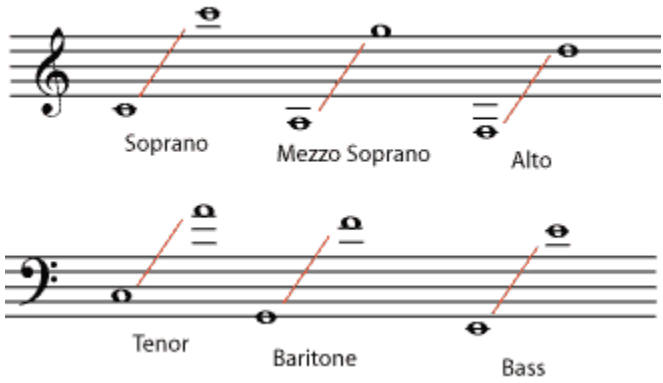

Image 6. Human Vocal Ranges

In vocal music, people are grouped as soprano, alto, tenor, or bass depending on the natural ambit or range of their voice which is demonstrated on the musical scale with middle C as the focal point. Some will manifest the vocal timbre for soprano and some for other parts and this is based on the principle of adaptability. Requesting a natural bass voice to attend to soprano lines would be frustrating because he lacks the native adaptability to that part. This principle has been ignored in instrumental music where learners are asked to pick at random musical instruments of their choosing or by the assignment of the teacher and this haphazard approach appears to be the reason for the frustrations experienced by musical instrument learners for a long time now. The random approach has been accommodated for instrumental music because an empirical parameter to check the physiological 'adaptability' of the prospective learners is lacking.

Some Human Physiological Defects and their Implications for Learning Musical Instruments

Blum (2000), reports that, " besides tendinitis and tendovaginitis, pathologies of the musician's hand are not more frequent compared to the entire population. Still several pathologies reach significant pronounced importance through the specific professional requirements."

- **Underbite**

An underbite is a term for a dental condition characterized by lower teeth that extend outward farther than the upper front teeth. This condition is called a class III malocclusion or prognathism. It creates a bulldog-like appearance in the mouth and face (Wikipedia, 2019).

Image 6. Underbite

The person with the dental condition of underbite should be guided away from brass and wind instruments. The reason is clear: his dental structure cannot accommodate proper embouchure, lip buzzing, articulation, and tonguing peculiar to the winds and brasses.

- **Muscle Atrophy**

Muscle atrophy is a condition where muscles waste away. It is usually caused by a lack of physical activity. When a disease or injury makes it difficult or impossible for you to move an arm or leg, the lack of mobility can result in muscle wasting. Over time, without regular

movement, your arm or leg can start to appear smaller but not shorter than the one you are able to move. In some cases, muscle wasting can be reversed with a proper diet, exercise, or physical therapy. (Wikipedia, September, 2019).

The implications of this condition are enormous for learning any musical instrument because of the fact that all musical instruments require various kinds of muscular activity for their activation.

- **Rheumatoid Arthritis**

This is a chronic inflammatory disorder affecting many joints, including those in the hands and feet. In rheumatoid arthritis, the body's immune system attacks its own tissue, including joints. In severe cases, it attacks internal organs (Wikipedia, 2019).

Image 7. Rheumatoid Arthritis

This condition creates serious impediments to learning any musical instrument because of the deformity it leaves on the fingers.

- **Cerebral Palsy**

This is a congenital disorder of movement, muscle tone or posture due to abnormal brain development, often before birth. Symptoms include exaggerated reflexes, floppy or rigid limbs and involuntary motions. These appear by early childhood (Wikipedia, 2019).

This condition places the patient at a disadvantage in learning musical instruments because of the challenges of muscular and reflex control

- **Contractures**

This is a physiological condition where muscles or tendons that have remained too tight for too long, thus becoming shorter. They develop when these normally elastic tissues are replaced by inelastic tissues (Wikipedia, 2019).

