CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The history of Western orchestral instruments dates back to the Renaissance (1450-1600) when vocal music held sway. Then the orchestra was not given much attention because of its presumed role and use in pagan worship and rituals. But the coming of the Baroque period saw a revolution for Western orchestral instruments as some instruments were employed for the first time in the church to serve as instrumental combinations for doubling vocal lines (The New Harvard Dictionary of Music, 1986). Kamien (1988) expounds thus:

> Though still subordinate to vocal music, instrumental music did become more important during the renaissance. Traditionally, instrumentalists accompanied voices or played music intended for singing. Even in the early 1500s instrumental music was largely adapted from vocal music. Instrumental groups performed polyphonic vocal pieces, which were often published with the indication to be sung or played. Soloists used the harpsichord, organ, or lute to play simple arrangements of vocal works (Pp. 122-123).

The Renaissance, as it were, struck blows from which the Church was still reeling, freeing orchestral music from the age-long fetters of ecclesiasticism. The rise of opera, instrumental music, and in fact of secular music as a separate entity during the Baroque period gave a new complexion to the whole world of music. From this period, interest in musical instruments grew and witnessed remarkable improvement on the making, design, timbre, sophistication, and versatility. Versatility, as we shall see later, is a unique feature of Western orchestral musical instruments.

Despite the challenge of freeing Western musical instruments from the fetters of ecclesiasticism mentioned earlier, Western orchestra faced yet another challenge in the making of the instruments. The nature and roles of orchestral instruments demanded that they met certain scientific and acoustical specifications in their making and this was somewhat beyond the scope of musicians. Organology, as an aspect of music, studies the nature of musical instruments but the actual making of these instruments with precision of timbre, range, tuning, register, with their intrinsic sophistication, and the delineation of their respective pitches and partials were strictly the preoccupation of technocrats and instrument

makers. For instance, the construction of a violin, among other things, requires such precise scientific and acoustical considerations as: type of wood for the body of the instrument, acoustic qualities of the wood, varnishing for the wood, and the acoustics of sound production using the bow.

It has been discovered (Leipp, 1969) that, using pine wood and maple for the body of the violin has precious advantages such as straight fibers, low density (roughly between 0.4 and 0.5), resistance to deformation etc. For prime acoustic quality of the woods, the wood is cut down in winter, and cut into quarters which are stored in a dry, well-aired place for several years. This procedure checks the density, muting coefficient, rigidity, resistance to deformation and hygroscopicity (a term meaning the level of tolerance of the wood with humidity and salts). Experience also shows that the violin's sound alters perceptibly after varnishing and thus affects the density, elasticity, rigidity, and the damping capacity of the instrument. These are just a few of the many technicalities and intricacies of musical instrument making.

The challenge of making orchestral musical instruments during the renaissance, therefore, became quite a task. But breakthrough came through the expertise and doggedness of pioneer instrument makers like, Andrea Amati (1511-1580), Antonio Stradivari (1644-1737), Denner (1700-1750), Theobald Boehm (1794-1881), Adolph Sax (1814-1894), Arnold Dolmetsch (1858-1940) and many others (The New Harvard Dictionary of Music, 1986). Andrea Amati was acclaimed for founding violin making in Cremona and established its pre-eminence there and developed the basic proportions of the string family (violin, viola, and cello (The new Harvard Dictionary of Music, 1986:918). But it took the ingenuity of Antonio Stradivari, however, to refine the form, symmetry, and beauty of the violin.

Theobald Boehm pioneered the making of the flute although his idea (the Boehm fingering system), has generally influenced woodwind instrument construction and fingering (The New Harvard Dictionary of Music, 1986). Adolph Sax was renowned for inventing and patenting the saxophone (The new Harvard Dictionary of Music, 1986). Some of the musical instruments came as descendants of earlier musical instruments. For example, the clarinet descended from the chalumeau. The oboe, a double-reed woodwind orchestral instrument, descended from the Shawn. Pitched in C with the range of B flat to a''', the oboe has

made the transition to its modern form at the hands of 17th century Dutch instrument makers.

Western orchestral musical instruments as we have observed thus far and as we see them today have traversed a complex and dynamic history hence their sophistication, peculiarity, and versatility. The instruments come in families (string, woodwind, brass, percussion) but within some families (particularly woodwind and brass), there exist sub-classes or various types of each member of a given family due to the demand placed on the instruments by composers and performers with regard to transposition, tone colour, versatility and their varied roles in the orchestra. For instance, within the woodwind family there are varieties or sub classes of the saxophone, for example, the E flat sopranino, B flat soprano, E flat alto, B flat tenor, E flat baritone, B flat bass, E flat contrabass, and B flat sub contrabass (The new Harvard Dictionary of Music, 1986:728).The trumpet also, which is brass, comes in various species and named according to the pitch class of their fundamental. For instance, we have trumpets in B flat, C, D, E flat, F, and A. The B flat trumpet is used mostly in school bands and popular music. The C trumpet is the favorite among orchestral players and is non-transposing (The new Harvard Dictionary of Music, 1986:880).

These orchestral musical instruments with their respective families and species, though somewhat leaves a beginner with the advantage of choosing from a variety of instruments, somehow pose some difficulties and confusion for the beginner. Most undergraduate student learners most times spend a long time trying to figure out the orchestral instrument that best suits them. Also the intrinsic peculiarity and sophistication of these instruments raise some concern regarding the availability of genuine models and the genuineness of available ones. During the renaissance, there were few patented instrument makers but the plethora of instrument makers we have today has seriously compromised the originality of orchestral musical instruments. Historically, one can observe that the peculiarity, versatility, and sophistication of these instruments are features that have distinguished them and which instrument makers carefully maintained then. For instance, the intricacies and the acoustical precision of forming the tone holes, bell, mouthpiece, reed and the keys of the clarinet, for example, are highly technical issues that can disrupt the efficiency of the instrument if compromised. Describing the acoustical challenges in instrument design and manufacture, Kohut (1973) reports:

> If Pythagorean tuning is desired in melodic performance and just intonation is preferable in harmonic music, what system shall the instrument manufacturer use in designing a wind instrument? The most practical system to use is, of course, equal temperament. Use of Pythagorean, just, or mean-tone tuning would require fifty or more notes per octave in order for the player to play comfortably in all keys; since this is not practical, wind players must learn to alter the pitch of individual notes away from tempered intonation as needed to meet the particular melodic or harmonic requirements of a specific solo or ensemble passage (p. 67).

On versatility mentioned earlier, an orchestral instrument like the trumpet has the capability of producing a series of notes and partials using just one valve or fingering. In fact the range of any orchestral musical instrument has been technically defined as the compass of the notes (low and high) that can be produced by an average player. But a given instrument can yield almost an infinite range of notes in the hands of an advanced player. Kamien (1988:13) highlights this point thus, 'While a trained singer's range is about 2 octaves, many instruments command 3 or 4 octaves, and some have 6 or 7'. In fact, certain advanced trumpet players, for instance, have been known to produce pitches that are beyond annotated ranges. Nicolo Paganini (1784-1840), the virtuoso violinist, also was acclaimed for redefining the scope of the violin. Frederic Chopin (1810-1849) also, was renowned for making the piano sound very beautiful thereby creating the illusion that the piano sings (Kamien, 1988). If orchestral musical instruments are capable of these dimensions, the learning or teaching of these instruments with inadequate models frustrates the ardent learner and diminishes the scope of the instruments.

Orchestral musical instruments also, by virtue of their intrinsic nature, pose some difficulty to the learner. The violin, saxophone, or trumpet might look very easy to an enthusiastic learner but the actual learning and mastery of any of the instruments take time. Some individuals, unarguably, are born with native dexterity for musical instruments but mastering an orchestral instrument takes more time and concentration than one can envisage. Kamien (1988) submits that 'Natural gifts are not enough. A developing performer studies for years with fine teachers, practices many hours a day, and cultivates musical taste and a sense of style` (p.82). Even under the tutelage of a competent instrument teacher of, let's say the trumpet, the learner still faces the challenge of tonguing, fingering, breath control, sight-reading, daily practice, and a practice chamber or some remote place to curb interference. How many undergraduate orchestral learners therefore can brace up to such challenges and

tenacity? So many of them find this very challenging and veer into learning the guitar, violin, clarinet, or saxophone believing they would find them less demanding. But there is no evidence from research that a given orchestral musical instrument is relatively easier than the other. The instrumental teacher, also, is not left out of the ensuing melee. He faces conditions different from those encountered by choral music teachers. Instrumental music teaching involves a conglomeration of fingerings, embouchures, bowings, and other specialized techniques and knowledge like the scraping of a bassoon reed, stopping notes on the French horn, pizzicatoon the violin, and the several fingerings for high G on the clarinet. All these are highly technical and demand skill and learning.

To some people music appears easy and simple. Even the typical Nigerian society believes that music is not worth the space and time in the Higher Institutions or that one should study it as he awaits his proper course of study or as a last resort to admission problems. Also some people erroneously believe that because virtually everyone can hum a tune that everyone also can easily hum or sing his way through music at the undergraduate level. So, many undergraduate students flux into music departments with this presumption but the curriculum of music studies in the higher institution is designed to integrate music theory, voice, orchestral, and ensemble performances in order to produce a viable music person. One of the ideologies and principles of music education is that one educated in music should at least play a musical instrument, among other things. This ideology is not misplaced. In the typical African setting, the apprenticeship system of learning musical instruments or styles of music is always encouraged. Okafor (2005) reminded us that:

> Basically, the apprenticeship system gives the most formal music education in the Nigerian culture. This varies from the teaching of new music or dance to a village group to the lengthy study of a ritual or ceremonial instrument. As an illustration, a group scouts for, or locates a group with an appropriate dance and music, and invites a teaching team of this group to its home (p. 191).

Most undergraduate music students completely avoid playing musical instruments despite the fact that mastering a musical instrument is a prerequisite to the completion of their studies. The attitude of most female undergraduate students in music is even more worrisome. They shy away from learning and practicing on any musical instruments believing it is not feminine to play instruments but to sing. This attitude appears to be the reason for the general poor enrolment, commitment, and performance by most female

students. This attitude also appears to be the extension of our immediate society's ideology that the female folks should not play dominant or tasking roles in the society. Some have also erroneously designated some instruments as 'feminine` and others 'masculine` and this has led to too many female students embracing the violin and abandoning every other orchestral instrument to their male counterparts. Although some orchestral instruments like the trumpet and tuba prove quite tasking and energy-sapping but there is no evidence from existing research that the violin is more feminine than the trumpet or that playing the latter is detrimental to health.

Despite these numerous challenges to the effective teaching/learning of Western orchestral musical instruments and the demands it places on the instrumental teacher, evidence of the gains of learning a musical instrument or playing in the orchestra abounds from empirical research and personal experiences of orchestral players. In fact the ability to play a musical instrument and interpret music was a mark of an educated person during the renaissance (Kamien, 1988). The Nigerian society places the same obligation on music students. Mbanugo (2006:1) observes that "previous investigations have noted that the Nigerian populace only understands music as a practical phenomenon. Consequently, high practical music competence is expected of the products of Nigerian music education programmes". Guiding music students through instrumental and orchestral experience has some specific advantages to their overall music education and it is on this background that Music Departments in higher institutions across the world incorporate orchestral ensemble as a basic feature of their curriculum. Among the proven gains of participating in instrumental/orchestral music are:

- Discipline
- Aesthetic fulfillment
- Cognitive and psycho-motor enhancement
- Self confidence
- Sense of belonging
- Social/peer recognition and relevance for accomplishments as performers
- Transfer of training/experience to other musical or life challenges
- Means of economic sustenance
- Group co-operation
- Career opportunities, etc.

Western orchestral ensemble as an aspect of the curriculum of music studies in Nigerian higher institutions may come with certain intrinsic challenges but the gains quite out-weigh the surging challenges. Currently in the Music Department of Nnamdi Azikiwe University, Awka, the teaching/ learning of these instruments is showing some prospects. This is attestable in the students' Individual Performance Studies (IPS) and their involvement in the chamber orchestra in the Department. The students commence learning of their respective orchestral instruments as early as possible within a given semester with the aid of an assigned teacher who furnishes the learner with appropriate pieces for his instrument at his level of playing. The entire experience culminates into a performance exam which requires the student to perform with his instrument and with the chamber orchestra before a panel of adjudicators. Although there still persist some challenges to the effective teaching and learning of these orchestral instruments as mentioned earlier in this paper, nevertheless the writer believes that the proper implementation of the findings and recommendations of this research will improve the teaching and learning of the instruments and usher the Western chamber orchestra of the Department into international repute.

1.2 Statement of the Problem

The teaching and learning of Western orchestral musical instruments is a major feature of the curriculum of music studies in tertiary institutions and the mastery of a western orchestral instrument also, is a basic prerequisite for graduating in music. This ideology is based on the premise that, a graduate of music, irrespective of his cultural orientation and musical inclination, should be able to interpret and appreciate the music of other cultures through instrumental experience. Currently, there is a growing concern on the role university music graduates can play in the larger society such as teaching, raising a choir or orchestra, music directing, composition and music production etc., and such demands could be met through efficient instrumental experience. Unfortunately there are challenges to these ideals in the Music Department of Nnamdi Azikiwe University, Awka. Although the general output of Western orchestral instrumental experience in the Department is gradually improving, there still exist certain areas that demand immediate attention for improvement. For example, the quality of some of the orchestral instruments; the attitude of students to learning musical instruments, the level of expertise of some of the instrumental teachers/lecturers in handling

the orchestral instruments; the apparent aversion to some instruments (the brasses and winds) by students are all issues the research seeks to address.

1.3 Purpose Of Study

The purpose of this study is to ascertain the problems and prospects in the teaching and learning of Western orchestral musical instruments in the Department of Music, Nnamdi Azikiwe University, Awka. To achieve this, the researcher intends to find out:

(i) The Western orchestral musical instruments that exist in the Department of Music, Nnamdi Azikiwe University, Awka.

(ii) The relationship between the nature of Western orchestral musical instruments and the challenges in teaching and learning them.

(iii) The criteria for assigning Western orchestral musical instruments to students in the Department of Music, Nnamdi Azikiwe University, Awka

(iv) The methods employed by the lecturers in teaching Western orchestral musical instruments in Nnamdi Azikiwe University, Awka

(v) The modes of evaluating performance in Western orchestral musical instruments in Nnamdi Azikiwe University, Awka

(vi) The prospects of teaching and learning Western orchestral musical instruments in Nnamdi Azikwe University, Awka.

(vii) The problems militating against the effective teaching and learning of Western orchestral musical instruments in Nnamdi Azikiwe University, Awka.

(viii) The possible solutions to the problems.

1.4 Significance of the Study

The findings of this research would be beneficial to music educators involved in the teaching of Western orchestral musical instruments and to undergraduate music students in Nigerian higher institutions who are confronted with the task of mastering their orchestral instruments. The findings will also inspire policy makers in music education, curriculum planners, and music educators in general and possibly serve as reference point in resuscitating and improving studies in Western Orchestral instruments in various Nigerian universities. Also, by furnishing the orchestral scheme with appropriate and relevant materials (music scores) from different musical genres for individual practice, general rehearsals and performance, the

forum is created for cultural integration, interaction, music appreciation and the widening of the compass of instrumental learning, practice and performance among students.

1.5 Scope of the Study

This research specifically covered the teaching and learning of Western orchestral musical instruments in Nnamdi Azikiwe University, Awka. The University is located at Awka, Anambra state along the Onitsha-Enugu express road and sited on an area spanning over 502 hectares of land of the state capital. The undergraduate students of the music department are taken as the research sample and currently the Music Department has about 115 students ranging from Diploma to fourth (4th) year degree who are actively involved in the learning of the various orchestral instruments. Also the scope of Western orchestral musical instruments studied was limited to those in common use among students in the Music Department of the Nnamdi Azikiwe university, Awka such as the strings (violin, viola, cello); woodwinds (flute, B flat clarinet, saxophones- soprano, alto, and tenor); brass (B flat cornet, B flat trumpet, trombone, French horn, tuba).

Fig 1: Map of Nigeria showing Anambra State

Source: Anambra State Ministry of Information

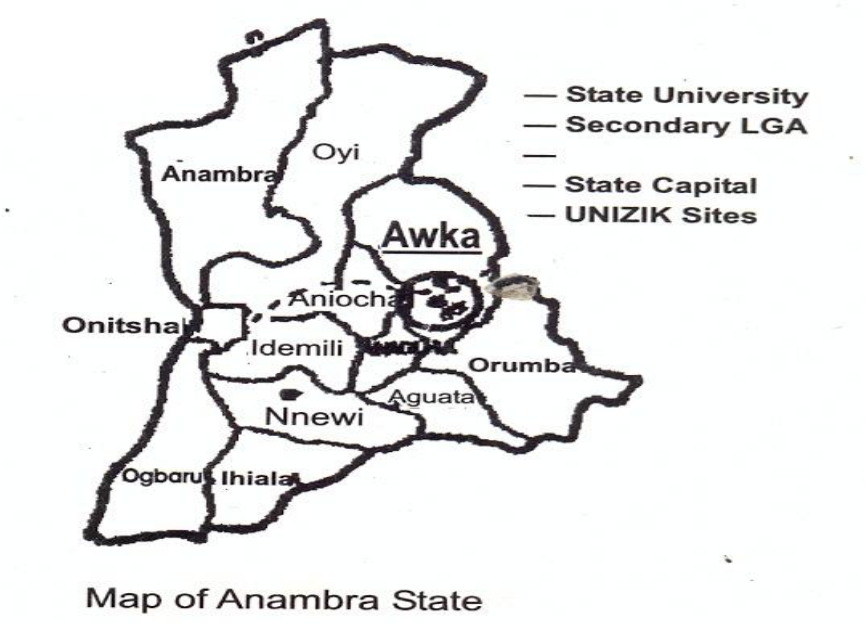

Fig.2: Map of Anambra State showing Awka (The location of Nnamdi Azikiwe University, Awka).

Source: Anambra State Ministry of Information

1.6 Research Questions

The following research questions were raised to guide the study:

1. What are the Western orchestral musical instruments that exist in the Department of Music, Nnamdi Azikiwe University, Awka.
2. Is there a relationship between the nature of Western orchestral musical instruments and the challenges in teaching and learning them?
3. What are the criteria for assigning Western orchestral musical instruments to students in the Department of Music, Nnamdi Azkiwe University, Awka.?
4. What are the methods adopted in teaching Western orchestral musical instruments in the Department of Music, Nnamdi Azikiwe University, Awka.?
5. What are the modes of evaluating the performance of the students in the learning of Western Orchestral musical instruments in the Department of Music, Nnamdi Azkiwe University, Awka?
6. What are the prospects of teaching and learning of Western orchestral instruments in the Department of Music, Nnamdi Azkiwe University, Awka.?
7. What are the problems militating against the effective teaching and learning of Western orchestral instruments in the Department of Music, Nnamdi Azikiwe University, Awka.?
8. What are the possible solutions to the problems?

1.7 Research Hypothesis

The following null hypotheses were postulated to guide the research:

1. The Western orchestral musical instruments existing in the Department appear to be relatively few.
2. There is no significant difference in the opinion of the respondents regarding the nature of Western orchestral musical instruments and the challenges in teaching and learning them.
3. The criteria used in assigning or approving Western orchestral musical Instruments to students appear not to be suitable.
4. There is no significant difference in the opinion of the respondents regarding the relevance of the methods adopted in teaching Western orchestral musical instruments in the Department.
5. The modes adopted in evaluating performances of the students in Western orchestral musical instruments appear not to be effective
6. There is no significant difference in the opinion of the respondents regarding the prospects of teaching and learning of Western orchestral musical instruments.
7. There is no significant difference in the opinion of the respondents on the perceived problems militating against the teaching and learning of Western orchestral musical instruments

CHAPTER TWO
LITERATURE REVIEW

Introduction

Relevant literatures to the study were sourced and reviewed under these the following subheadings:

- **Conceptual Framework**
- **Theoretical Framework**
- **Empirical Studies**
- **Summary of Reviewed Literature**

2.1 Conceptual Framework

The study of the teaching and learning process of Western orchestral musical instruments unavoidably presents a plethora of concepts that demand some clarification as they apply to the research. These concepts relate to the teaching/learning process, the definition and description of a musical instrument, the making/crafting of the instruments, classification of the instruments, tuning, harmonics, transposition, fundamental, partials/overtone series, range, register, embouchure, tonguing, breathing, fingering and the actual playing techniques. Hoffer (1991) captures this in his submission:

> Instrumental teachers face conditions different from those encountered by choral music teachers. Instrumental music involves a conglomeration of fingerings, embouchures, bowings, and other specialized techniques and knowledge. Scraping a bassoon reed, stopping notes on the French horn, spiccato bowing on the violin, the several fingerings for high G on the clarinet- these are all highly technical bits of skill and learning. Teachers of choral music face many challenges, but at least all human voices produce sound in the same way (p. 238).

These concepts shall be examined in detail as they relate to Western orchestral instruments generally and also to respective families and individual instruments of each family.

2.1.1 The Concepts of Teaching and Learning

The concepts of teaching and learning are two congruous concepts which represent the main thrust of educational psychology. Educational psychology is the study of how humans learn

in educational settings, the effectiveness of educational interventions, the psychology of teaching, and the social psychology of schools as organizations (Child, 2004). Teaching has been defined as: 'An environmental arrangement which involves an organism mentally and/or physically in a set of organized activities, and where those activities are facilitated in consonance with a given goal (or lack of a goal)' (Onwuegbu, 1979). Leonhard & House (1972:275) see teaching as ''the organization and conduct of learning experiences''. Learning on the other hand refers to the process of acquiring new, or modifying and reinforcing existing knowledge, behaviours, skills, values, or preferences and may involve synthesizing different types of information (Child, 2004). Leonhard & House (1972:121) posit that, "Learning is growth; learning is development; learning is experience; learning is something new that has been added; learning is a process that results in change in behavior". A more operational definition of learning is that, 'Learning is a process which begins with a problem, progresses to the solution of the problem by the apprehension, clarification, and application of meaning and results in a change in behavior' (Leonhard & House, 1972). Child (2004) observes that "Whilst there is no complete agreement amongst psychologists about the nature of the learning process, they do accept the basic premise that learning occurs whenever one adopts new, or modifies existing , behavior patterns in a way which has some influence on future performance or attitudes". The purpose of teaching is to facilitate learning. Fundamentally, there can be no teaching unless learning takes place, but it must be recognized that learning often takes place without the formal guidance of a teacher.

Observing the congruous relationship existing between teaching and learning, Leonhard &House (1972) explain that:

> A crucial point in understanding the relationship between teaching and learning is that it is the student who learns and that every student must do his own learning. Teaching merely serves to arrange the learning environment for the student and to increase the efficiency of his learning (p. 276)

The ability to learn is possessed by humans, animals and some machines. Learning is not compulsory; it is contextual. It does not happen all at once, but builds upon and is shaped by what we already know. To that end, learning may be viewed as a process, rather than a collection of factual and procedural knowledge. Learning produces changes in the organism and the changes are relatively permanent. Furthermore, human learning may occur as part of education, personal development, schooling or training. It is goal-oriented and aided by

motivation. Child (2004:121) strongly argues that "The importance of studying learning processes is self-evident, since one of the central purposes of the teacher's task in formal educational settings is to provide well-organized experiences so as to speed up the process of learning, thus enabling pupils (learners) to make reasoned choices in solving life's problems". The objective of teaching/learning is typically accomplished through either an informal or formal approach to learning, including a course of study and lesson plan that teaches skills, knowledge and/or thinking skills. Different ways to teach are often referred to as pedagogy. When deciding what teaching method to use teachers consider students' background knowledge, environment, and their learning goals as well as standardized curricula as determined by the relevant authority. Educational psychology is concerned also with how students learn and develop, often focusing on subgroups such as gifted learners and those subject to specific disabilities. Educational psychologists sometimes overemphasize the tie between teaching and learning even though evidences have shown that learning can still take place informally without a formal setting.

2.1.2 General Concepts Applicable to Musical Instruments

Though not all musical instruments employ to the peculiar concepts of tonguing, fingering, striking, bowing etc, but virtually all musical instruments have a history, distinctive features, range, and class. The following concepts, therefore, apply to all known Western musical instruments in general.

2.1.2 (a) Definition and Basic Operation

A musical instrument is a device created or adapted to make musical sounds. In principle, any object that produces sound can be a musical instrument. The history of musical instruments dates to the beginnings of human culture. Early musical instruments may have been used for ritual: such as a trumpet to signal success on the hunt, or a drum in a religious ceremony. Cultures eventually developed composition and performance of melodies for entertainment. Musical instruments evolved in step with changing applications (Campbell & Myers, 2004). Western orchestral instruments, therefore, are a select group of musical instruments which feature mainly in Western orchestra and among them are the Strings (violin, viola, cello, double bass); Woodwinds (clarinet, flute, piccolo, saxophone, English horn, oboe, bassoon); Brass (trumpet, trombone, French horn, tuba); the Percussion family (drums, bells, cymbals, triangle, timpani etc.), with the occasional inclusion of the keyboards (harpsichord, organ, piano, etc.).

2.1.2 (b) The Construction/Invention of Western Orchestral Instruments

Musical instruments are constructed in a broad array of styles and shapes, using many different materials. Early musical instruments were made from found objects such as shells and plant parts. As instruments evolved, so did the selection and quality of materials. Virtually every material in nature has been used by at least one culture to make musical instruments (Montagu, 2007). This practice is still sustained today with the varied material make-up of modern musical instruments, particularly Western orchestral instruments where some instruments are made of wood (recorder, flute); brass (trumpet, trombone) fibre/plastic (recorder), metal (triangle, timpani) and sometimes with the combination of various materials (percussion instruments). There appears to be a scientific or acoustic basis for the material choice of musical instruments but this concept shall be discussed in detail under the body make-up of the respective instrumental families.

2.1.2 (c) Organology and Classification

There are many different methods of classifying musical instruments. Various methods examine aspects such as the physical properties of the instrument (material, colour, shape, etc.), the use of the instrument, the mechanism of sound production, the range of the instrument, and the instrument's place in an orchestra or other ensemble. Most methods are specific to a geographic area or cultural group and were developed to serve the unique classification requirements of the group. The problem with these specialized classification schemes is that they tend to break down once they are applied outside of their original area. For example, a system based on instrument use would fail if a culture invented a new use for the same instrument. Scholars recognize Hornbostel-Sachs as the only system that applies to any culture and, provides only possible classification for each instrument (Kartomi, 1990; Sachs, 1940). The original Hornbostel-Sachs system classified instruments into four main groups thus:

- **Idiophones:** These are musical instrumentswhich produce sound by vibrating the primary body of the instrument itself; they are sorted into concussion, percussion, shaken, scraped, split, and plucked idiophones, such as xylophone, drum, etc,.
- **Membranophones:** These are musical instruments which produce sound by a vibrating stretched membrane; they may be drums, which are struck by hand, with a stick, or rubbed.

- **Chordophones:** These are musical instruments which produce sound by vibrating one or more strings; they are sorted into according to the relationship between the string(s) and the sounding board or chamber. For example, if the strings are laid out parallel to the sounding board and there is no neck, the instrument is a zither whether it is plucked like an autoharp or struck with hammers like a piano. If the instrument has strings parallel to the sounding board or chamber and the strings extend past the board with a neck, then the instrument is a lute, whether the sound chamber is constructed of wood like a guitar or uses a membrane like a banjo.
- **Aerophones:** These are musical instruments which produce sound by a vibrating column of air; they are sorted into free aerophones such as a bullroarer or whip, which moves freely through the air; flutes, which causes the air to pass over a sharp edge; reed instruments, which use a vibrating reed; and lip-vibrated aerophones such as trumpets, for which the lips themselves function as vibrating reeds.

Musical instruments are also often classified by their musical range in comparison with other instruments in the same family. This system of classification is useful when placing instruments in context of an orchestra or other ensemble. The classifications are named after singing voice classifications thus:

- **Soprano Instruments:** flute, violin, soprano saxophone, trumpet, clarinet, oboe, piccolo, etc,.
- **Alto Instruments:** alto saxophone, French horn, English horn, viola, alto horn
- **Tenor Instruments:** trombone, tenor saxophone, tenor drum
- **Baritone Instrument:** bassoon, baritone saxophone, bass clarinet, cello, baritone horn
- **Bass Instruments:** double bass, bass guitar, bass saxophone, tuba, bass drum, euphonium.

The drawback behind this system of classification is that it is not completely precise. Some instruments fall into more than one category: for example, the cello may be considered tenor, baritone or bass, depending on the how its music fits into the ensemble, and the trombone may be alto, tenor, baritone, or bass and the French horn, bass, baritone, tenor, or alto, depending on the range it is played in. Some instruments have their range as part of their name: soprano saxophone, tenor saxophone, baritone horn, alto flute, bass guitar, etc. Additional adjectives describe instruments above the soprano range or below the bass, for

example: sopranino saxophone, contrabass clarinet. When used in the name of an instrument, these terms are relative, describing the instrument's range in comparison to other instruments of its family and not in comparison to the human voice range or instruments of other families. For example, a bass flute's range is from C3 to F#6, while a bass clarinet plays one octave lower.

Another form of classification came by the pioneer work of Andre' Schaeffner, and his classification scheme was exhaustive, potentially covering all real conceivable instruments (Wikipedia Encyclopedia, 2013). Schaefffner's system has only two top-level categories which he denoted by Roman numerals:

I: Instruments that make sound from vibrating solids

- I.A: no tension (free solid, for example xylophones, cymbals, or claves)
- I.B: linguaphones (lamellophones) (solid fixed at only one end, such as kalimba or thumb piano;
- I.C: chordophones (solid fixed at both ends, i.e. strings such as piano or harp); plus drums

II: Instruments that make sound from vibrating air (such as clarinets, trumpets, etc.).

The system agrees with Mahillon and Hornbostel-Sachs for chordophones, but groups percussion instruments differently.

Other classifications exist which classify instruments according to the materials from which they are made. For example, percussion instruments made from metal are sometimes called metallophones, while those made of stone are called lithophones. Similarly, wind instruments made from metal are often categorized as brass instruments. Sometimes instruments are classed according to the method of their construction rather than their materials. For example, Lamellaphones are instruments that produce sound by the plucked of their "lamella" or tongues"- strips of metal, wood, or bamboo fixed to a sound-board or resonator. In the Hornbostel-Sachs classification of musical instruments, lamellaphones are considered plucked idiophones, a category that includes various forms of jaw harp and the European mechanical music box, as well as the huge variety of African and Afro-Latin thumb pianos such as the mbira and marimbula (Marcuse, 1975).

For Western orchestral instruments, the most commonly used system of classification divides the instruments into the Strings (violin, viola, cello, double bass); Woodwinds (clarinet,

flute, piccolo, saxophone, English horn, oboe, bassoon); Brass (trumpet, trombone, French horn, Euphonium, tuba); the Percussion family (drums, bells, cymbals, triangle, timpani etc.), with the occasional inclusion of the keyboards (harpsichord, organ, piano, etc.).

2.1.2 (d) Range of Musical Instruments

The range of a musical instrument is the "span of pitches between highest and lowest of the instrument (The New Harvard Dictionary of Music, 1988). An instrument is often made in different sizes that produce different ranges. For instance the saxophone family includes soprano, alto, tenor, baritone, and bass saxophones (Kamien, 1986). There are various forms of range applicable to Western orchestral instruments. They are, sounding range, written range, designated range, duration range, and dynamic range.

- **Sounding Range:** This refers to the pitches produced by an instrument.
- **Written Range:** This refers to the compass (span) of notes written in the sheet music, where the part is sometimes transposed for convenience. A piccolo typically has a sounding range one octave higher than its written range.
- **Designated Range:** This is a set of notes the player should or can achieve while playing.
- **Duration Range:** This is the difference between the shortest and longest rhythm used.
- **Dynamic Range**: This refers to the difference between the quietest and loudest volume of an instrument.

Although woodwind instruments and string instruments have no theoretical upper limit to their range (subject to practical limits), they generally cannot go below their designated range. Brass instruments, on the other hand, can play beyond their designated ranges. Notes lower than the brass instrument's designated range are called pedal tones. The playing range of a brass instrument depends on both the technical limitations of the instrument and the skill of the player. Classical arrangements seldom make woodwind or brass instruments play beyond their designated range. String musicians play the bottom of their ranges very frequently, but the top of a string instrument's range is rather fuzzy, and it is unusual for a string player to exceed the designated range. It is quite rare for wind musicians to play the extremes of their instruments. The most common exception is that in many 20^{th} century works, pedal tones are called for in bass trombones. The concept of range influences the classification of some musical instruments as we have already mentioned earlier.

2.1.2 (f) Transposition

Transposition is a musical concept denoting the rewriting or performance of music at a pitch other than the original one (The New Harvard Dictionary of Music, 1986). Transposition also refers to the process, or operation, of moving a collection of notes (pitches or pitch classes) up or down in pitch by a constant interval (Wikipedia Encyclopedia).Transposition affects instrumental music as much as vocal music. The player of an instrument at one pitch, for example, will be required to transpose in order to perform a part written at another pitch. There are various kinds of transposition in music:

- **Chromatic Transposition:** In chromatic transposition one shifts every pitch in a collection of notes by a fixed number of semitones. For instance, if one transposes the pitches C4-E4-G4 upwards by four semitones, one obtains the pitches E4-G$^{\#}$4-B4.
- **Scalar Transposition:** In scalar transposition one shifts every pitch in a collection by a fixed number of scale steps relative to some scale. For example, if one transposes the pitches C4-E4-G4 up by two steps relative to the familiar C major scale, one obtains the pitches E4- G4-B4. If one transposes the same pitches up by two steps relative to the F major scale, one obtains instead E4-G4-B^{b}4. Scalar transposition is sometimes called diatonic transposition, but this term can be misleading, as it suggests transposition with respect to a diatonic scale. However, scalar transposition can occur with respect to any type of scale, not just the diatonic.
- **Sight Transposition:** Although transpositions are usually written out, musicians are occasionally asked to transpose music "at sight", that is, to read the music in one key while playing in another. Musicians who play transposing instruments sometimes have to do this (for example when encountering an unusual transposition or key, such as clarinet in C), as well as singers' accompanists, since singers sometimes request a different key than the one printed in the music to better fit their vocal range. There are three basic techniques for teaching sight transposition: interval, clef, and numbers.

(i) Transposing by Interval: First one determines the interval between the written key and the target key. Then one imagines the notes up (or down) by the corresponding interval. A performer using this method may calculate each note individually, or group notes together (e.g. "a descending chromatic passage starting on F" might become a "descending chromatic passage starting on A" in the target key).

(ii) Transposing by Clef: Clef transposition is routinely taught (among other places) in Belgium and France. One imagines a different clef and a different key signature than

the ones printed. The change of clef is used so that the lines and spaces correspond to different notes than the lines and spaces of the original score. Seven clefs are used for this: treble (2^{nd} line G-clef), bass (4^{th} line F-clef), baritone (3^{rd} line F-clef or 5-th line C-clef, although in France and Belgium sight-reading exercises for this clef, as a preparation for clef transposition practice, are always printed with the 3^{rd} line F-clef), and C-clefs on the four lowest lines; these allow any given staff position to correspond to each of the seven note names A through G. The signature is then adjusted for the actual accidental (natural, sharp or flat) one wants on that note. The octave may also have to be adjusted (this sort of practice ignores the conventional octave implication of the clefs), but this is a trivial matter for most musicians.

(iii) Transposing by Numbers: Transposing by numbers means, one determines the scale degree of the written note (e.g. first, fourth, fifth, etc.) in the given key. The performer then plays the corresponding scale degree of the target chord.

2.1.2 (g) Transposing Instruments

A transposing instrument is a musical instrument whose music is notated at a pitch different from the pitch that actually sounds concert pitch). Playing a written C on a transposing instrument produces a pitch other than C, and that pitch identifies the interval of transposition when describing the instrument. For example, a written C on a B^b clarinet sounds a concert B^b. For the trumpet, music for all models is written as if they were C trumpets (written C sounds B^b for a B^b trumpet). This allows players to switch instruments without learning new fingerings. Those models other than the C are said to be transposing instruments. Rather than a property of the instrument, the transposition is a convention of music notation- however, instruments whose music is typically notated in this way are called transposing instruments. For some instruments (e.g., the piccolo or the double bass), the sounding pitch is still a C, but in a different octave; these instruments are said to transpose "at the octave".

2.1. 2 (h) Timbre/ Tone Colour of Musical Instruments

Tone colour refers to the character of a sound, as distinct from its pitch; hence the quality of sound that distinguishes one instrument from another. It is largely, though not exclusively, a function of the relative strengths of the harmonics and sometimes non-harmonic frequencies) present in the sound (The New Harvard dictionary of Music, 1986). Tone colour (sometimes called timbre) is intrinsic acoustic quality that distinguishes one instrument from the other. The concept of tone colour or timbre also distinguishes various orchestral instruments within

a given family. For instance, the sound of a trumpet playing from a distance differs from that of a trombone even without seeing the player or the instruments themselves. An instrument's tone colour may vary with the register (part of the total range) in which it is played. A clarinet sounds dark and rich in its low register, but its high register is brilliant and piercing (Kamien, 1986).

2.1.3 Concepts Peculiar to the String Family

The New Harvard dictionary of music (1986) defines a stringed instrument as, "an instrument in which one or more strings constitute the principal vibrating system. The string or strings may be set in motion by bowing, plucking, or striking". Popular orchestral instruments of the string family are the violin, viola, 'cello, and string bass. Kamien (1988) describes the strings thus:

> The violin, viola, cello (violoncello), and double bass ("bass fiddle," sometimes called simply a bass) form the symphony orchestra's string section. They vary in tone color as well as in size and range; the double bass is the largest and has the lowest range. Of all the instrument groups, the strings have the greatest versatility and expressive range. They produce many tone colours and have wide ranges of pitch and dynamics. String players can produce tones that are brilliant and rapid or slow and throbbing; they can control tone as subtly as a singer. Orchestral works tend to rely more on the string instruments than any other group (p. 16).

The construction of string orchestral instruments involves certain conceptual considerations and principles that influence the adequacy of the instrument. Such mechanical and acoustical concepts which relate directly to the functionality of orchestral string instruments are body make-up, hygroscopy, string tension, timbre, compass and range, etc.

The body of string musical instruments is generally made of wood because it hardly distorts tonal images and basic musical sound (klotman, 1996). On the nature and choice of wood for the body of string instruments, Leipp (1969) observes that:

> Using pine wood and maple for the body of the violin has precious advantages such as straight fibers, low density (roughly between 0.4 and 0.5), resistance to deformation etc. For prime acoustic quality of the woods, the wood is cut down in winter, and cut into quarters which are stored in a dry, well-aired place for several years. This procedure checks the density, muting coefficient, rigidity, resistance to deformation

and hygroscopicity (a term meaning the level of tolerance of the wood with humidity and salts) (p. 65).

Experience also shows that the violin's sound alters perceptibly after varnishing and thus affects the density, elasticity, rigidity, and the damping capacity of the instrument.

2.1. 3 (a) Acoustic Qualities of the Woods

Woods for instrument making (pines and maples) are carefully chosen for precious reasons already mentioned. For instance, the ordinary spruce-the most valued variety of pine- is used in all Italian and German stringed instruments because of its precious advantages: straight fibers, low density (roughly between 0.4 and 0.5), and resistance to deformation. Sound travels quite rapidly in it (between 16,000 and 20,000 feet/second; the elastic modulus in the direction of the fibers is very high (1,100 to 1,500). Several kinds of maple wood are used concurrently (the plane maple and the sycamore maple) even though their density is medium (0.6 to 0.8) and sound travels definitely slower in them (10,000 to 13, 000 feet/second) than in pine wood; and the elastic modulus is reduced by half. Two important characteristics have determined the choice of this wood for the back of stringed instruments. First, it looks very fine: the undulations of the fibers produce very beautiful plays of colour; second, its resistance to deformation is well known. Leipp (1969) explains further that other sensitive acoustic parameters of wood exist which can be subjected to scientific testing for instrument making. For example,

- **Density**

This can be measured easily. Given equal dimensions, it determines the weight of an instrument, and therefore its inertia, which in turn governs the transient response, that is the duration of attack of a sound.

- **Muting coefficient**

This is determined by the nature of the inner structure of the material; it partially conditions the duration of extinction of sound once its active cause has stopped.

- **Speed of sound in the material**

This determines the clarity**,** the keenness of sound in the sample. It depends on the relation between the elastic modulus and the density of the material.

- **Rigidity**

Rigidity can be tested by measuring torsion stress.

- **Resistance to deformation**

This matters a great deal. The stringed instrument undergoes considerable pressures with regard to both its dimensions and its bulk. Its sonorous qualities are modified by deformations

- **Hygroscopicity**

Humidity modifies the properties of the woods, particularly when these are porous and contain hygroscopic salts.

2.1.3 (b) Varnish and the sonority of stringed instruments

Varnish a solution of resin in oil applied to the body of a stringed instrument to give it a protective gloss) has been found to alter the sound and perceptibility of stringed instruments after varnishing. Leipp (1969) reports that this process modifies one or several of the following physical properties of stringed instruments:

- **Density**

The penetration of products into the tables increases the density of the wood. This usually varies from 1.05 to 1.5. The density of the resins is therefore a little higher than the wood. The increase of density is therefore negligible, except in the case of penetrating varnishes, for example varnishes of linseed oil applied without sizing. Therefore the density of resins cannot notably modify the sound of the instrument.

- **Elasticity**

Elasticity is connected with the spectrum, that is, with the quality of the sound. Practice demonstrates that a top-varnish causes only insignificant alterations in the sound. It is quite otherwise with penetrating varnishes. In this case, the tender parts of the wood (summer wood) absorb oil and resin voraciously. During the drying-which can take a very long time-the summer wood hardens gradually, and a homogenization of the pine wood takes place. This makes the elasticity of transverse flexion to draw closer to the longitudinal elasticity, and under these conditions the sound of the instrument alters with time.

- **Rigidity**

Instrument makers empirically estimate the rigidity of tables by holding them at both ends and subjecting them to torsion tests. Experience in varnishing shows that the torsional rigidity of a table varies very little with the light varnishes such as the ancient makers used.

- **Damping capacity**

If the table of a stringed instrument is struck, the vibration dies away gradually. The damping speed depends on many parameters; the internal friction of the materials, combined with their molecular structure, plays an important part. Now, varnishing can certainly modify the damping capacity of the tables. Experience proves that a good damping capacity is indispensable for stringed musical instruments, but if it is too great the instrument because dull; the ancient Italian instrument makers seem to have reached a summit in this matter.

2.1.3(c) Varnish and Its visual/Aesthetic Effects on Stringed Instruments

This may not have a direct bearing on the basic functioning of stringed musical instruments, but it is worth mentioning that varnish contributes immensely to the aesthetic beauty and appeal of stringed instruments. Leipp (1969), explains that ancient Italian varnishes applied on the instruments by Italian instrument makers contributed to the peculiar visual and aesthetic qualities of the instruments and these are:

- **Brilliancy**

The paste of the old Italian varnishes seems to be a peculiarly shining product. It is known that this quality is connected with the index of refraction of the consistent materials. A ray of light passing from a slightly refracting medium into a highly refracting one will break up. In this case, the angle of incidence i is greater than the angle of refraction r, and only one portion of the light penetrates into the second medium, the other being reflected on the surface (R1). The proportion of light reflected by the surface depends on the difference of the indices of refraction of the two media. The higher the index of refraction in a varnish, the more light is reflected on the surface. Thus, linseed oil has an index of refraction of 1.485 and colophony (a type of resin) will be 1.543 after evaporation of the solvent and a varnish of colophony and linseed oil will necessarily have a weaker one. Therefore, varnish with pure colophony will be brighter than a varnish with oil and colophony, but less resistant than the latter.

- **Transparency**

In spite of their strong colour, the ancient Italian varnishes have a remarkable transparency. The care that the ancient craftsmen and artist took in selecting and sorting their gums and other ingredients certainly had something to do with this. We learn from physics that a coloured varnish is all the more transparent, since the index of refraction in the colouring matter is closer to that of the resins which make up the varnish. Resins coloured naturally or resinous matter (dragon's blood, gamboges, etc.) usually supply this condition. These products were once used as effect, as actual documents prove. Therefore it is the indices of refraction which determine the brilliance and the transparency of a varnish.

- **Scintillation**

The classical varnishes offer a further peculiarity. Under the microscope and under directed light, we observe myriad bright dots that glisten as the direction of light changes. When a ray of light passes from a refracting medium into a less refracting one, we notice that at a given angle of incidence no light passes through the surface between the two media; this known is as total internal reflection. It is precisely this total reflection of light on the small surfaces of wood, lying at various angles, that produces these brilliant scintillations.

- **Polarization of light**

When we look at beautiful old Italian instrument in a diffused light, the surface of the back looks a fairly uniform yellow or orange. But if we direct a beam of light along the back in a given direction, we notice bright colours- for example, red-yellow alternating in the grain. This is a matter of light polarization. Many observations and experiments have shown that the effects of polarization were known to the ancient Italian instrument makers. Considering the longitudinal section of the back of a stringed instrument, maple fibres are not straight but undulating. These fibres are cut smooth when the surface of the back is leveled by planes and scrapers. But since these tools never cut perfectly clean, the wood's surface presents an aspect more or less like velvet; in the grain we see hairs pointing in opposite directions, as in A and B above, and these hairs determine a polarization of light. According to the direction of the light in and the position of the eye, zone B, in which there are total reflections, will appear very light, while zone A will be dark and saturated with colour. After many experiments the phenomenon is very obvious, and the direction of light in which the wood is planed bears an important part. The hairs are flattened in one direction or the other, as when we make polarizing screens. When we use fine sandpaper on the wood's surface, the effect

disappears almost entirely. The invention of sandpaper made the surfacing of the tables easier, but was an essential cause of the decadence of beautiful stringed instruments varnishes.

The subtle interplay and relationship of art and science in stringed instrument making is overwhelming. The crafting of these instruments without recourse to scientific principles undermines their adequacy. Leipp (1969) captures this inextricable relationship thus:

> The problems of varnishing can be solved thanks to a scientific approach; apparatus and methods are to hand, and the secret of the ancient varnishes can be discovered. This applies to the whole technique of stringed instrument manufacture; science is now able to solve various problems raised by instrument making. Unfortunately, too many instrument makers are not yet convinced of this and reject with indignation any intrusion of science into their art. There is no doubt that this spirit is one of the principal causes of the stagnation in instrument making. One day it will be admitted that art is nothing without science (p. 85).

The intricacies of the aforementioned concepts on stringed instrument making have contributed to the historical uniqueness and genuineness of the instruments, whether these principles and conventions are still maintained by contemporary stringed instrument makers is a serious issue.