Image 8. Contractures

This condition is a permanent shortening of a muscle area, such as is seen in the tightest muscles of people with conditions like spastic cerebral palsy (Wikipedia, 2019). This condition clearly poses serious challenges for a normal life to the patient. Consequently, because musical instruments require handling as a basic step in learning them, this condition therefore places the bearer at serious disadvantage.

- **Dystonia**

This is an involuntary muscle contraction that causes repetitive or twisting movements. Dystonia may affect one or more parts of the body and sometimes the entire body. The condition can be mild or severe (Wikipedia, 2019).

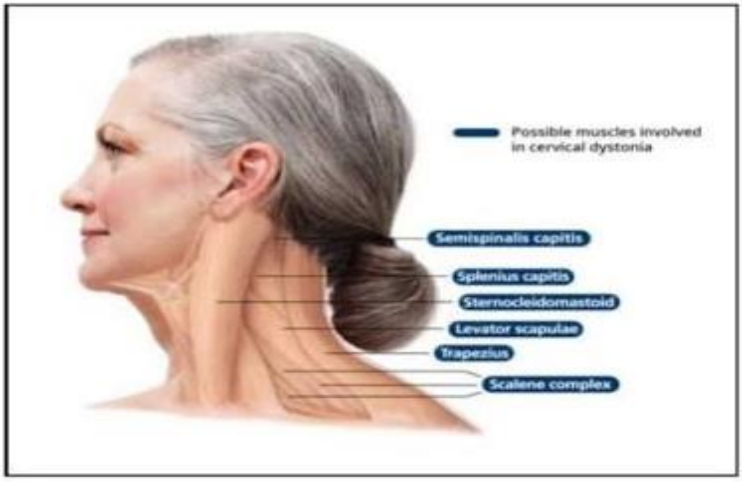

Image 9. Dystonia

Symptoms of Dystonia

- Patient has a "dragging lag"
- Involuntary pulling of the neck
- Patient experiences cramping of the foot
- Speech difficulty
- Uncontrollable blinking patient feels pain and is exhausted all the time

This physiological condition renders the potential of learning musical instruments almost impossible because of the involuntary distortions and contortions of the muscles associated with it.

- **Dyspnea**

This is a subjective sensation experienced and described differently by patients but generally characterized by:

- Shortness of breath
- Unpleasant breathing
- Labored, difficult, or heavy breathing
- Uncomfortable sensation when breathing
- Unable to get enough air
- Breathlessness