On the general make-up of the body of string musical instruments, klotman (1996) submits that:

> The tops of string musical instruments are usually made of even, narrow-grained spruce. The head, the neck, the sides or ribs, and the bridge are made of various grades of maple. The nut, the fingerboard, the saddle, and the inlaid purfling should be made of ebony, but they may also be rosewood or boxwood. Chin rests may well vary. They may be made of ebony, rosewood, boxwood, or a plastic. The best end pins are made of steel and should be adjustable. The finish should be of high quality, polished varnish. Lacquer is not acceptable for string instruments. The better bows are made of pernambuco wood. A good quality brazil-wood may be an adequate substitute, but under no circumstances should one accept beechwood (p. 3).

These clarifications, obviously, serve as caution in acquiring string instruments for teaching and learning.

2.1.3(d) Body Nomenclature of Stringed Instruments

Among the string family (violin, viola, 'cello, string bass), there are certain terms which describe the body parts and basic features of the instruments technically referred to as body Nomenclature (Klotman, 19960). These body parts control the overall functionality of the instruments. For example, the scroll, peg, peg-box, nut, fingerboard, neck, top, ribs (bouts), purfling, F hole, bridge, tuner, tailpiece, chin rest, saddle, tailpiece gut, and button.

On the general nomenclature of the body of stringed instruments Klotman (1996), reports that:

> All string instruments use the same nomenclature for their various parts. Since cellos and basses rest on the floor, they have additional items, such as an end pin and adjusting screw that keeps the end pin in place. (Naturally there is no chinrest on the cello or bass). To prevent sliding, these instruments should utilize a stop of some sort or find a hole in the floor where the end pin may be inserted to provide stability (p. 3).

Regarding the bow, klotman (1996), expatiates that:

> The nomenclature for the bow is the same for each member of the string family. The parts of the bow for each instrument vary in size and thickness in proportion to the length of the stick. The only instrument with two styles of bow is the string bass, which may be played with either a French - or German –style ("Butler") bow. However, the French conforms to the bows of the other members of the string family and is the more popular in most string classes (p. 6).

These sensitive issues regarding the general body make-up and parts of stringed instruments are concepts which presuppose the genuineness and adequacy of the instruments and which, invariably, informs the acquisition of any of the instruments. These also explain why the Stradivari string models continued to be popular among orchestral string players because of the conformity of the model to acoustical standards. Regrettably, modern instrument makers are not as thorough and painstaking as the ancient instrument makers with regard to the aforementioned concepts and acoustical parameters and that has affected the genuineness of modern orchestral instruments. Leipp (1969) regrets this:

> The ancient instrument makers selected on the spot the trees that suited their purposes. They thus obtained certain homogeneity between the various pieces,

allowing for gradual and empiric correction of their models. It is no longer so now, to the detriment of the quality of modern instrument making (p.66).

2.1. 3 (e) Functionality of the Body Parts of Stringed Instruments

A thorough understanding of the various parts of the instrument and their respective functions is a prerequisite to mastering the given instrument. The concept of nomenclature of the parts of a given string instruments is so crucial for it informs the string teacher appropriately. Klotman (1996: 3) reasonably submits that, "it is important that the string teacher be able to identify the parts by their correct terms, since these are the common language of string players. For instance, the tuner serves exclusively for refining the tuning of the string above by a semitone. The bridge serves for stretching the strings on the fingerboard and is held by the tension of the strings. The tuning pegs serve for adjusting and tuning the strings. The tuning pegs are more effective when the strings are completely out of tune while the fine tuners fine tune the strings up or down by semitones. The chin rest, as the name implies, accommodates the chin in playing the violin and viola. The sound post, or soul post, fits precisely inside the instruments between the back and top, below the treble foot of the bridge, which it helps support. It also transmits vibrations between the top and the back of the instruments. The tailpiece anchors the strings to the lower bout of the instruments by means of the tailgut, which loops around an ebony button called the tailpin.

2.1. 3 (f) Tuning

Tuning has been defined as, "the act of adjusting the fundamental sounding frequency or frequencies of an instrument, usually to bring it or them into agreement with some predetermined pitch" (The New Harvard dictionary of Music, 1986).The concept of tuning is peculiar to all members of the stringed family owing to their structure and nature. Stringed orchestral instruments are generally body-structured to have strings attached to a fingered board and adjusted with tuning pegs to yield the desired fundamental pitches of the respective strings. Also, the strings and the pegs naturally get distuned by mere contact with objects or wear out under certain adverse climatic conditions. The problem of distuning, therefore, places the burden of constant retuning on the string player. Even though strings naturally get adjusted to the tuning pegs and the fingerboard over time, climatic conditions still affect their torsion pressure and thus require periodic retuning.

2.1. 3(g) Bowing

Bowing is the technique of using the bow on stringed instruments (The New Harvard Dictionary of Music, 1988). The characteristic long, sustained, and singing sound produced by the violin, viola, violoncello, and double bass is due to the drawing of the bow against their strings. This sustaining of musical sound with a bow is comparable to a singer using breath to sustain sounds and sing long, smooth, or legato melodies. In modern practice, the bow is almost held in the right hand for bowing while the left is used for fingering. When the player pulls the bow across the strings (such that the frog moves away from the instrument), it is called a down-bow; pushing the bow so the frog moves toward the instrument is an up-bow (the directions "down" and "up" are literally descriptive for violins and violas, and are employed in analogous fashion for the cello and double bass). Two consecutive notes played in the same bow direction are referred to as hooked bow; a down-bow following a whole down-bow is called a retake (Wikipedia Encyclopedia, 2013). Without the bow the violin family could only be played pizzicato.

2.1. 3 (h) Harmonics

In string playing, harmonics are divided into two categories, natural and artificial, and a single harmonic note may be produced in several ways in either of these categories. The effect of a particular harmonic note may be due to the use of a particular string, finger, or location on the string. Each method produces a different tone colour; composers, writers, and conductors usually designated the method best suited to the effect they are trying to produce. The tone produced when the bow is drawn across an open string is called the fundamental. The pitch of the fundamental is determined by the nodes, which are the stationary points at either end of the vibrating string; in the case of an open string, the nodes are the nut and the bridge. By touching an open string at the midpoint lightly, so that it is not pressed against the fingerboard, and drawing the bow across the string, a natural harmonic is obtained one octave above the fundamental. Pressing a finger down firmly at the midpoint of the string introduces a new nodal point- the point of contact between the string and the fingerboard. Since the location of the nodes determines the fundamental, a new fundamental is produced. If one maintains this new nodal point with the first finger and touches the same string lightly at a different point with the third or fourth finger, the result, when the bow is drawn across the string, will be an artificial harmonic. Artificial harmonics may be produced by touching the string lightly at points one-third, one-quarter, or one-fifth of the way along the effective part

of the string (i.e., the part bounded by the bridge and the nodal point maintained by the first finger). On harmonics of stringed instruments, Klotman (1969) advices that:

> When playing harmonics, it is a good idea to move the bow closer to the bridge than usual and apply the usual amount of pressure. There is a tendency on the part of inexperienced players to relax the pressure of the bow arm because they are touching lightly with the fingers of the left hand. Harmonics may be introduced early in string instruction as a device to develop a good "pull" and correct use of the bow arm. Much will depend on the ability of the student and the teacher`s background in proceeding at this level of instruction (p. 227).

To indicate a natural harmonic, a composer writes the pitch at which the string is touched lightly and places a small circle above it; or else he indicates the place where the string is touched lightly by a diamond-shaped note. To indicate an artificial harmonic, a composer writes in the customary way the pitch at which the string is pressed firmly, and above it he writes a diamond-shaped note to indicate where the string is touched lightly.

2.1. 3 (i) Techniques of String Instrument Playing

Certain technical terms and concepts that apply to the general technique of playing string instruments shall be explained here. For example,

- ***Pizzicato***

The Italian word *pizzicato* (abbreviated pizz.) indicates that the player is to pluck the string with the finger. This technique produces a unique sound effect; it also is useful in the early stages of learning to play a string instrument. By using pizzicato, the performer is relieved of any bowing problems while learning the notes of a piece. Pizziczto may be done with the right hand or with the left hand if the right hand is occupied with bowing. Modern music may require "nail" pizzicato, where the string is plucked with a fingernail; "snap" pizzicato, which is achieved by plucking the string with such force that it snaps against the fingerboard; thumb pizzicato, which is accompanied by softly stroking the string with the fleshly part of the thumb; or the two-fingered pizzicato, used for rapid passages and also in order to avoid an arpeggio effect.

- ***Spiccato***

The *spiccato,* a sharp staccato, is an off-the string bow stroke. It is sometimes referred to as "bouncing bow". However, one must be careful not to assume that the bow is bounced like a

ball. Actually, the *spiccato* bow moves in a horizontal direction like a detache bow, except that there is a lift after each stroke, creating the bouncing effect. Occasionally, one uses a pure vertical motion for special effects. There are two broad categories of *spiccato* notes, controlled and uncontrolled. On controlled strokes, the right arm is primarily responsible for the style. On uncontrolled strokes, such as *sautile* or *ricochet*, the execution is a result of the natural tension and spring of the bow. The right arm is completely relaxed for all forms of *spiccato* bowings. A beginning student should experiment to find which part of the bow is most resilient.

- ***Vibrato***

Vibrato entails slight fluctuation of pitch used by performers to enrich or intensify the sound. In modern string playing, vibrato is produced by rocking the left hand, usually from the wrist, as note is played. The New Harvard Dictionary of Music (1986) reports that, "Since the early years of twentieth century, vibrato, particularly on stringed instruments, has become essentially an organic feature of tone production, a means of adding continuous intensity to the sound. Klotman (1988), reports that:

> Many students are found to have a natural vibrato, and they should be encouraged to experiment with it. Some students, for a variety of reasons, however, find the vibrato difficult; placing undue pressure on them to vibrate too early in their development can be an inhibiting factor (p. 222).

- ***Detache`***

Literally, the term merely means detached notes that are not slurred. In practice, it is the smooth change from one bow stroke to another. Often it is misrepresented as meaning strokes with a space between notes. The detache may be played at any part of the bow in a legato (smooth) manner. On the down-bow, the second, third, and fourth fingers pull the bow, while on the up-bow the first finger pushes the bow. To achieve smooth transfer in this finger action, the fingers of the right hand must be flexible and relaxed.

- ***Staccato***

The *staccato* note is a detached, separated, or disconnected note played with the bow remaining on the string. There are many types of staccato; the style of music determines the type to be played. A good rule for determining the duration of a *staccato* is that it is one-half of its written value.

- **Slur**

Slurred notes are those that continue in the same direction or follow in sequence without a bow change. The character of slurred notes may vary. It may be smooth, *staccato*, or even *spiccato*.

- ***Tremolo***

The term *tremolo* signifies the technique of moving the bow as rapidly as possible back and forth for the duration of the note value. It is best achieved at the point of the bow with a rather straight arm, but not rigid. To achieve the necessary speed of the stroke, primarily use the fingers and hand from the wrist. It may be played anywhere on the string- near the bridge, over the fingerboard, etc.

- **Hooked Bowing**

The term hooked bowing is applied to the technique of tying or slurring notes to avoid awkward bowings or improper accents.

- ***Loure`*** **(portato)**

The *portato* style is a semi-staccato type of bowing that is smoothly separated, or "pulsed". It is used to enunciate certain notes without pausing between them. To accomplish this type of bowing, a slight pressure is placed on the notes.

- ***SulPonticello***

This type of bowing is done with the hair of the bow as close to the bridge as possible. To acquire the desired effect, it is helpful to tilt the bow hair slightly away from the bridge.

- ***ColLegno***

Literally the term means "with the wood". In performing this type of bowing, the string is struck (or tapped) with the wood side of the bow. It is helpful to tilt the bow so that the hair is turned away from the bridge. *Collegno* style is generally performed with the upper half of the stick.

- ***SulTasto***

This style gives a *sotto-voce* effect. It is performed with the bow placed over the fingerboard. The fingers of the right hand should be completely relaxed and hold the bow rather loosely.

- ***Colle`***

This stroke begins with the bow placed on the string similar to an up-bow spiccato. At the moment of contact, the string is pinched lightly but with a sharp attack. As soon as the notes are sounded, the bow is immediately lifted off the string in preparation for the next stroke **.**

- **Double Stop**

Double stop is the execution of two or more pitches simultaneously or in such a way as to create the effect of simultaneity on a bowed, stringed instrument (The New Harvard dictionary of Music, 1986). Double stops are used to teach beginning students because they amplify the string tone. In addition, playing double stops helps to develop a desirable string tone since it cannot be done without rubbing the bow against the strings. Beginners tend to allow the bow to slide, producing a glassy tone, but double-stop playing requires a good pull and push. Another advantage is that this kind of practice will eventually lead to smoother string crossings.

- **Crossing Strings and Double Stops**

For proper articulation of double stops, the student should learn the concept of crossing strings as a prerequisite. For crossing strings, it is of the utmost importance to keep the fingers down on the upper string through each crossing. This requirement is reinforced in the double-stop exercise, since the student cannot play a double stop correctly unless the fingers are kept down. In addition, the student becomes more acutely aware of intonation, since it is required to play a scale with a pedal point; the pedal tone must be kept constant, and each note of the scale must be tuned against it. When crossing strings, it is well to emphasize keeping the left fingers down as much as possible. This will not only facilitate a smoother crossing, but also will assist in developing better left-hand technique. Because of the bowing angle of the violin and viola which moves somewhat perpendicular to the ground, when going from a lower string to an upper string, begin with a down –bow. The cello and bass bows move parallel to the ground; therefore it is preferable, because of the arm and wrist movement, to begin with an up-bow when going from a lower string to an upper string. This applies mainly to a sequence of alternating notes. One should bear in mind, however, that, we are applying this principle to strings and not pitches, so that on the string bass, the open G is higher than the open D and therefore begins with a down-bow.

- ***Martele`***

The *martele`* is a *staccato* stroke that is referred to as hammered stroke. Each stroke must be prepared for by pressure before playing and must be followed by an immediate release of pressure. At the same time the bow is drawn quickly. The next stroke follows the same procedure- pressing, releasing, and at the same time moving the bow quickly. As in *staccato*, the bow remains in contact with the string at all times. *Martele`*, however, is more accented, and it is marked with a wedge (ı). The *martele`* is usually played with the upper third of the bow; the grand martele is played with the whole bow.

- **Zipping**

As a student begins to use the fingers of the left hand, he or she tends to grip the neck of the instrument. To relieve this tension, several exercises should be employed regularly. Zipping, which is placing the second finger lightly on a string and just sliding it up and down the neck, producing a siren sound, is one device to prevent a tense grip. If a student is gripping the neck of the instrument, his thumb will not move freely. In violin and viola playing, zipping may also reveal how well the student is holding the instrument with the jaw. Unless the jaw is holding the instrument securely, the left hand is not free to move.

- **Tapping**

Another technique to improve hand position is to tap the strings silently with all four fingers of the left hand in various positions (first position, third position, etc.), or at various points on the different strings. This develops mobility in hand movement, which is so essential to proper string playing.

- **Scordatura**

A special scheme to tune the open strings in such a way that unusual effects, such as tone clusters, can be created by merely playing open strings. It literally means to retune the strings to pitches other than the established pitches and can be used in a variety of ways (Klotman, 1988).

- **Shifting**

The chief function of shifting is to extend the range of the instrument. There are seven basic positions, plus variations added to accommodate modern fingerings; the string bass and cello also have intermediate (half) positions. To achieve a smooth shift, the left hand must be considered a unit that is free to move on the string. This freedom must be emphasized from

the beginning of instruction. One of the major obstacles to achieving a smooth shift is tenseness in the left thumb. To prevent this, it is helpful for the student to regard the thumb as an elevator that carries the hand when moving from a lower to a higher position. It moves at the same time with the hand fingers. The finger that is on the string when the student begins to shift remains on the string until the hand arrives in its new position. The finger that is to be used then falls into place, completing the shift. However, if the performer is moving to a new position, and the finger that is to be played is one lower than the finger initiating the shift, the finger that has a lower number falls into place while the shift is in progress. On the backward shifts, the same rules of relaxation and freedom apply. However, it is the finger on the string that initiates the shift. Throughout, the basic relationship between the thumb and the fingers remains the same in the first four positions on the cello and bass, and the first three positions on the violin and viola. Beyond these positions, the thumb will pass gradually under the neck of the instrument as the hand moves to the higher positions. Klotman (1969:214), outlines the basic purpose of shifting thus:

(i) Shifting extends the range of the instrument.
(ii) It facilitates technique by helping to avoid awkward string crossing.
(iii) It avoids awkward fingerings in passages.
(iv) It may be used for musical effects, such as retaining a desired tone colour by staying on a single string in a musical phrase.
(v) It may be used for an emotional effect, such as a glissando or portamento.

2.1. 3 (j) Some Descriptive and Distinctive Features of the Various Stringed Instruments

Although all instruments of the string family employ similar instrumental concepts, they still have respective distinctive features. The playing ranges of the instruments of the string family also overlap each other, but the tone quality and physical size of each distinguishes them from one another. These features are discussed in detail below.

- **Violin**

The violin is a string instrument, usually with four strings tuned in perfect fifths. It is the smallest, highest- pitched member of the violin family of string instruments. The violin is played (or produces sound) by drawing a bow across one or more strings (which may be stopped by the fingers of the other hand to produce a full range of pitches), by plucking the strings (with either hand), or by a variety of other techniques. The violin is played by musicians in a wide variety of musical genres, including baroque music, classical jazz, folk

music, rock and roll, and soft rock (Auer, 1960). The parts of a violin are usually made from different types of wood (although electric violins may not be made of wood at all, since their sound may not be dependent on specific acoustic characteristics of the instrument's construction), and it is usually strung with gut, nylon 6 or other synthetic, or steel strings. The voice of a violin depends on its shape, the wood it is made from, the graduation (the thickness profile) of both the top and back, and the varnish that coats its outside surface. The varnish and especially the wood continue to improve with age, making the fixed supply of old violins much sought-after.

The bridge is a precisely cut piece of maple that forms the lower anchor point of the vibrating length of the strings and transmits the vibration of the strings to the body of the instrument. Its top curve holds the strings at the proper height from the fingerboard in an arc, allowing each to be sounded separately by the bow. The sound post, or soul post, fits precisely inside the instrument between the back and top, below the treble foot of the bridge, which it helps support. It also transmits vibrations between the top and the back of the instrument. The tailpiece anchors the strings to the lower bout of the violin by means of the tailgut, which loops around an ebony button called the tailpin (sometimes confusingly called the endpin, like the cello's spike, which fits into a tapered hole in the bottom block). Very often the E string will have a fine tuning lever worked by a small screw turned by the fingers. Fine tuners may also be applied to the other strings, especially on a beginner's instrument, and are sometimes built into the tail piece (Galamian, 2013).

Virtually all the features found in the violin also apply to all other instruments of the string (viol) family; therefore, we shall now highlight features which are peculiar to the remaining respective stringed instruments having mentioned their shared characteristics.

- **Viola**

The viola is a bowed string instrument. It is slightly larger than a violin in size and has a deeper sound. Since the 18^{th} century it has been the middle voice of the violin family, between the violin (which is tuned a perfect fifth above it) and the cello (which is tuned an octave below it). The viola is similar in material and construction to the violin. A full-size viola's body is between 1 inch (25mm) and 4 inches (100mm) longer than the body of a full-size violin (i.e., between 15 and 18 inches (38 and 46cm)), with an average length of 16 inches (41cm).

The viola's four strings are normally tuned in fifths: the lowest string is C3 (an octave below middle C), with G3, D4 and A4 above it. This tuning is exactly one fifth below the violin, so that they have three strings in common- G, D, and A- and is one octave above the cello. Each string of a viola is wrapped around a peg near the scroll and is tuned by turning the peg. The tuning C-G-D-A is used for the great majority of all viola music. However, other tunings are occasionally employed, both in classical music, where the technique is known as scordatura, and in some folk styles. Mozart, in his Sinfornia Concertante for violin, viola and orchestra in E flat, wrote the viola part in D major and specified that the viola's strings were to be raised in pitch by a semitone: his intention was probably to give the viola a brighter tone so as to avoid it being overpowered by the rest of the ensemble (Barret, 1978).

The technique required for playing a viola has certain differences compared with that of a violin, partly because of its larger size: the notes are spread out farther along the fingerboard and often require different fingerings. The viola's less responsive strings and the heavier bow warrant a somewhat different bowing technique, and a violist has to lean more intensely on the strings. The viola is held in the same manner as the violin, however due to its larger size, some adjustments must be made for accommodation. The viola, just like the violin, is placed on top of the left shoulder between the shoulder and the left side of the face (chin). Because of the viola's size, violists with short arms tend to use smaller sized violas for easier playing. The most immediately noticeable adjustment that a player accustomed to playing violin has to make are to use wider-spaced fingerings. The viola is generally strung with heavier strings than the violin. This, combined with its larger size and lower pitch range, results in a deeper and mellower tone. However, the thicker strings mean that the viola speaks more slowly. Practically speaking, if a violist and violinist are playing together, the violist must begin moving the bow a fraction of a second sooner than the violinist. The thicker strings also mean that more weight must be applied with the bow to make them speak.

The viola's bow has a wider band of horsehair than a violin's bow, which is particularly noticeable near the frog. Viola bows (70-74) grams are heavier than violin bows (58-61 grams). Also the profile of the rectangular outside corner of a viola bow frog generally is more rounded than on violin bows (Wikipedia Encyclopedia, 2013).

- **Cello**

The cello is a bowed string instrument with four strings tuned in perfect fifths. It is also a member of the violin family. The name cello is an abbreviation of the Italian violoncello,

which means “little violone”, referring to the violone (“big viol”), the lowest pitched instrument of the viol family, the group of instruments that went out of fashion around the end of the 17th century in most countries except France, where they survived another half century or so before the louder violin family came into greater favour in that country too. The cello is used as a solo instrument, as well as in chamber music ensembles, string orchestras, and as a member of the string section of symphony orchestra. It is the second largest bowed string instrument in the modern symphony orchestra, the double bass being the largest.

The cello is typically made from wood, although other materials such as carbon fibre or aluminum may be used. A traditional cello has a spruce top, with maple for the back, sides, and neck. Other woods, such as polar or willow, are sometimes used for the back and sides. Less expensive cellos frequently have tops and backs made of laminated wood. The top and back are traditionally hand-carved, though less expensive cellos are often machine-produced. The sides, or ribs, are made by heating the wood and bending it around forms. The cello body has a wide top bout, narrow middle formed by two C-bouts, and wide bottom bout, with the bridge and F holes just below the middle. The top and back of the cello has decorative border inlay known as purfling. While purfling is attractive, it is also functional: if the instrument is struck, the purfling can prevent cracking of the wood. A crack may form at the rim of the instrument, but spreads no further. Without purfling, cracks can spread up or down the top or back. Playing, travelling and the weather all affect the cello and can increase a crack if purfling is not in place. Less expensive instruments typically have painted purfling (Potter, 1964).

Strings on cello have cores made out of gut (sheep or goat), metal, or synthetic materials, such as perlon. Most modern strings used today are also wound with metallic materials like aluminum, titanium and chromium. Cellists may mix different types of strings on their instruments. The pitches of the open strings are C, G, D, and A.

The tailpiece and endpin are found in the lower part of the cello. The tailpiece is traditionally made of ebony or another hardwood, but can also be made of plastic or steel. It attaches the strings to the lower end of the cello, and can have one or more fine tuners. The endpin or spike is made of wood, metal or rigid carbon fibre and supports the cello in playing position. In the Baroque period the cello was held between the calves. The endpin was introduced by Adrien Servais around 1845 to give the instrument greater stability. Modern endpins are retractable and adjustable, older ones were removed when not in use (Potter, 1964).

Internally, the cello has two important features: a bass bar, which is glued to the underside of the top of the instrument, and a round wooden sound post, which is wedged between the top and bottom plates. The bass bar, found under the bass foot of the bridge, serves to support the cello's top and distribute the vibrations. The sound post, found under the treble side of the bridge, connects the back and front of the cello. Like the bridge the sound post is not glued, but kept in place by the tensions of the bridge and strings. Together, the bass bar and sound post transfer the strings' vibrations to the top (front) of the instrument (and to a lesser extent the back), acting as a diaphragm to produce the instrument's sound (Smith, 1993).

An average cello bow is 73 cm long (shorter than a violin or viola bow) 3cm high (from the frog to the stick) and 1.5 cm wide. The frog of a cello bow typically has a rounded corner like that of a viola bow, but is wider. A cello bow is roughly 10 grams heavier than a viola bow, which in turn is roughly 10 grams heavier than a violin bow.

Cellos are tuned in fifths, starting with A3, followed by D3, G2, and then C2 (two octaves below middle C) as the lowest string. It is tuned in the same intervals as the viola, but an octave lower. Unlike the violin or viola but similar to the double bass, the cello has an endpin that rests on the floor to support the instrument's weight. The cello is most closely associated with European classical music, and has been described as the closest sounding instrument to the male human voice. The instrument is a part of the standard orchestra and is the bass voice of the string quartet, as well as being part of many other chamber groups. A large number of concertos and sonatas have been written for the cello.

- **Double Bass**

The double bass, also called the string bass, upright bass, bass fiddle, bass violin, doghouse bass, contrabass, bass viol, stand-up bass, bull fiddle or simply bass, is the largest and lowest-pitched bowed string instrument of the viol family in the modern symphony orchestra, with strings usually tuned to E1, A1, D2 and G2. The double bass is a standard member of the string section of the orchestra and smaller string ensembles in Western classical music. In addition, it is used in other genres such as jazz, 1950s-style blues and rock and roll, rockabilly/psychobilly, traditional country music, bluegrass, tango and many types of folk music (Stanton, 1965).

The double bass stands around 180 cm (six feet) from scroll to endpin, and is typically constructed from several types of wood, including maple for the back, spruce for the top, and

ebony for the fingerboard. It is uncertain whether the instrument is a descendant of the viola da gamba or of the violin, but it is traditionally aligned with the violin family. While the double bass is nearly identical in construction to other violin family instruments, it also embodies features found in the older viol family. Like many other string instruments, the double bass is played either with a bow (arco) or by plucking the strings (pizziczto). When playing the instrument, the bassist either stands or sits on a high stool and leans the instrument against the bassist's body with the bass turned slightly inwards in order to more easily reach the strings. This stance is also a key reason for the bass's sloped shoulders, which mark it apart from the other members of the violin family, as the narrower shoulders facilitate playing of the strings in their higher registers (Green, 1971). The double bass features many parts that are similar to members of the violin family, including a bridge, f-holes, a tailpiece, a scroll, and a sound post. Unlike the rest of the violin family, the double bass still reflects influence, and can be considered partly derived, from the viol family of instruments, in particular the violone, the bass member of the viol family. The double bass also differs from members of the violin family in that the shoulders are typically sloped, the back is often angled (both to allow easier access to the instrument, particularly in the upper range), and machine tuners are always fitted. Lack of standardization in design means one double bass can sound and look very different from another.

Another important distinction between the double bass and other members of the violin family is the construction of the pegbox. While the violin, viola, and cello all use friction pegs for gross tuning adjustments, the double bass has metal machine heads. The key on the tuning machine turns a metal worm, which drives a worm gear that winds the string. While this development makes fine tuners unnecessary, a very small number of bassists use them nevertheless. At the base of the double bass is a metal rod with a spiked end called the endpin, which rests on the floor. This endpin is generally more robust than that of a cello, because of the greater mass of the double bass.

Prior to the mid-20th century, double bass string were usually made of gut, but, since that time, steel has largely replaced it, because steel strings hold their pitch better and yield more volume when played with the bow. Gut strings are also more vulnerable to changes of humidity and temperature, and they break much more easily than steel strings.

The double bass bow comes in two different forms: the "French" or "overhand" bow is similar in shape and implementation to the bow used on the other members of the orchestral

string instrument family, while the “German” or “Butler” bow is typically broader and shorter, and is held in a “hand shake” position. These two bows provide different ways of moving the arm and distributing force on the strings. Proponents of the French bow argue that it is more maneuverable, due to the angle at which the player holds the bow. Advocates of the German bow claim that it allows the player to apply more arm weight on the strings. The differences between the two, however, are minute for a proficient player, and modern players in major orchestras use both bows (Wikipedia Encyclopedia, 2013). Double bass bows vary in length, ranging from 60cm (24”) to 75cm (30”). Pernambuco, also known as Brazilwood, is regarded as an excellent quality stick material, but due to its scarcity and expense, other materials are increasingly being used. Less expensive student bows may be constructed of solid fibre glass, or of less valuable varieties of brazilwood. The double bass bow is usually strung with either white or black horsehair, or a combination of the two, as opposed to the customary white horsehair used on the bows of other string instruments. Some bassists argue that the slightly rougher black hair “grabs” the heavier, lower strings better. As well, some bassists and luthiers believe that it is easier to produce a smoother sound with the white variety.

String players apply rosin to the bow hair so it will “grip” the string and make it vibrate. Double bass rosin is generally softer and stickier than violin rosin to allow the hair to grab the thicker strings better, but players use a wide variety of rosins that vary from quite hard (like violin rosin) to quite soft, depending on the weather, the humidity, and the preference of the player. The amount used generally depends on type of music being performed as well as the personal preferences of the player. Bassists may apply more rosin in works for large orchestras (e.g., Brahms symphonies) than for delicate chamber orchestra (Green, 1971).

The double bass is generally tuned in fourths, in contrast to other members of the orchestral string family, which are tuned in fifths. The standard tuning (low to high) is E-A-D-G, starting from E below second low C (concert pitch). This is the same as the standard tuning of a bass guitar and is one octave lower than the four lowest-pitched strings of standard guitar tuning.

Performing on the bass can be physically demanding because the strings are large and thick. Also, the space between notes on the fingerboard is large due to the scale length and string spacing, so players have to shift positions frequently. The bass is usually discouraged for people with shorter arms and smaller hands due to the big note gaps and the thick strings. The

increased use of playing techniques such as thumb position and modifications to the bass, such as the use of lighter-gauge strings at lower tension, have eased the difficulty of playing the instrument. Bass parts have relatively fewer fast passages, double stops, or large jumps in range. These parts are usually given to the cello section because it is a smaller instrument and are typically tuned together (Krolick, 1959).

2.1.4 Concepts Relating to Brass Orchestral Instruments

The New Harvard Dictionary of Music (1986) defines brass instruments as,

> 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 (P.107).

A more technical definition holds that, "A brass instrument is a musical instrument that produces sound by sympathetic vibration of air in a tubular resonator in sympathy with the vibration of the player's lips" (Wikipedia Encyclopedia, 2013). The notion of "sympathetic vibration" or "sympathetic resonance" refers to a harmonic phenomenon wherein a formerly passive string or vibratory body responds to external vibrations to which it has a harmonic likeness. The classic example is demonstrated with two similar tuning-forks of which one is mounted on a wooden box. If the other one is struck and then placed on the box, then muted, the un-struck mounted fork will be heard. In similar fashion, strings will respond to the external vibrations of a tuning-fork when sufficient harmonic relations exist between the respective vibratory modes (Remnant, 1989). Regarding brass instruments, the sympathetic resonance exists between player's vibrating lips and the instrument's tubing.

2.1.4 (a) Classification and Types of Brass Instruments

Common members of the brass family are the trumpet, cornet, horn, trombone, euphonium, and tuba. All brass instruments have a mouthpiece, tubing that carries the air, and a bell that makes the sound louder. Sound is produced when the player buzzes the lips together while blowing. The vibrations of brass instruments come from the musician's lips as he or she blows into a cup- or funnel- shaped mouthpiece. The vibrations are amplified and coloured in a tube that is coiled (to make it easy to carry and play). The tube is flared at the end to form a bell. Modern brass instruments are actually made of brass, but their earlier counterparts were

made of hollow animal horns, elephant tusks, wood, and even glass (Kamien, 1986:24). Modern brass instruments generally come in one or a combination of these families:

- **Valved Brass instruments**

Members of this group use a set of valves (typically three or four but as many as seven or more in some cases) operated by the player's fingers that introduce additional tubing, or crooks, into the instrument, changing its overall length. This family includes all of the modern brass instruments (trumpet, horn, euphonium, and tuba) except the trombone.

- **Slide Brass Instruments**

Slide brass instruments use a slide to change the length of tubing. The main instruments in this category are the trombone family, though valve trombones are occasionally used, especially in jazz.

- **Natural Brass Instruments**

These only play notes in the instrument's harmonic series. These include the bugle and older variants of the trumpet and horn. The trumpet was a natural brass instrument prior to about 1795 and horn before about 1820. In the 18th century, makers developed interchangeable crooks of different lengths, which let players use a single instrument in more than one key. Natural instruments are still played for period performances and some ceremonial functions, and are occasionally found in more modern scores, such as those by Richard Wagner and Richard Struss (Baines, 1993).

- **Keyed or Fingered Brass Instruments**

These use holes along the body of the instrument, which were covered by fingers or by finger-operated pads (keys) in a similar way to a woodwind instrument. These included the cornett, serpent, ophicleide, keyed bugle, and keyed trumpet. They are more difficult to play than valved instruments (Baines, 1993). Our present study involves the valved and slide groups of brass instruments.

2.1. 4 (b) Acoustics of Brass Instruments

Acousticians characterize many of the properties of musical instruments by their "acoustic impedance spectrum". This is a measure of how much sound pressure is generated by a sound wave of a given frequency in the instrument. For a brass instrument, the lips require a strong

pressure signal to help the lips vibrate, so brass instruments tend to play notes near the peaks in the graph of acoustic impedance as a function of frequency (Baines, 1993).

2.1.4 (c) The pitch of Brass instruments

Several factors influence the pitch of brass instruments such as, slides, valves, crooks, or keys. These change the vibratory length of the tubing, thus changing the available harmonic series, while the player's embouchure, lip tension and air flow serve to select the specific harmonic produced from the available series. Succinctly, the pitch of a brass instrument is determined by the fundamental frequency and frequencies of its overtones for each vibrating length achievable through the instrument's valve, slide, key or crook system. The view of most scholars is that the term "brass instrument" should be defined by the way the sound is made, as above, and not by whether the instrument is actually made of brass. Thus one finds brass instruments made of wood, like alphorn, the cornett, the serpent and the didgeridoo, while some wind instruments are made of brass, like the saxophone.

2.1. 4 (d) Sound Production in Brass Instruments

Because the player of a brass instrument has direct control of the prime vibrator (the lips), brass instruments exploit the player's ability to select the harmonic at which the instrument's column of air vibrates. By making the instrument about twice as long as the equivalent woodwind instrument and starting with the second harmonic, players can get a good range of notes simply by varying the tension of their lips. Most brass instruments are fitted with a removable mouthpiece. Different shapes, sizes and styles of mouthpiece may be used to suit different embouchures, or to more easily produce certain tonal characteristics. Trumpets, trombones, and tubas are characteristically fitted with a cupped mouthpiece, while horns are fitted with a conical mouthpiece. The interesting difference between a woodwind instrument and a brass instrument is that woodwind instruments are non-directional, that is, the sound produced propagates in all directions with approximately equal volume. Brass instruments, on the other hand, are highly directional, with most of the sound produced travelling straight outward from the bell. This difference makes it significantly more difficult to record a brass instrument accurately. It also plays a major role in some performance situations, such as in marching bands.

2.1. 4 (e) Body Make-up and Nomenclature

Traditionally brass instruments are normally made of brass (mixture of copper and zinc), polished and then lacquered to prevent corrosion. Some higher quality and higher cost instruments use gold or silver plating to prevent corrosion. A few specialty instruments are made of wood. Alternatives to brass include other alloys containing significant amounts of copper or silver. These alloys are biostatic due to the oligodynamic effect, and thus suppress growth of molds, fungi or bacteria. Brass instruments constructed from stainless steel or aluminum have good sound quality but are rapidly colonized by microorganisms and become unpleasant to play. Most higher quality instruments are designed to prevent or reduce galvanic corrosion between any steel in the valves and springs, and the brass of the tubing. This may take the form of desiccant design, to keep the valves dry, sacrificial zincs, replaceable valve cores and springs, plastic insulating washers, or nonconductive or noble materials for the valve cores and springs.

The making of the bells of brass instruments involves some technicality called metal beating. In making the bell of, for example, a trumpet, a person lays out a pattern and shapes sheet metal into a bell-shape using templates, machine tools, hand tools, and blueprints (Baines, 1993).

2.1. 4 (f) Functionality of the Body Partsof Brass Instruments

- **Mouthpiece**

The mouthpiece is a simple circular opening that leads, via a semi-spherical or conical cavity, to the main body of the instrument. Brass instruments mouthpieces are made of brass and are roughly bell- shaped. Three principal components influence tone quality: the cavity for the lips, which is larger or smaller according to the range and tone of the instrument; the throat at the bottom of this cavity; and the back bore leading from the throat to the instrument. A shallow, cup-shaped cavity with a sharp-edged throat, as in a trumpet mouthpiece, tends to produce brighter sounds, with spicy harmonics. A deeper, funnel-shaped cavity with little or no throat or back bore, as in the French horn mouthpiece, encourages a smooth and mellow sound with few harmonics (The New Harvard dictionary of Music, 1986). Mouthpieces vary to suit the tone of the instrument. Lower instruments also have larger mouthpieces, to maximize resonance. Also mouthpieces are selected to suit the embouchure of the player, to produce a certain timbre, or to optimize the instrument for

certain playing styles. For example, trumpet and trombone mouthpieces are usually semi-spherical whereas French horn mouthpieces are conical (Baines, 1993).

The mouthpiece has a large effect on instrument sound. Major effects are due to the shape of the cup, shape of the throat, and the inner rim diameter. In addition, players often choose a mouthpiece that complements their playing styles. In general, brass players who concentrate on the upper range prefer a mouthpiece with a narrow bore, and players who emphasize the lower range prefer a wider bore.

Table 1

The Effects of Different Aspects of Mouthpiece Design

Mouthpiece element	**Effects on playing**	**Typical size/nature (Trumpet)**	**Typical size/nature (Tuba)**
Innerrimdiameter	Larger inner rim diameters are optimized for lower ranges, giving a richer tone, smaller diameters assist high range playing	~16.0mm	~32mm
Rim width	Wider rim widths reduce the pressure on the lips, allowing greater stamina. It does, however, reduce flexibility.	~5, 6, or 7mm	~6mm
Rim contour	Flatter rim contours tend to appear on rims with sharper edges.	Varied	Varied
Rim edge (or bite)	Sharper rim edges reduce stamina but increase control. More smoothed rims are commonly found on deeper cups.	Varied	Varied
Cup depth	Shallower cups greatly assist playing in high ranges but do so at the cost of fullness of tone. Deeper cups assist low range flexibility and rich tone.	Around half the inner rim diameter.	¾ to 2 times the inner rim diameter.
Cup shape	Semi-spherical cups have brighter, more projected tones, while conical cups have less tone definition	Semi-spherical	Both.
Throat contour	In semi-spherical cups, a sharper throat contour gives a harsher, projected tone and a rounded contour gives a deeper, richer tone. Conical cups with a smooth throat have less definition.	Relatively sharp.	Unusually rounded.
Throat diameter	Larger throat diameters give more volume but less control. Smaller diameters have much more control but significant volume limitations.	~3.6mm	~7.6mm
Backbore	More conical backbores give a richer tone, while more cylindrical ones give a brighter, more projected tone.	Fairly cylindrical	Varied

(Wikipedia Encyclopedia, 2013)

2.1. 4 (g) Types of mouthpiece

Makers commonly construct mouthpieces from various types of material, with different costs, properties, and features, for example,

- **Brass**

Mouthpieces have traditionally been formed of solid brass. These are almost then plated in some other metal, because many people are mildly allergic to raw brass, and because raw brass tarnishes rapidly.

- **Plastic**

Plastic mouthpieces are usually made of Lexan plastic, and are often available in various colors. They are durable and do not chip or dent as do metal mouthpieces. Less expensive than metal mouthpieces, players commonly use them when playing outdoors- particularly marching brass players- because they have short "warm-up" time. But some players feel plastic mouthpieces have an inferior tone quality and feel, compared to metal.

- **Stainless Steel/Titanium**

Recent additions to the mouthpiece world include stainless steel and titanium. They are relatively rare, produced by few manufacturers. Some players feel stainless steel and titanium mouthpieces provide advantages over classic brass mouthpiece, including, anecdotally, a more centered feel and sound, as stainless steel and titanium do not absorb as many vibrations as brass, they require much less care, etc. –but they are much more expensive.

- **Silver – Plated**

Silver plating is common on all brass mouthpieces because it is cost-effective and good in terms of tone quality. It is also moderately germicidal. Silver plating is not as comfortable or as expensive as gold, but has properties and qualities that some feel facilitate certain styles of playing. Some believe that silver plate provides a clearer, darker sound than gold and is good for styles of playing that require clarity and projection. Silver-plate is less expensive than gold, but requires more maintenance because it tarnishes easily. Slightly tarnished silver-plate can be polished back to its brightness with silver polish.

- **Gold- Plated**

Some players believe gold-plated mouthpieces on brass instruments create fuller, richer tone that can also be somewhat darker timbre. For people allergic to silver, this is the best (but not cheapest) way to play a brass instrument without discomfort. Gold does not tarnish, and subsequently requires little maintenance apart from regular washing with soap and water. The extreme price of gold, however, means that the plating is usually relatively thin and thus fragile, and can be worn away with use.

It is obvious from the foregoing that the material make-up of mouthpiece affects tone quality, but there appears not to be any empirical proof of these intricacies but the subjective convictions and of individual brass players. The commonest mouthpiece type remains the silver –plated brass model even though its advantage over others has not been sufficiently proven.

2.1. 4(h) Valve

A valve is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways (Wikipedia Encyclopedia, 2013). Regarding musical instruments, a valve is "A mechanical device used on brass instruments to change rapidly their sounding length (The New Harvard Dictionary of Music, 1986). Valves for brass instruments were first conceived in 1814-15 by two German musicians, Heinrich Stozel of Breslau and Fredrich Bluhmel of Silesia. A conical rotary valve, square piston valves, and tubular piston valves were tried. The two most common types now are the piston valve, used on most American trumpets, and the rotary valve, more often seen on horns (The New Harvard Dictionary of Music, 1986).

- **Mechanism of the Valve**

In the modern piston valve, a piston moves up and down within a cylindrical casing. In modern rotary valve, a rotor rotates on its own axis within a cylindrical casing. Both have exactly the same function. When the valve is at rest or in "open" position, where it is held by a spring mechanism, the air column passes through one passage; but when the finger button or key controlling the valve is pressed, holes or depressions in the piston or rotor are aligned so as to bring another longer or sometimes shorter passage into play. A basic set of three valves is arranged so that the first adds enough tubing to lower the pitch of the instrument two semitones, the second a single semitone, and the third three semitones. Combinations of these can be used to lower the pitch an additional three semitones. Without some means of changing its length, a brass instrument can sound only a series of pitches corresponding approximately to the harmonic series. The three- valve system provides every chromatic pitch from the second pitch of this series upward. For example, the trumpet in C, whose tube is 48 inches long, sounds c` as the second pitch of its series and g` as the third. Between these pitches there are six intermediate ones; hence, six different pipe lengths are required, each obtained by lengthening the tube with the appropriate valve or valve combination. These six additional pipe lengths also make available the six semitones below c`. Altogether, valves

provide such an instrument with a chromatic scale from $f^{\#}$ to c``` and above. There are two flaws in this system. First, as more valves are brought into play, the air column is interrupted with more cylindrical tubing and more corners and bends, with the result that pitches requiring two or three valves may be stuffier and less stable. Fortunately these combinations are needed for only a few pitches.

The second flaw concerns intonation when two or more valves are used together. In the case of the hypothetical C trumpet, the first valve must increase the tube length by about 1/8, or 6 inches, to lower the pitch by two semitones and thus sound b^{b} or f `. In order to lower the pitch another semitone to a or e`, the first and second valves together or the third valve alone must increase the 48-inch tube by about 3/16, or 9 inches, to a total of 57 inches. In order to descend still another whole tone to g or d`, the tube that is now 57 inches long must itself be lengthened by 1/8 of its own length, or more than 7 inches. In producing a total of five semitones with the combination of the first and third valves, the first valve adds only about 6 inches to the 9 or so of the third. This combination is therefore more than an inch too short, and the pitches g and d` will be noticeably sharp. This will be true to an even greater extent for f# and c#`.

This problem is dealt with in several ways. The third valve passage is often made a bit longer because it is most often used in combinations and because valves one and two together are available as a substitute for valve three. Trumpets often have levers or rings (trigger/throw) that enable the player to lengthen the third and sometimes also the first valve slides. On lower -pitched instruments, a fourth valve is often provided that has the correct length of tube for the first and third valve combination and that can be lengthened to correct the combination of second and fourth valves as an alternative to the extremely sharp combination of valves one, two, and three. Another common solution, especially on baritones and tubas, is a compensating valve system, the most successful of which, invented by David James Blaikley in 1874, has double valves that automatically add compensating lengths of tubing when used in combination (The New Harvard Dictionary of Music, 1986).

2.1. 4 (i) Tubing

The additional tubing for each valve usually features a short tuning slide of its own for fine adjustment of the valve's tuning, except when it is too short to make this practicable. For the first and third valves this is often designed to be adjusted as the instrument is played, to account for the deficiencies in the valve system.

2.1. 4 (j) Trigger or Throw

Some valved brass instruments provide triggers or throws that manually lengthen (or, less commonly, shorten) the main tuning slide, a valve slide, or main tubing. These mechanisms alter the pitch of notes that are naturally sharp in a specific register of the instrument, or shift the instrument to another playing range. Triggers and throws generally permit speedy adjustment while playing. Trigger is used in two senses:

- A trigger can be a mechanical lever that lengthens a slide when pressed in a contrary direction. Triggers are sprung in such a way that they return the slide to its original position when released.
- The term "trigger" also describes a device that lengthens certain brass instrument's main length of tubing to shift its range to another playing range, as with certain trombones.

A throw is a simple metal grip for the player's finger or thumb, attached to a valve slide. The general term "throw" can describe a u-hook, a saddle (u-shaped grip), or a ring (ring-shaped ring) in which a player's finger or thumb rests. A player extends a finger or thumb to lengthen a slide, and retracts the finger to return the slide to its original position.

2.1.4 (k) Brass Instruments that use Triggers or Throws

- **Trumpet or Cornet**

Triggers or throws are sometimes found on the first valve slide. They are operated by the player's thumb and are used to adjust a large range of notes using the first valve, most notably the player's written top line F, the A directly above that, and the B^{b} above that. Other notes that require the first valve slide, but are not as problematic without it include the first line E, the F above that, the A above that, and the third line B^{b}. Triggers or throws are often found on the third valve slide. They are operated by the player's fourth finger, and are used to adjust the lower D and $C^{\#}$. Trumpets typically use throws, whilst cornets may have a throw or trigger.

- **Trombone**

Trombone triggers are primarily but not exclusively installed on the f-trigger, bass, and contrabass trombones to alter the length of tubing, thus making certain ranges and pitches more accessible.

- **Euphonium**

A euphonium occasionally has a trigger on valves other than 2 (especially 3), although many professional quality euphoniums, and indeed other brass instruments, have a trigger for the main tuning slide.

The mobile 3rd slide on the B^b trumpet serves to correct the tuning of certain sharp notes, notably the low D and $D^b(C^{\#})$ (Wiggins, 1970).

2.1. 4 (l) Slide

The slide is a U-shaped segment of cylindrical tubing fitted over two straight segments of tubing in such a way as to be able to slide easily in and out, thus changing the instrument's effective total length, and with it, its fundamental pitch (The New Harvard Dictionary of Music, 1986).On brass instruments generally, a tuning slide is a much shorter device of similar design intended for minor adjustments of the instrument's pitch. Instruments with valves may permit in this way the adjustment of the instrument as a whole as well as of each of the segments of tubing controlled by a valve.

2.1. 4 (m) General Techniques of Brass Instrument Playing

- **Embouchure**

Embouchure is a French word denoting the shape of the mouth when playing a wind musical instrument. It varies for musical instruments but all instruments of the brass family use the same embouchure for tone production. The embouchure for brass orchestral musical instruments (trumpet, cornet, trombone, French horn, euphonium, and tuba) is technically described thus:

Forming the Embouchure

(i) Close the mouth
(ii) Hold the lips together tightly
(iii) Place the mouth piece on the centre of the lips so that part of the upper lip and part of the lower lip are within the rim of the mouthpiece.
(iv) Shape the lips as if to say "mmmm"
(v) Corners of the mouth should be kept firm
(vi) Centre of the lips should be relaxed
(vii) Breath in through the corners of the mouth

(viii) After taking a full breath, blow steadily through the lips only. The change of pitch is regulated by stretching and relaxing the lips at different degrees of tension.

- **Tonguing**

Tonguing is the lifting of the tip of the tongue towards the upper teeth as in saying "taah, or "tuuh". The relationship between "embouchure and "tonguing" in brass instrument playing is that a good embouchure supplies enough airflow to the mouthpiece but tonguing helps produce a better/distinct sound. Proper tonguing follows this procedure:

The Technique of Proper Tonguing

(i) Breathe in through the corners of the mouth with the tongue flat at the bottom of the mouth (as in aaah).

(ii) Lift the tip of the tongue (as in taah) and place the tongue behind the upper teeth or in the roof of the mouth. The tongue must not touch the bottom part of the upper teeth.

(iii) Now direct a stream of air in the mouthpiece saying "taah-taah" or "tuuh-tuuh" and tonguing flows.

(iv) The tongue releases the wind stream for an initial attack and interrupts it for successive notes that are separately articulated.

Regarding brass orchestral instruments, various types of tonguing are obtainable: single tonguing, double tonguing, triple tonguing, flutter tonguing. Single tonguing, the simplest type, consists in using the tongue as if to pronounce the letter t one or more times. On a reed instrument, this will consist in removing the tongue from contact with the tip of the reed. On brass instruments, a sharp attack is produced if the tongue touches the opening between the lips, and a softer attack is produced by touching the roof of the mouth farther back or by producing a th. Double tonguing consists in using the tip and the back of the tongue touching on the upper teeth and the uvula respectively to sound t-k, t-k. This technique is used to play rapid notes in duple divisions . Similarly rapid notes in triple divisions may be played with triple tonguing (t-t-k, t-t-k or t-k-t, t-k-t). In flutter tonguing, the tongue is fluttered or trilled against the roof of the mouth, just behind the front teeth (The New Harvard Dictionary of Music, 1986).

2.1. 4 (n) Extended Techniques of Brass Instrument Playing

Contemporary music for brass instruments, particularly the trumpet, makes wide uses of extended playing techniques:

- **Growling**

Simultaneously humming while playing a note creates two sets of vibrations that interfere with each other and create a characteristic 'growling' sound. Many jazz players are acclaimed for using the technique, which is different from flutter-tonguing, where the tongue modifies the sound.

- **Double Tonguing**

The player articulates using the syllables ta-ka ta-ka ta-ka.

- **Doodle Tonguing**

The player tongues as if saying the word "doodle". This is a very faint tonguing similar in sound to a valve tremolo.

- **Triple Tonguing**

The same as double tonguing, but with the syllables ta-ta-ka ta-ta-ka or ta-ka-ta ta-ka-ta.

- **Glissando**

A player can slide between notes by depressing the valve halfway or changing the lip tension. Modern repertoire makes extensive use of this technique.

- **Flutter Tonguing**

The player rolls the tip of the tongue to produce a "growling like" tone. It is achieved as if one were rolling an R in the Spanish language. This technique is widely employed by composers Berio and Stockhausen.

- **Vibrato**

It is often regulated in contemporary repertoire through specific notation. Composers can call for everything from fast, slow or no vibrato to actual rhythmic patterns played with vibrato.

- **Pedal Tone**

Composers have written for two and a half octaves below the low F#, which is at the bottom of the standard range. Extreme low pedals are produced by slipping the lower lip out of the

mouthpiece. Claude Gordon assigned pedals as part of his trumpet practice routines that were a systematic expansion on his lessons with Herbert L. Clarke. The technique was pioneered by Bohumir Kryl (Wiggins, 1970).

- **Microtones**

Composers such as Scelsi and Stockhausen have made wide use of the trumpet's ability to play microtonally. Some instruments also feature a fourth valve that provides a quarter-tone between each tone.

- **Mute Belt**

Karlheinz Stockhausen pioneered the use of a mute belt, worn around the player's waist, to enable rapid mute changes during pieces. The belt allows the performer to make faster and quieter mute changes, as well as enabling the performer to move around the stage.

- **Valve Tremolo**

Many notes on some brass instruments can be played in several different valve combinations. By alternating between valve combinations on the same note, a tremolo effect can be created. Berio makes extended use of this technique in his sequenza X.

- **Noises**

By hissing, clicking, or breathing through the instrument, the brass instrument can be made to resonate in ways that do not sound at all like a brass instrument. Noises may require amplification.

- **Preparation**

Composers have called for brass players to play under water, or with certain slides removed. It is increasingly common for composers to specify all sorts of preparations for brass, particularly trumpet. Extreme preparations involve alternate constructions, such as double bells and extra valves.

- **Singing**

Composers such as Robert Erickson and Mark-Anthony Turnage have called for trumpeters to sing during the course of a piece, often while playing. It is possible to create a multiphonic effect by singing and playing different notes simultaneously.

- **Split Tone**

Brass players can produce more than one tone simultaneously by vibrating the two lips at different speeds. The interval produced is usually an octave or a fifth.

- **Lip Trill or Shake**

By rapidly varying lip tension, but not changing the depressed valves, the pitch varies quickly between adjacent harmonics. These are usually done, and more straightforward to execute, in the upper register.

2.1. 4(o) Breathing

Hoffer (1991), enlightens that "All wind players should learn to play with adequate breath support". Breath support alone is considered to be 40 percent of playing a brass instrument. Instrumental breath support is similar to the breath support required in singing. The same organs and muscles are used, and their function is the same. The differences are in the degree of abdominal muscle action demanded and in the natural resistance offered the airstream by reeds and brass mouth pieces. On breath control and support in brass playing, Hoffer (1991) observes that:

> As in singing, playing a good tone requires a relaxed and open throat and a slow controlled airstream. Tension should be maintained in the abdominal muscles as the sound is produced. Advanced players may not require a great amount of abdominal muscle tension because they know precisely which muscles to use and how much to use them. It is more difficult to maintain breath support when the player's attention is diverted to fingerings or rhythmic figures. Breath support, therefore, must become a habit (p. 247).

Furthermore on breathing, Wiggins (1970) suggests:

> At the beginning, breathe naturally and deeply, using the diaphragm to control both inhalation and exhalation, and take the air in through the sides of the mouth. Do not raise the shoulders when taking a breath (a common fault with the beginner), and keep the arms away from the sides so that the movement of the chest is not restricted (p.iii).

2.1. 4 (p) Transposition

Most brass orchestral instruments transpose except the C trumpet, trombone, and tuba. Transposition is technically defined as the performance of music at a pitch other than the original one. Transposing instruments, also, are defined as instruments whose notated pitch is different from their sounded pitch (The New Harvard Dictionary of Music, 1986). The emergence of transposing instruments (particularly brass) was a fall out of experimentation as evidenced by this report:

> The use of transposing brass instruments derives from the need, before the advent of valves, to have a separate natural instrument for each of the principal keys to be played in. The use of transposition for differently pitched valved instruments of the same family permits the player to employ the same relationship of fingerings to notation for all instruments of the family. This is also true of reed families such as the saxophone. The different instruments within a family make available a variety of tone colours and registers. Orchestral scores have traditionally presented the parts for transposing instruments in their transposed pitches. Some scores of 20^{th} -century music, however, notate all parts at (sounding) pitch (New Harvard Dictionary of Music, 1986).

Transpositions are named according to the note that sounds when a written C is played. That is, all transposing instruments sound their name when written C is played. For instance, a B flat trumpet or cornet sounds B flat when it plays a written C. Music for all models is written as if they were C trumpets (written C sounds B^b for a B^b trumpet). This allows players to switch instruments without learning new fingerings. Those models other than C are said to be transposing instruments. Key signatures often correspond to the transposition interval. That is, for trumpet or cornet in B flat whose notes sound a major second lower than written; the key signature for the key a major second above concert pitch is used.

2.1. 4 (q) Distinctive Features of Instruments of the Brass Family

- **Trumpet**

The modern trumpet has three valves and a bore that is partly cylindrical, partly conical. The standard orchestral trumpet, built in B-flat, has a range of about three octaves extending upward from the F-sharp below middle C (F3 sharp=185Hz). Models in D, C, and other

pitches also exist. The trumpet is the highest sounding member of the brass family (Tarr, 1988).

- **Cornet**

The cornet is a brass instrument very similar to the trumpet, distinguished by its conical bore, compact shape, and mellower tone quality. The most common cornet is a transposing instrument in B^b. It is related to the renaissance and early baroque cornett. The cornet was invented by adding valves to the post horn in 1884. The valves allowed for melodic playing through the register of the cornet. Trumpets were slower to adopt the new valve technology, so for the next 100 years or more, composers often wrote separate parts for trumpet and cornet.

Cornets and trumpets made in a given key (usually the key of B^b) play at the same pitch, and the technique for playing the instruments is nearly identical. However, cornets and trumpets are not entirely interchangeable, as they differ in timbre. Unlike the trumpet, which has a cylindrical bore up until the bell section, the tubing of the cornet has a mostly conical bore, starting very narrow at the mouthpiece and gradually widening towards the bell. Cornets following the 1913 patent of E.A. Couturier can have a continuously conical bore. The conical bore of the cornet is primarily responsible for its characteristic warm, mellow tone, which can be distinguished from the more penetrating sound of the trumpet. The conical bore of the trumpet also makes it more agile than the trumpet when playing fast passages, but correct pitching is often less assured. The cornet is often preferred for young beginners as it is easier to hold, with its center of gravity much closer to the player (Baines, 1993).

- **Trombone**

The trombone is a musical instrument of the brass family with a predominantly cylindrical tube bent into an elongated “S” shape. Like all brass instruments, sound is produced when the player’s vibrating lips (embouchure) cause the air column inside the instrument to vibrate. Nearly all trombones have a telescoping slide mechanism that varies the length of the instrument to change the pitch. Instead of a slide, the valve trombone has three valves like those on a trumpet.

The trombone is a predominantly cylindrical tube bent into an elongated “S” shape. Rather than being completely cylindrical from end to end, the tube is a complex series of tapers with the smallest at the mouthpiece receiver and the largest just before the bell flare. The design of

these tapers affects the intonation of the instrument. As with other brass instruments, sound is produced by blowing air through pursed lips producing a vibration that creates a standing wave in the instrument. The detachable cup-shaped mouthpiece is similar to that of the baritone horn and closely related to that of the trumpet. It has the venture: a small constriction of the air column that adds resistance greatly affecting the tone of the instrument, and is inserted into the mouthpiece receiver in the slide section. The slide section consists of a leadpipe, the inner and outer slide tubes, and the bracing, or stays. The modern stays are soldered, while sackbuts (medieval precursors to trombones) were made with loose, unsoldered stays (this remained the pattern for German trombones until the mid-20th century).

The 'slide', the most distinctive feature of the trombone, allows the player to extend the length of the air column, lowering the pitch. To prevent friction from slowing the action of the slide, additional sleeves were developed during the Renaissance, and these stockings were soldered onto the ends of the inner slide tubes. Nowadays, the stockings are incorporated into the manufacturing process of the inner slide tubes and represent a fractional widening of the tube to accommodate the necessary method of alleviating friction. This part of the slide must be lubricated frequently. Additional tubing connects the slide to the bell of the instrument through a neckpipe, and bell or back bow (U-bend). The joint connecting the slide and bell sections is furnished with a ferrule to secure the connection of the two parts of the instrument, though older models from the early 20th century and before were usually equipped with friction joints and no ancillary mechanism to tighten the joint (Guion, 1988).

- **Euphonium**

The euphonium is a conical-bore, tenor-voiced brass instrument. The euphonium derives its name from the Greek word euphonos, meaning "well-sounding" or "sweet- voiced". The euphonium is pitched in concert B^{b,} meaning that when no valves are in use the instrument will produce partials of the B^{b} harmonic series. It is generally orchestrated as a non-transposing instrument like the trombone, written at concert pitch in the bass clef with higher passages in the tenor clef. Treble clef euphonium parts transposing down a major ninth are included in much concert band music: in the British-style brass band tradition, euphonium music is always written this way. In continental European band music, parts for the euphonium may be written in the bass clef as a B^{b} transposing instrument sounding a major second lower than written.

Professional models have three top-action valves, played with the first three fingers of the right hand, plus a "compensating" fourth valve, generally found midway down the right side of the instrument, played with the left index finger. Beginner models often have only the three top-action valves, while some intermediate "student" models may have a fourth top-action valve, played with the fourth finger of the right hand. Compensating systems are expensive to build, and there is in general a substantial difference in price between compensating and non-compensating models.

As with the other conical-bored instruments, the cornet, flugelhorn, horn, and tuba, the euphonium's tubing gradually increases in diameter throughout its length, resulting in a softer, gentler tone compared to cylindrical-bore instruments such as the trumpet, trombone, sudrophone, and baritone horn. While a truly characteristic euphonium sound is rather hard to define precisely, most players would agree that an ideal sound is dark, rich, warm, and velvety, with virtually no hardness to it. On the other hand, the desired sound varies geographically; European players, especially British ones, generally use a faster, more constant vibrato and a more veiled tone, while Americans tend to prefer a more straightforward, open sound with slower and less frequent vibrato.

The euphonium has an extensive range, comfortably from E2 to about $B^{b}4$for intermediate players (using scientific pitch notation). In professional hands this may extend from B0 to as high as $B^{b}5$. The lowest notes obtainable depend on the valve set-up of the instrument. All instruments are chromatic down to E2, but 4-valved instruments extend that down to at least C2. Non-compensating four-valved instruments suffer from intonation problems from $E^{b}2$ down to C2 and cannot produce the low B1; compensating instruments do not have such intonation problems and can play the low B-natural. From $B^{b}1$ down lies the "pedal range", i.e. the fundamentals of the instrument's harmonic series. They are easily produced on the euphonium as compared to other brass instruments, and the extent of the range depends on the make of the instrument in exactly the same way as just described. Thus, on a compensating four-valved instrument, the lowest note possible is B0, sometimes called double pedal b, which is six ledger lines below the bass clef.

Though the euphonium's fingerings are no different from those of the trumpet or tuba, beginning euphoniumists will likely experience significant problems with intonation, response, and range compared to other beginning brass players. In addition, it is very difficult for students, even of high-school age, to develop the rich sound characteristic of the

euphonium, due partly to the instrument models used in schools and partly to the lack of awareness of good euphonium sound models (Bone, 2007).

- **The Horn**

The French horn (also known as the corno and French horn) is a brass instrument made of more than 20feet (6.1m) of tubing wrapped into coil with a flared bell. Descended from the natural horn, the instrument is often informally known as the French horn. However, this is technically incorrect since the instrument is not French in origin, but German. Therefore the International Horn Society has recommended since 1971 that the instrument be simply called the horn. French horn is still the most commonly used name for the instrument in the United States ((Baines, 1993).

Pitch is controlled through the adjustment of lip tension in the mouthpiece and the operation of valves by the left hand, which route the air into extra tubing. Most horns have lever-operated rotary valves, but some, especially older horns, use piston valves (similar to a trumpet's) and the Vienna horn uses double-piston valves, or pump valves. A horn without valves is known as a natural horn, changing pitch along the natural harmonics of the instrument (similar to a bugle).

Three valves control the flow of air in the single horn, which is tuned to F or less commonly B^b. The more common double horn has a fourth valve, usually operated by the thumb, which routes the air to one set of tubing tuned to F or another tuned to B^b. Triple horns with five valves are also made, tuned in F, B^b, and a descant E^b or F.

The horn is the third highest sounding instrument group in the brass family, below the cornet and, highest, the trumpet. Horns are mostly tuned in B^b or F, or a combination of both. In some traditions, novice players use a single horn in F, while others prefer the bb horn. The F horn is used more commonly than the B^b horn, especially in school bands.

Compared to the other brass instruments in orchestras and concert bands, it has a very different mouthpiece, but has the widest usable range- approximately five octaves, depending on the ability of the player. To produce different notes on the horn, one must do many things- the seven most important are pressing the valves, holding the appropriate amount of lip tension, raising the soft palate, positioning the tongue, lowering the larynx, blowing air into the instrument, and placing the hand in the bell. More lip tension and faster air produces higher notes. Less lip tension and slower air produces lower notes. The right hand, usually

cupped at a “three o-clock” position in the bell, can lower the pitch, depending on how far into the bell the player puts it, by as much as a semitone in the instrument’s midrange. The horn plays in a higher portion of its overtone series compared to most brass instruments. Its conical bore (as opposed to the cylindrical bore of the trumpet or trombone) is largely responsible for its characteristic tone, often described as “mellow” (Baines, 1993).

- **Tuba**

The tuba is the largest and lowest-pitched brass instrument. Sound is produced by vibrating or “buzzing” the lips into a large cupped mouthpiece. It is one of the most recent additions to the modern symphony orchestra, first appearing in the mid-19th century, when it largely replaced the ophicleide (Wikipedia Encyclopedia, 2013). Tubas are found in various pitches, most commonly in F, E^{b}, C, or B^{b}. The main tube of a B^{b} tuba is approximately 18 feet long, while that of a C tuba is 16 feet, of an E^{b} tuba 13 feet, and of an F tuba 12 feet. The instrument has a conical bore, meaning the bore diameter increases as a function of the tubing length from the mouthpiece to the bell. The conical bore causes the instrument to produce a preponderance of even-order harmonics. A tuba with its tubing wrapped for placing the instrument on the player’s lap is usually called a concert tuba or simply tuba. Tubas with the bells pointing forward instead of upward are often called recording tubas because of their popularity in the early days of recorded music, as their sound could more easily be directed at the recording instrument. When wrapped around the body for marching, it is traditionally called or known as a helicon. Most music for the tuba is written in bass clef in concert pitch, so tuba players must know the correct fingerings for their specific instrument. Traditional British-style brass band parts for the tuba are usually written in treble clef, with the B^{b} tuba sounding two octaves and one step below and the E^{b} tuba sounding one octave and a major sixth below the written pitch. This allows musicians to change instruments without learning new fingerings for the same written music. Consequently, when its music is written in treble clef, the tuba is a transposing instrument, but not when the music is in bass clef.

An orchestra usually has a single tuba, though an additional tuba may be asked for. It is the principal bass instrument in symphonic and military bands, and those ensembles generally have more. It serves as the bass of the brass section and of brass quintets and choirs (though many small brass ensembles will use the euphonium or bass trombone as the lowest voice), as well as reinforcement for the bass voices of the strings and woodwinds, and as a solo instrument (Bevan, 1978).

2.1.5 Concepts Relating to the 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 (The New Harvard dictionary of Music, 1986). Common members of this group are the saxophone, flute, piccolo, clarinet, etc. 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 cornett and the serpent, are not regarded as woodwinds because they are lip vibrated (The New Harvard Dictionary of Music, 1986).

2.1.5 (a) Classification and Types of Woodwind Instruments

Woodwindsmaybeclassifiedaccording to the means by which the air column is set into motion as well as by the extent to which the tube of which they consist more nearly approximates a cylinder or a cone. All, however, vary their pitch by the same method: all have side holes that can be covered or left open so as to vary the effective length of the tube (The New Harvard Dictionary of Music, 1986). The principal families of Western woodwinds encountered today and their principal characters are listed in the table below:

Table 2

Types and the Principal Characteristics of Modern Woodwind Instruments

Instrument	**Reed**	**Body**	**Bore**
Flute	None	Metal	Cylindrical
Recorder	None	Wood	Conical
Clarinet	Single	Wood	Cylindrical
Saxophone	Single	Wood	Conical
Oboe	Double	Wood	Conical
Bassoon	Double	Wood	Conical
Sarrusophone	Double	Metal	Conical

(Sptizer, J & Neil, Z. , 2004).

Members of this family that shall form our study are the flute, saxophone, and clarinet.

2.1.5 (b) Body Make-up of Woodwind Instruments and their Functionality

- **Reed**

A reed is a thin strip of material which vibrates to produce a sound on a musical instrument. The reeds of most woodwind instruments are made from Arundodonax ("Giant cane") or synthetic material; tuned reeds (as harmonicas and accordions) are made of metal or synthetics. Single reeds are used on the mouthpieces of clarinets and saxophones. The back of the reed is flat and is placed against the mouth piece, the rounded top side tapers to a thin tip. These reeds are roughly rectangular in shape except for the thin vibrating tip, which is curved to match the curve of the mouthpiece tip. All single reeds are shaped similarly but vary in size to fit each instrument's mouth piece. Reeds designed for the same instrument may look identical to each other, but may vary in thickness ("hardness or "strength"). Hardness is generally measured on a scale of 1 through 5 from softest to hardest. This is not a standardized scale and reed strengths vary by manufacturer. Cane of different grades (density, stiffness), even if cut with the same profile, will also respond differently.

Double reeds are used on the oboe, English horn, bassoon, contrabassoon, sarrusophone, bagpipes, etc. They are typically not used in conjunction with a mouthpiece; rather the two reeds vibrate against each other. However, in the case of the crumhorn and bagpipes, a reed cap that contains an airway is placed over the reeds and blown without the reeds actually coming in contact with the player's mouth. Reed strengths are graded from hard to soft (Carroll, 1999).

- **Tone Hole**

A tone hole is an opening in the body of a wind instrument which, when covered by a key, alters the pitch of the sound produced.

2.1.5 (c) Tone Hole Mechanism and the Acoustics of Woodwinds

The resonant frequencies of air column in a pipe are inversely proportional to the pipe's effective length. For a pipe with no tone holes, the effective length is the physical length plus corrections for end effects. A shorter pipe, in other words, produces higher notes. An open hole in the side of the pipe shortens the pipe's effective length and therefore raises the pitch of the notes it produces. Generally a large hole in a given position reduces the effective length to something slightly larger than the effective length of a pipe cut off at that position; a smaller hole produces a longer effective length. Covering the hole with a finger or with a pad

operated by a key, increases the effective length and lowers the pitch again. However, a pipe with a closed tone hole is not acoustically identical to a pipe with no hole, the closed hole modifies the pipe's shape and its effective length. When there are multiple tone holes, the first (highest) open tone hole usually has the largest influence on the pipe's effective length. However, closing holes below the first open hole can lower the pitch significantly; such cross fingerings may often be useful. Generally a large hole in a given position reduces the effective length to something slightly larger than the effective length of a pipe cut off at that position; a smaller hole produces a longer effective length (Carroll, 1999).

2.1.5 (d) Distinctive Features of the Respective Woodwind Instruments

Instruments of the woodwind family share some basic features in common (such as acoustics, body make-up, mechanism of sound production, etc), but there are certain features peculiar to each member of the family. Such distinctive features of the respective members of the family are discussed below:

- **Flute**

The flute is a reedless wind instrument of the woodwind family that produces its sound from the flow of air across an opening. According to the instrument classification of Hornbostel-Sachs, flutes are categorized as edge-blown (or transverse) aerophones (Wikipedia Encyclopedia, 2013). The Western concert flute, a descendant of the 9^{th} -century German flute, is a transverse flute that is closed at the top. An embouchure hole is positioned near the top, across and into which the player blows. The flute has circular tone holes, larger than the finger hole of its baroque predecessors. The size and placement of tone holes, the key mechanism, and the fingering system used to produce the notes in the flute's range were evolved from 1832-1847 by Theobald Boehm, and greatly improved the instrument's dynamic range and intonation over those of its predecessors. With some refinements (and the rare exception of the Kimgma system and other custom adapted fingering systems), Western concert flutes typically conform to Boehm's design, known as the Boehm system (Baines, 1997).

The standard concert flute is pitched in the key of C and has a range of three octaves starting from middle C (or one half-step lower, when a B foot is attached to the instrument). This means that the concert flute is one of the highest common orchestral instruments, with the exception of the piccolo, which plays an octave higher. G alto and C bass flutes are used occasionally, and are pitched fourth and an octave below the concert flute, respectively.

A flute produces sound when a stream of air directed across a hole in the instrument creates a vibration of air at the hole. The air stream across this hole creates a Bernoulli, or siphon. The player changes the pitch of the sound produced by opening and closing holes in the body of the instrument, thus changing the effective length of the resonator and its corresponding resonant frequency.

- **Clarinet**

The clarinet is a type of woodwind instrument that has a single-reed mouthpiece, a straight cylindrical tube with an approximately cylindrical bore, and a flaring bell. There are many types of clarinets of differing sizes and pitches, comprising a large family of instruments. The unmodified word clarinet usually refers to the B^b soprano clarinet, by far the most common type, which has a large range of nearly four octaves. The clarinet family is the largest woodwind family, with more than a dozen types, ranging from the (extremely rare) BBB^b octo-contrabass to the A^b piccolo clarinet. Of these, many are rare or obsolete (there is only one BBB^b octo –contrabass clarinet in existence, for example), and music written for them is usually played on more common versions of the instrument.

The cylindrical bore of the clarinet is primarily responsible for the clarinet's distinctive timbre, which varies between its three main registers, known as the chalumeau, clarion, and altissimo. The tone quality can vary greatly with the musician, the music, the instrument, the mouthpiece, and the reed. The differences in instruments and geographical isolation of players in different countries led to the development, from the last part of the 18^{th} century onwards, of several different schools of clarinet playing. The most prominent were the German/Viennese traditions and the French school. The latter was centered on the clarinetists of the Conservatoire de Paris. The proliferation of recorded music has made examples of different styles of clarinet playing available. The modern clarinetist has a diverse palette of "acceptable" tone qualities to choose from (Karp, 1986).

The A clarinet and B^b clarinet have nearly the same bore, and use the same mouthpiece and often the same barrel for both. The A and B^b instruments have nearly identical tone quality, although the A typically has a slightly warmer sound. The tone of the E^b clarinet is brighter than that of the lower clarinets and can be heard even through loud orchestral textures. The bass clarinet has a characteristically deep, mellow sound, while the alto clarinet is similar in tone to the bass and the basset horn has a tone quality comparable to the A clarinet (Baines, 1997).

Clarinets have the largest pitch range of common woodwinds. The intricate key organization that makes this range possible can make the playability of some passages awkward. The bottom of the clarinet's written range is defined by the keywork on each instrument; standard keywork schemes allow a low E on the common B^b clarinet. The lowest concert pitch depends on the transposition of the instrument in question. Nearly all soprano and piccolo clarinets have keywork enabling them to play the E below middle C and their lowest written note (in scientific pitch notation that sounds D_3 on a soprano clarinet or C_4, that is, concert middle C, on a piccolo clarinet), though some B^b clarinets go down to E^b_3 to enable them to match the range of the A clarinet. On the B^b soprano clarinet, the concert pitch of the lowest note is D_3, a whole tone lower than the written pitch. Most alto and bass clarinets have additional keywork to written C_3. Among the less commonly encountered members of the clarinet family, contra-alto and contrabass clarinets may have keywork to written E^b_3, D_3, or C_3, the basset clarinet and basset horn generally go low C_3.

Defining the top range of a clarinet's range is difficult, since many advanced players can produce notes well above the highest notes commonly found in method books. The G two octaves above G_4 is usually the highest note clarinetists encounter in classical repertoire. The C above that (C_7 i.e, resting on the fifth ledger line above the treble staff) is attainable by advanced players and is shown on many fingering charts, and fingerings as high as G_7 exist.

The range of a clarinet can be divided into three distinct registers. The lowest register, consisting of the notes up to the written Bb above middle C (B^b_4), is known as the chalumeau register (named after the instrument that was the clarinet's immediate predecessor). The middle register is termed the clarion (sometimes clarion) register and spans just over an octave (from written B above middle C (B_4) to the C two octaves above middle C (C_6)); it is the dominant range for most members of the clarinet family. The top or altissimo register consists of the notes above the written C two octaves above middle C (C_6). Unlike other woodwinds, all three registers have characteristically different sounds. the chalumeau register is rich and dark. The clarion register is brighter and sweet, like a trumpet (clarino) heard from afar. The altissimo register can be piercing and sometimes shrill (Ridley, 1986).

- **Saxophone**

The saxophone (also referred to as the sax) is a conical-bore woodwind musical instrument. Saxophones are usually made of brass and played with a single-reed mouthpiece similar to that of the clarinet. The saxophone was invented by the Belgian instrument maker Adolphe

Sax in 1846. He wanted to create an instrument that would be the most powerful and vocal of the woodwinds, and the most adaptive of the brasses- that would fill the vacant middle ground between the two sections. He began developing an instrument with the projection of a brass instrument and the agility of a woodwind. He wanted it to overblow at the octave, unlike the clarinet, which rises in pitch by a twelfth when overblown. An instrument that overblew at the octave would have identical fingering for both registers. He wanted to create an instrument that would be the most powerful and vocal of the woodwinds, and the most adaptive of the brass- that would fill the vacant middle ground between the two sections. He patented the saxophone in June 24, 1846, in two groups of seven instruments each. Each series consisted of instruments of various sizes in alternating transposition. The series pitched in B^b and E^b, designed for military bands, has proved extremely popular and most saxophones encountered today are from this series. Instruments from the so-called "orchestral" series, pitched in C and F, never gained a foothold, and Bb and E^b instruments have now replaced the C and F instruments in classical music (Horwood, 1992).

The saxophone consists of an approximately conical tube of thin brass, sometimes plated with silver, gold, or nickel, flared at the tip to form a bell. At intervals along the tube are between 20 and 23 tone holes of varying size, including two very small 'speaker' holes to assist the playing of the upper register. These holes are covered by keys (also known as pad cups), containing soft leather pads, which are closed to produce an airtight seal; at rest some of the holes stand open and others are closed. The keys are controlled by buttons pressed by the fingers, while the right thumb sits under a thumb rest to help keep the saxophone balanced. The fingering for the saxophone is a combination of that of the oboe with the Boehm system, and is very similar to the flute or the upper register of the clarinet. Instruments that play to low A have a left thumb key for that note.

The simplest design of saxophone is a straight conical tube, and the sopranino and soprano saxophones are usually of this straight design. However, as the lower-pitched instruments would be unacceptably long if straight, for ergonomic reasons, the larger instruments usually incorporate a U-bend at, or slightly above, the third-lowest tone hole. As this would cause the bell of the instrument to point almost directly upward, the end of the instrument is either beveled or tilted slightly forward. This U-shape has become an iconic feature of the saxophone family, to the extent that soprano and even sopranino saxes are sometimes made in curved style, even though not strictly necessary. By contrast, tenors and even baritones have occasionally been made in the straight style. Most commonly, however, the alto and

tenor saxophones incorporate a curved 'crook' above the highest tone hole but below the top speaker hole, tilting the mouthpiece through 90 degrees; the baritone, bass and contrabass extend the length of the bore by triple-folding this section (Howe, 2003).

2.1. 8 Concepts Relating to Orchestral Percussion Instruments

Although the empirical scope of this study does not cover much of orchestral percussion instruments because of their relative scarcity in our research context; they are still worth mentioning and explaining in some detail. Percussion instruments 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 (The New Harvard Dictionary of Music, 1986). Orchestral percussion generally refers to percussion instruments used in Western orchestras and concert bands mainly in classical music and related styles. The term can also refer to the department or study of performance on said instruments at a music school or conservatory. Generally within such a department, students are required to study all aspects of orchestral playing; with marimba, snare drum, and timpani being the three most basic areas of study. Orchestral percussion does not usually include drum set studies (Wikipedia Encyclopedia, 2013).

2.1. 8 (a) History and Roles of Percussion Instruments

Percussion is arguably the most versatile of any instrument family in that it can be used in practically every genre or style of music. In an orchestral setting, percussionists are generally called on to provide different textures in the ensemble. Some percussion instruments are more commonly used than others. Timpani, for example, has been seen in Western classical music since the 17th century and became a standard orchestral instrument long before many other percussion instruments. Snare drum, bass drum, and crash cymbals were adopted soon thereafter and quickly became associated with the orchestra as well (Blades, 1992). Regarding the history and roles of percussion instruments in Western orchestra, Kamien (1988) reports that:

> Percussion instruments have long been used to emphasize rhythm and to heighten climaxes. But until about 1900, they played a far less important role in western music than strings, woodwinds, or brasses. Composers of our century have been more willing to exploit the special colors of the percussion group and have occasionally written entire pieces to show it off, such as Ionization (1931) by Edgar Varese (p.29)

2.1. 8 (b) Sound Production in Percussion Instruments

The vibrations of percussion instruments are set up by stretched membranes, like the calfskin of the kettle drum, or by plates or bars made of steel, wood, or other sonorous materials. Extremely loud sounds may be drawn from percussion instruments like the bass drum or cymbals; however, percussion sounds die away more quickly than those of other instruments (Kamien, 1988).

2.1.8(c) Classification and Types of Western Orchestral Percussion Instruments

Western orchestral percussion instruments are subdivided into instruments of definite pitch and indefinite pitch, depending on whether they produce a tone or a noise-like sound (Kamien, 1988). They are listed in the table below:

Table 3

Subdivision of Western Orchestral Percussion Instruments

DefinitePitch	**Indefinite Pitch**
Timpani (kettledrums)	Side drum (snare drum)
Glockenspiel	Bass drum
Xylophone	Tambourine
Celesta	Triangle
Chimes	Cymbals, Gong (tam-tam

(Wikipedia Encyclopedia, 2013).

The various instruments are discussed in detail here:

- **Gong and Tam-tam**

Gongs and tam-tams are easily confused with one another. A gong, generally, is a large hung cymbal with a “nipple”. As such, they are usually known as nipple gongs. This nipple is a small dome in the centre of the cymbal that produces a single note when struck with a soft beater. Conversely, a tam-tam has no nipple, and so has a flat central area. When this cymbal is struck with a beater, (most usually a soft beater) it produces a myriad of sounds with no single overruling note. One can distinguish the two by ear by following a simple method. A gong sounds like a slightly muffled church bell, producing a soft but clear note, whereas a tam-tam sounds much more like a large metal object being struck by a hard material (Blades, 1992).

- **Mallet Instruments**

Mallet percussion (also known as keyboard or tuned percussion) is the general name given to the pitched percussion family. The name is a slight misnomer, in that almost every percussion instrument is struck with some type of mallet or stick. With the exception of the marimba, almost every other keyboard instrument has been used widely in an orchestral setting.

- **Bass Drum**

The bass drum is a large type of drum, approximately 90cm in diameter and 40cm deep, consisting of a cylindrical wooden shell with two heads tensioned as are those of the side drum (The New Harvard Dictionary of Music, 1986). In an orchestral setting, the concert bass drum plays an integral role in the overall feel of a piece of music. In orchestral literature, the bass drum usually deals more with colouring and shading the sounds of the orchestra as opposed to providing a solid, rhythmic foundation like in marching and drum set. The bass drum is usually used to accent strong points in the music and is often combined with a cymbal crash to further accentuate the moment. Though the bass drum is possibly the least frequently requested instrument at auditions, it actually takes a fair amount of skill to play correctly given the number of variables that can change when playing it (beater, beating, location, amount/type of muffling, stroke, etc.)

- **Snare Drum/Side Drum**

The snare drum or side drum is a widely used unpitched percussion instrument. It is often used in orchestras, marching bands and concert bands, drum corps and many other applications. It is at the center of the drum kit, the most prominent drum in most marching and stage bands, and the instrument that students of both orchestral and kit drumming learn to play first. The snare drum is almost always double-headed, with rattles (called snares) of gut, metal wire or synthetics stretched across one or both heads. There are three main types where:

(i) A single set of snares is applied to the underside of the bottom (resonant) (unplayed) head. Orchestral and drum kit players use extremely thin, specialized resonant snare drum heads, far too light to be played directly, for this bottom head.

(ii) Marching and pipe band side drums have a second set of snares on the underside of the top (played or batter) head on the inside of the drum, as well as a set on the underside of the bottom head.

(iii) The caixa de Guerra ("war box") and tarol are Latin American snare drums with a single set of snares on the top of the top head.

Different types of modern snare drums can also be found, like piccolo snares, that have a smaller depth and popcorn snares that are smaller in diameter for a higher pitch, and rope-tuned snares (Blades, 1992).

- **The Mechanism and Techniques of the Snare Drum**

The snare drum can be played by striking it with a drum stick or any other form of beater, including brushes and rutes, which produce a softer sounding vibration from the wires. When using a stick, the drummer may strike either the head of the drum, the rim, or the shell. When the top head is struck the snares vibrate against the bottom head, also known as the resonate head, producing a cracking sound. The snares can often be thrown off with a lever on the strainer so that the drum only produces a sound reminiscent of a tom-tom. Rim shots are a technique associated with snare drums in which the head and rim are struck simultaneously with one stick (or in concert playing, a stick placed on the head and rim struck by the opposite stick) (Wikipedia Encyclopedia, 2013).

- **Cymbals**

Cymbals are a common percussion instrument. Cymbals consist of thin, normally round plates of various alloys. The majority of cymbals are of indefinite pitch, although small disc-shaped cymbals based on ancient designs sound a definite note. Cymbals are used in many ensembles ranging from the orchestra, percussion ensembles, jazz bands, heavy metal bands, and marching groups. Drum kits usually incorporate at least a crash, ride or crash/ride, and a pair of hi-hat cymbals.

2.1. 8 (d) Anatomy of the Cymbal and Sound Production

The anatomy of the cymbal plays a large part in the sound it creates. The hole is drilled in the center of the cymbal and it is used to either mount the cymbal on a stand or straps (for hand playing). The bell, dome, or cup is the raised section immediately surrounding the hole. The bell produces a higher "pinging" pitch than the rest of the cymbal. The bow is the rest of the surface surrounding the bell. The bow is sometimes described in two areas: the ride and crash area. The ride area is the thicker section closer to the bell while the crash area is the thinner tapering section near the edge. The edge or rim is the immediate circumference of the cymbal. Cymbals are measured by their diameter often in inches or centimeters. The size of

the cymbal affects its sound, larger cymbals usually being louder and having longer sustain. The weight describes how thick the cymbal is. Cymbal weights are important to the sound they produce and how they play. Heavier cymbals have a louder volume, more cut, and better stick articulation (when using drum sticks). Thin cymbals have fuller sound, lower pitch, and faster response. The profile of the cymbal is the vertical distance of the bow from the bottom of the bell to the cymbal edge (higher profile cymbals are more bowl shaped). The profile affects the pitch of the cymbal: higher profile cymbals have higher pitch.

2.1.8 (e) Types of Cymbal

- **Clash Cymbals**

Orchestral clash cymbals are traditionally used in pairs, each one having a strap set in the bell of the cymbal by which they are held.

- **Crash Cymbals or Plates**

The sound can be obtained by rubbing their edges together in a sliding movement for a "sizzle", striking them against each other in what is called a "clash", tapping the edge of one against the body of the other in what is called tap-clash, scrapping the edge of one from the inside of the bell to the edge for a "scrape" or shutting the cymbals together and choking the sound in what is called a "hi-hat chick"

- **Hi-hats**

Crash cymbals evolved into the low-sock and from this to the modern hi-hat. Even in a modern drum kit, they remain paired with the bass drum as the two instruments which are played with the player's feet. However, hi-hat cymbals tend to be heavy with little taper, more similar to a ride cymbal than as found in a drum kit, and perform a ride rather than a clash function.

- **Suspended Cymbal**

Another type of the cymbal is the suspended cymbal. This instrument takes its name from the traditional method of suspending the cymbal by means of a leather strap or rope, thus allowing the cymbal to vibrate as freely as possible for maximum musical effect. Early jazz drumming pioneers borrowed this style of cymbal mounting during the early 1900s and later drummers further developed this instrument into the mounted horizontal or nearly horizontally mounted "crash" cymbals of a modern drum kit. However, most modern drum kits do not employ a leather strap suspension system. Many modern drum kits use a mount

with felt or otherwise dampening fabric to act as a barrier to hold the cymbals between metal clamps: thus forming day ride cymbal. Suspended cymbals can be played with yarn, sponge or cord wrapped mallets. The first known instance of using a sponge-headed mallet on a cymbal is the final chord of Hector Berlioz' Symphonie Fantastique (Baines, 2005).

2.1. 8 (f) Techniques of Suspended Cymbal Playing

Composers sometimes specifically request other types of mallets like felt mallets or timpani beaters for different attack and sustain qualities. Suspended cymbals can produce bright and slicing tones when forcefully struck, and give an eerie transparent "windy" sound when played quietly. A tremolo, or roll (played with two mallets alternately striking on opposing sides of the cymbal) can build in volume from almost inaudible to an overwhelming climax in a satisfying smooth manner. The edge of a suspended cymbal may be hit with shoulder of a drum stick to obtain a sound somewhat akin to that of a pair of clash cymbals. Other methods of playing include scraping a coin or a triangle beater rapidly across the ridges on the top of the cymbal, giving a "zing" sound (as some players do in the fourth movement of Dvorak's Symphony No. 9). Other effects that can be used include drawing a cello or bass bow across the edge of the cymbal for a sound not unlike squealing car breaks.

- **Ancient Cymbals**

Ancient cymbals or tuned cymbals are much more rarely called for. Their timbre is entirely different, more like that of small hand-bells or of the notes of the keyed harmonica. They are not struck full against each other, but by one of their edges, and the note given in by them is higher in proportion as they are thicker and smaller.

2.1. 8 (g) Roles of Cymbals in Orchestra

Cymbals offer a composer nearly endless amounts of color and effect. Their unique timbre allows them to project even against a full orchestra and through the heaviest of orchestrations and enhance articulation and nearly any dynamic. Cymbals have been utilized historically to suggest frenzy, fury or bacchanalian revels, as seen in the Venus music in Wagner's Tannhauser, Grieg's Peer Gynt Suite (Baines, 2005).

- **Timpani or Kettledrums**

These are drums made of a skin called stretched over a large bowl traditionally made of copper. They are played by striking the head with a specialized drum stick called a timpani stick or timpani mallet. Timpani evolved from military drums to become a staple of the

classical orchestra by the last third of the 18th century. Today, they are used in many types of musical ensembles including concert, marching, and even some rock bands (Wikipedia Encyclopedia, 2013). Timpani is an Italian plural, the singular of which is timpano. However, in informal English speech a single instrument is rarely called timpani: several are more typically referred to collectively as kettledrums, timpani, temple drums, or simply timps. They are also often incorrectly termed timpanis. A musician who plays the timpani is a timpanist.

2.1. 8 (h) Body Make-up and Timbre of the Timpani

The basic timpani drum consists of a drumhead stretched across the opening of a bowl typically made of copper or, in less expensive models, fiberglass and sometimes aluminum. The drumhead is affixed to a hoop (also called fleshhoop), which in turn is held onto the bowl by a counterhoop, which is then held by means of a number of tuning screws called tension rods placed regularly around the circumference. The head's tension can be adjusted by loosening or tightening the rods. Most timpani have six to eight tension rods. The shape of the bowl contributes to the quality of the drum. For example, hemispheric bowls produce brighter tones while parabolic bowls produce darker tones. Another factor that affects the timbre of the drum is the quality of the bowl's surface. Copper bowls may have a smooth, machined surface or a rough surface with many small dents hammered into it.

- **Tuning the Timpani**

Prior to playing the instruments, the timpanist must clear the heads by equalizing the tension at each tuning screw. This is done so that every spot on the head is tuned to exactly the same pitch. When the head is clear, the timpani will produce a beautiful, in-tune sound. If the head is not clear, the pitch of the drum will rise or fall after the initial impact, and the drum will produce different pitches at different dynamic levels. Timpanists are required to have a well-developed sense of relative pitch, and must develop techniques to tune undetectably and accurately in the middle of a performance. Tuning is often tested with a light tap from a single finger, which produces a near-silent note that nonetheless matches the tune of the drum when struck with a mallet. Some timpani are equipped with tuning gauges, which provide a visual indication of the drum's pitch. They are physically connected either to the counterhoop, in which case the gauge indicates how far the counterhoop is pushed down, or the pedal, in which case the gauge indicates the position of the pedal.

- **Techniques of Playing the Timpani**

For general playing, a timpanist will beat the head approximately 4 inches in from the edge. Beating at this spot produces the round, resonant sound commonly associated with timpani. A timpani roll (most commonly signaled in a score by tr) is executed by rapidly striking the drum, alternating between left and right sticks, extending the duration of the sound as required and allowing increases or decreases in volume. In general, timpanists do not use multiple bounce rolls like those played on the snare drum, as the soft nature of timpani sticks causes the rebound of the stick to be reduced, causing multiple bounce rolls to sound muffled. The tone quality of the drum can be altered without switching sticks or adjusting the tuning of the drum. For example, by playing closer to the edge of the head, the sound becomes thinner. A more *staccato* sound can be produced by changing the velocity of the stroke or playing closer to the centre of the head. There are many more possible variations in technique a timpanist uses during the course of playing to produce subtle timbral differences.

- **Glockenspiel**

A glockenspiel is a percussion instrument composed of a set of tuned keys arranged in the fashion of the keyboard of a piano. In this way, it is similar to the xylophone; however, the xylophone's bars are made of wood, while the glockenspiel's are metal plates or tubes, thus making it a metallophone. The glockenspiel, moreover, is usually smaller and higher in pitch. In German, a carillion is called a Glockenspiel, while in French, the glockenspiel is often called a carillon. In music scores the glockenspiel is sometimes designated by the Italian term campanelli.

- **Structural Description of the Glockenspiel**

When used in a marching or military band, the bars are sometimes mounted in a portable case and held vertically, sometimes in lyre-shaped frame. However, sometimes the bars are held horizontally using a harness similar to a marching snare harness. In orchestral use, the bars are mounted horizontally. A pair of hard, unwrapped mallets, generally with heads made of plastic or metal, are used to strike the bars, although mallet heads can also be made of rubber (though using too-soft rubber can result in a dull sound) if laid out horizontally, a keyboard may be attached to the instrument to allow chords to be more easily played. Another method of playing chords is to play with four mallets, two per hand.