- Air hunger
- Choking
- Suffocation

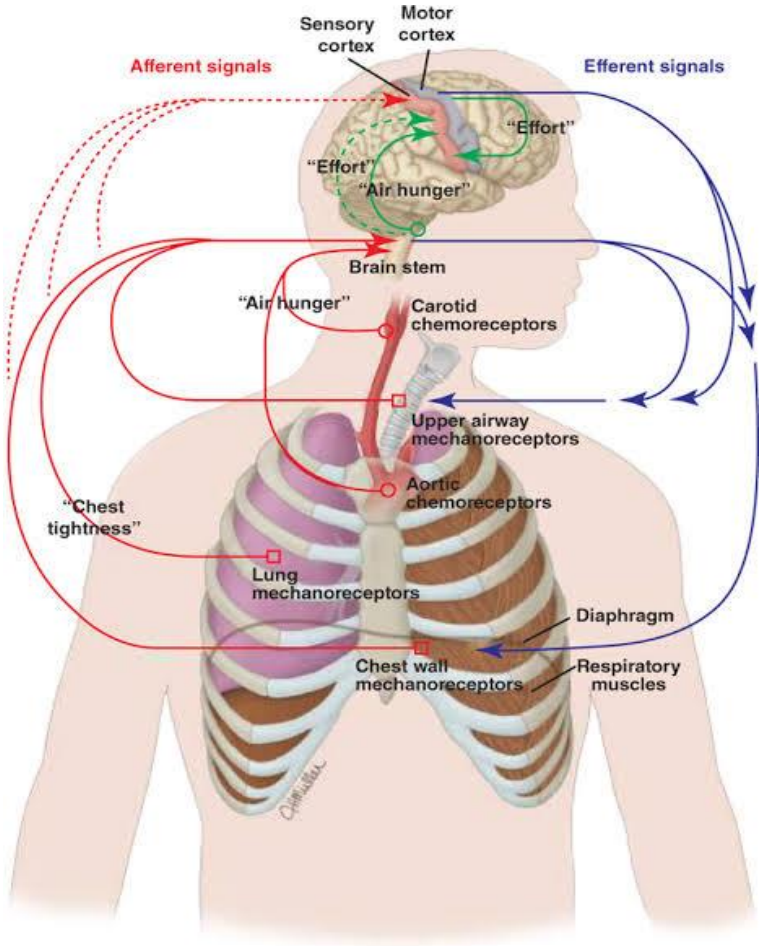

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Image 10. Dyspnea (Wikipedia, 2019).

People with dyspnea should be guided away from brass and wind instruments because of their intensive air demand. Even when one

with the condition reluctantly or out of ignorance engages on the winds and brasses; he or she would never achieve mastery because of the complications that would emanate.
The problems resulting from dyspnea is not particular to instrumental music but even to vocal music because of the role of the diaphragm and lungs in producing notes.

- **Fissured Tongue**

This is a benign condition affecting the top surface of the tongue. A normal tongue is relatively flat across its length. A fissured tongue is marked by a deep, prominent groove in the middle. There may also be small furrows or fissures across the surface, causing the tongue to have a wrinkled appearance (Wikipedia, 2019).

Image 11. Fissured Tongue

A fissured tongue can make it appear as though the tongue were split in half length wise. This makes it easy for doctors to and dentists to diagnose the condition. The middle section of the tongue is most often affected, but there may also be fissures on other areas of the tongue. A fissured tongue can occur in association with several

disorders. It is usually asymptomatic (no symptoms are apparent) (Wikipedia, 2019).
Clearly a person with the condition of 'fissured tongue' should not attempt any musical instrument from the wind and brass families because of the technique of tonguing which is basic in playing them. Such persons can make their choices from the strings, percussions, or keyboards which place no demand on the tongue.

Clarification of some apparent contradictions
This paper appears to have taken a position of complete musical hopelessness for individuals with the highlighted physiological conditions. No one is musically hopeless; however, it is proper that a learner be guided away from a musical instrument that he cannot easily or never adapt to and guided towards one, which can give him or her, the most fulfilling musical experience. Also trends in music therapy show evidences of various types of psychological and bodily restorations such as in cases of autism in children, Alzheimer, dementia, stroke, etc. through engagement in music –singing, music listening, drumming, and clapping to rhythm, etc.

Table 1.
Suggested Criteria for Choosing Western Musical Instruments

Class of Instrument	Physiological Criteria
Strings	Long and firm arms, long and slender fingers
Woodwinds	Firm lips and tongue, strong hands, strong and elastic breath
Keyboards	Long and strong hands, long and thin fingers
Brasses	Firm lips and tongue, strong and elastic breath, strong hands
Percussions	Strong leg/hand muscles

#Generally every aspiring musician should possess good sight for proper sight-reading

Recommendations

These recommendations have been proffered for effective teaching and learning of Western musical instruments in schools and higher institutions:

- Musical instrument tutors should carefully guide prospective learners through the choosing of musical instruments for learning
- Musical instrument Learners should endeavor to submit themselves to 'physiological adaptability checks' in order to ascertain their eligibility for any musical instrument.
- Even when learners are allowed to make their choices of instruments, they should be carefully advised on the line of divide between learning musical instruments for fun (music appreciation) and learning for mastery.
- There is need for musicologists to research further towards developing empirical parameters for choosing musical instruments.

Conclusion

This paper has highlighted various physical and physiological demands musical instruments place on learners. The need also for learners to meet those physiological criteria before choosing any musical instrument has been captured for effective learning. The random assigning and choosing of musical instruments have been found to be counterproductive. If musicologists could successfully develop an adaptability test for vocal ranges in vocal music, instrumental music therefore should not be abandoned to haphazard procedures.

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