- **Range of the Glockenspiel**

The glockenspiel is limited to the upper register, and usually covers about two and a half to three octaves, but can also reach up to 3.5 octaves. The glockenspiel is a transposing instrument; its parts are written two octaves below the sounding notes. When struck, the bars give a very pure, belt-like sound.

2.1. 8 (h) Auxiliary Percussion

Auxiliary percussion (also known as battery percussion or accessory percussion) include instruments like the triangle, castanets, and tambourine. These instruments are often overlooked and treated as trivial or unimportant simply because, to the untrained eye (or ear), they seem easy to play. The truth is, however, that auxiliary percussion often requires the most use of extended techniques and that the parts for these instruments are frequently the most difficult. Other auxiliary percussion instruments include: wood block, temple block, shaker, finger cymbals, claves, guiro, maracas, bongos, congas, crash cymbal, suspended cymbal, ride cymbal, wind-chimes, hi-hat, and cowbell (Baines, 2005).

2.1.9 Concepts Relating to the Organization and Relationship of Western Orchestral Musical Instruments in an Ensemble

- **Instrumentation**

A modern orchestra is composed of (1) a basis of strings- first and second violins, violas, violoncellos and double basses; (2) the woodwind, consisting of flutes, sometimes including a piccolo; (3) the reed contingent, consisting of two complete families, the oboes with their tenors and basses (the Cor Anglais, bassoon and the double bassoon), the clarinets with their tenor and basses with the addition sometimes of saxophones; (4) the brass wind, consisting of the horns, a group sometimes completed by the tenor and tenor-bass Wagner tubas, the trumpet or cornet, the trombones (tenor, bass and contrabass), the tubas (tenor, bass and contrabass); the percussion instruments, including the kettle drums, bells, Glockenspiel, cymbals, triangle. Harps are added when required for special effects (Raynor, 1998).

- **Expanded Instrumentation**

Apart from the core orchestral complement, various other instruments are called for occasionally. These include the classical guitar, heckelphone, flugelhorn, cornet, harpsichord, and organ. Saxophones, for example, appear in a limited range of 19th and 20th century scores. The euphonium is featured in a few late Romantic and 20th century works, usually playing parts marked “tenor tuba”. The 20th century orchestra was far more flexible than its

predecessors. During the times of Beethoven and Felix Mendelssohn, the orchestra was composed of a fairly standard core of instruments which was very rarely modified. As time progressed, and as the Romantic period saw changes in accepted modification with composers such as Berlioz, followed by Johannes Brahms and eventually Gustav Mahler, the 20th century saw that instrumentation could practically be hand-picked by the composer. Today, however, the modern orchestra has generally been considered standardized with the modern instrumentation listed below:

2.1.9 (a) Standard Instrumentation for the Modern Orchestra

- **Woodwinds**

2-4 flutes (one doubling piccolo);

2-4 oboes (one doubling English horn)

2-4 clarinets (one doubling bass clarinet)

1-4 saxophones

2-4 bassoons (one doubling contrabassoon)

- **Brass**

4-8 French horns in F

3-6 trumpets in C, B^b

3-6 trombones (one doubling bass trombone)

Baritone horn/euphonium

1-2 tubas

- **Percussion**

(Varies heavily according to composer's needs)

Timpani, snare drum, tenor drum, bass drum, cymbals, tam-tam, triangle, woodblock, tambourine, glockenspiel, xylophone, vibraphone, chimes, marimba, drum kit.

- **Keyboards**

Celesta, piano, organ.

- **Strings**

1-2 harps

(Guitar with microphone)

16-18 violins I

14-16 violins II

12-14 violas

10-12 cellos

8-10 double basses

2.1. 9 (b) Organization of Instruments in Standard Orchestra

Among the instrument groups and within each group of instruments, there is a generally accepted hierarchy. Every instrumental group (or section) has a 'principal' who is generally responsible for leading the group and playing orchestral solos. The violins are divided into two groups, first violin and second violin, each with its principal. The principal first violin is called the concertmaster and is considered the leader of not only the string section, but of the entire orchestra, subordinate only to the conductor. The principal trombone is considered the leader of the low brass section, while the principal trumpet is generally considered the leader of the entire brass section. Similarly, the principal oboe is considered the leader of the woodwind section, and is the player to whom all others tune. The horn, while technically a brass instrument, often acts in the role of both woodwind and brass. Most sections also have an assistant principal (or co-principal or associate principal), or in the case of the first violins, an assistant concertmaster, who often plays a *tutti* part in addition to replacing the principal in his or her absence.

A section string player plays unison with the rest of the section, except in the case of divided (divisi) parts, where upper and lower parts in the music are often assigned to "outside" (nearer the audience) and "inside" seated players. Where a solo part is called for in a string section, the section leader invariably plays that part. *Tutti* wind and brass players generally play a unique but non-solo part. Section percussionists play parts assigned to them by the principal percussionist. In modern times, the musicians are usually directed by a conductor, although early orchestras did not have one, giving this role to the concertmaster or the harpsichordist playing the continuo. Some modern orchestras also do without conductors, particularly smaller orchestras and those specializing in historically accurate (so-called "period") performances of baroque and earlier music (Raynor, 1998)).

The most frequently performed repertoire for a symphony orchestra is Western classical music or opera. However, orchestras are used sometimes in popular music, extensively in film music, and increasingly often in video game music. Currently the music department of Nnamdi Azikiwe University, Awka (our case study), incorporates folk songs as part of the repertoire for the orchestra. The reason for this practice appears to be to fortify the students with a culturally relevant orchestral experience.

2.1.9 (c) Colour

Timbre denotes the quality or colour of a tone which differentiates it from other tones and which is determined by the relative intensity of the overtones. But colour is a term most typically used to describe instrumental combinations. “Dark” and “bright” are in common usage and, although subjective, do have a physical basis, provided by a conflict (or lack thereof) of multiple overtone series.

2.1. 9 (d) The Orchestral Page

Cooper (1973) explains that Initial observations concerning an orchestral page include:

(i) The order of instruments from top to bottom is: woodwinds; brasses; percussion; harp (also piano; solo, if any; voices, if any); and strings.

(ii) In most instances, the instruments within each section are placed from high-sounding to low-sounding. The principal exception is that horns, which relate to both woodwinds and brass, are placed above trumpets on the page.

(iii) The tempo indication is placed above the woodwinds and often above the strings.

(iv) Dynamics are placed below the notes for instruments, and above the notes for voices.

(v) The variety of key signatures is caused by the fact that some instruments are transposing instruments (sound at different interval than written)

2.1. 9 (e) Transposition

Standard orchestral instruments which transpose are the English horn, clarinet, French horn, and trumpet. The piccolo sounds an octave higher than written, while the double bass and contrabassoon sound an octave lower. Transpositions are named according to the note that sounds when a written C is played. That is, all transposing instruments sound their name when written C is played. For instance, a B flat clarinet sounds B flat when it plays a written C. Key signatures often correspond to the transposition interval.

2.1. 9 (f) Reasons for Transposing

Though writing for transposing instruments entails more work for a composer or arranger, there are several reasons to transpose for certain instruments. They are:

- **Switching**

Transposing makes it easier to move between instruments in certain families of instruments. Many instruments are members of a family of instruments that differ mainly in size, such as the saxophone, clarinet, flute, etc. the instruments in these families have differing ranges, with the members sounding lower as they get larger, but an identical pattern of fingering on two instruments in the same family produces pitches a fixed interval apart. For example, the fingerings which produce the notes of a C major scale on a flute, a non-transposing instrument, produce a G major scale on an alto flute. As a result these instruments' parts are notated so that the written notes are fingered the same way on each instrument, making it easier for a single instrumentalist to play several instruments in the same family. However, a few instrument families, such as trombones and tubas, are not written transposed. Instruments that transpose this way are often referred to as being in a certain "key, such as the "A clarinet or "clarinet in A". The instrument's key tells which pitch will sound when the player plays a note written as C. A player of a B-flat clarinet who reads a written C will sound a B-flat while the player of an A clarinet will read the same note and sound an A.

- **Reconciling Pitch Standards**

During the Baroque period, and notably in the music of J. S. Bach, instruments used for different purposes were often tuned to different pitch standards, called Chorton ("choir pitch") and Kammerton ("chamber [music] pitch"). When they played together in an ensemble, the parts of some instruments would then have to be transposed to compensate. In many of Bach's cantatas the organ part is notated a full step lower than the other instruments. A few early-music ensembles of the present day must do something similar if they comprise some instruments tuned to A415 and others to A440, approximately a semitone apart. Modern builders of continuo instruments (cello, double bass, and harpsichord) sometimes include movable keyboards which can play with either pitch standard.

- **Accommodating Extreme Ranges of Instruments**

If an instrument has a range too high or too low for composers to easily write its music on bass or treble clef, the music may be written either an octave higher or an octave lower than it

sounds, in order to reduce the use of ledger lines. Instruments that "transpose at octave" are not playing in a different key from concert pitch instruments, but sound an octave higher or lower than written. Some instruments with extremely high or low ranges use two-, or even three- octave transposition.

2.1.9 (g) Instrumental Ranges

Cooper (1973:74) advises that 'A knowledge of instrumental ranges… and their relative dynamic strength in each register is essential for an inquiring musician'.

2.1. 9 (h) Register

The register of an orchestral musical instrument refers to a specific segment of the total range of pitches available to the instrument. It may often be described loosely simply as high, low, etc (The New Harvard dictionary of Music, 1986). The relationship between the concept of range and register of an orchestral musical instrument is somewhat complex. For instance, while the range refers to the compass of the instrument explorable by an average player (Ottman, 1972); the register of the instrument can be explored beyond the given range lower or higher. This has some implications for the student because the combinations of the various instruments in orchestra often demand the low or high registers of a given orchestral instrument. The student therefore endeavours to, not only be familiar with the normal range of his instrument, but also, be acquainted with the dimensions of its register in order to function effectively in the orchestra. The concept of register and its exploitation play a very crucial part in instrumental combinations in ensemble. For instance, some members of an instrumental family play particular roles among their counterparts with regard to their low or high register. For example, the violin, trumpet, piccolo, and cymbals play leading role in their group owing to their distinctive high registers. Also the string bass, tuba, baritone sax, and bass drum are distinguished for their deep and low registers in their respective groups and are used to add "weight" to the orchestra (Kamien, 1986).

2.1. 9 (i) Instrumental Combination

In traditional scoring, several principles and concepts are observed, each of which requires considerable knowledge and experience before it is completely mastered and used with sophistication. These principles include:

- **Vertical Balance**

Vertical balance is achieved by specific combination of instruments, agreement with the overtone series, dynamic adjustments, and placement in terms of range (Cooper, 1973).

Cooper (1973: 76), points out that, "Generally speaking, in chordal progressions or in a contrapuntal texture of equal voices, an even vertical balance is desirable. Most orchestral music is, of course, beyond these limited categories. In a composite texture of melodic, accompanimental, and supporting bass functions, the vertical balance is appropriately adjusted by the composer.

- **Horizontal Balance**

According to cooper (1973), horizontalbalance in traditional scoring involves at least three different considerations:

(i) Equal voicing in a contrapuntal texture.
(ii) Careful voice leading in general, including the resolution of dissonant intervals and the maintenance of a logical line, appropriate for the style.
(iii) The development of a musical logic in each part and for the instrumental design as a whole.

- **Textural Balance**

Textural balance provides for both contrast and unity. Passages employing the full orchestra (tutti) are typically contrasted by sections for fewer instruments or for specific colours.

2.1.9 (j) Sitting Arrangement for Orchestral Instruments

The concept of spatial arrangement of instruments directly informs the modern positioning and sitting arrangement of instruments of the orchestra. The modern symphony orchestra seating plan features about a hundred western orchestral instruments arranged in the order: first violins (about 18) and second violins (about (16) on the left of the podium or conductor; harps (2) and piano (1) on the extreme left of the podium; the percussions (1 xylophone, 4 timpanis, 1 glockenspiel, 1 snare drum, 1 bass drum and I pair of cymbals) on the extreme rear –left ; the woodwinds (3 flutes, 3 oboes, 3 clarinets, 1 piccolo, 1 English horn, 3 bassoons, 1 contrabassoon and 1 bass clarinet) at the center facing the podium; the brasses (6

French horns, 4 trumpets, 4 trumpets and 1 tuba) directly behind the woodwinds; and 12 violas, 10 cellos and 8 double basses on the right of the podium (Sptizer & Neil, 2004)

2.2 Theoretical Review

The teaching/learning process, undeniably, has attracted one of the most extensive theoretical attention and discourse among other concepts in the field of education. History is generous with scholars, psychologists, sociologists, and philosophers that made relevant contributions regarding the various modes of instruction (teaching) and the acquisition of knowledge (learning) by man. Notable among them are, Aristotle, Plato, Socrates, Pythagoras, and numerous modern educational thinkers such as, Lev Vygosky (1896-1934), Jean Piaget (1896-1980), Ivan Pavlov (1849-1936), Jean-Jacques Rousseau (1712-1778), Seymour Papert (1928-…), Maria Montessori (1870-1952), Jerome Bruner (1915…), John B. Watson (1878-1958), John Dewey (1859- 1952), Benjamin Bloom (1913-1999), John Locke (1632-1704) etc. Certain scholars also left indelible marks in the field of music education, such as Shinichi Suzuki (1898-1998), Carl Orff (1895-1982), Zoltan Kodaly (1882-1967), Emile Jaques-Dalcroze (1865- 1950), Edwin E. Gordon, etc.

2.2.1 The Domains of Learning

Benjamin Bloom (1913-1999), an American psychologist, made contributions to the classification of educational objectives and to the theory of learning. In 1956, Bloom edited the first volume of Taxonomy of Educational Objectives: the Classification of Educational Goals, which outlined a classification of learning objectives that has come to be known as Bloom's Taxonomy and remains a foundational and essential element within the educational community as evidenced in the 1981 survey of significant writings that have influenced the curriculum (Anderson & Krathwohl, 2001). Bloom outlined the three domains of learning thus:

- **The cognitive Domain**

Skills in the cognitive domain revolve around knowledge, comprehension, and critical thinking on a particular subject. Traditional education tends to emphasize the skills in this domain, particularly the lower-order objectives. There are six levels in this particular domain, moving through the lowest order processes to the highest:

(i) **Knowledge**

Exhibiting memory of previously learned materials by recalling facts, terms, basic concepts and answers. For example, knowledge of specifics (terminology, specific facts); knowledge of ways and means of dealing with specifics (conventions, trends and sequences, classifications and categories, criteria, methodology); knowledge of the universals and abstractions in a field (principles and generalizations, theories and structures).

(ii) **Comprehension**

Demonstrating understanding of the facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas. For instance, translation, interpretation, and extrapolation.

(iii) **Application**

Using new knowledge. Solving problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way.

(iv) **Analysis**

Examining and breaking information into parts by identifying motives or causes. Making inferences and finding evidence to support generalizations. For instance, analysis of elements, analysis of relationships, analysis of organizational principles.

(v) **Synthesis**

Compiling information together in a different way by combining elements in a new pattern or proposing alternative solutions. For instance, production of a unique communication, production of a plan, or proposed set of operations, derivation of a set of abstract relations.

(vi) **Evaluation**

Presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria. For instance, judgments in terms of internal evidence judgments in terms of external criteria.

- **The Affective Domain**

Skills in the affective domain describe the way people react emotionally and their ability to feel other living things' pain or joy. Affective objectives typically target the awareness and growth in attitudes, emotion, and feelings. There are five levels in the affective domain moving through the lowest order processes to the highest:

(i) **Receiving**

The lowest level, the student passively pays attention. Without this level no learning can occur. Receiving is about the student's memory and recognition as well.

(ii) **Responding**

The student actively participates in the learning process, not only attends to a stimulus; the student also reacts in some way.

(iii) **Valuing**

The student attaches a value to an object, phenomenon, or piece of information. The student associates a value or some values to the knowledge he acquired.

(iv) **Organizing**

The student can put together different values, information, and ideas and accommodate them within his/her own schema; comparing, relating and elaborating on what has been learned.

(v) **Characterizing**

The student holds a particular value or belief that now exerts on his/her behavior so that it becomes a characteristic.

- **The Psychomotor Domain**

Skills in the psychomotor domain describe the ability to physically manipulate a tool or instrument like a hand or a hammer. Psychomotor objectives usually focus on change and/or development in behavior and/or skills. This domain has three levels:

(i) **Perception**

This is the learners perception of his performance, whether quicker, better, more accurate, etc.

(i) **Adaptation**

Skills are well developed and the individual can modify movement patterns to fit special requirements. Examples: responds effectively to unexpected experiences.

(ii) **Origination**

Creating new movement patterns to fit a particular situation or specific problem. Learning outcomes emphasize creativity based upon highly developed skills.

These three domains of learning (cognitive, affective, and psychomotor) are not mutually exclusive. For example, in learning to play chess, the person will have to learn the rules of the game (cognitive domain); but he also has to learn how to set up the chess pieces on the chess board and also how to properly hold and move a chess piece (psychomotor). Furthermore, later in the game the person may even learn to love the game itself, value its applications in life, and appreciate its history (affective domain) (Wikipedia Encyclopedia, 2013).

2.2.2 Theories of Learning

The experimental and pioneer works of several scholars have led to the evolution of theories of learning. These learning theories have also influenced the teaching process immensely. The theories are reviewed below:

2.2.2 (a) The Behavioural Theory:

The behaviourist school (championed by Pavlov, Skinner, Thorndike, Tolma, and others) operates on the principle of "stimulus- response." All behavior is caused by external stimuli (operant conditioning). All behaviour can be explained without the need to consider internal mental states or consciousness. Behaviourism assumes a learner is essentially passive, responding to environmental stimuli. The learner starts off as a clean slate (i.e. tabula rasa) and behaviour is shaped through positive reinforcement or negative reinforcement. Both positive reinforcement and negative reinforcement increase the probability that the antecedent behaviour will happen again. In contrast, punishment (both positive and negative) decreases the likelihood that the antecedent behaviour will happen again. Positive indicates the application of a stimulus; negative indicates the withholding of a stimulus. Learning is therefore defined as a change in behaviour in the learner (Staats, 1963).

- **Operant Conditioning Vs Classical Conditioning**

The experimental works of Ivan Pavlov and B. F. Skinner led to two forms of conditioning in the behaviourist school. Operant conditioning (championed by B. F. Skinner) is a behaviourist theory based on the fundamental idea that behaviours that are reinforced will tend to continue, while behaviours that are punished will eventually end. Classical conditioning (championed by Pavlov) is a reflexive or automatic type of learning in which a stimulus acquires the capacity to evoke a response that was originally evoked by another stimulus. Operant conditioning is technically described as a process that attempts to modify behaviour through the use of positive and negative reinforcement. Through operant conditioning, an individual makes an association between a particular behaviour and a

consequence. For example I: Parents rewarding a child's excellent grades with candy or some other prize.

Example II: A school teacher awards points to those students who are most calm and well-behaved. Students eventually realize that when they voluntarily become quieter and better behaved, that they earn more points.

Example III: A form of reinforcement (such as food) is given to an animal every time the animal (example, a hungry lion) presses a lever.

The term "operant conditioning" originated by the behaviourist B. F. Skinner, who believed that one should focus on the external, observable causes of behaviour (rather than try to unpack the internal thoughts and motivations). Reinforcement comes in two forms: positive and negative.

(i) **Positive and Negative Reinforcers**

Positive reinforcers are favourable events or outcomes that are given to the individual after the desired behaviour. This may come in the form of praise, rewards, etc. negative reinforcers typically are characterized by the removal of an undesired or unpleasant outcome after the desired behavior. A response is strengthened as something considered negative is removed. The goal in both of these cases of reinforcement is for the behaviour to increase.

(ii) **Positive and Negative Punishment**

Punishment, in contrast, is when the increase of something undesirable attempts to cause a decrease in the behaviour that follows. Positive punishment is when unfavourable events or outcomes are given in order to weaken the response that follows. Negative punishment is characterized by when a favourable event or outcome is removed after an undesired behavior occurs. The goal in both cases of punishment is for a behavior to decrease.

What then is the difference between operant conditioning and classical conditioning? In operant conditioning, a voluntary response is then followed by a reinforcing stimulus. In this way, the voluntary response (e.g. studying for an exam) is more likely to be done by the individual. In contrast, classical conditioning is when a stimulus automatically triggers involuntary response (Baum, 1994).

2.2.2 (b) The Cognitive Theory

The cognitivist paradigm essentially argues that the "black box" of the mind should be opened and understood. The learner is viewed as an information processor (like a computer). The cognitivist revolution replaced behaviourism in 1960s as the dominant paradigm. Cognitivism focuses on the inner mental activities of humans. The "black box" of the human mind is valuable and necessary for understanding how people learn. Mental processes such as thinking, memory, knowing, and problem-solving need to be explored. Knowledge can be seen as a schema or symbolic mental constructions. Learning is defined as change in a learner's schemata. Cognitivism, in response to behaviourism, reasons that people are not "programmed animals" that merely respond to environmental stimuli; people are rational beings that require active participation in order to learn, and whose actions are a consequence of thinking. Changes in behaviour are observed, but only as an indication of what is occurring in the learner's head. Cognitivism uses the metaphor of the mind as computer: information comes in, is being processed, and leads to certain outcomes (Shettleworth, 2010).

2.2.2 (c) Constructivism

Constructivism, as a perspective in education, explains how knowledge is constructed in the human being when information comes into contact with existing knowledge that had been developed by experiences. It has its roots in cognitive psychology and biology and an approach to education that lays emphasis on the ways knowledge is created in order to adapt to the world. Constructs are the different types of filters we choose to place over our realities to change our reality from chaos to order. The crux of constructivism is that learning is an active, constructive process. The learner is an information constructor. People actively construct or create their own subjective representations of objective reality. New information is linked to prior knowledge, thus mental representations are subjective. Constructivism has implications for the theory of instruction. Discovery, hands-on, experiential, collaborative, project-based, and task-based learning are a number of applications that base teaching and learning on consructivism (Gardner, 2006).

2.2.2 (d) The Gestalt Theory

Gestalt psychology or gestalism is a theory of mind and brain of the Berlin school; the operational principle of Gestalt psychology is that the brain is holistic, parallel, and analog, with self-organizing tendencies. The principle maintains that the human eye sees objects in their entirety before perceiving their individual parts, suggesting the whole is greater than the

sum of its parts. Gestalt psychology tries to understand the laws of our ability to acquire and maintain stable precepts in a noisy world. Gestalt theorists stipulate that perception is the product of complex interactions among various stimuli. Contrary to the behaviourist approach to understanding the elements of cognitive processes, gestalt psychologists sought to understand their organization. The gestalt effect is the form-generating capability of our senses, particularly with respect to the visual recognition of figures and whole forms instead of just a collection of simple lines and curves. In psychology, gestalism is often opposed to structuralism. The phrase "The whole is greater than the sum of its parts" is often used when explaining gestalt theory, though this is a mistranslation of Kurt Koffka's original phrase, "The whole is other than the sum of the parts". Gestalt theory allows for the breakup of elements from the whole situation into what it really is (Bouton, 2007).

2.2.2 (e) Social Learning Theory (Bandura)

Bandura's social learning theory posits that people learn from one another, via observation, imitation, and modeling. The theory has often been called a bridge between behaviourist and cognitive learning theories because it encompasses attention, memory, and motivation (Wikipedia Encyclopedia, 2013). The crux of the social learning theory is that people learn through observing others' behaviour, attitudes, and outcomes of those behaviours. Most human behaviour is learned observationally through modeling: from observing others, one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action. Social learning theory explains human behaviour in terms of continuous reciprocal interaction between cognitive, behavioural, and environmental influences (Staats, 1963).

2.2.2 (f) Humanism

Humanism is a paradigm/philosophy/pedagogical approach that believes learning is viewed as a personal act to fulfill one's potential. The central assumption of humanism is that people act with intentionality and values. This is in contrast to the behaviourist notion of operant conditioning (which argues that all behavior is the result of the application of consequences) and cognitive psychologist belief that the discovering knowledge or constructing meaning is central to learning. Humanism focuses on the human freedom, dignity, and potential. Humanists also believe that it is necessary to study the person as a whole, especially as an individual grows and develops over the lifespan. It follows that the study of the self, motivation, and goals are areas of particular interest (Huitt, 2001).

2.2.2 (g) Elaboration Theory

Elaboration theory is an instructional design theory that argues that content to be learned should be organized from simple to complex order, while providing a meaningful context in which subsequent ideas can be integrated. This paradigm shift from teacher-centric instruction to learner centered instruction has caused "new needs for instruction to be sequenced. Charles Reigeluth of Indiana University posited Elaboration theory, an instructional design model that aims to help select and sequence content in a way that will optimize attainment of learning goals. Proponents feel the use of motivators, analogies, summaries and syntheses lead to effective learning. While the theory does not address primarily affective content, it is intended for medium to complex kinds of cognitive and psychomotor learning (Reigeluth, 1999). Elaboration theory has the following values:

(i) It values a sequence of instruction that is as holistic as possible, to foster meaning-making and motivation.
(ii) It allows learners to make much scope and sequence decisions on their own during the learning process.
(iii) It is an approach that facilitates rapid prototyping in the instructional development process.
(iv) It integrates viable approaches to scope and sequence into a coherent design theory.

2.2.2 (h) Stage Theory of Cognitive Development (Piaget)

Piaget's stage theory of cognitive development is a description of cognitive development as four distinct stages in children: sensorimotor, preoperational, concrete, and formal. His model describes how the mind processes new information encountered. He posited that children progress through 4 stages and that they all do so in the same order. The four stages are described briefly thus:

- **Sensorimotor:** (Birth to 2yrs old).

The infant builds an understanding of himself or herself and reality (and how things work) through interactions with the environment. It is able to differentiate between itself and objects. Learning takes place via assimilation (the organization of information and absorbing it into schema) and accommodation (when an object cannot be assimilated and the schemata have to be modified to include the object.

- **Preoperational Stage** (ages 2-4)

The child is not yet able to conceptualize abstractly and needs concrete physical situations. Objects are classified in simple ways, especially by important features.

- **Concrete Operations** (ages 7-11)

As physical experience accumulates, accommodation is increased. The child begins to think abstractly and conceptualize, creating logical structures that explain his or her physical experiences.

- **Formal Operations**(11-15)

This is when cognition reaches its final form. By this stage, the person no longer requires concrete objects to make rational judgments. He or she is capable of deductive and hypothetical reasoning. His or her ability for abstract thinking is very similar to an adult.

Piaget's stage theory has enormous implications for education in the sense that the existence of a maturational unfolding of conceptual skills being linked with certain periods in the lives of learners has an obvious bearing on curriculum planning. Piaget is quite clear in his belief that neurological development and a progression of concept-forming skills must appear before full intellectual maturation is possible. The theory implies that certain periods are critical in mental growth. Teachers should, therefore, have some awareness of the range of possibilities in the concept formation of their learners (Child, 2004). That is, there exists a tender stage for cognitive development in which learning should not be delayed.

2.2.2 (i) Social Development Theory (Vygotsky)

Social Development Theory is the work of Russian psychologist, Lev Vygotsky (1896-1934), who lived during the Russian Revolution. Vygotsky's work was largely unknown to the West until it was published in 1962. His theory is one of the foundations of constructivism. It asserts three major themes:

- Social interaction plays a fundamental role in the process of cognitive development. In contrast to Jean Piaget's understanding of child development (in which development necessarily precedes learning), Vygotsky felt social learning precedes development. According to Vygotsky(1978), "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level;

first, between people (inter-psychological) and then inside the child (intra-psychological).

- The More Knowledgeable Order (MKO). The MKO refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is normally thought of as being a teacher, coach, or older adult, but MKO could also be peers, a younger person, or even computers.

- The Zone of Proximal Development (ZPD). The ZPD is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability solving the problem independently.

Vygotsky focused on the connections between people and the socio-cultural context in which they act and interact in shared experiences. According to vygotsky, humans use tools that develop from culture, such as speech and writing, to mediate their social environments. Initially children develop these tools to serve solely as social functions and ways to communicate needs. Vygotsky believed that the internalization of these tools led to higher thinking skills (Kozulin, 1990).

Vygotsky's theory promotes learning contexts in which students play an active role in learning in contrast to the traditionally held transmissionist or instructionist model in which a teacher or lecturer transmits information to students. Roles of the teacher and student are therefore shifted, as a teacher should collaborate with his or her students in order to help facilitate meaning construction in students, learning therefore becomes a reciprocal experience for the students and teacher.

2.2.2 (j) Theory of Community of Practice (Lave and Wenger)

The term was first used in 1991 by theorists Jean Lave and Etienne Wenger who discussed the notion of legitimate peripheral participation. The theory posits that groups of people who share a concern or a passion for something they do can learn how to do it better as they interact regularly. Communities of practice can be defined, in part, as a process of social learning that occurs when people who have a common interest in a subject or area collaborate over an extended period of time, sharing ideas and strategies, determine solutions, and build innovations. Learning can be, and often is, an accidental outcome that accompanies these

social processes (Lave and Wenger, 1998). The significance of this theory to learning is that it supports collaborative and interactive learning.

2.2.3 Learning and the Mechanism of the Brain

Almost all the neurons in the brain are generated before birth, during the first three months of pregnancy, and the newborn child's brain has a similar number of neurons to that of an adult. Many more neurons form more than are needed, and only those that form active connections with other neurons survive. In the first year after birth the infant brain undergoes an intense phase of development, during which excessive numbers of connections between neurons are formed, and many of these excess connections must be cut back through the process of synaptic pruning that follows. This pruning process is just as important as a stage of development as the early rapid growth of connections between brain cells. The process during which large numbers of connections between neurons are formed is called synaptogenesis (Wikipedia Encyclopedia, 2013).

2.2.3 (a) Attention and Executive control

Attention refers to the brain mechanisms that allow us to focus on particular aspects of the sensory environment to the relative exclusion of others. Attention modulates sensory processing in 'top-down" fashion. Maintaining selective attention toward a particular item or person for a prolonged period is clearly a critical underpinning skill for the classroom. Attention is a key cognitive skill which if impaired can result in difficulty in completing tasks or attending to details. Aspects of attention may also be atypical in learners showing anti-social behaviour and conduct disorders. From the perspective of basic neuro -science, recent evidence suggests that attention skills may be one of the human brain functions that respond to early intervention and training (Gopher, 1999).

2.2.3 (b) Memory

Memory is a term often used to describe the activities of acquiring, retaining and recalling (Child, 2004). Memory is fundamental to learning in the sense that, to show that learning has taken place, we have to rely on a person's ability to remember something by either mental or physical means. We refer to a hypothetical possession- the memory- which is regarded almost as a place, located in the brain, where recoverable experience and knowledge are housed. When we call upon the memory, the process of recovery is called remembering. Child (2004) explains that "the processes hypothesized in contemporary views about memory are encoding, storage and retrieval:

ENCODING ⟶ **STORAGE** ⟶ **RETRIEVAL**

(Input to memory) (Held in memory) (Taken from memory)

Encoding is the process whereby information is thought to be put into the memory; storage relates to the methods assumed to be involved in the retention of information; retrieval relates to the processes of recovery of stored information from memory.

2.2.3 (c) The Various Types of Memory

The brain does not store memories in one unified structure, as might be seen in a computer's hard disk drive. Instead, different types of memory are stored in different regions of the brain. Various types of memory exist and they are described below:

- **Short-term Memory**

Short-term memory (or "primary" or "active memory") is the capacity for holding a small amount of information in mind in an active, readily available state for a short period of time. The duration of short-term memory (when rehearsal or active maintenance is prevented) is believed to be in the order of seconds. A commonly cited capacity is 7+ or – 2 elements. In contrast, long-term memory indefinitely stores a seemingly unlimited amount of information (Wikipedia Encyclopedia, 2013).

- **Long-term Memory**

Long-term memory (LTM) is memory in which associations among items are stored, as part of the theory of a dual-store memory model. The division of long-term and short-term memory has been supported by several double dissociation experiments. According to the theory, long-term memory differs structurally and functionally from sensory memory, working memory, short-term memory, and intermediate-term memory. While short-term and working memories persist for only about 20 to 30 seconds, information can remain in intermediate-term memory for 5 to 8 hours and in long-term memory indefinitely. This differs from the theory of the single-store retrieved context model that has no differentiation between short-term and long-term memory. Long-term memory is an important aspect of cognition. LTM can be divided into three processes: encoding, storage, and retrieval. Encoding of long-term memory occurs in the cortex at the medial temporal lobe, and damage to the medial temporal lobe is known to cause anterodrade amnesia (Wikipedia Encyclopedia, 2013).

Long-term memory is typically divided up into more major headings:

(i) **Explicit Memory/Declarative Memory**

This refers to all memories that are consciously available. These are encoded by the hippocampus, entornimal cortex, and perihinal cortex, but consolidated and stored elsewhere. The precise location of storage is unknown, but the temporal cortex has been proposed as a likely candidate.

(i) **Episodic memory**

This refers to memory for specific events in time, as well as supporting their formation and retrieval. Some examples of episodic memory would be remembering someone's name and what happened at your last interaction with each other. Experiments have indicated that older adults have worse episodic memories than younger adults because episodic memory requires context dependent memory.

(ii) **Semantic Memory**

This refers to knowledge about factual information, such as information remembered for a test. In contrast with episodic memory older adults and younger adults do not show much of a difference with semantic memory, presumably because semantic memory does not depend on context memory.

- **Implicit memory**

This refers to the use of objects or movements of the body, such as how exactly to use a pencil, drive a car, or ride a bicycle. This type of memory is encoded and it is presumed stored by the cerebellum and striatum.

- **Procedural Memory**

Procedural memory is memory for the performance of particular types of action. Procedural memory guides the processes we perform and most frequently resides below the level of conscious awareness. When needed, procedural memories are automatically retrieved and utilized for the execution of the integrated procedures involved in both cognitive and motor skills, from tying shoes to flying an airplane to reading. Procedural memories are accessed and used without the need for conscious control or attention. Procedural memory is created through "procedural learning" or, repeating a complex activity over and over again until all of

the relevant neural systems work together to automatically produce the activity. Implicit procedural learning is essential to the development of any motor skill or cognitive activity.

- **Working Memory**

Working memory is the system that actively holds multiple pieces of transitory information in the mind, where they can be manipulated. This involves execution of verbal and non-verbal tasks- such as reasoning and comprehension- and makes them available for further information-processing. Working memory is generally used synonymously with short-term memory, depending on how these two forms of memory are defined. Working memory includes subsystems that store and manipulate visual images or verbal information, as well as a central executive that coordinates the subsystems. It includes visual representations of the possible moves, and awareness of the flow of information into and out of memory, all stored for a limited amount of time. Working memory tasks require monitoring (i.e., manipulation of information or behaviours) as part of completing goal-directed actions in the setting of interfering processes and distractions. Theories exist both regarding the theoretical structure of working memory and the role of specific parts of the brain involved in working memory. Research identifies the frontal cortex, parietal cortex, anterior cingulated, and parts of the basal ganglia as crucial. The neural basis of working memory has been derived from lesion experiments in animals and functional imaging upon humans (Wikipedia Encyclopedia, 2013). There is now extensive evidence, as mentioned earlier, that working memory is linked to key learning outcomes in literacy and numeracy. A longitudinal study confirmed that a child's working memory at 5 years old is a better predictor of academic success than IQ.

2.2.4 Heredity

Heredity is the biological phenomenon of living things passing on their own qualities from parent to child in the cells of the body. Heredity is a vital factor in learning and human intelligence. On heredity, Child (2004) reports that:

> An important biological fact is that the human race has a vast pool of characteristics, which can be transmitted from generation to generation during the process of reproducing its kind. In discussing such complex human qualities as intelligence and personality we will frequently have cause to wonder to what extent the potential for individual characteristics is inherited and to what extent the life experiences of individuals shape the outcome of these inherited properties (p. 33).

He informs further that:

> It is common knowledge that the basic structures for reproducing human characteristics are the germ cells (female ovum, or egg, and male sperm). Within each is found a nucleus which contains the chromosome material- long, thread-like structures now known to be made up of chains of chemicals. The basic unit for the transmission of characteristics from parent to offspring is the gene. Using powerful chemical and electron-microscopic techniques, biologists have found that each gene is a specific area along the chromosome with a unique chemical composition (Child 2004:33).

Heredity has helped understand the complex nature of learning and the explanations for individual differences in human intelligence and learning.

2.2.5 Human Intelligence

Intelligence refers to the ability to learn and understand. The concept of intelligence has attracted the most attention among educational psychologists. Heim (1970) defines intelligent activity as consisting of "grasping the essentials in a given situation and responding appropriately to them" Child (2004) highlighting the implications of varied human intelligence to learning avers that:

> We are all well aware that some (learners) can cope with certain situations better than others. Thus the detection and measurement of differences are important for the teacher. It would be disastrous for children (learners) if we did not quickly recognize their cognitive strengths and weaknesses, because the intellectually dull cannot, in general, cope with the same cognitive tasks as the intellectually bright of the same age, although they may possess special; skills in particular abilities (p. 221).

The implications of the variability and individual differences in human intelligence to learning and teaching is that teachers should approach the teaching/learning process with caution and strive to accommodate all learners irrespective of their differences.

2.2.6 The Relationship between Memory, Intelligence, and Learning

Although an increasing number of researchers is seeking to establish educational neuroscience as a productive field of research, debate still continues with regard to the potential for practical collaboration or relationship between the fields of neuroscience and

education, and whether neuro-scientific research really has anything to offer educators. Despite optimism from many who believe that neuroscience can make a meaningful contribution to education, and that the potential exists for the establishment of a research field of educational neuro science, some researchers believe that the two disciplines are simply too different to ever be directly in a practically meaningful way. The "neuroscience and education argument" stems from three major findings in developmental neurobiology:

- Early childhood is characterized by rapid growth in the number of synapses in the brain (synaptogenesis- the process during which large numbers of connections between neurons are formed in the brain), and this expansion is followed by a pruning period.
- There are so called experience dependent critical periods during which the developing brain is best suited to develop certain sensory and motor skills.
- A stimulus rich environment causes greater synaptogenesis. The essential argument is that children are capable of learning more at an early age when they have an excess of synaptic growth and peak brain activity.

Despite the argument, evidence abounds of the intricate relationship and interdependency between the two fields. For instance, the knowledge of early brain development afforded by neurobiology has been used to support various arguments with regard to education. For example, the idea that any subject can be taught to young children in some intellectually honest form, due to the great adaptability and learning potential of the young brain. Alternatively, the idea that critical periods exist for learning certain skills or knowledge sets appeals to the fact that in animal studies, if the developing brain is deprived of certain sensory inputs, the brain areas responsible for processing those inputs fail to develop fully later inn development.

There is now extensive evidence, as mentioned earlier, that working memory is linked to key learning outcomes in literacy and numeracy. A longitudinal study confirmed that a child's working memory at 5 years old is a better predictor of academic success than IQ. In a large scale screening study, one in ten children in mainstream classroom were identified with working memory deficits. The majority of them performed very poorly in academic achievements, independent of their IQ. Without appropriate intervention, these children lag behind their peers. A recent study of 37 school-age children with significant learning disabilities has shown that working memory capacity at baseline measurement, but not IQ,

predicts learning outcomes two years later. This suggests that working memory impairments are associated with low learning outcomes and constitute a high risk factor for educational underachievement for children. In children with learning disabilities such as dyslexia, ADHD, and developmental coordination disorder, a similar pattern is evident (Wikipedia Encyclopedia, 2013).

The implications of the intricate relationship of the brain, memory, intelligence, and learning are that learning is a function of the brain, memory, and intelligence and should be a central concern to teachers.

2.2.7 Sensation, Attention, and Perception

The three neuro-psychological phenomena (sensation, attention, and perception) play vital and complex roles in learning. Sensation is said to occur when any sense organ (eye, ear, nose, skin containing pressure and pain cells) receives a stimulus from the external or internal environment (Child, 2004). This can, and frequently does, occur without our knowledge. Sound waves, for instance, are impinging on the eardrum and causing disturbances which we do not register. If one listens attentively for a moment you will soon discover many sounds which would have passed you by had you not made a search for them.

The ability of human beings to process some part of the incoming sensations to the sense organs and to ignore everything else is referred to as attention (Child, 2004). Receiving and attending to a noise or the touch of a material is only part of the story, because we need to interpret the selected sensations in the light of the present context and our past experience. This internal analysis and integration of sensations by the brain is termed perception (Child, 2004).

On attention and the teaching/learning process, Child (2004) explains furthermore that:

> The process of catching and holding attention starts when a teacher first meets a class. Experience teaches us how easy it is to get off on the wrong foot with someone else. A casual word or gesture can so easily be misunderstood. This effect can be multiplied in a class of children. The flow and ‘feel’ of a lesson or part of a lesson is often established at the beginning, and if matters go wrong, it is difficult to recover (p. 47).

The implications of the phenomena of sensation, attention, and perception are that sensory perception, attention and analysis have an important place in teaching and learning. Also, attracting learners’ interest and attention is central to the role of the teacher. Furthermore,

holding attention is equally important to attracting learners' attention. Teacher movement, voice, using various sensory channels and developing teacher –learner interaction are amongst the important ways of holding attention.

2.2.8 Sleep and Learning

Many competing theories have been made to discover the possible connections between sleep and learning in humans. One theory is that sleep consolidates and optimizes the layout of memories (Walker, 2009). Sleep is a natural periodic state of rest for the mind and body. According to the American Academy of Sleep Medicine, it is important and essential for students to obtain the right amount of sleep in order to succeed in academics. AASM (American Academy of Sleep Medicine) states that getting good nights of sleep is one of the best ways to maximize performance on finals. It is possible that the more chaotic and sporadic one's sleeping schedule is, the harder it will be for that individual to pull through the rigours of academics. Sleep loss may lead to learning and memory impairment. In addition, lack of sleep can lead to decreased attention and vigilance.

2.2.9 Talent and Giftedness

The two congruous concepts, talent and giftedness play sensitive roles in learning and thus, cannot be ignored. On the definition of giftedness, Kirk & Gallagher (1983) explain that:

> Each culture defines giftedness in its own image and fixes the nature of the gifted person for that culture. From that definition we learn something about the values and lifestyles of the culture. The person called gifted in primitive society may be very different from one so designated in an advanced technological society. Ancient Greece honoured the orator, whereas Rome valued the engineer and the soldier. The earliest definition of the gifted in the United States was tied to an IQ score, and particularly to the Standford-Binet Intelligence Test that was developed by Lewis Terman shortly after World War I (p. 68).

The term 'talent' is used in various ways, but the commonest and the one adopted here refers to exceptional performance in a specific field of human endeavour (Child, 2004). Great artist, athletes, scientists, musicians, dancers, writers or engineers, for example, would fall into this definition. Child (2004: 264) furthermore explains that, "By examining the intellectual and personality profiles of living or past talented people, several psychologists have tried to build up a stereotype of characteristics typical of the talented." Regarding giftedness, Child (2004)

notes that “There is no single, widely accepted definition of giftedness. What defines the concept is determined by the measures psychologists choose to investigate it.” Generally, psychologists regard gifted people as those with exceptionally high measures of human abilities. On the distinctive and personal qualities of gifted and talented learners, Child (2004) submits that:

> Personal qualities of gifted and talented people include higher intelligence (convergent thinking), high divergent thinking ability, earlier development in reading, writing and talking, good memory and consequent good knowledge base, greater speed of problem-solving, enjoyment of complexity, tolerance of ambiguity, persistence in tasks of interest with high powers of concentration and on. Environmentally, they benefit from having parents with well-defined attitudes to education, who are positive in their encouragement of children to do well at school, who are positive in their involvement (‘doing things together’), who are prepared to support with material help (books, instruments), etc.(p.267).

Shore and Kanevsky (1993) also raised some hallmarks of giftedness in people such as, speed, problem representation and categorization, procedural knowledge, flexibility and preference for complexity.

Talent and giftedness have subtle implications for teaching and learning as outlined below: teachers should brace for gifted and talented learners in their classrooms. Every learner has special needs not least those who are gifted and talented. Furthermore, teachers and instructors must not think that the gifted and talented can ‘fend for themselves’; they need special attention suited to their abilities.

2.2.10 Learning Difficulties and Disorders

Learning difficulties and disorders are generally described as problems which impede learning. They stem from numerous factors which tend to disrupt human physiological, neurological, biological, psychological, or emotional equilibrium. Child (2004:282) reports that these learning difficulties and disorders usually manifest “when learners are physically disabled, emotionally disturbed or culturally deprived, exhibit some degree of intellectual or mental disability where scholastic performance is below the average expected of a learner’s age group.” Most teachers who deal with average and below-average pupils, especially in infant and primary schools, meet children who do not seem to profit from the usual

educational methods and content provided. Intellectual disability in the present context is being reserved for those who are slow learners. Where learners are not coping with the work normally expected of their age group, they are said to be slow learners. Child (2004:283) further draws attention that "teachers have, understandably, been worried about their abilities to cope with any form of special need as their training and experience have largely been devoted to normal school settings." The commonest learning difficulties and disorders are retardation, dyslexia (difficulty with words), autism (disability in interpreting sensory experiences, particularly hearing and seeing). Other physical disabilities that can also impair learning are muscular dystrophy, spasticism, spinia bifida, poloio, cerebral palsy, arthritis and delicacy (Child, 2004). Certain physical conditions seriously impede learning such as, epilepsy, asthma, cystic fibrosis, haemophilia, sickle cell anaemia, congenital heart disease, diabetes, renal failure, eczema, rheumatoid disorders and lukaemia and childhood cancers. There are also mental health problems which can constitute learning disorders and difficulties such as, eating disorders, substance abuse, neurotic (depression and obsession, suicidal behaviour, excitability- apathy, hysteria and amnesia, phobias) and psychotic disorders (hallucinations, schizophrenia, delusions, bizarre behaviour which are few and far between (Child, 2004).

The implications of these disorders and learning difficulties to the teaching/learning process is that, provision for learners with special educational needs should be part of the daily work of most teachers. Also, in the early years, any signs of decline in achievement should be monitored with an eye to some causes requiring special provision.

2.2.11 Various Types of Learning

Since learning involves the acquisition, modification and reinforcement of existing knowledge, beahaviours, skills and values; it takes usually takes many forms. The various types and forms of learning are discussed below:

- **Sensitization**

Sensitization is an example of non-associative learning in which the progressive amplification of a response follows repeated administration of a stimulus. An ordinary example of this mechanism is the repeated tonic stimulation of peripheral nerves that will occur if a person rubs his arm continuously. After a while, this stimulation will create a warm sensation that will eventually turn painful. The pain is the result of the progressively amplified synaptic response of the peripheral nerves warning the person that the stimulation

is harmful. Sensitization is thought to underlie both adaptive as well as maladaptive learning processes in the organism (Bouton, 2007).

- **Associative Learning (classical/operant conditioning)**

Associative learning is the process by which an association between two stimuli or a behaviour and a stimulus is learned. The two forms of associative learning are classical and operant conditioning. In classical conditioning a previous neutral stimulus is repeatedly presented together with a reflex eliciting stimuli until eventually the neutral stimulus will elicit a response on its own. In operant conditioning a certain behaviour is either reinforced or punished which results in an altered probability that the behaviour will happen again. Operant conditioning is simply the use of consequences to modify the occurrence and form of behaviour. Operant conditioning is distinguished from classical (Pavlovian conditioning) in that operant conditioning uses reinforcement/punishment to alter an action-outcome association. In contrast classical (Pavlovian conditioning) involves strengthening of the stimulus-outcome association. The typical paradigm for classical conditioning involves repeatedly pairing an unconditioned stimulus (which unfailingly evokes a reflexive response) with another previously neutral stimulus (which does not normally evoke the response). Following conditioning, the response occurs both to the unconditioned stimulus and to the other unrelated stimulus (now referred to as the "conditioned stimulus"). The response to the conditioned stimulus is termed a conditioned response. The classic example is Pavlov and his dogs. Meat powder naturally will make a dog salivate when it is put into a dog's mouth; salivating is a reflexive response to the meat powder. The first time Pavlov rang the bell, the neutral stimulus, the dogs did not salivate, but once he put the meat powder in their mouths they began to salivate. After numerous pairings of the bell and the food the dogs learned that bell was a signal that the food was about to come and began to salivate when the bell was rung. Once this occurred, the bell became the conditioned stimulus (CS) and the salivation to the bell became the conditioned response (CR) (Gazzaniga, 2010).

- **Imprinting**

Imprinting is the term used in psychology and ethology to describe any kind of phase-sensitive learning (learning occurring at a particular life stage) that is rapid and apparently independent of the consequences of behaviour. It was first used to describe situations in which an animal or person learns the characteristics of some stimulus, which is therefore said to be "imprinted" onto the subject (Bransford, 2000).

- **Observational Learning**

The learning process most characteristic of humans is imitation; one's personal repetition of an observed behaviour, such as dance. Recent research with children has shown that observational learning is well suited to seeding behaviours that can spread widely across a culture through a process called a diffusion chain, where individuals initially learn a behaviour by observing another individual perform that behavior, and then serve as a model from which other individuals learn the behaviour (Bransford, 2000). Humans can copy three types of information simultaneously: the demonstrator's goals, actions, and environmental outcomes. Through copying these types of information, (most) infants will tune into their surrounding culture.

- **Enculturation**

Enculturation is the process by which a person learns the requirements of their native culture by which he or she is surrounded, and acquires values and behaviours that are appropriate or necessary in that culture. The influences which direct or shape the individual, whether deliberately or not, include parents, other adults, and peers. If successful, enculturation results in competence in the language, values and rituals of the culture (Henry, 1988).

- **Episodic Learning**

Episodic learning is a change in behaviour that occurs as a result of an event. For example, a fear of dogs that follows being bitten by a dog is episodic learning. Episodic learning is so named because events are recorded into the episodic memory, which is one of the three forms of explicit learning and retrieval, along with perceptual memory and semantic memory (Bransford, 2000).

- **Multimedia Learning**

Multimedia learning is where a person uses both auditory and visual stimuli to learn information. This type of learning relies on dual-coding theory (Mayer, 2001)**.188**

- **Rote Learning**

Rote learning means learning or memorizing abstract concepts in whole without immediate attention to meaning as opposed to learning them in bits or parts with attention to meaning. For example, teaching pupils to memorize numbers or letters of the alphabet is rote learning because there is no direct or immediate connection between the alphabets and their corresponding sounds or the immediate use of numbers. Child (2004; 134) explains that: 'A

theoretical debate surrounds the subject of whether it is better to learn by small steps (Skinner) or large chunks (Gestalt psychologists). For the teacher, there is clearly a time and a place for both approaches`. Although rote learning has its limitations, for it tends to preclude the logical acquisition of further meaningful knowledge (Child, 2004); it still has its place in learning. Child (2004) expounds that:

> Any symbolic form new to the child (learner) will require rote memorization. For example, the letters of the alphabet, numbers, musical notation and chemical symbols have to be learned by heart. Basic mathematical or physical equations, causes and outcomes in history, structure and functions in biology, etc., require a combination of straight memorization and logical build from previous knowledge (p.135).

Rote learning is a technique which avoids understanding the inner complexities and inferences of the subject that is being learned and instead focuses on memorizing the material so that it can be recalled by the learner exactly the way it was read or heard. The major practice involved in rote learning techniques is "learning by repetition", based on the idea that one will be able to quickly recall the material (but not necessarily its meaning) the more it is repeated. Rote learning is used in diverse areas, from mathematics to music to religion. Although it has been criticized by some schools of thought, it is still a necessity in many situations.

- **Meaningful Learning**

Meaningful learning is the concept that learned knowledge (e.g., a fact) is fully understood to the extent that it relates to other knowledge. To this end, meaningful contrasts with rote learning in which information is acquired without regard to understanding. Meaningful learning, on the other hand, implies that there is a comprehensive knowledge of the context of the facts learned (Wade, 1997).

- **Modeling**

Modeling has been defined as 'learning by imitation' (Mager, 1968). Mager pointed out that: students learn more by imitation if the model has prestige. In educational psychology, modeling refers to the demonstration of a way of behaving to a learner in order for that behaviour to be imitated.

- **Informal Learning**

Informal learning occurs through the experience of day to day situations (for example, one would learn how to look ahead while walking because of the danger inherent in not paying attention to where one is going). It is learning from life, during a meal at table, play, exploring, etc. (Wade, 1997)

- **Formal Learning**

Formal learning is learning that takes place within a teacher-student relationship, such as in a school system. The term formal learning has nothing to do with the formality of the learning, but rather the way it is directed and organized. In formal learning, the learning or training department set out the goals and objectives of the learning (Bruner, 1960).

- **Non-formal Learning**

Non-formal learning is organized learning outside the formal learning system. For example, learning by coming together with people with similar interests and exchanging viewpoints in clubs, or in (international) youth organizations, workshops, concerts, etc.(Wade, 1997).

- **The Combined Approach**

The educational system may use a combination of formal, informal, and non-formal learning methods. In some cases (schools), students can get points that continue in the formal-learning system if they get work done in informal-learning circuits (Bruner, 1960).

- **Tangential Learning**

Tangential learning is the process by which people will self-educate themselves if a topic is exposed to them in a content that they already enjoy. For example, after playing a music-based video game, some people may be motivated to learn how to play a real instrument, or after watching a T.V show. Self-education can be improved with systematization. According to experts in natural learning, self-oriented learning training has proven to be an effective tool for assisting independent learners with the natural phases of learning (Gazzaniga, 2010)).

- **Active Learning**

Active learning occurs when a person takes control of their learning experiences. Since understanding information is the key aspect of learning, it is important for learners to recognize what they understand and what they do not. By doing so, they can monitor their own mastery of subjects. Active learning encourages learners to have an internal dialogue in

which they are verbalizing their understandings. This and other meta-cognitive strategies can be taught to a child over time. Studies within metacognition have proven the value in active learning, claiming that the learning is usually at a stronger level as a result. In addition, learners have more incentive to learn when they have control over not only how they learn, but also what they learn (Bonwell & Eison, 1991).

- **E-Learning and Augmented Learning**

E-learning refers to the use of electronic media and information and communication technologies (ICT) in education. E-learning is inclusive of, and is broadly synonymous with multimedia learning, technology-enhanced learning (TEL), computer -based instruction (CBI), computer-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) (which are also called learning platforms), m-learning, and digital educational collaboration. These alternative names emphasize a particular aspect, component or delivery method. E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite, CD-ROM, and computer–based learning, as well as local intranet/extranet and web-based learning. Information and communication systems, whether free-standing or based on either local networks or the internet in networked learning underly many e-learning processes. E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or may be instructor-led, or synchronous learning. E-learning is suited to distance learning and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term blended learning is commonly used. It is commonly thought that new technologies make a big difference in education. Many proponents of e-learning believe that everyone must be equipped with basic knowledge of technology, as well as a vehicle for reaching educational goals (Wikipedia Encyclopedia, 2013).

- **Discovery Learning**

Discovery learning is a technique of inquiry-based instruction and is considered a constructivist based approach to education. It is supported by the work of learning theorists and psychologists such as Jean Piaget, Jerome Bruner, and Seymour Papert, mentioned earlier in the work. Jerome Bruner is often credited with originating discovery learning in the 1960s, but his ideas are very similar to those of earlier writers (e.g. John Dewey). Bruner argues that “practice in discovering for oneself teaches one to acquire information in a way

that makes that information more readily viable in problem solving" (Bruner, 1961). This philosophy later became the discovery learning movement of the 1960s. The mantra of this philosophical movement suggests that we should 'learn by doing'. A discovery learning task can range from implicit pattern detection, to the elicitation of explanations and working through manuals to conducting simulations. Discovery learning can occur whenever the student is not provided with an exact answer but rather the materials in order to find the answer themselves. Discovery learning takes place in problem solving situations where the learner draws on his own experience and prior knowledge and is a method of instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments (Bruner, 1961).

- **Competency-Based Learning**

Competency-based learning or competency-based education and training is an approach to teaching and learning more often used in learning concrete skills than abstract learning. It differs from other non-related approaches in that the unit of learning is extremely fine grained. Rather than a course or a module, every individual skills/learning outcome known as a competency is one single unit. Learners work on one competency at a time, which is likely a small component of a larger learning goal. The student is evaluated on the individual competency, and only once they have mastered it do they move on to others. After that, higher or more complex competencies are learned to a degree of mastery and isolated from other topics. Another common component of competency-based learning is the ability to skip learning modules entirely if the learners can demonstrate they already have mastery. That can be done either through prior learning assessment or formative testing. Competency-based learning is learner-focused and works naturally with independent study and with the instructor in the role of facilitator. Learners often find different individuals skills more difficult than others. This learning method allows a student to learn those individual skills they find challenging at their own pace, practicing and refining as much as they like. Then they can move rapidly through other skills to which they are more adept (Hall, 1976).

- **Learning by Teaching**

Learning by teaching is a learning method that allows pupils and students to prepare and to teach lessons, or parts of lessons. It is not the same with presentations or lectures by students, as students not only convey certain content, but also choose their own methods and didactic

approaches in teaching classmates that subject. Neither is it the same with tutoring, because the teacher has intensive control of, and gives support for, the learning process in learning by teaching as against other methods. If students have to present and train new contents with their classmates, a non-linear process of collective knowledge-construction will be set up (Gartner, 1971).

- **Latent Learning**

Latent learning is a form of learning that is not immediately expressed in an overt response; it occurs without any obvious reinforcement of the behaviour or associations that are learned. Interest in latent learning arose largely because the phenomenon seemed to conflict with the widely-held view that reinforcement was necessary for learning to occur (Wade, 1997).

- **Co-operative Learning**

Co-operative learning is an approach to organizing classroom activities into academic and social learning experiences. It differs from group work, and it has been described as "structuring positive interdependence". Students must work in groups to complete tasks collectively toward academic goals. Unlike individual learning, which can be competitive in nature, students learning co-operate positively capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.). Furthermore, the teacher's role changes from giving information to facilitating students' learning. Everyone succeeds when the group succeeds. Successful co-operative learning tasks have been described as intellectually demanding, creative, open-ended, and involve higher order thinking tasks (Slavin, 1990; Gilles, 2003).

- **Collaboration**

Collaboration is working with each other to do a task. It is a recursive process where two or more people or organizations work together to realize shared goals, (this is more than the intersection of common goals seen in co-operative ventures, but a deep, collective, determination to reach an identical objective). For example, an endeavour that is creative in nature: by sharing knowledge, learning and building consensus. Most collaboration requires leadership, although the form of leadership can be social within a decentralized and egalitarian group. In particular, teams that work collaboratively can obtain greater resources, recognition and reward when facing competition for finite resources. Structured forms of collaboration encourage introspection of behavior and communication. These methods specifically aim to increase the success of teams as they engage in collaborative problem

solving. Forms, rubrics, charts and graphs are useful in these situations to objectively document personal traits with the goal of improving performance in current and future projects (Spence, 2006).

- **Problem-Based Learning**

Problem-based learning (PBL) is a student-centered pedagogy in which students learn about a subject through the experience of problem solving. Students learn both thinking strategies and domain knowledge. The PBL format originated from the medical school of thought, and is now used in other schools of thought too. The goals of PBL are to help the students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation. Problem-based learning is a type of active learning. Working in groups, students identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem. The role of the instructor (known as the tutor in PBL) is to facilitate learning by supporting, guiding, and monitoring the learning process. The tutor must build students' confidence to take on the problem, and encourage the students, while also stretching their understanding. PBL represents a paradigm shift from traditional teaching and learning philosophy, which is more often lecture-based. The constructs for teaching PBL are very different from traditional classroom/lecture teaching (Hmelo-Silver, 2004).

- **Incremental Reading**

Incremental reading is a method for learning and retaining information from reading that might otherwise be forgotten. It is particularly targeted to people who are trying to learn a large amount of information at once, particularly if that information is varied. Incremental reading works by breaking up key points of articles, often dozens or thousands of articles, into flashcards, which are then learned over an extended period. Incremental reading is based on psychological principles of long-term memory storage and retrieval (Wikipedia Encyclopedi, 2013).

- **Kinesthetic Learning**

Kinesthetic learning (also known as tactile learning) is a learning style in which learning takes place by the student carrying out a physical activity, rather than listening to a lecture or watching a demonstration. People with a preference for kinesthetic learning are also commonly known as "do-ers" (Bransford, 2000).

- **Motor Learning**

Motor learning is a 'relatively permanent" change, resulting from practice or a novel experience in the capability for responding (Guthrie, 1952). It often involves improving the smoothness and accuracy of movements and is obviously necessary for complicated movements such as speaking, playing the piano, and climbing trees; but it is also important for calibrating simple movements like reflexes as parameters of the body and environment change over time (Gazzaniga, 2010).

- **Motivation**

Motivation is a psychological feature that arouses an organism to act towards a desired goal and elicits, controls, and sustains certain goal-oriented behaviours. It can be considered a driving force; a psychological one that compels or reinforces an action toward a desired goal. For example, hunger is a motivation that elicits a desire to eat. Motivation is the purpose or psychological cause of an action. Motivation has been shown to have roots in physiological, behavioural, cognitive, and social areas. Motivation may be rooted in a basic impulse to optimize well-being, minimize physical pain and maximize pleasure. It can also originate from specific physical needs such as eating, sleeping or resting, and sex. Motivation is an inner drive to behave or act in a certain manner. These inner conditions such as wishes, desires, goals, activate to move in a particular direction in behavior (Schultz, 2010).

2.2.12 Instructional Theories

Instructional theories are theories that offer explicit guidance on how to better help people learn and develop. These are theories that focus on how to structure material for promoting the education of human beings (Reigeluth, 1999). Instructional theories differ from learning theories in that a learning theory describes how learning takes place and instructional theory prescribes how to better help people learn. Learning theories often inform instructional theory.

2.2.12 (a) Some Instructional Theorists

History abounds with scholars who have made remarkable contributions to instructional theory. They are:

- **Socrates (circa 470-399 BC)**

He introduced the method of "elenchus", where a problem is broken down into a series of questions, the answers to which gradually elicit the sought after answer. This approach is

most strongly felt today in the use of the scientific method, where hypothesis is the first stage of problem solving.

- **Aristotle (circa 384-322 BC)**

He postulated that experience is the source of knowledge and believed that knowledge was gained through experiencing the environment. He believed knowledge was associative, meaning one idea will trigger the recall of the other which is a prelude to sequential learning and schema development.

- **Plato (428/427 BC- 3348/347 BC)**

He believed people learn about ideas through reasoning. Plato taught mental discipline. He believed if we exercised our mind, our mind would strengthen; therefore, he advocated rigor and mental discipline.

- **John Locke (1632- 1704)**

He believed that skills and knowledge are acquired through example and practice, not exhaustive drills that require learners to memorize rules or principles; also, that desirable behaviours are learned by unconsciously imitating the manners of role models (Dunn, 1969).

- **Etienne Bonnot de Condillac (1715-1780)**

He emphasized the importance of using the senses to increase learning. Condillac's work is significant to the field of education because he was among the first to emphasize the importance of manipulating matter as well as ideas to construct behavioural learning, advocating a sense luscious environment to provide a stimulus response-learning environment.

- **John Dewey (1859-1952)**

He argued that in order for education to be most effective, content must be presented in a way that allows the student to relate the information to prior experiences, thus deepening the connection with this new knowledge (Bernstein, 1966).

- **Jean Piaget (1896-1980)**

He explored the changes in internal cognitive structure as well as recognizing the contribution of environment to learning. He identified four stages of mental growth (sensori-motor, preoperational, concrete operational, and formal operational) (Kesselring, 1999).

- **B. F. skinner (1904-1990)**

Skinner's theories of behaviour were highly influential on many early instructional theorists because their hypotheses can be tested fairly easily with the scientific process (Baum, 1994).

- **Benjamin Bloom (1913-1999)**

Bloom developed the Taxonomy of Educational Objective (the cognitive, affective, and psychomotor domains) - one of the first modern codifications of the learning process (Anderson & Krathwohl, 2001)

- **Jerome Bruner (1915-)**

He explored how mental processes could be linked to teaching (emphasizing, among other things, learning through discovery) (Bruner, 1960).

- **Robert Gagne (1916-2002)**

He developed a model that highlighted eight different forms of learning and in 1965 published Conditions of Learning for Florida State University's Department of Educational Research (Gagne, 1977).

- **Paulo Freire (1921-1997)**

His work is significant because of his emphasis on respectful cooperative dialogue involving people working with each other; his concern with praxis, informed action that enhances community and leads us to act in ways that make for justice and human flourishing; his attention to developing consciousness for educating the oppressed; his insistence on situating educational activity in the lived experience of participants; and his ability to transcend the divide between teachers and learners.

2.2.13 Forms of Instructional Theory

There are various facets of instructional theory, and they are:

- **Andragody**

(Originally used by Alexander Kapp- A German educator in 1883). Andragogy was developed into a theory of adult education by the American educator Malcom Knowles. The word came from the Greek (andro-) or "man" and (ago) to "lead"; so it literally means, "to lead the man". Learning strategies focus on mature learning with a mentor that encourages,

enables the mature learner by providing access to appropriate resources, and refrains from obtrusive interference.

- **Diskagogy**

A neologism developed for preschool education that focuses on schema building. Here the caregiver demonstrates factual knowledge. Caregiver observes, measures, and modifies behavioural change in specific direction. The teacher/child relationship in this scenario is one of entertainment.

- **Heutagogy**

This is the study of self-determined learning. The word appears to come from an irregular formation of the Greek words (heurista) meaning "to discover" (heuretikos) meaning 'inventive", (heuriskein) meaning 'to find", and (ago) "to lead"; so it is constructed to mean "to lead to invention, discoveries, findings" and consists of learning strategies focused on mature learners where a facilitator enables quested learning to allow for modification of existing knowledge and creation of new knowledge.

- **Pedagogy**

The word comes from Greek (pedagogue); in which (ped) means "child" and (ago) means "lead"; so it literally means " to lead the child" where a teacher develops conceptual knowledge and manages the content of learning activities. (Wikipedia Encyclopedia, 2013).

2.2.14 Other Instructional Theories

Apart from the aforementioned basic forms of instructional theory, there are other types of instructional theory based on empirical research. These are:

- **Cognitive Load Theory**

Cognitive load theory developed out of several empirical studies of learners, as they interacted with instructional materials. Sweller and his associates began to measure the effects of working memory load, and found that the format of instructional materials has a direct effect on the performance of the learners using those materials. By the mid- to late-1990s, Sweller and his associates had discovered several learning effects related to cognitive load and the design of instruction (e.g. the split attention effect, redundancy effect, and the worked-example effect (Chandler & Sweller, 1991).

- **Gagne's Theory of Instruction**

Gagne's instructional theory is widely used in the design of instruction by instructional designers in many settings, and its continuing influence in the field of educational technology can be seen in the more than 130 times that Gagne has been cited in prominent journals in the field during the period from 1985 through 1990. Synthesizing ideas from behaviourism and cognitivism, he provides a clear template, which is easy to follow for designing instructional events. Instructional designers who follow Gagne's theory will likely have tightly focused efficient instruction (Gagne, 1977).

- **Overview of Gagne's Instructional Theory**

According to Gagne, learning occurs in a series of learning events. Each learning event must be accomplished before the next in order for learning to take place. Similarly, instructional events should mirror the learning events thus:

(i) **Gaining attention**: To ensure reception of coming instruction, the teacher gives the learners a stimulus. Before the learners can start to process any new information, the instructor must gain the attention of the learners. This might entail using abrupt changes in the instruction.

(ii) **Informing Learners of the Objectives**: The teacher tells the learner what they will be able to do because of the instruction. The teacher communicates the desired outcome to the group.

(iii) **Stimulation Recall of Prior Learning:** The teacher asks for recall of existing relevant knowledge.

(iv) **Presenting the Stimulus:** The teacher gives emphasis to distinctive features.

(v) **Providing Learning Guidance:** The teacher helps the students in understanding (semantic encoding) by providing organization and relevance.

(vi) **Eliciting Performance:** The teacher asks the learners to respond, demonstrating learning.

(vii) **Providing Feedback:** The teacher gives informative feedback on the learners' performance.

(viii) **Assessing Performance:** The teacher requires more learner performance, and gives feedback, to reinforce learning.

(ix) **Enhancing Retention and Transfer:** The teacher provides varied practice to generalize the capability (Gagne, 1977).

Some educators believe that Gagne's taxonomy of learning outcomes and events of instruction oversimplify the learning process by over-prescribing. However, using them as part of a complete instructional package can assist many educators in becoming more organized and staying focused on the instructional goals.

2.2.15 InstructionalDesign

Instructional design (also called instructional system design (ISD)) is the practice of creating "instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing. The process consists of determining the current state and needs of the learner, defining the end goal of instruction, and creating some "intervention" to assist in the transition. Ideally the process is informed by pedagogically (process of teaching) and andragogically (adult learning) tested theories of learning and may take place in student-only, teacher-led or community-based settings. The outcome of this instruction may be directly observable and scientifically measured or completely hidden and assumed. There are many instructional design models but many are based on the ADDIE model with the five phases: analysis, design, development, implementation, and evaluation. As a field, instructional design is historically and traditionally rooted in cognitive and behavioural psychology, though recently constructivism (learning theory) has influenced thinking in the field (Driscoll, 2004).

2.2.16 Teaching Principles and Methods

The general assumption in the congruous relationship between teaching and learning is that teaching precedes learning. This assumption is not always true owing to the existence of various types of learning which are independent of the teaching context such as informal learning, non-formal learning, discovery learning, intuitive learning, etc. This research also has avoided this general assumption by first reviewing the learning process before the teaching process due to the fact that a thorough understanding of the complexities of the learning process can sufficiently inspire teaching. That is, as has been mentioned earlier in the preceding paragraph, learning theories inform instructional theories. Below is a review of some teaching methods:

- **Lecture**

A lecture is oral presentations intended to present information or teach people about a particular subject, for example by a university or college teacher. Lectures are used to convey critical information, history, background, theories and equations. Usually the lecturer stands

at the front of the room and recites information relevant to the lecture's content. Though lectures are much criticized as a teaching method, universities have not yet found particular alternative teaching methods for the large majority of their courses. Critics point out that lecturing is mainly a one-way method of communication that does not involve significant audience participation. Therefore, lecturing is often contrasted to active learning. Lectures delivered by talented speakers can be highly stimulating, at the very least, lectures have survived in academia as a quick, cheap and efficient way of introducing large numbers of students to a particular field of study (Driscoll, 2004).

- **Demonstration**

Demonstration involves showing by reason of proof, explaining or making clear by use of examples or experiments. Put more simply, demonstration means to clearly show. In teaching through demonstration, students are set up to potentially conceptualize class material more effectively as shown in a study which specifically focuses on chemistry demonstrations presented by teachers. Demonstrations often occur when students have a hard time connecting theories to actual practice or when students are unable to understand application of theories (Mackie & Williamson, 2007). Teachers do not only demonstrate specific learning concepts within the classroom, they can also participate in demonstration classrooms to help improve their own teaching strategies, which may or may not be demonstrative in nature.

2.3 Empirical Framework

We shall review the various theoretical developments in this work thus far, their relevance to instrumental music and the contributions of various scholars to instrumental music pedagogy.

2.3.1 Some Learning Theories and Their Relevance to Instrumental Music

No one learning theory provides all the answers to the teaching/learning process. Also all the theories put together do not provide all the answers. The only course that can be justifiably taken is a pragmatic one, choosing from among the experimental findings the points of clear relevance to our task. In most cases, psychologists are not really arguing about the findings so much as the interpretations of those findings. The relevance of the various theories of learning to instrumental music is discussed briefly here:

- **Behaviourism**

Applied behaviour analysis, a research-based science utilizing behavioural principle of operant conditioning, is effective in a range of educational settings. For example, teachers can alter student behaviour by systematically rewarding students who follow classroom rules with praise, stars, or tokens exchangeable for sundry items. Despite the demonstrated efficacy of awards in changing behaviour, their use in education has been criticized by proponents of self-determination theory, who claim that praise and other rewards undermine intrinsic motivation. There is evidence from experience that tangible rewards decrease intrinsic motivation in specific situations, such as when the student already has a high level of intrinsic motivation to perform the goal behavior. But the results showing detrimental effects are counterbalanced by evidence that, in other situations, such as when rewards are given for attaining a gradually increasing standard of performance, rewards enhance intrinsic motivation (Baum, 1994).

Thorndike's and Skinner's behavioruist theory of operant (instrumental) conditioning which emphasizes the use of adequate apparatus that blends with the learning objective, content and method has obviously implications that 'learning depends on the nearness of stimulus and response' (Ojukwu, 2011: 42). Using appropriate musical instruments in teaching instrumental music is very essential. For instance, if a teacher wants his student to distinguish between stringed instruments and woodwinds, it is worthwhile presenting samples of the various instruments for proper distinction. They should be presented at the same time as learning is taking place.

Also, operant conditioning emphasizes that a response must be made by the learner for learning to occur. And so, activities that sustain and induce learners' active participation should always be provided (Ojukwu, 2011). Ikibe (2002:102) rightly submits that, 'active musical experiences are the only ways learners can get to understand what they learn in music'. Engaging students with their various orchestral instruments in instrumental classes always and with the direct involvement and supervision of the teacher can enhance orchestral instrumental learning a great deal. Skinner's reinforcement theory can also be useful in the instrumental class if the teacher can commend his students regarding their successful instrumentation of let's say, phrasing, embouchure, articulation, legato playing, or proper interpretation of ornamented passages, etc.

Furthermore, findings from Pavlov's behaviourist theory of classical conditioning can be applied to instrumental music education by pairing music theory or class singing with the actual instrumental lessons so that the later (instrumental lessons-which they may find tedious ([neutral response]) may elicit positive learning response with the former (music theory or class singing -which they may find more interesting [positive response]).

- **Cognitivism**

Among current educational psychologists, the cognitive perspective is more widely held than the behavioural perspective, perhaps because it admits causally related mental constructs such as traits, beliefs, memories, motivations and emotions. Cognitive theories claim that memory structures determine how information is perceived, processed, stored, retrieved and forgotten (Child, 2004).

The main thrust of the cognitive school is the perception, processing, storage, and retrieval of information. This theory has enormous relevance to instrumental music. The bulk of the theoretical basis of instrumental music relies on memorizing and rote-learning instrument's classification, ranges, transpositions, compass, clef, fingering techniques, systems and charts, bowing techniques and systems, etc.

Furthermore, Piaget's cognitive theory of stages in mental development raises the issue of 'critical period' which implies that learning after this sensitive or critical period can seriously be impaired. This has serious implications for instrumental music education in the sense that instrument teachers should be sensitive to learners who may not have had instrumental learning or formal musical learning at all. Every learner should be allowed to adapt to the instrumental class at his cognitive pace and ability.

- **The Developmental School**

Developmental psychology, and especially the psychology of cognitive development, opens a special perspective for educational psychology. This is so because education and the psychology of cognitive development converge on a number of crucial assumptions. First, the psychology of cognitive development defines human cognitive competence at successive phases of development. Education aims to help students acquire knowledge and develop skills which are compatible with their understanding and problem-solving capabilities at different ages. Thus, knowing the students' level on a developmental sequence provides information on the kind and level of knowledge they can assimilate, which, in turn, can be

used as a frame for organizing the subject matter to be taught at different school grades. This is the reason why Piaget's theory of cognitive development was so influential for education, especially mathematics and science education. In the same direction, the neo-piagetian theories of cognitive development suggest that in addition to the concerns above, sequencing of concepts and skills in teaching must take account of the processing and working memory capacities that characterize successive age levels.

Also the psychology of cognitive development involves understanding how cognitive change takes place and recognizing the factors and processes which enable cognitive competence to develop. Education also capitalizes on cognitive change, because the construction of knowledge presupposes effective teaching methods that would move the student from a lower to a higher level of understanding. Mechanisms such as reflection on actual or mental actions vis-à-vis alternative solutions to problems, tagging new concepts or solutions to symbols that help one recall and mentally manipulate them are just a few examples of how mechanisms of cognitive development may be used to facilitate learning.

Furthermore, the psychology of cognitive development is concerned with individual differences in the organization of cognitive processes and abilities, in their rate of change, and in their mechanisms of change. The principles underlying intra and inter-individual differences could be educationally useful, because knowing how students differ with regard to the various dimensions of cognitive development, such as processing and representational capacity, self-understanding and self-regulation, and the various domains of understanding, such as mathematical, scientific, or verbal abilities, would enable the teacher to cater for the needs of the different students so that no one is left out (Bouton, 2007).

This theory applies constructively to instrumental music curriculum by implying that 'knowing the students level' on a developmental sequence provides information on the kind and level of knowledge they can assimilate, which, in turn, can be used as a frame for organizing the subject matter to be taught at different school grades. The instrumental and orchestral scheme should be designed to follow a developmental sequence encompassing all grades (from intermediate to advanced).

Furthermore the cognitive developmental theory has great implications for instrumental music education by virtue of its emphasis on sensitivity to individual differences in the organization of cognitive processes. In teaching instrumental music, pieces and materials for

individual studies should be presented with varying degrees of difficulty and technicality regarding the respective capabilities of the learners.

- **The Social Cognitive School**

Social cognitive theory is a highly influential fusion of behavioural, cognitive and social elements that was initially developed by educational psychologist Albert Bandura. In its earlier, neo-behavioural incarnation called 'Social Learning Theory', Bandura emphasized the process of observational learning in which a learner's behaviour changes as a result of observing others' behaviour and its consequences. The theory indentified several factors that determine whether observing a mode will affect behavioural or cognitive change. These factors include the learner's developmental status, the perceived prestige and competence of the model, the consequences to the learner's goals, and the learner's self-efficacy. The concept of self-efficacy, which played an important role in later developments of the theory, refers to the learner's belief in his or her ability to perform the modeled behaviour.

An experiment by Shchunk and Hanson, that studied grade 2 students who had previously experienced difficulty in learning subtraction, illustrates the type of research stimulated by social learning theory. One group of students observed a subtraction demonstration by a teacher and then participated in an instructional programme on subtraction. A second group observed other grade 2 students performing the same subtraction procedures and then participated in the same instructional programme. The students who observed peer models scored higher on a subtraction post-test and also reported greater confidence in their subtraction ability. The results were interpreted as supporting the hypothesis that perceived similarity of the model to the learner increases self-efficacy, leading to more effective learning of modeled behaviours. It is supposed that peer modeling is particularly effective for students who have low self-efficacy.

Over the last decade, much research activity in educational psychology has focused on developing theories of self-regulated learning (SRL) and metacognition. These theories work from the central premise that effective learners are active agents who construct knowledge by setting goals, analyzing tasks, planning strategies and monitoring their understanding. Research has indicated that learners who are better at goal-setting and self –monitoring tend to have greater intrinsic task interest and self-efficacy, and that teaching strategies can increase academic achievement (Bransford, 2000).

- **The Constructivist School**

Constructivism is a category of learning theory in which emphasis is placed on the agency and prior "knowing" and experience of the learner, and often on the social and cultural determinants of the learning process. Educational psychologists distinguish individual (or psychological) constructivism, identified with Piaget's theory of cognitive development, from social constructivism. A dominant influence on the latter type is Lev Vygosky's work on socio cultural learning, describing how interactions with adults, more capable peers, and cognitive tools are internalized to form mental constructs. Elaborating on Vygosky's theory, Jerome Bruner and other educational psychologists developed the important concept of instructional scaffolding, in which the social or information environment offers supports for learning that are gradually withdrawn as they become internalized.

The crux of this theory being that learner's interactions with adults, influential peers, and cognitive tools are internalized to form mental constructs is very meaningful to instrumental music education. For instance, learners can form early mental constructs of musical instruments, instrumentation, and even instrumental ensemble, if they are exposed as early as possible to such experience formally or informally through their social and cultural interactions. The constructivist theory of learning explains knowledge as a result of the process by which the young learner creates meaning from his or her experiences (Cambell & Scott-Kassner, 2010).

- **The Motivational School**

Motivation is an internal state that activates guides and sustains behavior. Motivation can have several impacting effects on how students learn and how they behave towards subject matter, provide direction towards goals, enhance cognitive processing abilities and performance, direct behaviour toward particular goals, lead to increased effort and energy, and increase initiation of and persistence in activities. Educational psychology research on motivation is concerned with the volition or will that students bring to a task, their level of interest and intrinsic motivation, the personally held goals that guide their behavior, and their belief about the causes of their success or failure. As intrinsic motivation deals with activities that act as their own rewards, extrinsic motivation deals with motivations that are brought on by consequences or punishments. A form of attribution theory developed by Bernard Weiner describes how students' beliefs about the causes of academic success or failure to lack of ability, and ability is perceived as uncontrollable, they experience the emotions of shame and

embarrassment and consequently decrease effort and show poorer performance. In contrast, when students attribute failure to lack of effort, and effort is perceived as controllable, they experience the emotion of guilt and consequently increase effort and show improved performance (Driscoll, 2004).

- **Kinesthetic Theory of Learning**

The crux of this theory is that learning involves a complex interplay or amalgamation of simple habits. Consequently, the mastery of an instrument is a complex amalgamation of many simple habits. Because kinesthetic learning is so basic to instrumental playing, teacher's efforts should also be directed toward building good habit patterns. For example, developing an embouchure is largely a matter of muscle movement and strength. Teachers cannot hope to establish proper embouchure if they present it once and then proceed to other activities. Embouchure must be reinforced over a long period of time, through a variety of approaches and frequent short reminders (Hoffer, 1991).

2.3.2 Principles of Musical Learning

A principle is a rule of action based upon all pertinent information. In educational circles it is a fundamental truth regarding the relationship of factors with which a teacher deals. The principle serves to express the meaning of a fact or set of facts that one can decide what course to pursue (Leonhard & House, 1972). Several learning principles have been found to be relevant and applicable to music learning even though music educators and scholars have not all agreed on all. Leonhard & House (1972) have outlined eleven (11) principles which show much relevance to musical learning. The various musical learning principles and their brief explanations are shown below:

- **Efficient learning begins with a compelling and intelligible problem**

The learner must have a purpose in view if his learning efforts are to be more than fumbling, and he gains purpose when confronted with a problem he desires to solve. The problem may be playing a piece he wishes to learn, preparing for a recital appearance, hearing harmonic changes in a passage which stirs his imagination, comprehending a chord progression, or mastering a technical difficulty in performance.

- **The learner must perceive the relationship between his learning experiences and the problem he wants to solve**

In learning music theory the student must be led to see that the skills and understandings he acquires are applicable to the refinement of his musical behavior. Likewise, the student practicing studies and exercises must perceive the relationship between his practice and expressive musical results. If this is not so, both phases of music study inevitably become sterile, routine, and monotonous and have little meaning for the student.

1. **Motivation is central to efficient musical learning**

Incentives, interest, pressures, purposes, recognition, and rewards are all involved in motivation. Musical learning has an abundance of sources of motivation. These include basic human responsiveness to music, the emotional satisfaction that comes from musical participation, the possibilities for demonstrable progressive success, and the almost universal social approval accorded musical accomplishment.

- **Learning depends upon impressions received by the senses**

In musical learning, hearing, sight and kinesthetic feel are all involved. It appears obvious that hearing merits primary emphasis, but much musical learning is carried on without sufficient attention to musical hearing. Aural awareness is the key to all musical learning, and the music-learning situation should be constantly focused on ear training. Sight and kinesthetic feel are important but properly come into play only after aural concepts are well established.

- **Provisional tries must be made in musical learning**

The learner needs the opportunity for provisional tries once he knows what he is trying to do. It should be recognized that he is likely to make more wrong tries than right ones, but he profits from his tries only if he has a conception of the musical effect he is trying to achieve. Learning proceeds from crudeness to precision, and it is a mistake to break patterns up into meaningless bits so that the learner can achieve perfection at the beginning. The pattern for efficient musical learning is (a) an aural conception of what is to be achieved, (b) provisional tries, (c) reflection on what is right and what is wrong, and (d) a decision on changes to be made in the next tries.

- **The perfection of complicated skills requires the correct forms of movement established by practice**

Practice is essential to the development of performance skills, but a great deal of practice is frequently carried on for long periods with no notion of its purpose, and repetition without learning is all too common. A problem of musical expression should initiate the development of technique, and the best technical practice is carried on in a context of actual music. Once problems of technique have been identified and understood, practice materials may be taken from the context in which the problem occurred occasionally from a book of studies. Practice is likely to result in learning if the following conditions are present: (a) the learner sees the problem; (b) the learner is conscious of the need for practice; (c) the practice material is directly related to the problem; (d) the practice is characterized by reflection, self-criticism, and further reflection; and (e) the learner participates in the selection of practice material.

- **Musical learning has a sequence of synthesis-analysis-synthesis**

Efficient musical learning is always directed at a musically intelligible whole, not toward the bits and pieces of musical structure, musical technique, or musical experience. Once a concept of the whole has been established, there begins the analysis phase during which the parts are differentiated in relation to the whole. This, in turn, leads to reorganization or restructuring of the whole, the parts, and the interrelationships among them are clarified. For example, in learning a new song by rote children should first grasp the expressive intent of the song. They hear the song, become aware of the general contour of the melody, and try to sing it. With repeated hearings and further tries at singing it they gradually refine their concept of the song. If some passages present rhythmic or melodic difficulties, they are taken out of context, worked on, and placed back into the context of the phrase in which they occur. Thus an accurate and expressive performance of the song gradually emerges.

- **Learning is active process**

Learning takes place only through activity by the learner. His activity may be mental, physical, or both, but there must be a release of energy directed at the learning problem. Efficient musical learning requires exploration and discovery of musical meaning by the student. The learner must have a sense of personal involvement in the learning problem.

- **Learning is highly individualized**

The ability to learn depends upon both native endowment and previous experience which make the individual what he is. In every group there are wide variations in musical

knowledge, understanding, skill, and in attitudes and emotions. The same teaching materials, teaching methods, and motivating devices cannot work equally well with all students. Pressure may stimulate some students but retard others. Recitals and contests undoubtedly are advantageous for some students but not for others. The clue to the individualization of the learning situation lies in understanding each student, his motives, his capacities, his purposes, and his personality.

- **Learning may transfer if generalization takes place**

The question of transfer is of crucial importance in musical learning, because unless transfer does take place, musical independence can never result. It is obvious that musical learning does occur without transfer. Evidence of this is found in the great number of musicians who learn to play a few compositions beautifully while under the guidance of a teacher but who are unable to prepare a performance independently. Likewise, learnings accruing from the music theory class frequently do not transfer to a pupil's performance. Failure to obtain transfer often results from undue concern with specifics and details, without adequate attention to deriving and applying generalizations to all phases of musical experience (Perkings & Salomon, 1992).

- **Learning is affected by the total environment of the learning situation**

Physical and social factors have a direct influence on the effectiveness of learning experiences. The learner is interacting not only with the teacher and the instructional materials and methods but with the total situation. An attractive, well-lighted, comfortable room and good equipment represent important factors in efficient learning. The social climate likewise has a potent effect on learning. The learner works more efficiently under cheerful, helpful teacher who shows interest in his progress and his problems. A feeling of security and lack of tension are important characteristics of good learning situation (Leonhard & House, 1972).

2.3.3 The Various Types of Learning and their Relevance to Instrumental Music

The various types and forms of learning and their applicability to instrumental music are discussed below:

- **Associative Learning (classical/operant conditioning)**

Associative learning is the process by which an association between two stimuli or a behaviour and a stimulus is learned. The two forms of associative learning are classical and

operant conditioning. In classical conditioning a previous neutral stimulus is repeatedly presented together with a reflex eliciting stimuli until eventually the neutral stimulus will elicit a response on its own. In operant conditioning a certain behaviour is either reinforced or punished which results in an altered probability that the behavior will happen again. Operant conditioning is simply the use of consequences to modify the occurrence and form of behaviour. Operant conditioning is distinguished from classical (Pavlovian conditioning) in that operant conditioning uses reinforcement/punishment to alter an action-outcome association. In contrast classical (Pavlovian conditioning) involves strengthening of the stimulus-outcome association. The typical paradigm for classical conditioning involves repeatedly pairing an unconditioned stimulus (which unfailingly evokes a reflexive response) with another previously neutral stimulus (which does not normally evoke the response) (Gazzaniga, 2010)..

Obviously, as mentioned earlier, learning depends on the nearness of stimulus and response (Ojukwu, 2011). Using appropriate musical instruments in teaching instrumental music is very essential. For instance, if a teacher wants his student to distinguish between stringed instruments and woodwinds, it is worthwhile presenting samples of the various instruments for proper distinction. They should be presented at the same time as learning is taking place.

Also, operant conditioning being the fulcrum of associative learning applies to instrumental music in the sense that the learner's response of handling or fiddling (an operant) with an orchestral instrument can progress (be conditioned) towards increased interest in learning the instrument as the instrument responds to simple manipulation by the learner even without direct influence of a teacher!

- **Observational Learning**

The learning process most characteristic of humans is imitation; one's personal repetition of an observed behaviour, such as dance. Recent research with children has shown that observational learning is well suited to seeding behaviours that can spread widely across a culture through a process called a diffusion chain, where individuals initially learn a behaviour by observing another individual perform that behavior, and then serve as a model from which other individuals learn the behavior (Bransford, 2000). Humans can copy three types of information simultaneously: the demonstrator's goals, actions, and environmental outcomes. Through copying these types of information, (most) infants will tune into their surrounding culture.

One can learn certain instrumental techniques by observing. Such instrumental techniques as proper posture, holding the instrument, bowing, fingering, embouchure, etc, can be learned by observing the instrumental teacher, colleague, or any experienced instrumentalist. For example, instruments of the string family (violin, viola, 'cello, and string bass) require a great deal of observation (proper posture with the instrument, hand placements on the instrument, holding the bow, fingering, and bowing) for effective learning of any of the instruments. Also such instrument as the transverse flute demand intensive observational learning (i.e., the transverse/horizontal placing of the instrument for proper embouchure).

- **Enculturation**

Enculturation is the process by which a person learns the requirements of their native culture by which he or she is surrounded, and acquires values and behaviours that are appropriate or necessary in that culture. The influences which direct or shape the individual, whether deliberately or not, include parents, other adults, and peers. If successful, enculturation results in competence in the language, values and rituals of the culture (Henry, 1988).

Music is a culture, and instrumental music is a sub-culture of music. If a learner does not receive enculturation regarding the norms of instrumental and orchestral music, he or she may have difficulties adapting. Such instrumental norms relate to the proper handling and packaging of the instruments (e.g. the stringed instruments require carriage in their boxes, should not be held at the neck, the bow should always be left loose when not in use; the valves of brass instruments should always remain oiled and never be exposed to friction or abrasion; the reeds of woodwind instruments come in various specifications with regard to player-capacity and are always wetted 10 to 15 minutes before playing; a learner who has an underbite (i.e. lower teeth in front of upper) or crooked teeth should be guided away from brasses; small students should not try large instruments; learners who have thick fingers should avoid the violin because notes in the higher positions are too close together to allow for thick fingers (Hoffer, 1991). Furthermore, learners should be aware of the various and varied roles of instruments in the orchestra, sitting positions, and the capabilities and limitations of their various instruments.

- **Episodic Learning**

Episodic learning is a change in behaviour that occurs as a result of an event. For example, a fear of dogs that follows being bitten by a dog is episodic learning. Episodic learning is so named because events are recorded into the episodic memory, which is one of the three forms

of explicit learning and retrieval, along with perceptual memory and semantic memory (Bransford, 2000).

Watching a symphony orchestra (live or recorded) or an orchestral concert could constitute episodic learning and foster interest in learning western orchestral instruments. Watching performances by some sections of the orchestra, or listening to peculiar rendition of a familiar tune, or even the virtuosity of an orchestral player can greatly motivate one towards learning an orchestral instrument.

- **Multimedia Learning**

Multimedia learning is where a person uses both auditory and visual stimuli to learn information. This type of learning relies on dual-coding theory (Mayer, 2001)**.**

Modern instrumental pedagogy employs multimedia learning a lot. There are now various audio-visual CDs that illustrate and guide learners through various stages of instruction and instrumental experience. Such audio-visual materials exist for the strings, brasses, woodwinds, percussion. Even video CDs of performances by some philharmonic orchestras around the world can serve for multimedia learning.

- **Rote Learning**

Rote learning means learning or memorizing abstract concepts in whole without immediate attention to meaning as opposed to learning them in bits or parts with attention to meaning. For example, teaching pupils to memorize numbers or letters of the alphabet is rote learning because there is no direct or immediate connection between the alphabets and their corresponding sounds or the immediate use of numbers. Child (2004; 134) explains that: "A theoretical debate surrounds the subject of whether it is better to learn by small steps (Skinner) or large chunks (Gestalt psychologists)". For the teacher, there is clearly a time and a place for both approaches. Although rote learning has its limitations, for it tends to preclude the logical acquisition of further meaningful knowledge (Child, 2004); it still has its place in learning. Child (2004) expounds that:

> Any symbolic form new to the child (learner) will require rote memorization. For example, the letters of the alphabet, numbers, musical notation and chemical symbols have to be learned by heart. Basic mathematical or physical equations, causes and outcomes in history, structure and functions in biology, etc., require a combination of straight memorization and logical build from previous knowledge (p. 135).

Rote learning is a technique which avoids understanding the inner complexities and inferences of the subject that is being learned and instead focuses on memorizing the material so that it can be recalled by the learner exactly the way it was read or heard. The major practice involved in rote learning techniques is "learning by repetition", based on the idea that one will be able to quickly recall the material (but not necessarily its meaning) the more it is repeated. Rote learning is used in diverse areas, from mathematics to music to religion. Although it has been criticized by some schools of thought, it is still a necessity in many situations (Child, 2004).

Instrumental learning obviously draws much on rote learning. For instance, memorizing note placement on staff for sight-reading and the various keys and their relative positions on the instrument are all forms of rote learning. On the place of rote learning in instrumental music, Hoffer (1991) avers:

> Rote teaching is useful in the early stages of study, because beginning students find it difficult to coordinate the mechanics of instrument playing with reading notation. Rote procedures allow the proper mechanics of playing to be assimilated without the distraction of notes. When there are no music stands, teachers can move about freely to help with fingering or playing positions. Sometimes difficult problems, such as crossing the break between registers on the clarinet, are best introduced by rote. Rote procedures are especially valuable in string classes because all string instruments are in concert pitch; all produce tone in the same manner (whether plucked or bowed), and all have most of their open strings in common (p. 243).

- **Meaningful Learning**

Meaningful learning is the concept that learned knowledge (e.g., a fact) is fully understood to the extent that it relates to other knowledge. To this end, meaningful learning contrasts with rote learning in which information is acquired without regard to understanding. Meaningful learning, on the other hand, implies there is a comprehensive knowledge of the context of the facts learned (Wade, 1997).

Employing meaningful learning to instrumental music involves applying the various abstract concepts and rudiments of music learned by rote to practical use in instrumentation. For instance, the ranges of the instruments should be played for emphasis, the various transposition equivalents of transposing instruments can be shown by playing the affected

instruments, and attempts should be made on interpreting some of the tunes scored on for the various orchestral instruments with proper attention to and application of musical dynamics, phrasing, and expression marks. The instrumental teacher plays a crucial role here for he serves as the bridge between concepts learned by rote (rote learning) and their actual interpretation and application to instrumentation (meaningful learning).

- **Modeling**

Modeling has been defined as 'learning by imitation' (Mager, 1968: 61). Mager pointed out that: students learn more by imitation if the model has prestige. Modeling is both a factor in learning as well as an aspect of instruction. In educational psychology, modeling refers to the demonstration of a way of behaving to a learner in order for that behavior to be imitated. It is by modeling that we learn how to behave in most unfamiliar situations. Regarding modeling, Mager (1968) avers that:

- Students learn more by imitation if the model has prestige (for the student)
- The student will perform more of what he has learned if he has seen the model being reinforced rather than punished for that performance.
- When a student sees a model being punished, the student will tend not to engage in the kind of behaviour that was punished.
- When a student sees a model doing things he should not do (transgressions) and there is no aversive consequence to the model, there is an increase in the probability that the student will do those undesirable things (p. 635).

Modeling tells us that if we would maximize subject matter approach tendencies in our students, we must exhibit those behaviours ourselves. Obviously modeling can enhance instrumental learning greatly if instrumental teachers can exploit its enormous advantage. The young student of an orchestral instrument can be motivated towards a successful instrumental experience if the teacher can do more than just flipping learning charts and pieces across to the student to work out. Does the instrumental teacher actually know his instrument? Does he interpret scores efficiently with the instrument? Does his student see him rehearse or perform with the instrument? Does the instrument teacher preserve some dignity and respect among people? These are just few of the factors and attributes that can influence a learner.

- **Formal Learning**

Formal learning is learning that takes place within a teacher-student relationship, such as in a school system. The term formal learning has nothing to do with the formality of the learning, but rather the way it is directed and organized. In formal learning, the learning or training department set out the goals and objectives of the learning (Bruner, 1960).

Formal learning, as the name implies, involves a formal setting, curriculum and scheme, plan, teaching-learning process, and evaluation. Although learning can still take place without these formal arrangements, they still serve their value in teaching and learning. In instrumental music for example, the following factors and principles guide the instrumental learning/teaching process: learning environment suitable for instrumental music, age of the learner and the suitable instrument, his entry behaviour (prior knowledge that may or may not be useful), learner's attitude to musical instruments and music in general, learner's health history and condition in order to avoid musical instruments that might pose health risks (some blown instruments), teacher qualification, specialization, and competence regarding orchestral instruments, appropriate materials for instrumental instruction, adequate instrumental curriculum and scheme , instrumental instructional procedures and techniques, and evaluation in individual performance studies (IPS) and orchestral.

- **Non-formal Learning**

Non-formal learning is organized learning outside the formal learning system. For example learning by coming together with people with similar interests and exchanging viewpoints in clubs, or in (international) youth organizations, workshops, concerts, etc. People can learn and even master orchestral instruments outside the confines and formalities of school or university. Churches, clubs, youth fora, band groups, music studios etc, are among the various places where non-formal learning of western orchestral instruments can take place (Wade, 1997).

Several music students are known to have shown competence in various orchestral instruments in band playing and churches before their forage into formal instrumental learning in the university.

- **Tangential Learning**

Tangential learning is the process by which people will self-educate if a topic is exposed to them in a content that they already enjoy. For example, after playing a music-based video

game, some people may be motivated to learn how to play a real instrument, or after watching a T.V show. Self-education can be improved with systematization. According to experts in natural learning, self-oriented learning training has proven to be an effective tool for assisting independent learners with the natural phases of learning (Gazzaniga, 2010).

- **Active Learning**

Active learning occurs when a person takes control of his learning experience. Since understanding information is the key aspect of learning, it is important for learners to recognize what they understand and what they do not. By doing so, they can monitor their own mastery of subjects. Active learning encourages learners to have an internal dialogue in which they are verbalizing their understandings. This and other meta-cognitive strategies can be taught to a child over time. Studies within metacognition have proven the value in active learning, claiming that the learning is usually at a stronger level as a result. In addition, learners have more incentive to learn when they have control over not only how they learn, but also what they learn (Bonwell & Eison, 1991).

Active learning of Western orchestral instruments can manifest in students who have had a rewarding instrumental exposure in their secondary schools and who consequently become music students in their tertiary learning. Having gone through the rudimentary stages of instrumental pedagogy- proper holding of the instrument, fingering, basic embouchure, tonguing, bowing, sight reading, etc. - the enthusiastic learner can actively take control, engage and guide himself through an effective learning experience even without much dependence on the teacher. The obvious drawback to active learning is that proper teacher-guidance and evaluation may be completely lost and the entire endeavour might end up unproductive.

- **Distributed Learning**

Educational psychologists have found that it is far more efficient to learn a skill in numerous short sessions than it is to learn the same thing in a few long sessions. Some psychologists refer to this principle as ‘distributed effort’, others as ‘distributed practice’ or ‘spaced practice’ (Hoffer, 1989). So it is many times more efficient to practise an instrument for one hour each day of the week than it is to practice seven hours in one day. More learning takes place in the first ten minutes of practice than takes place in the next ten, and with each additional amount of study there is a corresponding reduction in the amount learned. Hoffer,

(1989) captures further more reasons for advocating distributed learning/practice in instrumental music:

> There are several other reasons for encouraging distributed effort in teaching. First, fatigue and boredom set in during long practise sessions, and the desire to improve is diminished. Second, mistakes are more likely to be repeated in a long session and become fixed in the response pattern. Third, forgetting is a learning experience because it shows what elements have been inadequately learned. If there are additional practice sessions, these weaknesses can be overcome. Fourth, a person tends to resist immediate repetition of an act, and this resistance continues as the repletion continues. Fifth, incorrect acts are forgotten more quickly than correct ones, and spaced practice allows incorrect responses to be dropped (p. 89).

- **E-Learning and Augmented Learning**

E-learning refers to the use of electronic media and information and communication technologies (ICT) in education. E-learning is inclusive of, and is broadly synonymous with multimedia learning, technology-enhanced learning (TEL), computer -based instruction (CBI), computer-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) (which are also called learning platforms), m-learning, and digital educational collaboration. These alternative names emphasize a particular aspect, component or delivery method. E-learning includes numerous types of media that deliver text, audio, images, animation, and streaming video, and includes technology applications and processes such as audio or video tape, satellite, CD-ROM, and computer–based learning, as well as local intranet/extranet and web-based learning. Information and communication systems, whether free-standing or based on either local networks or the internet in networked learning, underly many e-learning processes. E-learning can occur in or out of the classroom. It can be self-paced, asynchronous learning or may be instructor-led, or synchronous learning. E-learning is suited to distance learning and flexible learning, but it can also be used in conjunction with face-to-face teaching, in which case the term blended learning is commonly used. It is commonly thought that new technologies make a big difference in education. Many proponents of e-learning believe that everyone must be equipped with basic knowledge of technology, as well as a vehicle for reaching educational goals (Wikipedia Encyclopedia, 2013).

E-learning can greatly enhance the learning of musical instruments by way of the learner's interaction with internet sites teaching instrumentation. Several educative sites and links now drill learners on beginner, intermediate, and advanced instrumental techniques. These internet sites come with some musically attractive and suggestive appellations as their address, for example, freegigmusic.com, 8notes.com,4barsrest.com,musiciansfriend.com,sheetmusicplus,essentialsofmusic.com, etc. several of the sites also offer free music scores and rudimentary instrumental courses to learners. Some University orchestral professors also offer free instruction on various orchestral musical instruments of their expertise. A serious student can benefit from these learning opportunities online, even though one drawback to e-learning is that there are so many uncensored materials online which can misguide the learner.

- **Discovery Learning**

Discovery learning is a technique of inquiry-based instruction and is considered a constructivist based approach to education. It is supported by the work of learning theorists and psychologists such as Jean Piaget, Jerome Bruner, and Seymour Papert, mentioned earlier in the work. Jerome Bruner is often credited with originating discovery learning in the 1960s, but his ideas are very similar to those of earlier writers (e.g. John Dewey). Bruner argues that "practice in discovering for oneself teaches one to acquire information in a way that makes that information more readily viable in problem solving" (Bruner, 1961). This philosophy later became the discovery learning movement of the 1960s. The mantra of this philosophical movement suggests that we should 'learn by doing'. A discovery learning task can range from implicit pattern detection, to the elicitation of explanations and working through manuals to conducting simulations. Discovery learning can occur whenever the student is not provided with an exact answer but rather the materials in order to find the answer themselves. Discovery learning takes place in problem solving situations where the learner draws on his own experience and prior knowledge and is a method of instruction through which students interact with their environment by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments.

Instrumental learning may not survive without discovery learning. What the orchestral instrument teacher may discuss in the instrumental class cannot always suffice for a successful instrumental experience for the learner. There is still need for the learner to further explore his instrument and make more discoveries in the privacy of his study. The essence of

individual practice comes into play here, for one rarely makes discovery as a group but during personal search. Certain instrumental techniques, dispositions and individual disabilities, which may not be evident during general instrumental classes, may be discovered during individual practice sessions. For example, some violin players quite often discover they possess natural vibrato even without any formal effort to learn it. Some brass players somehow discover, early or late, that they lack the physical abdominal strength to sustain notes for long or notes in the high registers of their instruments. Western orchestral musical instruments also are so dynamic and versatile that they demand some intricate discovery of their mechanism for mastery. For instance, the trumpet student may not completely understand the function of the tuning slide until he plays certain notes using rapid combination of valves and discovers the distuning effect of rapid combination of valves which the tuning slide helps to correct.

- **Competency-Based Learning**

Competency-based learning or competency-based education and training is an approach to teaching and learning more often used in learning concrete skills than abstract learning. It differs from other non-related approaches in that the unit of learning is extremely fine grained. Rather than a course or a module every individual skills/learning outcome, known as a competency, is one single unit. Learners work on one competency at a time, which is likely a small component of a larger learning goal. The student is evaluated on the individual competency, and only once they have mastered it do they move on to others. After that, higher or more complex competencies are learned to a degree of mastery and isolated from other topics. Another common component of competency-based learning is the ability to skip learning modules entirely if the learner can demonstrate they already have mastery. That can be done either through prior learning assessment or formative testing. Competency-based learning is learner-focused and works naturally with independent study and with the instructor in the role of facilitator. Learners often find different individual skills more difficult than others. This learning method allows a student to learn those individual skills they find challenging at their own pace, practicing and refining as much as they like. Then they can move rapidly through other skills to which they are more adept (Hall, 1976).

Competency-based learning can greatly facilitate instrumental learning by its technique of breaking the entire learning goal into structured or a hierarchy of competencies. First, competency-based learning recognizes that there exists individual dispositions and

capabilities in learning and that every learner should learn at his pace. Second, it also encourages that the content of learning should be presented in strata to the learner, that is, from the simplest, simple, intermediate, difficult, to advanced modules. Applying this to instrumental music, one discovers that the sequence in learning orchestral musical instruments (the violin family, for example) should commence from: (i) general description and identification of the body parts of the instruments with knowledge of their relative and respective functions, (ii) fixing and tuning the strings, (iii) application of rosin and bow adjustment, (iv) bowing exercises, (v) simple sightreading, and (vi) bowing and playing techniques (vibrato, spiccato, arco, pizzicato, double stop, etc). The learner can move on to any competency module if he shows improvement on the preceding module. Relating compency-based learning to the brasses (trumpet, for example), the sequence of the learning module should somewhat include such peculiar competences as valve oiling and adjustment, tonguing drills (simple tonguing, double tonguing, triple tonguing, flutter tonguing), and such advanced playing techniques as, high –register- notes articulation, split tone articulation, etc.

- **Learning by Teaching**

Learning by teaching is a learning method that allows pupils and students to prepare and to teach lessons, or parts of lessons. It is not the same with presentations or lectures by students, as students not only convey certain content, but also choose their own methods and didactic approaches in teaching classmates that subject. Neither is it the same with tutoring, because the teacher has intensive control of, and gives support for, the learning process in learning by teaching as against other methods. If students have to present and train new contents with their classmates, a non-linear process of collective knowledge-construction will be set up (Gartner, 1971).

Students usually gather as a group to learn instrumental techniques from one another or under the ‘tutelage’ of fellow students with relatively higher competence. When students engage themselves this way learning takes place. This informal setting can take the shape of discussion class, rehearsals, recitals, etc. It is also advisable and beneficial for music students to engage in industrial training or field experience of some sort in schools, churches, media institutions, etc, where they can actively get involved in teaching pupils, raising choirs, bands, or orchestra, performance and musical presentations, etc, in order to learn empirically and more field knowledge that can enhance their overall learning. For instance, the challenge

of raising a nursery choir or orchestra can spur the student into more research and knowledge in choral or instrumental music.

- **Latent Learning**

Latent learning is a form of learning that is not immediately expressed in an overt response; it occurs without any obvious reinforcement of the behavior or associations that are learned. Interest in latent learning arose largely because the phenomenon seemed to conflict with the widely-held view that reinforcement was necessary for learning to occur (Wade, 1997).

Latent learning can play a crucial role in instrumental learning in the sense that the brain is capable of memorizing and storing experiences and vast knowledge that can be retrieved later and put to use. Latent learning is the idea behind the Suzuki approach which emphasizes children be exposed to songs (folk, patriotic, didactic, classical, etc) as early as possible so that the brain can start to 'feel' and 'hear' music as early as possible and which can prove beneficial in later life. Suzuki recommended using pre-recorded music to help students learn notes, phrasing, dynamics, rhythm, and beautiful tone quality by ear. Suzuki pointed out that great artist (such as Mozart) were surrounded with excellent performances from birth, and that the advent of recording technology made this aspect of their environment possible to achieve for large numbers of 'ordinary' people whose parents were not themselves great musicians. He emphasized 'Saturation in the musical community, including attendance at local concerts of classical music, exposure to and friendship with other music students, and listening to music performed by artists (professional classical musicians of high caliber) in the home every day (starting before birth if possible.

- **Co-operative Learning**

Co-operative learning is an approach to organizing classroom activities into academic and social learning experiences. It differs from group work, and it has been described as "structuring positive interdependence". Students must work in groups to complete tasks collectively toward academic goals. Unlike individual learning, which can be competitive in nature, students learning to co-operate positively capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.). Furthermore, the teacher's role changes from giving information to facilitating students' learning. Everyone succeeds when the group succeeds. Successful co-operative learning tasks have been described as intellectually demanding, creative, open-ended, and involve higher order thinking tasks (Slavin, 1990; Gilles, 2003).

Co-operative learning, evidently, is the idea behind the tradition of grouping students (of various backgrounds and levels of study) into ensemble groups, which also include Western orchestral ensemble group, where every individual in each group is expected to work with the ideology that, 'everyone succeeds when the group succeeds' thereby, capitalizing on one another's resources and skills, evaluating one another's ideas, and monitoring one another's work. Although 'group work' or 'collaboration' is still present in co-operative learning, the difference lies in the fact that collaboration can take place formally or informally, that is, advisedly or not, but co-operative learning is usually designed to take place in certain learning experiences in order to foster positive interdependence among learners.

- **Collaboration**

Collaboration is working with each other to do a task. It is a recursive process where two or more people or organizations work together to realize shared goals, (this is more than the intersection of common goals seen in co-operative ventures, but a deep, collective, determination to reach an identical objective)- for example, an endeavour that is creative in nature- by sharing knowledge, learning and building consensus. Most collaboration requires leadership, although the form of leadership can be social within a decentralized and egalitarian group. In particular, teams that work collaboratively can obtain greater resources, recognition and reward when facing competition for finite resources. Structured forms of collaboration encourage introspection of behaviour and communication. These methods specifically aim to increase the success of teams as they engage in collaborative problem solving. Forms, rubrics, charts and graphs are useful in these situations to objectively document personal traits with the goal of improving performance in current and future projects (Spence, 2006).

The theory of group practice or collaborative learning is a relevant one in learning instruments for the obvious reason that it fosters motivation. This fact is sustained by Hoffer's submission that 'There is also motivation when students work together to learn (Hoffer, 1991: 240).

- **Problem-Based Learning**

Problem-based learning (PBL) is a student-centered pedagogy in which students learn about a subject through the experience of problem solving. Students learn both thinking strategies and domain knowledge. The PBL format originated from the medical school of thought, and is now used in other schools of thought too. The goals of PBL are to help the students

develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation. Problem-based learning is a type of active learning. Working in groups, students identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem. The role of the instructor (known as the tutor in PBL) is to facilitate learning by supporting, guiding, and monitoring the learning process. The tutor must build students' confidence to take on the problem, and encourage the students, while also stretching their understanding. PBL represents a paradigm shift from traditional teaching and learning philosophy, which is more often lecture-based. The constructs for teaching PBL are very different from traditional classroom/lecture teaching (Hmelo-Silver, 2004).

Problem-based learning (PBL) can greatly facilitate instrumental learning by virtue of its emphasis that the learner be engaged in sequential problem solving as part of his learning. This can take the form of providing students with adequate instrumental pieces and scores with varied degrees of difficulty which relate to their orchestral instruments and which they can practice during individual practice time. Sometimes the pieces and scores could be presented impromptu to the students during instrumental sessions with the objective of enhancing their responsiveness, and adaptability in handling difficulties in instrumental performance without prior preparation.

- **Incremental Reading**

Incremental reading is a method for learning and retaining information from reading that might otherwise be forgotten. It is particularly targeted to people who are trying to learn a large amount of information at once, particularly if that information is varied. Incremental reading works by breaking up key points of articles, often dozens or thousands of articles, into flashcards, which are then learned over an extended period. Incremental reading is based on psychological principles of long-term memory storage and retrieval (Wikipedia Encyclopedia, 2013).

Incremental reading or learning, an aspect of cognitivism, can prove beneficial in instrumental learning for the fact that it encourages memorization of relatively large materials for subsequent retrieval. Although all learners do not have equal capacities of long-term memory, but instrumental players have found it useful to memorize the entire sections of their pieces in the course of practicing and this usually enhances the actual sight-playing during performance. This practice is also encouraged for soloists. Some obvious reasons

inform this practice: first, one is considered to have mastered his piece if he can sing it by heart. The same applies to instrumental music; if one can memorize his piece, he can play it through. Second, in stage performance one usually encounters several uncertainties which could be handled by prior memorization of one's piece. For instance, when a player 'misses' his line in a performance (maybe a bar, a phrase, or an entire section of the work), he can easily blend back by playing from memory. When pieces get mixed up or flip off during performance, the instrumentalist can tactfully fall back to storage-retrieval dynamism of his long-term memory to complete the performance.

- **Kinesthetic Learning**

Kinesthetic learning (also known as tactile learning) is a learning style in which learning takes place by the student carrying out a physical activity, rather than listening to a lecture or watching a demonstration. People with a preference for kinesthetic learning are also commonly known as "do-ers" (Bransford, 2000).

Learning and playing western orchestral instruments involve a great deal of kinesthetic learning experience. For example, learning the trumpet involves setting up the learning environment with such requirements as oiling the instrument, fixing the music stand with the required learning chart or music score, warming the instrument with some preliminary note (low, medium, high) attacks, taking the proper posture for actual playing, taking rests in-between the entire learning period, and reversing the sequence of these activities for closure. These are all basic physical activities peculiar to instrumental learning and which are typical of kinesthetic learning.

- **Psychomotor or Motor Learning**

Psychomotor learning is the relationship between cognitive functions and physical movement. Psychomotor learning is demonstrated by physical skills such as movement, coordination, manipulation, dexterity, grace, strength, speed; actions which demonstrate the fine motor skills such as use of precision instruments or tools, or actions which evidence gross motor skills such as the use of the body in dance, music or athletic performance (Gazzaniga, 2010).

Motor learning is a 'relatively permanent" change, resulting from practice or a novel experience, in the capability for responding (Guthrie, 1952). It often involves improving the smoothness and accuracy of movements and is obviously necessary for complicated

movements such as speaking, playing the piano, and climbing trees; but it is also important for calibrating simple movements like reflexes as parameters of the body and environment change over time.

Virtually all Western Orchestral musical instruments require motor learning in their playing. String bowing, valve and tone- hole fingering, pedaling and beating on percussion instruments, and the mechanism of the lips and tongue for embouchure and tonguing in the brasses and woodwinds are all examples of motor experience.

- **Motivation**

Motivation is a psychological feature that arouses an organism to act towards a desired goal and elicits, controls, and sustains certain goal-oriented behaviours. It can be considered a driving force; a psychological one that compels or reinforces an action toward a desired goal. For example, hunger is a motivation that elicits a desire to eat motivation is the purpose or psychological cause of an action. Motivation has been shown to have roots in physiological, behavioural, cognitive, and social areas. Motivation may be rooted in a basic impulse to optimize well-being, minimize physical pain and maximize pleasure. It can also originate from specific physical needs such as eating, sleeping or resting, and sex. Motivation is an inner drive to behave or act in a certain manner. These inner conditions such as wishes, desires, goals, activate to move in a particular direction in behaviour (Schultz, 2010).

- **Transfer of Learning**

Transfer of learning/training is the extension of acquired knowledge or skill from one field to another. Hoffer (1989) explains it thus: “if you study one subject, and what you learn in that subject contributes to your understanding of a second subject, transfer of learning has taken place” (p. 37). On factors that facilitate transfer of learning, Child (2004) avers that, “The most significant finding is that where there are common factors in the content or in the procedures adopted in carrying out two tasks, transfer is possible” (p. 170). Relating the phenomenon of transfer to music, Leonhard & House (1972) assert that, “Learning may transfer if generalization takes place. The question of transfer is of crucial importance in musical learning, because unless transfer does take place, musical independence can never result” (p. 166).

The concept of transfer of learning is a major factor in instrumental learning. Students who had ‘good’ instrumental experience in their primary education easily adapt to instrumental

learning in the higher tiers of learning. For instance, playing the recorder in the primary school can facilitate transfer to Western orchestral instruments such as the clarinet, saxophone, flute, and even the brasses (trumpet, trombone, etc, if the learner is well guided). The fact is that the recorder, being a woodwind, offers the same learning principles and playing techniques intrinsic to all woodwinds such as, holding and playing posture for the instrument, embouchure, tonguing, breathing and breath support, fingering, etc. transfer of learning, also, is the idea behind Carl Orff's approach to childhood music teaching/learning by laying emphasis on using pre-band or rhythm instruments such as the marimba, vibraphone, xylophone, etc. Orff's method facilitates a sense of rhythm in young learners which can prove beneficial or 'transfer' during musical exercise in later life.

As a matter of fact all the various learning types already reviewed may not be applicable to instrumental music without 'transfer'. For instance, rote learning cannot apply to instrumental music if proper transfer of part of the learner's bulk of theoretical knowledge does not take place.

2.3.4 Learning Difficulties/Disorders and Their Implications for Instrumental Music

Learning difficulties and disorders have been described as problems which impede learning. They stem from numerous factors which tend to disrupt human physiological, neurological, biological, psychological, or emotional equilibrium. Child (2004) reports that these learning difficulties and disorders usually manifest "when learners are physically disabled, emotionally disturbed or culturally deprived, exhibit some degree of intellectual or mental disability where scholastic performance is below the average expected of a learner's age group" (p. 242). Most teachers who deal with average and below-average pupils, especially in infant and primary schools, meet children who do not seem to profit from the usual educational methods and content provided in the curriculum. Intellectual disability in the present context is being reserved for those who are slow learners. Where learners are not coping with the work normally expected of their age group, they are said to be slow learners. Child (2004) further draws attention that "teachers have, understandably, been worried about their abilities to cope with any form of special need as their training and experience have largely been devoted to normal school settings" (p. 283). The commonest learning difficulties and disorders are retardation, dyslexia (difficulty with words), autism (disability in interpreting sensory experiences, particularly hearing and seeing). Other physical disabilities that can also impair learning are muscular dystrophy, spasticism, spinia bifida, poloio,

cerebral palsy, arthritis and delicacy (Child, 2004). Certain physical conditions seriously impede learning such as, epilepsy, asthma, cystic fibrosis, haemophilia, sickle cell anaemia, congenital heart disease, diabetes, renal failure, eczema, rheumatoid disorders and lukaemia and childhood cancers. There are also mental health problems which can constitute learning disorders and difficulties such as, eating disorders, substance abuse, neurotic (depression and obsession, suicidal behaviour, excitability- apathy, hysteria and amnesia, phobias) and psychotic disorders (hallucinations, schizophrenia, delusions, bizarre behaviour which are few and far between (Child, 2004).

The implications of learning disorders and difficulties to the educational process in general is that, provision for learners with special educational needs should be part of the daily work of most teachers. Also, in the early years, any signs of decline in achievement should be monitored with an eye to some causes requiring special provision. Regarding the teaching and learning of orchestral musical instruments, the implications are numerous. For instance, learners with hearing difficulty will find it difficult adapting to normal instrumental rudiments of tone, pitch discrimination, and timbre. Learners with aphasia- a language problem which manifests as an impairment in comprehending or formulating messages probably due to central nervous system damage or dysfunction (Kirk & Gallagher (1983)- will find it very difficult reading music graded for an orchestral musical instrument. Learners with dyscalculia- unable to add or subtract ('arithmetic disorder') (Kirk & Gallagher, 1983) - will find it difficult to interpret the rhythmic values of notes in a given piece of music. Learners with aphonia (a complete loss of voice, Kirk & Gallagher, 1983) cannot adapt well to instrumental intonation that is, producing distinct tones on woodwinds and brasses. This is a factual phenomenon in music for there is a relationship between speech and intonation. Kirk & Gallagher (1983) explain further that, "the failure to produce adequate breath pressure to generate speech is usually considered to be a psychological problem rather than a physical one" (p. 300). Learners with cerebral palsy- a disorder of motor function due to brain dysfunction that, in most cases, is present at or near the time of birth (Kirk & Gallagher,1983)- have a major problem in holding and handling things (objects, gadgets, etc) and often have a variety of other problems in hearing and intellectual functioning, and consequently, social adaptation difficulties. This particular group of learners would find it very difficult holding and handling orchestral musical instruments if they were to learn them.

2.3.5 Learning Sequences in Music

Edwin E. Gordon, a research professor at the University of South Carolina's Gordon Archive, and influential researcher, teacher, author, editor, and lecturer in the field of music education, has made significant contributions to the study of music aptitudes, audiation, music learning theory, rhythm in movement and music, and music development in infants and very young children through his theory: 'Learning Sequences in Music' (Gordon, 1984a). Gordon's theory uses three basic learning sequences- skill learning, tonal content, and rhythmic content. As a method of instruction, the learning sequences are combined in various learning sequence activities which, in turn, can be combined with classroom activities. In this method a skill level cannot be achieved except in combination with a tonal or rhythmic content level. This teaching/learning method is sequential and uses the concept of audiation, Gordon's term for mentally hearing and comprehending music. What then is audiation? In the English language, imagination implies a visual mode. Since there was no word similar to imagination for the auditory mode, Edwin Gordon coined the word audiation. Audiation is to sound in the same way that imagination is to images. For example, it may involve mentally hearing and comprehending music, even when no physical sound is present. It is a cognitive process by which the brain gives meaning to musical sounds. In essence, audiation of music is analogous to thinking in a language. Developed audiation includes the necessary understanding of music to enable the conscious prediction of patterns in unfamiliar music and sound (Gordon, 1984a). Audiation is fundamental to music learning, and knowledge of its role is considered basic to an understanding of the learning sequences involved. The theory proposes that audiation is a cognitive process and the musical equivalence of thinking in language. The sole measure of musical intelligence is the ability to audiate. In contrast to aural perception, audiation takes place when music is mentally heard and understood when the physical sound is no longer present (or never has been). According to Gordon (1984a):

> Audiation is to music what thought is to speech. Audiation is "performing" a piece of music in one's mind, "the process of assimilating and comprehending (not simply rehearing) music that one has just heard performed or has heard performed sometime in the past. We also audiate when we assimilate and comprehend music we may or may not have heard, but are reading in notation or composing or improvising". Audiation is not simply replaying what was heard in one's mind; this is called "inner hearing". Inner hearing is a product, whereas audiation is a process. Audiation requires a deeper understanding of the music and is a delayed music event, in contrast

> to being an immediate music event as with inner hearing. A person with better audiation ability may be able to process a song faster than a person with poorer audiation ability. Furthermore, the brain does not process every note of a song, and the brain only chooses the important parts of the song to "perform" (p. 5).

2.3.6 The Products of Musical Learning

Leonhard & House (1972) argue that "since learning leads to changes in behavior, any analysis of the learning process must give attention to the types of behavior involved and the kinds of changes desired" (p. 132). That is, what behaviours result from musical learning? What are the indicators or 'products' of musical learning? What qualities are expected of a learner who has acquired musical learning? Several products of music education have been identified (Leonhard & House, 1972) and they all seem to apply to instrumental music learning:

- **Musical Appreciation**

Appreciation is defined as the apprehension and enjoyment of the aesthetic import of music. Appreciation includes responsiveness to all the expressive elements of music such as rhythm, harmony, melody, texture, timbre, tonality, form and phrase line. To appreciate music is to perceive its embodied meaning, to become immersed in the unfolding and development of the musical idea. Appreciation requires awareness of tonal motion and tonal tendencies, the development of expectations in the presence of musical stimuli, sensitivity to the inhibition of tonal tendencies, and, finally, awareness that one's expectations have been either fulfilled or denied. The basis for the development of appreciation lies in the cultivation of sensitivity and responsiveness to the consistent movement of music, to the undulations between intensity and release, and to the expressive import of the moving line in music. Leonhard & House (1972) explain that:

> Appreciation regrettably has come to be associated principally with listening and the "music appreciation" class. Appreciation operates in listening but it is also present in artistic musical performance, ranging all the way from the beautiful singing of an elementary school general music class to the highly developed artistry of the concert performer (p. 133).

- **Musical Understanding**

Musical understanding is defined as the ability to bring accumulated musical learning to bear on the solution of musical problems. It involves the conscious use of information, skills, appreciation, and musical concepts in a cognitive framework when one is involved in such musical endeavours as listening, performing, composition, improvisation, and music reading. The principal ingredient of musical understanding is the ability to apply consciously one's knowledge of and sensitivity to embodied musical meaning, musical structure, and musical style to all types of musical experience. It seems evident that the development of musical understanding, along with the development of musical appreciation, represents a major cornerstone of any serious programme of music education.

- **Musical Knowledge**

Knowledge, or knowing, is a construct (a complex image or idea resulting from a synthesis by the mind), while recall, or recognition, is the overt behaviour from which we infer the presence or absence of the construct (Leonhard & House, 1972). Knowledge about music, when properly associated with the development of musical appreciation, understanding, and skill, represents an important facet of musical learning. Knowledge and information not related to the expressive meaning of music, like most isolated information, have only transient meaning and are very likely to be forgotten. Knowledge about music may be extrinsic or intrinsic to musical understanding and appreciation. Much of the information included in programme notes, record covers, and music appreciation courses is not directly relevant to these behaviours but aids appreciation by strengthening belief and creating a willing attitude in the listener or performer. Thus, information about the composer's life, the circumstances and reception of the first performance of a work, and so on, although not essential to musical understanding, does have a place in musical learning. Intrinsic knowledge includes information on the nature of musical materials, knowledge of musical form and musical styles, or knowledge of the descriptive programme used by a composer for a given work. Such knowledge is essential to musical understanding and properly merits greater emphasis in music education than extrinsic knowledge.

- **Musical Skills**

Although musical skill is often considered synonymous with musical technique, the present analysis of musical learning is marked by a broader conception of skill, encompassing skills

of listening, performance skills, and music reading. Each aspect of musical skill is considered in turn:

Skills of Listening: The listening activity frequently goes no further than the development of a pleasurable response to music. The listener learns to enjoy rich tone quality, a pleasant melody, or an exciting rhythm. Hearing of this type represents a point of departure for musical learning, but we must go further than this. Listening should always be pleasurable, but it should lead to the development of the ability for tonal thinking. The skilled listener has learned to discriminate in matters of melody, rhythm, and tempo, and to apprehend large tonal patterns. His listening skill includes awareness of tonal progression, sequence, phrase, motif, and contrast.

Skills of Performance: Two problems are identifiable in learning performance skills, the problem of control and the problem of action pattern, and the key to both lies in the 'musical intention' and the 'musical conception' to be realized. Musical understanding, appreciation, and listening skills are basic to the development of performance skills. Mere proficiency or technique, however fluent, cannot function expressively without these basic learnings. The focus of all efficient learning of performance skill and of good technical practice is upon the musical meaning one desires to express, the musical goal he has in view. This means that the learner must begin performance-skill development with the clearest possible conception of his expressive purposes and shape his technique in terms of those purposes.

- **Musical Attitudes**

Attitudes are defined as general emotionalized reactions for or against a thing (Leonhard & House, 1972). They may be positive or negative, with intensity ranging all the way from strongly for to strongly against. Attitudes affect the efficiency of all learning, since they form a basic part of an individual's readiness to learn. A student with a negative attitude towards music is certain to make little or no progress in learning music unless his attitude can be changed. Musical attitudes are learned, and a change in attitude represents a change in behaviour. Musical attitudes are acquired through four major means. First, long exposure to cumulative experiences which influence the individual. For example, a student whose musical experience has resulted in pleasure, satisfying accomplishment, and approval from his peers and parents is likely to have a highly favourable attitude toward music. If, on the other hand, lack of success, frustration and ridicule from parents or peers have attended his musical experience, a negative attitude is equally probable. Second, musical attitude is

acquired through a vivid or traumatic single experience. For example, the attitude of a student formally indifferent to music may be transformed by performing under a highly inspirational conductor, or by appearing with success and acclaim in a public recital. Another student may develop negative attitude towards music as a result of an embarrassing debacle in public performance. Attitudes are also acquired as a result of emulation of a person or an organization. For example, a child is likely to reflect the attitudes which his parents or other persons he admires hold towards music. Likewise, a band member in a school where the lack of cooperation and mutual regard between the band and vocal departments generates competition and antagonism is likely to have negative attitudes towards vocal music. Finally, attitudes are formed through association. If a person likes or dislikes one factor in a situation, the entire situation may assume similar coloration. For example, as a result of persistently unrewarding experience with sol-fa syllables in a general music class, a student may develop a negative attitude toward the class, even though he may have found some of his class experiences rewarding. Similarly, through association a student's attitude toward music may reflect his like or dislike of the music teacher.

- **Musical Initiative**

Musical initiative implies active musicianship which eventuates in musical independence. A person who has developed desirable musical initiative does things with and about music. He has a consuming interest in music and has gained the knowledge, understandings, skills, and other musical competencies which enable him to further pursue musical learning on his own and to take responsibility for shaping and enriching his own musical experiences. Musical initiative develops in music learning situations in which the student has the opportunity to explore music on his own, to exercise his musical preferences, to initiate musical projects, and to analyze his own musical problems and work toward their solution. The development of musical initiative requires interest in and responsiveness to music, coupled with a broad base of musical competencies.

2.3.7 Teaching Methods and Principles Applicable to Instrumental Music

The general assumption in the congruous relationship between teaching and learning is that teaching precedes learning. This assumption is not always true owing to the existence of various types of learning which are independent of the teaching context such as informal learning, non-formal learning, discovery learning, intuitive learning, etc. The fact is that a thorough understanding of the complexities of the learning process can sufficiently inspire

teaching. That is, as has been mentioned earlier in the preceding paragraph, learning theories inform instructional theories. Below is a review of the various teaching methods and principles which relate to instrumental music:

- **Motivation**

Motivation has been defined as consisting of internal processes and external incentives which spurs us on to satisfy some need (Child, 2004). He reasons further that:

> It would be safe to say that all theorists in the field of learning either explicitly or by implication argue that a motivated creature is more likely to learn than one which is not. Pavlov has to starve his dogs and Skinner his rats and pigeons to ensure they would learn (p. 132).

A study of motivation, therefore, is crucial for a teacher. Without a knowledge of the ways and means of encouraging children's (learners') learning, knowing about their 'appetites' in the widest sense of the word, being sensitive to their interests, the teacher's task would be impossible for this purpose, most teachers place an understanding of motivation very high on their list of priorities.

- **Teacher Enthusiasm**

Since teachers can affect how students perceive the course content, it has been found that teachers who showed enthusiasm towards the course materials and students can affect a positive learning experience towards the subject. On teacher/course evaluations, it has been found that teachers who have a positive disposition towards the course content tend to transfer their passion to receptive students. These teachers do not teach by rote but attempt to find new invigoration for the course materials on a daily basis. Students who had enthusiastic teachers tend to rate them higher than teachers who did not show much enthusiasm for the course. Teachers that exhibit enthusiasm can lead to students who are more likely to be engaged, interested, energetic, and curious about learning the subject matter. Recent research has found a correlation between teacher enthusiasm and students' intrinsic motivation to learn and vitality in the classroom. Teacher enthusiasm may contribute to a classroom atmosphere full of energy and enthusiasm which feed student interest and excitement in learning the subject matter. Controlled, experimental studies exploring intrinsic motivation of college students has shown that nonverbal expressions of enthusiasm, such as demonstrative gesturing, dramatic movements which are varied, and emotional facial expressions, result in

college students reporting higher levels of intrinsic motivation to learn. Students who experienced a very enthusiastic teacher were more likely to read lecture material outside of the classroom (Child, 2004).

- **Engaging the Learner**

Scholars have argued that learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their current level of mastery. This captures their motivation and builds on previous successes to enhance learner confidence (Gagne, 1977). This is in line with Vygotsky's concept of ZPD, which can be described as the distance between the actual development level (as determined by independent problem-solving) and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers) (Vygotsky, 1978).

Vygotsky (1978) further claimed that instruction is good only when it proceeds ahead of development. Then it awakens and rouses to life an entire set of functions in the stage of maturing, which lie in the ZPD. It is in this way that instruction plays an extremely important role in development. To fully engage and challenge the learner, the task and learning environment should reflect the complexity of the environment that the learner should be able to function in at the end of learning. Learners must not only have ownership of the learning or problem-solving process, but of the problem itself. It is also important for instructors to realize that although a curriculum may be set down for them, it inevitably becomes shaped by them into something personal that reflects their own belief systems, their thoughts and feelings about both the content of their instruction and their learners. Thus, the learning experience becomes a shared enterprise. The emotions and life contexts of those involved in the learning process must therefore be considered as an integral part of learning.

- **Modelling**

Modelling has been defined as 'learning by imitation' (Mager, 1968). It should also be observed that modeling is both a form of learning and an instructional principle. Modeling as an instructional approach has proven effective in pre- school violin teaching courtesy of Dr. Schininki Suzuki of Japan. This approach emphasizes the direct imitation of the young learner's (3yr olds) mother for rudimentary violin learning/playing.

2.3.8 Various Methods of Teaching Music and Their Bearing on Instrumental Music

Teaching methods are procedures used by a teacher to organize the learning experiences of his students (Leonhard & House, 1972). There exists a plethora of teaching methods used in education but not all of them are relevant to music. Also not all teaching methods employed in music are effective in teaching instrumental music. We shall explore the various teaching methods popular in music pedagogy and draw out their relevance to instrumental music.

- **Kodaly: Inner Hearing and Music Literacy**

Zoltan Kodaly (1882-1967) was a composer, ethnomusicologist, and advocate of music education for children. He and Bela Bartok (a fellow Hungarian) collected songs in Hungary, Romania, and other parts of Southeastern Europe. Kodaly's Ph.D. dissertation was on the stanzaic structure of Hungarian folk song. He lectured on composition, harmony, counterpoint, and orchestration at the Academy of Music in Budapest from 1907 to 1940. Kodaly was also greatly concerned with the education of children and was able to install a strong system of music instruction in the schools. Basically, this involved reliance upon singing and an early attack upon music reading using the tonic sol-fa syllables. Hand signals are coordinated with the use of syllables. The stress is upon unaccompanied, a cappella work, and part singing is introduced at a very early stage. Melodic and rhythmic dictation and improvisation of parts represent integral features of the system. Pentatonic scales are used extensively because of their important relation to Hungarian folk material and a stepping stone to the smaller intervals used in other scales (Leonhard & House, 1972).

Kodaly maintained that music is the right of not only the talented but all children, who can and should develop performance, listening, and literacy skills. What relevance, then, has Kodaly's emphasis on singing, solmization, and music reading on instrumental music? This question may be narrowed down to another question for proper interpretation: Does singing facilitate or aid instrumentation?

Obviously, experience in singing can prove beneficial in playing musical instruments, particularly melodic instruments. First, Singing develops aural sensitivity and proper pitch discrimination and intonation which are rudimentary to learning and playing orchestral instruments. Also, good singing entails memorizing melodic lines of songs, vocal parts and lines using solfege syllables (solmization) and this can easily transfer to playing the melodic lines of same songs using melodic orchestral instruments such as violin, trumpet, flute, saxophone, etc.

- **Orff: Expression Through Musical Experience**

The German, Carl Orff instituted the Orff system. This system also uses the pentatonic scale, but emphasizes the use of instruments. A number of these, the so-called Orff instruments are new creations reminiscent of the familiar rhythm band instruments. These are used, along with singing, to individualize certain rhythmic, harmonic, and melodic functions. Such renditions tend to develop through elaboration and improvisation, thus extending the creative experiences of the students. One criticism of Orff's plan is that it is based upon reenactment of music history and is thus "out of tune with today's world (Leonhard & House, 1972).

Orff's insistence on using pre-band or rhythm band instruments such as vibraphone, xylophone, marimba, and various other percussion instruments as early as possible in learning music can prove very beneficial to the young learner as he can easily transfer his skill and knowledge in these instruments to Western percussion instruments such as the, timpani, glockenspiel, snare drum, etc.

- **Suziki**

The Suzuki method is a method of teaching music conceived and executed by Japanese violinist and pedagogue Shin'ichi Suzuki (1898-1998) dating from the mid-20th century. The central belief of Suzuki, based on his language acquisition theories, is that all people are capable of learning from their environment. The essential components of his method spring from the desire to create the 'right environment' for learning music. He also believed that this positive environment would also help to foster character in students. (Hermann, 1996). In the original form, it is essentially a special style of individual instruction, staffed by Dr. Suziki's large corps of approved teachers. The pupils begin at preschool age and each lesson is audited by one of their parents who is to listen and supervise the following week's practice. The early stages are taught by rote, with much listening and direct imitation of the teacher. The characteristic patterns for beginners are short, choppy figures with rapid bow strokes, which are easier to manage than long legato bowings and phrases. Pupils are occasionally brought together for festivals where several will play in unison the various compositions included within the standard course of study and already memorized. The possibilities of the Suzuki plan have been recognized and several advocates have demonstrated the techniques in various clinics (Leonhard & House, 1972).

The Suziki approach can be summarized and outlined thus for clarity:

- Saturation in the musical community, including attendance at local concerts of classical music, exposure to and friendship with other music students, and listening to music performed by artists (professional classical musicians of high caliber) in the home every day starting before birth if possible.
- Deliberate avoidance of musical aptitude tests or 'auditions' to begin music study. Suzuki firmly believed that teachers who test for musical aptitude before taking students, or teachers who look for 'talented' students, are limiting themselves to people who have already started their music education. Just as every child is expected to learn their native language, Suzuki expected every child to be able to learn to play music well when they were surrounded with a musical environment from infancy.
- Emphasis on playing from a very young age, typically starting formal instruction between the ages of 3 and 5 years old and sometimes beginning as early as two years of age.
- In the beginning, learning music by ear is emphasized over reading musical notation. This follows Suzuki's observation that in language acquisition, a child learns to speak before learning to read. Related to this, memorization of all solo repertoires is expected, even after a student begins to use sheet music as a tool to learn new pieces.
- In addition to individual playing, regular playing (including playing in unison).
- Retaining and reviewing every piece of music ever learned on a regular basis, in order to raise technical and musical ability.
- Frequent public performance, so that performing is natural and enjoyable.
- Using well trained teachers, preferably also trained in using the Suzuki materials and philosophy.

Perhaps Dr Suzuki's greatest contribution to music teaching method is his unique approach to violin teaching/learning. Although the method has come under several criticisms regarding its general technique of instruction such as that, extensive listening to and copying of recordings, and early focus on memorization lead to: compromised sight reading skills, a tendency towards rote learning and mechanistic group performance at the expense of individual musicianship, any reliance on listening to a single piece in order to learn it is not sufficient for instilling a sense of the style of the work, students may progress and find themselves studying repertoire for which they are not yet emotionally prepared; yet the method has proven to be the most effective approach to violin teaching/learning (Hermann, 1996).

Also his emphasis on learning music by ear before reading musical notation, that is, memorization of all solo repertoires, proves very beneficial in learning and playing Western orchestral instrument where the student can first memorize his pieces ('learning his piece by ear') before the actual interpretation with a musical instrument.

- **Dalcroze: Movement with a Mission and Ear Sensitivitivy**

The founder of the Dalcroze approach was Emile Jaques-Dalcroze (1865-1950), a Swiss musician who served as professor of solfege, harmony, and composition at the Geneva Conservatory. His pedagogy originated early in the twentieth century as he experimented with approaches to ear training. Although he also stressed the 'perception and comprehension' of rhythm through leaping to rhythms of improvised piano music, his eurythmics has been inaccurately described as dance (Cambell & Sott-Kassner, 2010). He astutely recognized that, despite the advanced stages of technical proficiency that his students demonstrated through the playing of their instruments, notable gaps were evident in their musical abilities. Simple rhythms were wrongly rendered, and flaws in pitch and intonation were frequent. Students were demonstrating mechanical, not musical, understanding.

Drawing from the Dalcroze model, one recognizes that a successful instrumental experience should start with proper aural training that builds ear sensitivity and proper pitch intonation. Jaques-Dalcroze believed that people were musical when they came to possess an ensemble of physical and spiritual resources and capacities comprising the ear, brain, and body (Cambell & Sott-Kassner, 2010).

It should be observed that no particular teaching method offers a comprehensive solution to every problem of music education. In fact Leonhard & House (1972) advise that:

> It must be recognized that no one method of teaching provides the solution for all music-teaching problems. Each teaching situation dictates the most appropriate method to be used, and all methods of teaching or variations and combinations of methods may be used at different times. Even though it is impossible to prescribe teaching methods for a particular situation, there seems little doubt that music education lends itself admirably to student-centered methods (p. 277).

Cambell & Sott-Kassner, 2010) even advocate for ‘a personal method’ by every music teacher:

> Despite the myriad of techniques intended to advance the musical development of children (learners), each teacher in the end chooses to incorporate those pedagogical aspects that are harmonious with his or her personal goals and definitions of music education. Often, those goals are based upon the teacher’s own musical strengths and personal preferences in music and instruction. Singers may be inclined to sing more than to move or to play, pianists may be more prone to utilize a keyboard laboratory or to accompany songs and movement on the piano, and kinesthetically oriented teachers may center their music instruction on assorted movement experiences. There is no one correct way to teach musical understanding, skills, and values, nor is there one peculiar way to approach these goals (pp. 62-63).

2.3.9 Physiological Factors in Learning Instruments

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”. 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 (p. 239)

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 regarding the choice or assignment of western orchestral instruments to students:

> 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).

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.

2.3.10 Fundamental Physiological Exercise for instrumental Techniques

Playing musical instruments demands some degree of physiological fitness and flexibility. Several scholars have made relevant contributions regarding the nature of physiological exercises that are peculiar to and most appropriate for the playing techniques of various Western orchestral instruments. Such specialized instrumental techniques as bowing, note stopping, double and triple tonguing, embouchure, etc, require special and routine exercises that can facilitate them. In brass instrument playing, for example, breath support or breath control is regarded as the most challenging playing prerequisite requiring proper exercise for proper playing of any of the instruments. Mendez (1961:10) considers breath support alone to be 40 percent of playing a brass instrument. On physiological exercises for brass playing, Hoffer (1989) recommends:

> Stand. Place a hand against the abdominal wall, filling the lungs deeply. Then with the teacher or students timing the action, blow out the smallest possible stream of air between the lips, and note the slow inward movement of the abdominal wall. If a span of ten seconds is achieved, repeat the exercise, increasing the time to fifteen seconds, then to twenty, and so on over a period of days until a span of at least sixty or even ninety seconds is reached (p. 247).

For a strengthening of muscles for breath support, Stein (1958) suggests this simple exercise, which can be done at home: “Lying on the back, feet together, toes pointed away from the body, slowly raise stiffened legs to a 90-degree angle with the body, then slowly lower again”.(p. 20)

Generally, as in singing, playing a good tone requires a relaxed and open throat and a slow, controlled airstream. Tension should be maintained in the abdominal muscles as the sound is produced. Advanced players may not require a great amount of abdominal muscle tension because they know precisely which muscles to use and how much to use them. It is usually more difficult to maintain breath support when the player’s attention is diverted to fingerings or rhythmic figures. Breath support therefore must become a habit.

2.3.11 Teacher Competency/Incompetency

The success of the entire Western Orchestral instrumental teaching/learning process invariably depends on teacher-competency. How competent is the instrumental teacher on the instruments? Modern instrumental pedagogy recommends specialized instrumental teaching, thereby creating room for mastery and specialization. That is, each instrumental teacher is expected to teach one instrument on which he shows a reasonable level of competence. This approach is professionally sound due to the difficulties and challenges Western orchestral instruments pose owing to their sophistication and versatility. Quite often have instrumental programmes failed in schools and institutions due to teacher-incompetency. Teacher-competency is not just an index of virtuosity on a musical instrument but should include a thorough grasp on the intricacies of the teaching/learning process (of concepts, theories, methodologies, etc.). Truly, not all competent instrumentalists can teach their instruments. Commenting on teacher-competency, Ekwueme (2009) avers that:

> Competency-based teacher education is not new. It is indeed an ability to demonstrate the competencies necessary to teach. Because of the unique nature of music, the performing and visual arts, there are specific skills that must be developed. The major step would be to identify the necessary competencies that can contribute towards developing a teacher who will perform as a professional in a musical, creative, knowledgeable and ethical manner (p. 45).

2.3.12 Applying Reference Materials to Instrumental Pedagogy

The need and place of instructional materials, books, instrumental scheme, as reference points in learning Western orchestral musical instruments have been highlighted by several scholars. Hoffer (1991: 241) offers some questions for instrumental teachers to consider in selecting an instruction book:

- Are there instructions on the care and use of the instrument?
- Are there accurate illustrations of posture, position, and embouchure?
- Is there a readable fingering chart?
- Is the music interesting and worthwhile?
- Are the technical problems presented logically?
- Are the directions clear and simple?
- Is some ensemble music included?
- Are recordings of some of the music available on tapes or records?
- Are suggestions on embouchure, breath support, counting, and the like made in the book?
- Are a score and a teacher's manual available?

So far, some instructional books on instrumental rudiments are available. Among them is the popular Paul Herfurth's instrumental series A tune a day from Boston Music Company, Massachusetts which offer guides and basic playing techniques and exercises on Western orchestral instruments like the violin, viola, flute, clarinet, oboe, and alto-saxophone, etc.. Several authors and publishers also make available tapes or CDs for individual practice. The success of the Suziki method in teaching/learning violin is as a result of presenting students with pre-recorded tapes and CDs as an aural model to emulate. If one picture is worth a thousand words in the visual world, perhaps one well-played phrase or piece is worth a thousand words in teaching instrumental music.

Materials and pieces for instrumental instruction can also span across various genres and styles of music. For example, renaissance, baroque, suite, jazz, classical, contemporary, popular music, folk music, etc.

2.3.13 Organizing the Instrumental Class/Group

Organizing instrumental classes or groups presents some technical challenges which instrumental teachers should be sensitive to. Hoffer (1919; 241), raises some issues regarding the technicalities involved in organizing instrumental classes:

> Instrumental classes should meet a minimum of two times a week for thirty to forty-five minutes, and each group should not exceed fifteen members. If class sizes are consistently too large, it creates adaptability problems. With strings, for instance, it takes some time just to tune fifteen instruments and the larger the number, the less time there is in which to teach and give attention to each student. Even families of instruments in the same class present problems to teachers. Just as they get ready to call out a note to the clarinets, they remember that the note will be different for the flute; when they mention fingering to the violins, they must be ready to suggest another to the cellos. Also, range problems occur when the instruments are mixed. Concert F is easy for the trumpet but either somewhat high or low for a young French horn player depending on the octave attempted.

2.3.14 Teaching Rhythm

Rhythm is the pattern of movement of music in time (The New Harvard Dictionary of Music, 1986). It is that element of music that creates variety in a given piece of music. Proper interpretation and execution of rhythm is considered a basic requirement of music education and musicianship. Hoffer (1991:245) highlights that:

> One of the first requirements of music instruction is that it teaches the execution of rhythm. Beginning students can be permitted to tap foot lightly on each beat. Unless they have quite a bit of previous musical experience, the students during the first year may continue to maintain the beat with the foot. If students have trouble performing a rhythm correctly, they can set aside their instruments and clap out the pattern. If they have trouble maintaining a steady beat, they should practice standing up, marking time, and playing the music as they march in place. A frequent problem among young students is lack of distinction between the beat they tap and the rhythmic figure they play.

He recommends that ‘Marching helps to correct this tendency` (Hoffer (1991: 245).

2.3.15 Practice

Practice is a prerequisite to high-level music performance skill (Ericsson, Krampe, & Tesch-Romer, 1993). A successful instrumental experience invariably depends on consistent practicing. The aphorism that, 'practice makes perfect` holds true here. Specific practice strategies designed to improve performance have been advocated by many scholars. Such strategies have included practicing in a place without distractions (Allgood, 1983; Pedrick, 1998), mentally preparing (Raab, 1980), practicing at a regular time each day (Allgood, 1983), singing (Jarvis, 1980), practicing a pattern using a variety of rhythms (Grieve, 1989), using the metronome, tuner, and tape recorder (Allgood, 1983), and setting goals, warming-up, and practicing slowly until the section is error free (Pedrick, 1998). The nature, sophistication, and versatility of western orchestral instruments place much demand on the learner for constant practicing. Hoffer (1991) suggests that:

> Strange as it may seem, teachers need to teach their instrumental students how to practice. Telling young students "practice thirty minutes every day" is comparable to the physical education instructor saying, "spend thirty minutes a day building up your muscles." How? Doing what? A portion of each lesson must be devoted to giving specific directions on what is to be done outside of class. Beginning students need to know how fast to play the line of music, and they should know how to check their embouchure or position. Above all, they should realize that practicing is not a 'matter of putting in time.' The emphasis should be on practicing correctly. Short practice periods with a high level of concentration are more productive for the beginning instrumentalist (p. 245).

2.4. Summary of Reviewed Literature

Several concepts, theories, ideologies, and empirical principles have been explored thus far regarding the nature of the teaching/learning of Western orchestral musical instruments. The congruous concepts of teaching and learning have been found to be highly complex processes which require proper comprehension of their intrinsic nature before effective learning/teaching can occur. For instance, when a teacher engages the learner in the teaching-learning process, so many factors (biological, psychological, physiological, and environmental, etc) come into play and network for effective learning on the part of the

learner. The brain, memory, intelligence, attitude, motivation, health condition, and the learning environment all contribute to learning. Memory is fundamental to learning in the sense that, to show that learning has taken place, we have to rely on a person's ability to remember something by either mental or physical means. Learning can also take place without formal teaching or a formal setting. Various types of learning exist and some of them bear relevance to instrumental music. For example, rote learning (learning by memorizing), meaningful learning, discovery learning, collaboration, distributed learning, etc. Several learning theories also which support instrumental teaching and learning have also been analyzed. Some of those learning theories are behaviorism (operant/classical conditioning), which were championed by Skinner and Pavlov respectively. The behaviourist school upholds instrumental teaching/learning by virtue of the fact that a learner of an orchestral instrument comes with certain potentialities that can be molded (conditioned) through the instrumentality of instruction (teaching/conditioning). The cognitive school also in rejecting the behaviourists position of the mind as a tabla rasa 'clean slate' reasoned that the mental workings and dynamics of the human brain can be effectively studied. Cognitivism uses the metaphor of the mind as computer: information comes in, is being processed, and leads to certain outcomes. The cognitive theory has offered insight and the explanation to the concept of rote or rote learning, which explains the ability of the brain to memorize abstract concepts and retain them even without an immediate meaningful application or implication. Rote learning is exhibited in instrumental learning through the memorization of pitch classes of notes, instrumental ranges, transposition ranges and equivalents of orchestral instruments, an entire piece or score of music for sight-playing, etc.

Several learning disabilities and disorders have been discovered which impair instrumental learning. For example, learners with hearing difficulty will find it a problem adapting to normal instrumental rudiments of tone, pitch discrimination, and timbre. Learners with aphasia- a language problem which manifests as an impairment in comprehending or formulating messages probably due to central nervous system damage or dysfunction (Kirk & Gallagher (1983)- will find it very difficult reading music graded for an orchestral musical instrument.

Several instructional methods have also been explored along with various specialized methods of teaching music and their relevance to instrumental music. Lecture method of teaching has been criticized as being too 'detached' (non-interactive) for instrumental music. It does not suffice to address the instrumental or orchestral class on the rudiments,

organology, or techniques of playing Western orchestral instruments without some practical tips. Some other instructional methods have been found to be more interactive and effective in handling instrumental music. For example, demonstration, modeling, engaging the learner, motivation, etc. Some specialized methods of teaching music with their significance to instrumental music have also been explored. Such specialized methods are the Suzuki, Orff, and Kodaly. Dalcroze, etc. These methods all emphasize solmization as a precursor to successful musical experience and this is beneficial to learning musical instruments as it enhances pitch discrimination as early as possible. The peculiarity of the Suzuki method is quite appreciable in violin instruction. Orff's insistence on using pre-band or rhythm band instruments such as vibraphone, xylophone, marimba, and various other percussion instruments as early as possible in learning music can prove very beneficial to the young leaner as he can easily transfer his skill and knowledge in these instruments to Western percussion instruments such as the, timpani, glockenspiel, snare drum, etc. Kodaly's insistence on using singing as a tool can prove beneficial in playing musical instruments, particularly melodic instruments. First, Singing develops aural sensitivity and proper pitch discrimination and intonation, which are rudimentary to learning and playing orchestral instruments. Also, good singing entails memorizing melodic lines of songs, vocal parts and lines using in solfege syllables (solmization) and this can easily transfer to playing the melodic lines of same songs using melodic orchestral instruments such as violin, trumpet, flute, saxophone, etc. Drawing from the Dalcroze model, one recognizes that a successful instrumental experience should start with proper aural training that builds ear sensitivity and proper pitch intonation. Jaques-Dalcroze believed that people were musical when they came to possess an ensemble of physical and spiritual resources and capacities comprising the ear, brain, and body (Cambell & Sott-Kassner, 2010).

Several concepts relating to the organology and playing techniques of the various Western orchestral musical instruments with their intrinsic complexities have also been highlighted. Such concepts as bowing techniques (pizzicato, spiccato, double stop, vibrato, arco, martelle, tremolo etc), proper embouchure for each blown instrument, tonguing techniques (simple tonguing, double tonguing, triple tonguing, flutter tonguing, split tone, etc) and several others relating to other Western orchestral instruments were also explored.

The various 'products' of musical learning (as suggested by Leonhard & House, 1972) have been highlighted as they relate to instrumental music. For instance, one aspires to posses or is expected to manifest these musical qualities after his instrumental learning at least: musical

appreciation, musical knowledge, musical understanding, musical initiative, musical skill, etc.

Certain physiological factors and exercises which affect instrumental learning were also indentified. For instance, If a student 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. These physiological considerations obviously support the idea of instrumental teachers guiding students in choosing orchestral instruments. Regarding the actual playing of Western orchestral instruments, various exercises that enhance physiological flexibility and dexterity have been recommended by scholars. For instance, for a strengthening of muscles for breath support, Stein (1958) suggests this simple exercise, which can be done at home: “Lying on the back, feet together, toes pointed away from the body, slowly raise stiffened legs to a 90-degree angle with the body, then slowly lower again” (p. 20). Generally, as in singing, playing a good tone requires a relaxed and open throat and a slow, controlled airstream. Tension should be maintained in the abdominal muscles as the sound is produced. Advanced players may not require a great amount of abdominal muscle tension because they know precisely which muscles to use and how much to use them. It is usually more difficult to maintain breath support when the player’s attention is diverted to fingerings or rhythmic figures. Breath support therefore must become a habit.

Practice has been identified as an indispensible factor in learning and mastery of Western orchestral instrument. A successful instrumental experience invariably depends on consistent practicing. Specific practice strategies designed to improve performance have been advocated and recommended by many scholars. Such strategies have included practicing in a place without distractions (Allgood, 1983; Pedrick, 1998), mentally preparing (Raab, 1980), practicing at a regular time each day (Allgood, 1983), singing (Jarvis, 1980), practicing a pattern using a variety of rhythms (Grieve, 1989), using the metronome, tuner, and tape recorder (Allgood, 1983), and setting goals, warming-up, and practicing slowly until the section is error free (Pedrick, 1998). In fact, the nature, sophistication, and versatility of western orchestral instruments place much demand on the learner for constant practicing.

Finally, the success of the entire Western Orchestral instrumental teaching/learning process somewhat depends on teacher-competency. How competent is the instrumental teacher on the instruments? Modern instrumental pedagogy recommends specialized instrumental teaching, thereby creating room for mastery and specialization. That is, each instrumental teacher is expected to teach one instrument on which he shows a reasonable level of competency. This approach is professionally sound due to the difficulties and challenges Western orchestral instruments pose owing to their sophistication and versatility. Quite often have instrumental programmes failed in schools and institutions due to teacher-incompetency. Teacher-competency is not just an index of virtuosity on a musical instrument but should include a thorough grasp on the intricacies of the teaching/learning process (of concepts, theories, methodologies, etc.).

As we have observed thus far, the teaching/learning of Western orchestral musical instruments is a complex process that requires a thorough comprehension of the plethora of concepts, theories, principles, methodologies, and standard practices surrounding the instruments and their actual teaching/learning before a successful instrumental experience can be achieved. Western orchestral instruments due to their intrinsic sophistication, dynamism, and versatility pose some difficulty in their teaching and learning. The clarinet (a woodwind), for example, has been found to possess up to three registers (chameau, clarion, and altissimo), each with different timbres. The trumpet (a brass) and the saxophone (woodwind), for example, are so dynamic that it is usually evasive to delimit their respective ranges appropriately. Defining the top end of these instruments is usually difficult because many advanced players can produce notes well above the highest notes commonly found in method books. To produce different notes on the horn, for example, one must do many things- the seven most important are pressing the valves, holding the appropriate amount of lip tension, raising the soft palate, positioning the tongue, lowering the larynx, blowing air into the instrument, and placing the hand in the bell. More lip tension and faster air produces higher notes. Less lip tension and slower air produces lower notes. The right hand, usually cupped at a “three o-clock” position in the bell, can lower the pitch; depending on how far into the bell the player puts it, by as much as a semitone in the instrument’s midrange. These are some of the issues that make the teaching and learning of Western orchestral instruments a unique and challenging endeavour.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter discusses the procedures and methods employed in carrying out the research. The discussions were done under the following sub headings: research design, population of the study, sample and sampling technique, instruments for data collection, validation of instrument, reliability of instrument, method of data collection and method of data analysis.

3.1 Research Design

The study was a survey. Survey research design is one in which a group of people or items is studied by collecting and analyzing data from people or items considered to be representative of the entire population (Nworgu, 1991). Surveys employ a variety of data gathering instruments or techniques such as the questionnaire, interviews, observation, tests, etc. The Survey design was adopted because of its suitability for the research- The teaching and learning of Western orchestral musical instruments in Nnamdi Azikiwe University, Awka.

3.2 Area of Study

This study was carried out in the Music Department of Nnamdi Azikiwe University, Awka situated in Anambra State of Nigeria. Anambra State is one of the thirty-six (36) states of the federation situated in the South-East Geo-political Zone and shares boundries with Enugu, Ebonyi, Kogi, Delta, Rivers, Imo and Abia states.

3.3 Population of the Study

The population involved all members of the academic staff and undergraduate students of the department of music, Nnamdi Azikiwe University, Awka. This includes all students involved in learning Western orchestral instruments (that is, diploma, undergraduate). Currently the music department has twelve (12) members of the academic staff and about 116 undergraduate students (diploma and regular students). The tables below show the population distribution of the academic staff and students of the Department:

Table 4: The population and ranks of the music lecturers in Nnamdi Azikiwe University, Awka (2014)

S/N	Rank	Number
1	Professor	4
2	Associate Professor	---
3	Senior Lecturer	3
4	Lecturer I	2
5	Lecturer II	3
6.	Assistant Lecturer	----
7	Graduate Assistant	----
	Total	**12**

Source: Department of Music Nnamdi Azikiwe University, Awka.

Table 5: The population and levels of Study of the music students in Nnamdi Azikiwe University, Awka. (2014).

S/N	Level of Study	Number
1	Year I	42
2	Year II	34
3	Year III	25
4	Year IV	15
	Total	**116**

Source: Department of Music Nnamdi Azikiwe University, Awka.

3.4 Sample and Sampling Technique

The sample of the study includes twelve (12) lecturers and all 116 undergraduate students (spreading from year 1 diploma students to final year students). This was done due to the small number of the total population of lecturers and students in the Department of music. Students in Masters and Ph.D levels were not included as part of the sample because learning Western orchestral instruments is not a fundamental feature of their curriculum of music studies. Based on the number of lecturers and students (128), the entire population was studied. The number of the population also formed the sampled size. Therefore, there was no need for sampling.

3.5 Instruments for Data Collection

The instrument for data collection was the questionnaire based on modified (4) points likert scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) popularly called four (4) points modified likert scale. It was used to elicit information from the respondents. These points were reflected in the questionnaire which was shared to the respondents. The questionnaire was adopted because of its appropriateness for the research. There were two sets of the questionnaires: one for the lecturers and the other for students in order to capture the views of both categories of the research population.

The questionnaire for the lecturers has seven (7) sections titled: A, B, C, D, E, F, G and some open-ended questions. Section ‘A’ is on the personal data of the respondents and their teaching experiences and it contains about ten (10) items. Section ‘B’ is on the nature of Western orchestral instruments and it contains ten (10) items. Section ‘C’ is on the criteria for assigning Western orchestral instruments to students and it contains fifteen (15) items. Section ‘D’ is on the relevance of some teaching and learning methods in the teaching and learning of Western orchestral instruments and has twelve (12) items. Section ‘E’ captures the modes of evaluating performance in Western orchestral instruments in Nnamdi Azikiwe University, Awka and it contains eleven (11) items. Section ‘F’ is on the prospects of teaching and learning Western orchestral instruments in the University, while Section ‘G’ is on the challenges of teaching and learning Western orchestral instruments and it has thirteen (13) items.

The questionnaire for the music students has the same structure as that of the lecturers and also reflects similar ideas as found in that of the lecturers but differs by the nature of

questions posed. The questions were carefully designed to capture the opinions of students who are the focus of the entire teaching and learning experience. Section 'A' is on the personal data of the respondents and their learning experiences and it contains about twelve (12) items. Section 'B' is on the nature of Western orchestral instruments and it contains ten (10) items. Section 'C' is on the criteria for choosing Western orchestral instruments by students and it contains fifteen (15) items. Section 'D' is on the relevance of some teaching and learning methods in the teaching and learning of Western orchestral instruments and has twelve (12) items. Section E is on the prospects of learning Western orchestral instruments in Nnamdi Azikiwe University, Awka and it contains ten (10) items while Section 'F' captures the challenges of teaching and learning Western Orchestral instruments in Nnamdi Azikiwe University, Awka and it contains thirteen (13) items. The research also employed oral interviews in sourcing the opinions of several respondents regarding the subject matter.

3.6 Validation of Instrument

The questionnaire was designed to reflect the research questions. It was given to the project supervisor and two other research experts along with copies of the title of study, purpose of study, scope of study, and research questions for critical examination in order to ensure that they contained all necessary information as well as to ensure that no irrelevant information were included. The corrections and comments from the validators were reflected in the final draft of the instrument.

3.7 Reliability of Instrument

The reliability of the instrument was determined through a method known as test re-test. It was achieved by administering twenty copies of the instrument on a group of people outside the target population. After an interval of two weeks, the same instrument was administered a second time on the same group of people and responses of the first and the second exercise were analyzed through the application of Spearman rank order correlation coefficient. The analysis returned coefficients of 0.8, 0.78, 0.90, 0.77, 0.76 and 0.91 for the six research questions thus, showing an average coefficient of 0.82. This implies that the instrument is 82% reliable.

3.8 Method of Data Collection

The researcher adopted direct questionnaire administration method for obvious reasons. One, it afforded the researcher the opportunity of direct contact with the respondents so that clarifications or explanations may be made where necessary. Two, it minimized the magnitude of non-response which is often associated with surveys of this nature. Three, it enabled the researcher to know immediately whether the study was succeeding or failing. It involved issuing out the questionnaire to the respondents directly and waiting for its collection after it might have been completed. The researcher was assisted in this regard by his research assistants. Out of the 138 questionnaire distributed 106 were completed and returned thus showing a response rate of 84% which was considered adequate for the study.

3.9 Method of Data Analysis

The data generated in this study were analyzed using the following statistical tools: mean rating and standard deviation, t-test for small sample, t-test for independent large sample that is, (n >/ 30). All tests were carried out at 0.05 level of significance. This being the probability level at which we are willing to risk type 1 error. The points of the scale were as follows:

Strongly Disagree (SD) = 1 point

Disagree (D) = 2 points

Agree (A) = 3 points

Strongly Agree (SA) = 4 points

CHAPTER FOUR

PRESENTATION OF DATA AND ANALYSIS

In this chapter, all data collected for this study were presented and analyzed using appropriate statistical tools of analysis. The analysis were done in two sections namely, answer to research questions and test of hypotheses. All tests were done at 0.05 level of significance which is the probability at which we were willing to risk type I error.

4.1.Demographic Features of the Respondents

The lecturers and students of the music Department, Nnamdi Azikiwe University, Awka were interviewed in this study for their opinions on problems and prospects of teaching and learning of western Orchestral musical instruments in the department. The personal data of these respondents were presented on Tables 1 and 2 as shown below:

Table 6: Demographic Characteristics of the Lecturers

Sex	Rank	Length of service (in years)				Sum	Total	%
		0-5	6-10	11-15	16+			
Male	Graduate Assistant Assistant lecturer Lecturer II Lecturer I Senior lecturer Associate professor Professor	1	1	1	1	1 2 1	(4)	50.0
Female	Graduate Assistant Assistant lecturer Lecturer II Lecturer I Senior lecturer Associate professor Professor	1 1		1	1	1 1 2	(4)	50.0
	Total	3	1	2	2		8	100

Source: field Survey, 2014.

The analysis on Table 3 above shows that four male and female lecturers each were contacted during the field work. Out of the eight lecturers contacted, three of them are professors, two senior lecturers, one lecturer I and two lecturer II. The Table also shows that three out of the lecturers interviewed have lectured in the department between 0 and 5 years, one between 6

and 10 years, two between 11 and 15 years and 2 for 16 years and above. Thus, showing that about 62.5% have lectured in the department for at least 6 years and above.

Regarding the number of students under lecturers' instrumental supervision, some level of lopsidedness was observed. Whereas some lecturers said they have one or five students under their supervision, some said they are supervising as much as fifteen and twenty-one students. The orchestral musical instruments available for use in the department include clarinet, tenor sax, violin, viola, 'cello, trumpet, Euphonium and French Horn. It was also found that most of the lecturers meet with the students under their supervision once every week for the instrumental supervision.Also, some personal data of the students were collected and analyzed; the results are presented on Table 2 below:

Table 7: Personal Data of the Students

Sex	Early Music Experience (Nur/Pri/Sec)	Level of study					Total	(%)
		Diploma	100	200	300	400		
Male	Yes	2	2	7	3	5	19	20.2
	No	10	7	11	5	5	38	40.4
Female	Yes	-	2	2	3	4	11	11.7
	No	4	5	8	7	2	26	27.7
	Total	16	16	28	18	16	94	100

Source: Field Survey, 2014

The analysis on Table 4 above shows that 19 (20.2%) of the students interviewed who are male across all levels of study at the undergraduate level, have had early music experience before being admitted into the university to study music. On the other hand, 38 (40.4%) of them have not had any pre-knowledge of music before being admitted into the university. as for the female students, 11 (11.7%) have had pre-knowledge of music as a subject while 26 (27.7%) have not had any. Thus, showing that overall, 31.9% of the entire music students at the undergraduate levels are those that have had pre-knowledge of music as a course of study before being admitted into the university to study music.

In a related development, about 70% of the students said they chose music as their course of study in the university because of their passion and drive for the subject.

4.2 Weights and Class Limits of the Likert Scale

Statistically speaking, the class boundaries of each class represent the actual limits of the class both the lower and the upper limits. It is also usual in statistics to use the class boundaries in computing statistical averages rather than the absolute values. For example, the weight attached to 'strongly agree' as a response option as shown in Table 5 below is four (40 points but statistically, it is the tradition to treat the 4 points as starting from 3.5 to 4.5 as the actual lower and upper class boundaries respectively (Spiegel and Stephens, 2006).

Table 8: Weights and Class Limits of the Likert Scale

Response Option	Weight	Class Limit
Strongly Agree	4	3.5-4.5
Agree	3	2.5-3.5
Disagree	2	1.5-2.5
Strongly Disagree	1	0.5-1.5

Average: 2.5

From the modified Likert Scale presented on Table 5, any item that did not measure up to 2.5 is rejected while those that measure up to 2.5 and above are accepted.

4.3 Research Questions

In this section, efforts were made to answer the research questions raised to guide the study. The statistical tools used in this regard were the mean rating and standard deviation as well as simple summary statistics of percentages. Data resulting from Research Question One (RQ1) did not require any statistical analysis and thus was presented the way it came from the source.

4.3.1 Research Question One (RQ1)

What are the Western orchestral musical instruments that exist in the Department of Music, Nnamdi Azikiwe University Awka?

This research question sought to find out the types, number and adequacy of the Western orchestral musical instruments that exist in the Department so we can determine if they are relevant factors in the teaching and learning of Western orchestral musical instruments in the department. The data is presented on Table 5 below:

Table 9: Western Orchestral Musical Instruments existing in the Department of Music Nnamdi Azikiwe, University, Awka.

Class of Instrument	Number of Adequate Ones	Total
Strings	1 Violoncello, 1 viola	2
Woodwinds	2 Alto Sax, 1Tenor sax	3
Brass	2 Trumpets, 1Trombone,1French Horn, 1 Euphonium	5
Percussion	Nil	0

Source: Inventory of Musical Instruments (Department of Music, Nnamdi Azikiwe University, Awka). 2014.

From the table above, it is remarkable that very few Western orchestral musical instruments exist in the Department. There are no violins and string basses in the string family. Flutes, oboes, piccolos, clarinets and soprano saxophones are missing in the woodwinds. The brass family is lacking in cornets, tuba and bassoon, among others. There is no existence of any Western orchestral percussion instrument such as cymbals, kettledrums, triangle, bass drum, snare drums etc.

4.3. 2 Research Question Two (RQ2)

Is there a relationship between the nature of Western orchestral musical instruments and the challenges in teaching and learning them?

This research question sought to determine whether there is any significant difference in the opinion of the respondents (lecturers and students) on the nature of Western orchestral musical instruments in order to make both teachers and learners more knowledgeable on the peculiarity of the instruments. The responses are presented in Table 6.

Table 10: Mean Rating and Standard Deviation of the Respondents on the Nature of Western Orchestral Musical Instrument.

S/N	Items	Students $\bar{X}_1$			Lecturers $\bar{X}_2$		
			SD_1	Decision		SD_2	Decision
1	Western orchestral musical instruments are highly sophisticated musical instruments	3.10	1.56	Agreed	3.00	1.42	Agreed
2	As a result of their sophistication, some orchestral instruments pose serious difficulty in learning	3.50	1.48	Strongly agreed	3.21	1.39	Agreed
3	Some orchestral instruments are more suitable for female students than for male students	3.70	1.68	Strongly agree	3.50	1.59	Strongly agreed
4	Some orchestral instruments are more suitable for male students than for female students	3.41	1.62	Agreed	3.61	1.52	Strongly agreed
5	It is proper for students to study the acoustics of any orchestral instrument as a prerequisite to learning it	3.56	1.49	Strongly agreed	3.52	1.38	Strongly agreed
6	The scientific precision in the acoustics and design of Western orchestral instruments demand that the student must begin with a genuine copy.	3.92	1.84	Strongly agreed	3.41	1.62	Agreed
7	Genuine Western orchestral instruments are hardly affordable	3.08	1.42	Agreed	3.04	1.24	Agreed
8	The dynamic ranges of some Western orchestral instrument are inexhaustible and this factor poses a challenge in mastering the instruments.	3.04	1.24	Agreed	3.00	1.42	Agreed
9	Western orchestral instruments come in various pitch categories (soprano, alto, tenor, baritone, and bass) and this feature makes the instruments suitable to learners of different pitch preferences.	2.91	1.19	Agreed	2.51	1.17	Agreed
10	Most Western orchestral instruments are transposing and this sometimes poses some problems in interpreting pieces in various keys.	3.88	1.77	Strongly agreed	3.42	1.52	Agreed

$X_1 = 3.41$; $SD_1 = 1.53$; $n_1 = 94$: $= 3.22$; SD_2 1.43; $n_2 = 8$

The mean ratings of the respondents showed that students strongly agreed with 5 items namely, 2, 3, 5, 6 and 10 and merely agreed with other items, while the lecturers strongly agreed with 3 items namely, 3, 4 and 5 and merely agreed with others. It is remarkable that no item was disagreed with on the average.

4.3.2 Research Question Three (RQ3)

What are the criteria for assigning Western orchestral musical instruments to students? This research question is about the suitability of the criteria for assigning Western orchestral musical instruments to students. Respondents opinion presented in form of mean ratings and standard deviation are shown on Table 7.

Table 11: Mean Ratings of the Respondents Concerning the Suitability of Criteria for Assigning Western Orchestral Musical Instruments to Students

S/N	Item	Lecturers		
		Mean	SD	Decision
1	The most important point to consider in assigning an instrument is the students desire	3.67	1.62	Strongly agreed
2	It is proper to administer physical check, drill or adaptability test on the students before approving orchestral instruments for them	3.96	1.84	Strongly agreed
3	Orchestral instruments should be approved for students using random sampling to ensure no instrument is left out	2.04	1.21	Disagreed
4	Students with thick fingers should avoid playing the violin	2.00	1.22	Disagreed
5	Students with an underbite (lower teeth in front of upper) or crooked teeth should not choose any of the brasses.	3.04	1.24	Agreed
6	Small students should not try large instruments	3.49	1.45	Agreed
7	Students whose pitch sense is below average should especially avoid strings, piccolo, French horn, and trombone	1.79	1.55	Disagreed
8	Lecturers should guide students in instrument selection but should not require that a student take a particular instrument or none at all.	3.08	1.56	Agreed
9	A student can become proficient on an instrument while appearing to defy all the physical criteria	2.95	1.62	Agreed
10	The number of students encouraged to begin on each instrument should be in proportion to instrumentation needs of the Music Department	3.39	1.47	Agreed
11	There is usually a high incidence of dropping out among students who begin on an instrument other their first choice	3.11	1.48	Agreed
12	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later	3.38	1.81	Agreed
13	Students with shallow breaths should avoid the woodwinds and brasses	3.47	1.52	Agreed
14	Students with short arms should not choose from the cello and string bass.	3.21	1.19	Agreed
15	Students should first attempt every other Western orchestral instrument before choosing one	2.15	1.48	Disagreed
	Average	2.98	1.48	Agreed

The mean ratings of lecturers presented on Table 7 shows that they strongly agreed with the statements of items 1 and 2 and merely agreed with items 5, 6, 8,9,10,11,12,13 and 14. However, they disagreed with the statement of items 3, 4, 7, and 15. On the average, the respondents agreed with all the items with an average mean score of 2.98 and 1.48 standard deviation. The statements strongly agreed with include the following: the need to consider the students desire before assigning an instrument to him or her and the need to administer physical check, drill or adaptability test on the students before assigning or approving orchestral instruments for them. On the whole, the responses indicate that the criteria are quite suitable and are focused on producing competent students in Western orchestral musical instruments.

4.3.3 Research Question Four (RQ4)

What are the methods adopted in teaching Western orchestral musical instruments in the Department? This research question is concerned with the relevance of the methods adopted in teaching Western orchestral musical instruments in the department. The responses obtained are presented in Table 8.

Table 12: Mean Ratings of the Respondents on Relevance of Teaching Methods Adopted

S/N	Items	Students $\bar{X}_1$			Lecturers $\bar{X}_2$		
			SD_1	Decision		SD_2	Decision
1	Poor teaching and learning methods hamper effective teaching and learning of Western orchestral instruments	3.75	1.71	Strongly agreed	3.20	1.62	Agreed
2	The first approach to effective teaching and learning of Western orchestral instruments is to provide the 'right environment'(instrument rooms and practice chambers with proper acoustics)	3.91	1.81	Strongly agreed	3.31	1.73	Agreed
3	Carl Orff's emphasis on pre-band instruments (recorder, harmonica, marimba) to weed out the less talented and less interested students should be applied in the Music Department of Nnamdi Azikwe University, Awka	3.69	1.68	Strongly agree	2.25	1.23	Disagreed
4	Teaching musical Instruments should involve rhythmic activity, rudiments of music, record listening, aural training, sight reading, and sight	3.02	1.48	Agreed	3.97	1.91	Strongly agreed

	playing						
5	Rote learning (learning or memorizing abstract concepts in whole without immediate attention to meaning) has little or no relevance in learning orchestral instruments	3.51	1.47	Strongly agreed	3.48	1.56	Agreed
6	It is possible to master an orchestral instrument informally without any formal teacher-student setting	3.10	1.62	Agreed	3.46	1.49	Agreed
7	The Suzuki approach of commencing string teaching from infancy (3years) may not be applicable in teaching Nigerian undergraduate music students	3.40	1.56	Agreed	3.11	1.38	Agreed
8	Instrumental music teaching can be considered successful only if it produces students who can play their instruments expressively, read music readily, play by ear, and who have musical understanding	2.97	1.50	Agreed	2.40	1.21	Disagreed
9	Lecturers should not give students so much attention on their orchestral instruments but should teach the basics of the instruments and allow them to take control of their learning experiences (Active learning)	2.31	1.40	Disagreed	2.46	1.42	Disagreed
10	Students should be left on their own with their orchestral instruments so they can make personal discoveries on their instruments (discovery learning)	2.28	1.21	Disagreed	2.40	1.14	Disagreed
11		2.47	1.42	Disagreed	1.96	1.08	Disagreed

$\bar{X}_1 = 3.13$; $Sd_1 = 1.53$; $n_1 = 94$; $\bar{X}_2 = 2.91$; Sd_2 1.91; $n_2 = 8$

Mean ratings of the respondents (students and lecturers) showed that students strongly agreed with items1, 2, 3 and 5 and merely agree with items 4, 6, 7 and 8 while disagreeing with items 9, 10 and 11. On the other hand, the lecturers strongly agreed with item 4 only, merely agreed with items 1, 2, 5, 6 and 7. They disagreed with items 3, 8, 9, 10 and 11. The result showed further that on the average, both students and the lecturers agreed with all the items with mean ratings of 3.13 and 2.91 respectively. Issues raised in research question include: the negative effect of poor teaching methods on learning Western orchestral instruments, the need to provide the 'right environment' for the teaching and learning of the instruments, the

need to involve rhythmic activity, rudiments of music, record listening, aural training, sight reading and sight playing exercises among others.

It is worth mentioning that the opinion of the students did not differ significantly on what should be the proper teaching methods as the mean ratings and standard deviation has revealed. It was agreed by both the students and the lecturers that the need for right environment for the teaching and learning of the instruments should not be neglected.

4.3.4 Research Question Five (RQ5)

What are the modes of evaluating the performance of the students in the learning of Western Orchestral musical instruments in the Department? Research question four is on the effectiveness of modes of evaluating the performance of the students on Western orchestral musical instruments in the department. Respondents' opinions are presented on Table 9.

Table 13: Mean Rating and standard deviation of Respondents on Effectiveness of Modes of Performance Evaluation in the use of Western Orchestral Instruments.

S/N	Item	Lecturers		
		$\overline{X}$	SD	Decision
1	It is proper to assess or evaluate students' performance on their orchestral instruments periodically	3.92	1.81	Strongly agreed
2	There appears to be no standard mode of evaluation for students' performance on their orchestral instruments in Nnamdi Azikiwe University, Awka	2.21	1.41	Disagreed
3	Generally students should be assessed on their orchestral instruments based on these fundamental criteria: fingering, articulation, phrasing, accuracy, attack, and sightreading	3.67	1.62	Strongly agreed
4	The aformentioned modes of evaluation are not always reliable in assessing students' competence	1.95	1.23	Disagreed
5	Lecturers can assess their students' performance using other modes of evaluation of their choice	3.08	1.56	Agreed
6	Even when there are acceptable modes of evaluation among adjudicators in a panel of evaluation or examination, the respective assessments of the adjudicators become too subjective to yield a reliable result	2.59	1.25	Agreed
7	The lack of a standard mode of evaluation and the unreliability of the respective adjudicators assessments pose serious difficulties in grading students' performance on Western orchestral instruments in Nnamdi Azikiwe University, Awka	3.10	1.48	Agreed
8	Enthusiastic students can still improve on their orchestral instruments irrespective of evaluation	3.75	1.68	Strongly agreed

9	Monitoring supervisor-student contacts and ensuring inter-adjudicator objectivity during final evaluation should be taken seriously	3.50	1.48	Strongly agreed
10	The impressions gathered by lecturers of individual student's progress during periodic scheduled contacts does not properly reflect the semester's continuos course assessment (CA) score for the student's performance on his orchestral instrument	1.47	1.09	Disagreed
11	Each lecturer should provide the continuous assessment (CA) score for each student assigned to him for final computation of evaluation grades based on the student's performance while in contact with him as scheduled and not by the panel of adjudicators	3.79	1.71	Strongly agreed
	Average	3.00	1.48	Agreed

Mean rating of the respondents shown on Table 7 indicate that they strongly agreed with five items, namely: items 1, 3, 8, 9 and 11; merely agreed with items 5, 6 and 7. They disagreed with items 2, 4 and 10. On the average, the respondents agreed with all the statements with a mean rating of 3.00 and 1.48 standard deviation. Highlights of the items under consideration include the need to evaluate students' performance on the orchestral instruments periodically, the perception of absence of standard mode of evaluation for students' performance and the impression that the modes of evaluation are not always reliable in assessing students' competence among other issues.

4.3.5 Research Question Six (RQ6)

What are the prospects in the teaching and learning of Western orchestral instruments in the Department? Research question five seeks to know whether there are prospects of teaching and learning Western orchestral musical instruments in the department. The respondents' opinions are presented on Table 11.

Table 14: Mean Ratings of the Respondents on the Prospects in Teaching and Learning Western Orchestral Instruments.

S/N	Items	Students			Lecturers		
		$\bar{X}_1$	SD_1	Decision	$\bar{X}_2$	SD_2	Decision
1	Every student can adapt to learning a Western orchestral instrument	3.13	1.43	Agreed	3.52	1.43	Strongly agreed
2	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later	3.67	1.62	Strongly agreed	3.25	1.39	Agreed
3	Students still forge ahead in learning and mastering their Western orchestral instruments despite the challenges	3.96	1.84	Strongly agreed	3.11	1.28	Agreed
4	Although there are no instructors for some Western orchestral instruments in the Music Department, but there is improvement in the handling of some of the available ones	3.96	1.84	Strongly agreed	3.27	1.41	Agreed
5	Students should be encouraged to take up voice, piano, or any Western orchestral instrument for their stress area to foster mastery	3.88	1.75	Strongly agreed	3.47	1.49	Agreed
6	Students will improve quite well in their orchestral instruments if they are provided with adequate practice rooms with sound proof cubicles and recordings for playback of their given pieces	3.79	1.68	Strongly agreed	3.92	1.61	Strongly agreed
7	Students will not improve on their orchestral instruments if there is no motivation and scheduled contact with their respective tutors	3.87	1.77	Strongly agreed	3.84	1.58	Strongly agreed
8	Some students can do well on their orchestral instruments if they change their negative attitude toward learning	3.50	1.48	Strongly agreed	3.67	1.67	Strongly agreed
9	The University can aid the teaching and learning of Western orchestral instruments if provision is made for the unavailable Western orchestral instruments and employ lecturers specializing in those instruments	3.75	1.68	Strongly agreed	3.71	1.59	Strongly agreed
10	The Music Department can facilitate students' improvement on orchestral instruments by engaging them in concerts and performances within and outside the University	3.67	1.42	Strongly agreed	3.89	1.48	Strongly agreed

The mean ratings of the respondents show that respondents (students and lecturers) strongly agreed with most of the items. The students agreed with nine items, namely: items 2, 3, 5, 6, 7, 8, 9 and 10 and merely agreed with item 1 only. Also, the lecturers strongly agreed with six items namely, items 1, 6, 7, 8, 9 and 10 and merely agreed with items 2, 3, 4 and 5. Overall, the respondents strongly agreed with all the items with an average of 3.72 and 1.65 standard deviation for the students and 3.57 with standard deviation of 1.49 for the lecturers. This is an indication that there are prospects for the teaching and learning of Western orchestral musical instruments in the department.

4.3.6 Research Question Seven (RQ7)

What are the problems militating against the effective teaching and learning of Western orchestral instruments in the Department? This research question seeks to determine whether there is any significant difference in the opinion of the respondents concerning the problems that militate against the teaching and learning of Western orchestral musical instruments in the department. The mean rating of the respondents are presented in Table 10.

Table 15: Mean Ratings of the Respondents on Problems Militating against the Teaching and Learning of Western Orchestral Musical Instruments in the Department.

S/N	Items	Students			Lecturers		
		$\overline{X}_1$	SD_1	Decision	$\overline{X}_2$	SD_2	Decision
1	Instrumental teachers face conditions different from those encountered by choral music teachers	3.50	1.41	Strongly agreed	3.42	1.56	Agreed
2	Instrumental music involves a conglomeration of fingerings, embouchures, bowings, and other specialized techniques and knowledge	3.71	1.59	Strongly agreed	3.68	1.49	Strongly agreed
3	The string teacher must be familiar with these bowing techniques for efficacy: *pizzicato, spiccato, vibrato, detache', staccato,tremolo, portato, col legno, sul ponticello,*double stop etc.	3.74	1.69	Strongly agreed	3.70	1.50	Strongly agreed
4	The brass teacher should be familiar with these techniques before he can effectively motivate his students: embouchure, tonguing, breath control, double tonguing, triple tonguing, flutter tonguing, transposition, range, split tone, pedal tone, microtones, and overtones	3.09	1.43	Agreed	3.74	1.58	Strongly agreed
5	Teaching woodwinds demands similar knowledge in the brasses but for reed types and their relative sizes,	3.48	1.54	Agreed	3.63	1.40	Strongly agreed
6	In teaching the percussions, one should be knowledgeable in all orchestral percussion	3.44	1.15	Agreed	3.40	1.50	Agreed

	instruments such as, timpani/kettledrums, glockenspiel, xylophone, celesta, chimes, cymbals, mallets, bass drum, snare drum etc.						
7	Each orchestral instrument should be taught by a lecturer who specializes in that.	3.91	1.26	Strongly agreed	3.00	1.31	Agreed
8	When there is no teacher for a given orchestral instrument, the instrument should be handled by any other teacher	3.21	1.45	Agreed	3.01	1.37	Agreed
9	Any lecturer can teach any orchestral instrument provided it is of the family of his specialized instrument. That is, the trumpet teacher can teach trombone or tuba, and the violin teacher can also teach viola, cello, or string bass.	2.71	1.17	Agreed	2.58	1.49	Agreed
10	Teaching Western orchestral instruments in the University is usually very difficult because most students had no instrumental learning in their primary and secondary schools	3.19	1.29	Agreed	3.11	1.30	Agreed
11	Instrumental instruction should be conceived as a continuous process from nursery school and kindergarten on to the completion of tertiary education	3.10	1.38	Agreed	3.51	1.31	Strongly agreed
12	Audition tests should be run for students applying for music in Nnamdi Azikiwe University, Awka to weed out untalented students	3.79	1.58	Strongly agreed	3.66	1.33	Strongly agreed
13	Some of the lecturers are not competent on their Western orchestral instruments	3.61	1.45	Strongly agreed	2.96	1.42	Agreed

$\overline{X}_1 = 3.42$; $\overline{X}_2 = 3.34$

$Sd_1 = 1.42$; $sd_2 = 1.43$

$n_1 = 94$; $n_2 = 8$

Table 10 shows that students strongly agreed with six items, namely: items 1, 2, 3, 7, 12 and 13 and merely agreed with items 4, 5, 6, 8, 9, 10 and 11. Also, the lecturers strongly agreed with items with items 2, 3, 4, 5, 11 and 12 and merely agreed with items 1, 6, 7, 8, 9, 10 and 13. It is however worthy of note that no item was disagreed with. Issues raised in the items include the following: the difference in conditions and challenges faced by choral music teachers and instrumental music teachers, and the components of instrumental music which involve highly specialized techniques among others.

Overall, the average mean rating for the students is 3.42 with a standard deviation of 1.42 while that of the lecturers is 3.34 and a standard deviation of 1.43. Thus showing no variation between the opinions of the two categories of the respondents.

4.3.7 Research Question Eight (RQ8)

What are the possible solutions to the problems? The responses to this research question are presented in Chapter six under recommendations.

4.4 Test of Hypotheses

All null hypotheses formulated to guide this study were tested in this section. The statistical tools used for the tests were the t-test for large independent sample that is ($n \geq 30$) and the t-test for small sample of ($n < 30$) (see explanations in the appendix). All tests were done at 0.05 level of significance, the probability at which we are willing to risk type I error.

4.4.1 The Western orchestral musical instruments existing in the Department appear to be relatively few.

There was no need for any statistical testing of this hypothesis because of the nature of data gathered on it. The inventory of Musical instruments from the Department of Music, Nnamdi Azikiwe University Awka (2013) showed that there exist few Western orchestral musical instruments in the Department (1 'Cello, 1 viola, 2 Alto Sax, 1 Tenor Sax, 2 Trumpets, 1 Trombone, 1 French Horn, and 1 Euphonium).

4.4.2 Hypothesis Two

Hypothesis two sought to establish whether there is any significant difference in the opinion of the respondents concerning the nature of Western orchestral musical instruments and the challenges in teaching and learning them. Accordingly, the null and alternative hypotheses were set as follows:

H_0: There is no significant difference in the opinion of the respondents regarding the nature of the Western orchestral musical instruments that exist in the department.

H_1: There is a significant difference in the opinion of the respondents regarding the nature of the Western orchestral musical instruments that exist in the department.

To test the hypothesis, the result of the respondents' mean ratings and standard deviation presented on Table 4 were used. The statistical tool for the test was t-test for difference of means. The level of significance and degrees of freedom (df) were respectively 0.05 and 100.

Table 16: Summary of T-test Result for Hypothesis II

Source of variation	N	$\bar{X}$	SD	DF	Standard error	Cal. t	Crit. t	P < 0.05
Students	94	3.41	1.53	100	0.281	0.359	1.960	Not significant
Lecturers	8	3.22	1.43					

N=102; P<0.05

Decision Rule: Summary of the t-test result shown above indicates that at 0.05 level of significance and 100 degrees of freedom (df), the calculated t-value (0.359) is less than the critical t-value (1.960). Consequently, the null hypothesis which suggests that there is no significant difference in the opinion of the respondents was accepted while the alternative was rejected. The result would have been doubtful if it had been otherwise given the results of the research question.

4.4.3 Hypothesis Three

This hypothesis sought to determine the suitability or otherwise of the criteria used in assigning or approving Western orchestral musical instruments for students. Accordingly, the null and alternative hypotheses were outlined as stated below:

H_0: The criteria used in assigning or approving Western orchestral musical instruments to students appears not to be suitable

H_1: The criteria used in assigning or approving western orchestral musical instruments to the students appear to be quite suitable.

To test the hypothesis, the result of the mean ratings and standard deviation presented on Table 5 were used. The statistical tool applied was the t-test for independent small sample that is, ($n< 30$). The level of significance chosen for the test was 0.05 and the degrees of freedom (df) was 7.

Table 17: Summary of t-test Result for Hypothesis III

Variable	N	$\bar{X}$	SD	S(e)	t.cal	t-tab	Population mean (m)	Sig. level (α)	Decision rule
Respondents	8	2.98	1.480	0.223	2.150	1.895	2.50	0.05	Significant

N= 8; Df=7; P< 0.05

Decision Rule: From the results presented on Table 13, it is easy to see that 0.05 level of significance and 7 degrees of freedom (df), the calculated t-value (2.150) is greater than the critical t-value (1.895). Therefore, the null hypothesis was rejected while the alternative which suggests that the criteria being used in assigning or approving Western orchestral musical instruments to the students appear to be quite adequate was accepted.

4.4.4 Hypothesis Four

Hypothesis four was formulated to assess whether there is any significant difference in the opinions expressed by the respondents on the relevance of methods adopted in teaching the use of Western orchestral instruments in the department. Accordingly, the null and alternative hypotheses were stated as follows:

H0: There is no significant difference in the opinion of the respondents regarding the relevance of method adopted in teaching Western orchestral musical instruments.

H_1: There is a significant difference in the opinion of the respondents regarding the relevance of methods adopted in teaching Western orchestral instruments.

To test the hypothesis, the results of mean ratings and standard deviation presented on Table 6 were used. The statistical tool was the t-test for large independent sample that is, (n≥30)the degree of freedom (df) was 100 at 0.05 level of significance.

Table 18: Summary of t-test Result for Hypothesis IV

Source of variation	N	$\bar{X}$	SD	DF	S (e)	Cal. t	Crit. t	P < 0.05
Students	94	3.13	1.53	100	0.530	0.415	1.960	Not significant
Lecturers	8	2.91	1.43					

N= 102; P< 0.05

Decision Rule: As could be seen from Table 12, the calculated t-value (0.530) is less than the critical t-value (1.960). Therefore, we do not reject the null because there was no weight of evidence against it. We conclude that there is no significant difference between the opinions expressed by students and the lecturers regarding the relevance of the methods adopted in teaching Western orchestral musical instruments in the department. The result would have been doubtful if it had been otherwise given the result of the research questions.

4.4.5 Hypothesis Five

This hypothesis sought to determine the effectiveness of modes of evaluating students' performance on Western orchestral musical instruments in the department. Accordingly, the null and alternative hypotheses were stated as follows:

H_0: The modes adopted in evaluating performance of the students in Western orchestral musical instruments appear not to be effective.

$H_{1:}$ The modes adopted in evaluating students' performance in Western orchestral musical instruments appear to be effective.

To test the hypothesis, the data on Table 9 were used. The statistical tool used was the t-test for small sample that is, (n< 30). The degrees of freedom and significance level were respectively 7 and 0.05.

Table 19: Summary of t-test Result for Hypothesis V

Variable	N	$\bar{X}$	SD	S(e)	DF	t-cal	t.crit	Pop. Mean (M)	Sig. level (α)	Decision rule
Respondents	8	3.00	1.48	0.523	7	0.956	1.895	2.50	0.05	Not. Sig.

Decision Rule: The result of the t-test presented on Table 15 shows that the calculated t-value 0.956 is less than the critical t-value (1.895). Consequently, the null hypothesis which suggests that the modes of evaluating performance of the students in Western orchestral musical instruments appear to be ineffective was accepted.

4.4.6 Hypothesis Six

Hypothesis six was formulated to determine the prospects in teaching and learning Western orchestral musical instruments in the department. Accordingly the null and alternative hypotheses were stated as follows:

H_0: There is no significant difference in the opinion of the respondents regarding the prospects of teaching and learning of Western orchestral musical instruments in the department.

H_1: There is a significant difference in the opinions of the respondents regarding the prospects of teaching and learning of Western orchestral musical instruments in the department.

To test the hypothesis, t-test for independentlarge sample was applied on the results' mean rating and standard deviation of the respondents presented on Table 9. The significance level and the degree of freedom (df) at which the test was carried out were respectively, 0.05 and 100.

Table 20: Summary of t-test Result for Hypothesis VI

Source of variation	N	$\bar{X}$	SD	DF	S (e)	Cal. t	Crit. T	P < 0.05
Students	94	3.72	1.65	100	0.554	0.271	1.960	Not significant
Lecturers	8	3.57	1.49					

N=102; P< 0.05

Decision Rule: The result of hypothesis six as presented on Table 20 shows that the value of calculated 't' is less than the value of critical 't'. Consequently, the null hypothesis was accepted and we conclude that there is no significant difference in the opinion of the respondents regarding the prospects of teaching and learning Western orchestral musical instruments in the department. The result would have been doubtful if it had been otherwise given the answers obtained from the research questions section.

4.4.7 Hypothesis Seven

This hypothesis seeks to determine whether there is significant difference in the opinion of the students regarding the perceived problems that militate against the effective teaching and learning of Western orchestral musical instruments in the department. Accordingly, the null and alternative hypotheses were stated as outlined below:

H_0: There is no significant difference in the opinion of the respondents on the perceived problems that militate against the teaching and learning of Western orchestral musical instruments.

$H_{1:}$ There is a significant difference in the opinion of the respondents on the perceived problems that militate against the teaching and learning of Western orchestral musical.

To test the hypothesis, the data on Table 21 was used. The statistical tool used was the t-test for difference in two means. The degrees of freedom and significance level were respectively 100 and 0.05.

Table 21: Summary of t-test Result for Hypothesis VII

Source of variation	N	$\bar{X}$	SD	DF	S (e)	Cal. t	Crit. T	P < 0.05
Students	94	3.42	1.42	100	0.523	0.152	1.960	Not significant
Lecturers	8	3.34	1.43					

N= 102; P< 0.05

Decision Rule: The result of hypothesis seven shows that there is no significant difference in the opinion of the respondents regarding perceived problems that militate against effective teaching and learning of Western orchestral instruments in the department. Therefore, the alternative hypothesis which suggests significant difference in their opinions was rejected.

4.5 Summary of the Data Analysis

It is significant that the analysis of the research questions agreed substantially with the result of the hypothesis of the study in many respects. Highlights of these were the relatively few Western orchestral instruments existing in the Department, the difficulty in learning Western orchestral musical instruments owing to their sophisticated nature, administering adaptability tests to students as a major criterion for assigning Western orchestral instruments to them, and the inadequacies emanating from the methods of teaching and the modes of evaluating students on their orchestral instruments.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The preceding chapter dealt with the presentation and analysis of data generated in this study. In this chapter, the findings arising from the answers to the research questions and results of the test of hypothesis formulated for the study were discussed.

5.1.1 The Western Orchestral Musical Instruments that Exist in the Department of Music, Nnamdi Azikiwe University, Awka

Ten (10) Western orchestral instruments (1 'Cello, 1 viola, 2 Alto Saxophones, 1 Tenor Saxophone, 2 Trumpets, 1 Trombone, 1 French Horn, and 1 Euphonium) were found to exist in the Department. This finding is worrisome considering the number of orchestral instruments required of a standard Music Department and the population of people (12 lecturers and 126 students) who are supposed to be engaged in teaching and learning with the instruments in the Department. Where there is a dearth of teaching and learning materials, education becomes haphazard. The need for the provision of enough and adequate Western orchestral instruments for teaching and learning in the Department is imperative.

5.1.2 The Relationship between the Nature of Western Orchestral Musical Instruments and the Challenges in Teaching and Learning them.

The result of hypothesis one indicates that there is no significant difference between the opinions of the respondents regarding the nature of Western orchestral musical instruments and the challenges of teaching and learning them. The result would have been doubtful if it had been otherwise given the answers to the research question two in which average mean scores for the students and that of the lecturers were respectively 3.41 and 3.22. The finding that some Western orchestral musical instruments are sophisticated and pose some difficulty in teaching and learning raises the need for both lecturers and students to study the nature and acoustics of the instruments as a prerequisite mastering them.

5.1.3 Suitability of the Criteria used in Assigning or Approving Western Orchestral Musical Instruments to Students

The finding that some Western orchestral instruments attract gender bias is consistent with the results from the work of Hal (2009) when he investigated difference in sex-by-instruments distribution. He found that girls play predominantly flutes, violins, and clarinets, and most boys play drums, trumpets and trombones. Also, there were some evidence that in band settings, girls were likely to play non-conforming gender instruments than were boys. In

a related development, O'Neill and Boultona (2009) found in their study of the extent to which boys' and girls' preferences are based on the gender stereotyped associations that girls showed a significant stronger preference for piano, flute and violin than boys, whereas boys expressed a stronger preference for the guitar, drums and trumpet than girls. The study found further from the log-linear analyses that boys and girls have similar ideas about which instruments should be played by members of each sex.

The implication of this is that the Western orchestral instrument teacher must as a matter of necessity identify the choice of his/her student in Western orchestral musical instrument before the assignment to the students. This position agrees with the submission by Umezinwa (2004: 20) that 'a student may choose an instrument because of the influence of another player or because of affordability or availability'. This will facilitate quick and easy learning of the musical instrument by the student. Therefore, it could be deduced that the most important point to consider in assigning an instrument is the student's choice or desire. It is also general opinion that physical check, drill or adaptability test be administered on the students before approving orchestral musical instruments for them.

The finding that small students should not try large instruments and that students whose pitch sense is low should especially avoid strings, piccolo, French horn and trombone is consistent with what obtains elsewhere. For instance, the performing Arts Handbook (2014) while writing on criteria for choosing an instrument noted that there are many physical characteristics that are closely connected to a student's success on a specific instrument. Those features are said to include: length of the arms, overall height, and shape of the face, lips and teeth. In addition, strong aural skills are necessary for string and some brass instruments (trombone and French horn) require fine motor control. Also, Students with shallow breaths should avoid the woodwinds and brasses just as students with short arms should be guided away from the cello and string bass.

However, it was found also that a student who appears not to pass these physical criteria may still become proficient on an instrument with serious practice. Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later. The opinion that there is usually a high incidence of dropping out among students who begin on instruments other than their first choice is not a very popular opinion among the respondents, just as many did not believe that students should first attempt other Western orchestral musical instrument before choosing one of them. In his contribution on what factors should

inform students' instrument selection, Bayley in Kauffman (2014) found that music teachers take active part in guiding their students' choice of instruments. Bazan in Kauffman (2014) found that the directors of the beginning bands develop their selection process through personal experience. The participants in the study indicated they felt students' instrument selection is influenced more through peer pressure, timbre and family input. Students' physical characteristics as well as proper guidance from the music teachers are quite necessary in selecting orchestral musical instruments.

5.1.4 The Relevance of the Methods Adopted in Teaching and Learning Western Orchestral Musical Instruments in the Department.

The result of test of hypothesis in this section indicates that there is no significant difference in the opinions shared by the lecturers and the students as regards the relevance of methods of teaching western orchestral musical instruments in the department. The opinions are that poor teaching and learning methods hamper effective teaching and learning of Western orchestral instruments and the first approach to effective teaching and learning of these instruments is to provide the 'right environment' (instrument rooms and practice chambers with proper acoustics). The study revealed the need to apply Carl Orff's emphasis on pre-band instruments (recorder, harmonica, marimba, etc) to' weed out' the less talented and incompetent students in the Department. Also, teaching musical instruments should involve rhythmic activity, rudiments of music, record listening, aural training, sight reading and sight playing exercises. In this section, it was revealed that rote learning (learning or memorizing abstract concepts in whole without immediate attention to meaning) does not have much relevance in learning western orchestral musical instruments. In the same vein, the Suzuki approach of commencing string teaching from infancy (3 years) may not be applicable in teaching Nigerian undergraduate music students. But instrumental music teaching can be considered successful only if it produces students who have musical understanding, who can play their instruments expressively, read music readily, and play by ear.

The opinion that lecturers should not give students so much attention on their orchestral instruments but should teach the basics of the instruments and allow them to take control of their learning experiences (active learning), is a popular one among the respondents. According to the respondents, students should be left on their own with their orchestral instruments after preliminary contacts with their instructors so that they can make personal discoveries on their instruments (discovery learning). This finding is supported by a study done by Maclead (2010) whose purpose was to compare the instructional strategies used by

experienced band and orchestral teachers when teaching a first year class an unfamiliar music excerpt. In the study, twelve teacher-behaviours were identified and operationally defined: echoing technique, question and answer, verbal instruction, co-verbal instruction, modeling without instrument during student performance, conducting, pedagogical touch, classroom management etc. Significant differences were found for nine out of the twelve behaviours. In general, band teachers used verbal instruction, conducting, question and answer techniques, and student performance with greater frequency than orchestral teachers, while orchestral teachers used echoing technique, co-verbal instruction, modeling, modeling with instrument during student performance and pedagogical touch with greater frequency. However, no significant difference was observed between the two groups for classroom management, modeling without an instrument during student performance. It is worth mentioning too that many did not subscribe to the idea that one can ignore teaching and learning methods and still improve on his orchestral instrument if he/she concentrates on his talent and giftedness. This is expected because no matter how talented or gifted somebody is, the need for proper guidance cannot be ignored.

5.1.5 Effectiveness of Modes Adopted in Evaluating Students' Performance in Western Orchestral Musical Instruments

The result of test of hypothesis in this section suggests that the modes adopted in assessing students' performances in Western orchestral instruments appear to be ineffective. This result represents the opinion of the majority of the respondents. For instance, while agreeing that it is proper to assess or evaluate students' performances in their orchestral instruments periodically, there is a feeling that there is no standard mode for the evaluation in the Department. The popular opinion is that students should be assessed on their orchestral instruments based on these fundamental criteria: fingering, articulation, phrasing, accuracy of pitch, breath control, attack and sightreading.

Nevertheless, the study revealed that despite the shortcomings in modes of evaluation or assessment, enthusiastic students can still improve on their orchestral instruments irrespective of assessment. It was equally agreed that monitoring supervisor-student contacts and ensuring inter-adjudicator objectivity during final evaluation should be taken seriously to facilitate quick and better understanding of orchestral musical instruments. This is because the impression gathered by lecturers of individual student's progress during periodic scheduled contacts does not adequately reflect the semester's continuous course assessment (CA) score for the student's performance on his/her orchestral instrument. This situation has provoked

the thinking that each lecturer should provide the continuous assessment (CA) score for each student assigned to him for final computation of evaluation grades based on the student's performance while in contact with him as scheduled and agreed by the panel of adjudicators.

5.1.6 Prospects in Teaching and Learning Western Orchestral Musical Instruments in the Department.

The result of the test of hypothesis indicates that there is no significant difference in the opinion of the respondents (lecturers and students) concerning the prospects of teaching and learning Western orchestral instruments in the Department of music. The lecturers and students interviewed in the department agreed that there is prospect for Western orchestral musical instruments in the Department. The study revealed that every student can adapt to the learning of his instrument if he develops a positive attitude and if there is adequate motivation from his teacher. The study also revealed that the students still forge ahead in learning and mastering their Western orchestral instruments despite the numerous challenges they face, particularly poor learning environment, lack of background in instrumental music, and lack of teachers in some orchestral instruments like the violin. In the opinion of the majority of the respondents, students would improve significantly in their orchestral instruments if they are provided with adequate practice rooms with sound proof cubicles and recordings for playback of their given pieces. However, it will be difficult to make desired progress in the teaching and learning of Western orchestral musical instruments if there is no motivation and scheduled contact with the respective instructors.

It was found from the study that students can improve on their instruments if they are encouraged to change their mindsets and negative attitudes toward learning the use of the orchestral instruments. It was also found that the university can aid the teaching and learning of Western orchestral instruments by adequately funding the department to facilitate the procurement of unavailable orchestral instruments and employing lecturers that specialize in those instruments that lack manpower. Essentially, music is a highly specialized area as recognized by the National Policy on Education 2004. The respondents are also of the opinion that the music Department can facilitate students' competence on their orchestral instruments by engaging them in concerts and performances within and outside the shores of the University.

5.1.7 Perceived Problems that Militate Against Effective Teaching and Learning of Western Orchestral Musical Instruments In the Department.

The result of test of hypothesis shows that there is no significant difference between the opinions of the respondents regarding what constitutes constraints to teaching and learning Western orchestral musical instruments in the department. Some of such challenges include the following: instrumental teachers face conditions that are different from those encountered by choral music teachers and instrumental music involves a conglomeration of fingerings, embouchures, bowings and other specialized techniques and knowledge. Others are that the string teacher must, as a matter of necessity, be familiar with these bowing techniques for efficacy: *staccato, tremolo, portato, col legno, sul ponticello, double stop,* etc. The brass teacher also must be familiar with these brass techniques before he can effectively motivate his students in: embouchure, tonguing, breath control, double tonguing, triple tonguing, flutter tonguing, transposition, range, split tone, fundamental pitch, pedal tone, microtones, and overtones.

The study revealed further that in teaching the percussion, one should be knowledgeable in all orchestral percussion instruments such as timpani/kettledrums, glockenspiel, xylophone, celesta, chimes, cymbals, mallets, bass drum, snare drum, etc. The problem here is that not all the instructors who handle these highly specialized areas have the competence and the required knowledge for them. For example, popular opinion from the study is that each orchestral instrument should be taught by a lecturer who specialized in them with the requisite skill. But the available manpower within the Department does not guarantee that, rather what obtains is that where there is no specialist for a given instrument, the instrument is usually handled by any other teacher who has some knowledge about the instrument. This improvisation approach creates serious limitation to teaching and learning of Western orchestral instruments owing to the sophistication of the instruments and the special skills required in teaching them.

In a related development, the presumption that any lecturer can teach any orchestral musical instrument provided the instrument belongs to the family of his specialized instrument seems to be a wrong one. The argument is straight: if the trumpet teacher can teach trombone or tuba and the violin teacher can also teach viola, cello or string bass, what then is the essence of specialization. If there is no adequate number of specialized lecturers for the various instruments, it then becomes a challenge which requires urgent solution. Teaching western orchestral musical instruments in the university comes with peculiar challenges particularly

where most of the students who find themselves in the Department of music have had little or no background in instrumental music in their formative years in school (nursery/primary/secondary). This foundational problem makes it difficult to effectively learn the orchestral instruments. In the opinion of the respondents, instrumental instruction should be conceived as a continuous process from kindergarten on to the completion of tertiary education. Also the idea that audition tests should be run for students applying for music in the University appears to be a popular one as a means of screening the students not necessarily to screen out untalented ones but to have standard and maintain some level of seriousness which will go a long way in reducing the rate of dropouts from the Department.

Another problem to the teaching and learning of Western orchestral musical instruments in the Department was found to be individual- based. What leads to students' dropout from the instrumental learning according to Stjern (2011) are: scheduling or time conflicts, perceived lack of achievements, loss of interest, and issues with the teacher. This was found from a study conducted to determine the factors that contribute to students' attrition in school music programmes. More than seventy percent of those interviewed gave the reasons enumerated above as cause of their withdrawal from their school music programme. The implication of this is that instrument teachers should gear towards motivating their students for an effective instrumental experience. The respondents were all affirmative that motivation is a powerful tool in the employ of a dedicated teacher.

5.2 Implications of the Findings

The implications of the various findings of the study as they relate to the teaching and learning of Western orchestral musical instruments in the Department are discussed in this section.

The finding that very few Western orchestral musical instruments exist in the Department calls for the immediate overhauling of the old existing instruments and the provision of new instruments that will be enough for teaching and learning experience. This also agrees with Umezinwa's (2004: 52) submission regarding the Department that, 'there is a serious lack and insufficiency of the facilities, equipment and musical instruments (African and Western) expected of a music department'.

The finding that some Western orchestral musical instruments are sophisticated and as a result, pose some difficulty in learning has obvious implications in teaching and learning the instruments in the Department. This fact raises the need for students to first take time in learning the acoustics, peculiarity and functionality of those instruments before choosing them as their Western orchestral instrument. Some of such instruments are the violin, clarinet, flute, saxophone, trumpet, tuba, French horn etc.

The finding that some Western orchestral musical instruments generate some gender bias places the responsibility on the instrumental teachers to disabuse the minds of the students from such notions as 'feminine' or 'masculine' instruments. However, the teacher should also be sensitive to the choices of his/her students regarding western orchestral instruments before assigning any to the students. Also, in approving orchestral instruments to students, the lecturer should be consistent with the finding that small students should not try large instruments; that students whose pitch sense is low should especially avoid strings; and that students with shallow breaths should avoid the woodwinds and brasses. Ignoring this finding may result in raising students who may handle their orchestral instruments with conspicuous limitations.

Poor teaching and learning methods have been found to be one of the major problems to the effective teaching and learning of Western orchestral musical instruments in the Department. This shifts the responsibility to the various instrument teachers in particular to find the best approaches towards teaching and learning the instruments. Any teaching endeavour that neglects methodology will surely encounter problems. Although there appears to be no perfect method of teaching instrumental music, but the study has revealed that teaching musical instruments should involve rhythmic activity, rudiments of music, record listening, aural training, sight reading and sight playing exercises.

Learning music, particularly instrumental music, in 'any' environment can be frustrating. The study revealed that students in the Department learn their orchestral instruments in unconducive environment and this has posed serious problems in the learning of the instruments. Western orchestral musical instruments are usually studied in instrument rooms and practice chambers with appropriate acoustics.

Students should be assessed periodically by their respective instrument teachers using some fundamental criteria. But the study observed that this practice is hardly maintained in the Department. Even where there exists such periodic assessing, there appears to be no standard

or agreed criteria for the grading. If there is no periodic evaluation of the performance of the students on their orchestral instruments, it would be difficult to monitor their growth. If there exists no standard criteria for assessing the students periodically, the results of the respective evaluations by the lecturers become haphazard. The study has revealed that students should be assessed on their orchestral instruments periodically based on these fundamental criteria: fingering, articulation, phrasing, accuracy, attack, and sight reading.

The study observed that there are no lecturers in the Department to teach some of the Western orchestral musical instruments even though the students still engage in learning them. The affected instruments are: flute, violin, string bass, French Horn, Tuba, trombone, euphonium, etc. This is a major setback in the teaching and learning of the instruments in the Department. Some lecturers have tried to bridge this gap by attempting teaching some other instruments that fall within the family of their instrumental specialization. For instance, the assumption is that the alto sax expert can still teach the basics of the flute, oboe, or tenor sax since all are woodwinds. Or that the trumpet specialist may try teaching the tuba, French Horn, trombone, or euphonium. This presumption may sound interesting but the sophistication of these instruments obviously defeats this idea. If the trumpet teacher can teach trombone or tuba and the violin expert teaches viola, cello or string bass, what then is the essence of specialization? The lack of specialists in some of these orchestral instruments is a problem requiring immediate solution. Currently in the Department, there is no expert on the violin even though the violin is considered a major Western orchestra instrument.

Despite these challenges, the study revealed that the students still forge ahead in learning their Western orchestral instruments. Even the impact of the unavailability of teachers for some of the instruments could not deter the students as they have continued to make improvements as a result of team work and careful study. For instance, in the violin where there is no teacher at all for the instrument, yet the instrument is the most patronized instrument by the students.

5.3 Recommendations

The following recommendations are made to help enhance productivity in the teaching and learning of Western orchestral musical instruments in the Department of Music, Nnamdi Azikiwe University , Awka.

5.3.1 Provision of More Western Orchestral Musical Instruments in the Department

The Music Department should be provided with funds to furnish the instrument room with adequate Western orchestral musical instruments as a matter of urgency. This would make the teaching and learning of the instruments a fulfilling experience.

5.3.2 The Difficulty in Learning Western Orchestral Musical Instruments

The nature and sophistication of Western orchestral musical instruments have been established as a major challenge in learning them. It is therefore recommended that:

- Students should be exposed to these instruments early in their formative years (nursery/primary/secondary) education in order to ease this problem. Going by Piaget's theory of the 'critical period', if formal learning does not commence early enough, learning becomes difficult.
- The government should not take up this challenge alone; music educators and experts in the field of music education should also take it as a responsibility and an emergency to do something about music education at the grassroots.

5.3.3 Approving Western Orchestral Musical Instruments for Students

The nature of Western orchestral musical instruments also raises some caution with regard to assigning them to students. Some of the instruments are relatively light, small; some are long, some are large and thereby requiring more energy in carrying and playing them. Some also demand highly technical approaches in playing them such as embouchure, tonguing, breathing techniques, fingering, etc. These factors constitute challenges in learning the instruments considering the fact that students, just like all humans, come with various physical capabilities and limitations. It is therefore recommended that these factors should be taken into account while assigning or approving Western orchestral instruments to students:

- Small students should not try large instruments.
- Students whose pitch senses are low should especially avoid the strings
- Students with shallow breaths should avoid the woodwinds and brasses.
- Student with short or thick fingers should also avoid the strings
- Generally, there should be physiological and adaptability tests or drills on students before approving any orchestral instrument to them.

Ignoring these suggestions may result in making the teaching and learning of the instruments a frustrating task.

5.3.4 Teaching and Learning Methods for Western Orchestral Musical Instruments

For the effective teaching and learning of Western orchestral musical instruments in the Department, these approaches should be considered:

- A good foundation in rudiments of music
- Rhythmic activity
- Aural training
- Record/CD listening
- Sight reading and sight playing exercises.
- Discovery learning (students should be encouraged to spend time alone on their instruments periodically in order to make personal discoveries)
- Modeling (The lecturers should teach by example. Students learn better when they watch their teachers playing on their respective Western orchestral instruments).
- The lecturers should meet with their respective students as scheduled.

5.3.5 Employing Specialists for the Orchestral Instruments

There are not enough lecturers or specialists to teach all the orchestral instruments in the Department and this creates problems. Some of the affected instruments are the violin, string bass, flute, French horn, soprano sax, oboe, trombone, tuba, and piccolo. These suggestions are proffered to tackle this problem:

- The University should employ, as a matter of urgency, lecturers whose specialties should include the affected instruments.
- Lecturers should avoid teaching Western orchestral instruments that are not their specialty because this negates standard practice.

5.3.6 Adequate Environment for the Teaching and Learning of Western Orchestral Instruments

A proper environment for the teaching and learning of Western orchestral instruments is the first factor to consider before venturing into the practice. Unfortunately standard practice rooms do not exist in the Department and this is a serious drawback. In fact, the Department has no standard befitting building for a Department of music. For effective teaching and

learning of western orchestral instruments in the Department, these recommendations should be considered:

- The University should first, as a matter of urgency, provide the Department with a Music Department building
- The building should house, among other things, practice rooms or chambers with appropriate acoustics for learning orchestral instruments
- Each Western orchestral musical instrument should have its peculiar practice chamber.

5.4 Limitations of the Study

The fundamental limitations of the study are delineated below:

(a) The area of study was Nnamdi Azikiwe University situated in Awka. Some other Universities across the Nation and beyond would have been included for variability.
(b) Use of the questionnaire as the only mode/instrument for data collection. Some other modes of data collection, like interviews would also have been employed. However, the researcher considered the questionnaire adequate for the study.
(c) Not all Western orchestral musical instruments were studied. The oboe, piccolo, String bass, and the percussions were not studied because they do not exist in the Department.

5. 5 Suggestions for Further Research

The researcher suggests for further studies the following investigations:

(a) Gender prejudice in learning Western orchestral musical instruments
(b) Advancing studies in African Orchestral instruments
(c) The fusion of Western and African orchestral instruments in ensemble.
(d) Employing Western orchestral musical instruments in extra musical functions.
(e) Replication of the current study from time to across tertiary institutions around the world.

5.6 Summary and Conclusion

The objective of this research was to find out the problems and prospects in the teaching and learning of Western orchestral musical instruments in the Department of Music, Nnamdi Azikiwe University, Awka. The study was inspired by the various challenges encountered by the students in learning and mastering their Western orchestral musical instruments as observed by the researcher. The scope of the Western orchestral musical instruments studied included the strings (violin, viola, 'cello, and the string bass); the woodwinds (flute, saxophones, clarinet); and the brass family (trumpet/cornet. trombone, tuba, French horn).

In carrying out the research, literatures relevant to the study were reviewed under the subheadings of conceptual framework, theoretical framework, and empirical studies which were finally summarized under 'summary of reviewed literature'. Data for the research were further sourced through questionnaire and interviews by the respondents which included all the lecturers and undergraduate students of the department. An item structured instrument developed by the researcher to reflect such options as strongly agree (SA), agree (A), disagree (D) and strongly disagree (SD) popularly called four (4) points modified likert scale was used to elicit information from the respondents. These points were reflected in the questionnaires which were shared to the respondents. The questionnaire was adopted because of its appropriateness for the research. There were two sets of the questionnaire: one for the lecturers and the other for students in order to capture the views of both categories of the research population. The data generated through the questionnaire were analyzed using the following statistical tools: mean rating and standard deviation, t-test for small sample and t-test for independent large sample that is, (n >/ 30). All tests were carried out at 0.05 level of significance. Six (6) research questions and hypotheses were set up, tested and analyzed.

The findings of the research show that the main challenges encountered by students in learning Western orchestral musical instruments emanated from the facts that: a few Western orchestral instruments exist in the Department; the sophisticated nature of the instruments; lecturers assign orchestral instruments haphazardly without recourse to any physical or physiological tests; poor teaching and learning methods hamper effective teaching and learning of Western orchestral instruments in the Department; there are not enough lecturers or specialists to teach all the orchestral instruments in the Department; and that the proper environment for the teaching and learning of Western orchestral instruments in the Department is lacking. The implications of the findings were highlighted and relevant

recommendations made which would improve the teaching and learning of the instruments in the Department

Finally, there are prospects in the teaching and learning of Western orchestral musical instruments in Nnamdi Azikiwe University, Awka despite the many challenges highlighted from the research. Learning Western orchestral Musical instruments is a major aspect of the curriculum of studies in the Music Department and therefore should be allowed to grow along with other areas of musicology like music history, theory and composition, African music, musicianship studies, keyboard studies etc. Moreover, a student who becomes competent on his orchestral instrument can live a fulfilled life after graduating and can easily fit into the larger world. The researcher, therefore, strongly believes that studies in Western orchestral musical instruments in the Department could be enhanced if the findings and recommendations of the research were considered.

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APPENDIX I

NNAMDI AZIKIWE UNIVERSITY, AWKA

FACULTY OF ARTS

DEPARTMENT OF MUSIC

Department of Music,

Faculty of Arts,

Nnamdi Azikiwe, University, Awka.

Feb, 2014

The Head of Department of Music,

Nnamdi Azikiwe University, Awka.

Sir,

RECOMMENDATION (RE: OKEKE, IKEDIMMA NWABUFO)

The above named student is my Ph.D student. His research work requires he collects data on the teaching and learning of Western orchestral instruments in the department. Kindly accord him due assistance.

Thanks.

Prof. (Mrs.) A. I .Onwuekwe

(Supervisor)

APPENDIX II

NNAMDI AZIKIWE UNIVERSITY, AWKA

FACULTY OF ARTS

DEPARTMENT OF MUSIC

RESEARCH REQUEST (A)

Department of Music,

Faculty of Arts,

Nnamdi Azikiwe, University, Awka.

Feb, 2014

The Head of Department of Music,

Nnamdi Azikiwe University, Awka.

Sir,

REQUEST TO USE YOUR UNDERGRADUATE STUDENTS AS MY RESEARCH SAMPLE

I am a Ph.D. student of the above named university carrying out a research on The Teaching/Learning of Western Orchestral Musical Instruments in Nnamdi Azikiwe, University, Awka: Problems and Prospects. Kindly allow me to interact with your undergraduate students for this cause.

I pledge that every information gathered in the course of the interaction shall be kept confidential and strictly for the purpose of this research.

Thanks.

Okeke, Ikedimma Nwabufo

APPENDIX III

NNAMDI AZIKIWE UNIVERSITY, AWKA

FACULTY OF ARTS

DEPARTMENT OF MUSIC

RESEARCH REQUEST (B)

Department of Music,

Faculty of Arts,

Nnamdi Azikiwe, University, Awka

Feb, 2014

The Head of Department of Music,

Nnamdi Azikiwe University, Awka.

Sir,

REQUEST TO INTERVIEW ALL LECTURERS IN YOUR DEPARTMENT FOR MY RESEARCH

I am a Ph.D. student of the above named university carrying out a research on The Teaching/Learning of Western Orchestral Musical Instruments in Nnamdi Azikiwe, University, Awka: Problems and Prospects. Kindly grant me interviews with all the lecturers in your department for this cause.

I pledge that every information gathered in the course of the interaction shall be kept confidential and strictly for the purpose of this research.

Thanks.

Okeke, Ikedimma Nwabufo

APPENDIX IV

NNAMDI AZIKIWE UNIVERSITY, AWKA

FACULTY OF ARTS

DEPARTMENT OF MUSIC

QUESTIONNAIRE FOR MUSIC STUDENTS

Dear Student,

I am a Ph.D student of the Department of music, Nnamdi Azikiwe University, Awka carrying out a research on The Teaching and Learning of Western Orchestral Instruments in Nnamdi Azikiwe, University, Awka: Problems and Prospects. Kindly complete the questionnaire below to enable me carry out the said research. I promise that any information given shall be treated confidentially.

Thanks for your anticipated co-operation.

Yours Sincerely

Okeke, Ikedimma Nwabufo.

SAMPLE OF QUESTIONNAIRE FOR STUDENTS

Perception of Students on the Teaching and Learning of Western Orchestral Musical Instruments in Nnamdi Azikiwe University, Awka.

SECTION A: Personal Data of the Respondent

Please tick ( ) in the box provided for the appropriate option that applies to you.

1. Name:_____
2. Sex: male/female
3. Age:_____
4. Department & Institution _____
5. Level of study/Mode of study _____

Educational Background

Tick ( ) or give relevant information when appropriate.

1. What primary/secondary school did you attend? _____
2. Did you do music at any of these levels (nursery/primary/secondary)? _____
3. Why did you choose music as your course of study in the University? _____
4. What is your Western orchestral instrument? _____
6. Why did you choose your orchestral instrument? _____
7. Who is your current instrument teacher in the university? _____
8. How often do you meet with him/her? _____

N/B: In the subsequent sections, please tick ( ) in the option that best suits your response. The options are scaled thus: **SA** (strongly agree), **A** (agree), **D** (disagree), **SD** (strongly disagree), **U** (undecided).

SECTION B: THE NATURE OF WESTERN ORCHESTRAL MUSICAL INSTRUMENTS

S/N	ITEM	SA	A	D	SD	U
1.	Western orchestral musical instruments are highly sophisticated musical instruments					
2.	As a result of their sophistication, some orchestral instruments pose serious difficulty in learning					
3.	Some orchestral instruments are more suitable for female students than for male students					
4.	Some orchestral instruments are more suitable for male students than for female students					
5.	It is proper for students to study the acoustics of any orchestral instrument as a prerequisite to learning it					
6.	The scientific precision in the acoustics and design of Western orchestral instruments demand that the student must begin with a genuine copy.					
7.	Genuine Western orchestral instruments are hardly affordable					
8.	The dynamic ranges of some Western orchestral instrument are inexhaustible and this factor poses a challenge in mastering the instruments.					
9.	Western orchestral instruments come in various pitch categories (soprano, alto, tenor, baritone, and bass) and this feature makes the instruments suitable to learners of different pitch preferences.					
10.	Most Western orchestral instruments are transposing and this sometimes poses some problems in interpreting pieces in various keys.					

SECTION C: CRITERIA FOR CHOOSING WESTERN ORCHESTRAL INSTRUMENTS

S/N	ITEM	SA	A	D	SD	U
1	The most important point to consider in choosing an orchestral instrument is the student's desire.					
2	It is proper to administer physical check, drill or adaptability test on the students before approving orchestral instruments for them					
3.	Orchestral instruments should be approved for students using random sampling to ensure no instrument is left out					
4.	Students with thick fingers should avoid playing the violin					
5.	Students with an underbite (lower teeth in front of upper) or crooked teeth should not choose any of the brasses.					
6.	Small students should not try large instruments					
7.	Students whose pitch sense is below average should especially avoid strings, piccolo, French horn, and trombone					
8.	Lecturers should guide students in instrument selection but should not require that a student take a particular instrument or none at all.					
9.	A student can become proficient on an instrument while appearing to defy all the physical criteria					
10.	The number of students encouraged to begin on each instrument should be in proportion to instrumentation needs of the Music Department					
11.	There is usually a high incidence of dropping out among students who begin on an instrument other their first choice					
12.	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later					
13.	Students with shallow breaths should avoid the woodwinds and brasses					
14.	Students with short arms should not choose from the cello and string bass.					
15.	Students should first attempt every other Western orchestral instrument before choosing one					

SECTION D: SOME TEACHING AND LEARNING METHODS AND THEIR RELEVANCE TO THE TEACHING AND LEARNING OF WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	Poor teaching and learning methods hamper effective teaching and learning of Western orchestral instruments					
2.	The first approach to effective teaching and learning of Western orchestral instruments is to provide the 'right environment'(instrument rooms and practice chambers with proper acoustics)					
3.	Carl Orff's emphasis on pre-band instruments (recorder, harmonica, marimba) to weed out the less talented and less interested students should be applied in the Music Department of Nnamdi Azikwe University, Awka					
4.	Teaching musical Instruments should involve rhythmic activity, rudiments of music, record listening, aural training, sight reading, and sight playing					
5.	Rote learning (learning or memorizing abstract concepts in whole without immediate attention to meaning) has little or no relevance in learning orchestral instruments					
6.	It is possible to master an orchestral instrument informally without any formal teacher-student setting					
7.	The Suzuki approach of commencing string teaching from infancy (3years) may not be applicable in teaching Nigerian undergraduate music students					
8.	Instrumental music teaching can be considered successful only if it produces students who can play their instruments expressively, read music readily, play by ear, and who have musical understanding					
9.	Lecturers should not give students so much attention on their orchestral instruments but should teach the basics of the instruments and allow them to take control of their learning experiences (Active learning)					
11.	Students should be left on their own with their orchestral instruments so they can make personal discoveries on their instruments (discovery learning)					
12.	One can ignore teaching and learning methods and still improve on his orchestral instrument if he concentrates on his talent and giftedness					

SECTION E: THE PROSPECTS OF LEARNING WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	Every student can adapt to learning a Western orchestral instrument					
2,	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later					
3.	Students still forge ahead in learning and mastering their Western orchestral instruments despite pressing challenges					
4.	Although there are no instructors for some Western orchestral instruments in the Music Department, but there is improvement in the handling of some of the available ones					
5.	Students should be encouraged to specialize in voice, piano, or any Western orchestral instrument as their stress area to foster mastery					
6.	Students will improve quite well in their orchestral instruments if they are provided with adequate practice rooms with sound proof cubicles and recordings for playback of their given pieces					
7.	Students will not improve on their orchestral instruments if there is no motivation and scheduled contact with their respective tutors					
8.	Some students can do well on their orchestral instruments if they change their negative attitude toward learning					
9.	The University can aid the teaching and learning of Western orchestral instruments if provision is made for the unavailable Western orchestral instruments and employ lecturers specializing in those instruments					
10.	The Music Department can facilitate students' improvement on orchestral instruments by engaging them in concerts and performances within and outside the University					

SECTION F: THE CHALLENGES OF LEARNING WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	The learning of Western orchestral instruments should remain compulsory in the university					
2.	The learning of Western orchestral instruments should be stopped in the university					
3.	There should be a lecturer to each Western orchestral instrument					
4.	There is hardly enough time for students to master their orchestral instruments in the light of other academic works.					
5.	There is not much guidance for the students on the orchestral instruments by the lecturers					
6.	Most of the students have had no contact with musical instruments before					
7.	There are no lecturers for some of the Western orchestral instruments and this creates some difficulties in learning those instruments					
8.	Students nonchalance to Western orchestral instruments creates a problem in learning the instruments					
9.	Generally female students are averse to learning musical instruments and this contributes to their relative poor performance on Western orchestral instruments					
11.	If there is increased supervision and motivation from the respective instrumental teachers, students will improve in learning their orchestral instruments					

What is/are your suggestion (s) to improve the teaching/learning of orchestral instruments in the university?

(a)_____

(b)_____

APPENDIX V

NNAMDI AZIKIWE UNIVERSITY, AWKA

FACULTY OF ARTS

DEPARTMENT OF MUSIC

QUESTIONNAIRE FOR MUSIC LECTURERS

Dear Sir/Ma,

I am a Ph.D student of the Department of music, Nnamdi Azikiwe University, Awka carrying out a research on The Teaching and Learning of Western Orchestral Instruments in Nnamdi Azikiwe, University, Awka: Problems and Prospects. Kindly complete the questionnaire below to enable me carry out the said research. I promise that any information given shall be treated confidentially.

Thanks for your anticipated co-operation.

_____

Okeke, Ikedimma Nwabufo.

SAMPLE OF QUESTIONNAIRE FOR MUSIC LECTURERS

Perception of Lecturers on the Teaching and Learning of Western Orchestral Instruments in Nnamdi Azikiwe University, Awka.

SECTION A: Personal Data of the Respondent

Please tick ( ) in the box provided for the appropriate option that applies to you.

1. Name:_____
2. Highest Qualification/Area of Specialization : _____
3. Rank: _____
4. Sex: male / female
5. Department & Institution: _____
6. University Teaching Experience: _____

Teaching Experience

Tick ( ) or give relevant information.

1. What is/are your orchestral instrument(s)? _____
2. How many students are under your instrumental supervision now? _____
3. How often do you meet with your students?_____
4. How regular are your students to instrumental supervisions? _____

N/B: In the subsequent sections,please tick () in the option that best suits your response. The options are scaled thus: SA (strongly agree), A (agree), D (disagree), SD (strongly disagree), U (undecided).

SECTION B: THE NATURE OF WESTERN ORCHESTRAL MUSICAL INSTRUMENTS

S/N	ITEM	SA	A	D	SD	U
1.	Western orchestral musical instruments are highly sophisticated musical instruments					
2.	As a result of their sophistication, some orchestral instruments pose serious difficulty in learning					
3.	Some orchestral instruments are more suitable for female students than for male students					
4.	Some orchestral instruments are more suitable for male students than for female students					
5.	It is proper for students to study the acoustics of any orchestral instrument as a prerequisite to learning it					
6.	The scientific precision in the acoustics and design of Western orchestral instruments demand that the student must begin with a genuine copy.					
7.	Genuine Western orchestral instruments are hardly affordable					
8.	The dynamic ranges of some Western orchestral instrument are inexhaustible and this factor poses a challenge in mastering the instruments.					
9.	Western orchestral instruments come in various pitch categories (soprano, alto, tenor, baritone, and bass) and this feature makes the instruments suitable to learners of different pitch preferences.					
10.	Most Western orchestral instruments are transposing and this sometimes poses some problems in interpreting pieces in various keys.					

SECTION C: CRITERIA FOR ASSIGNING/APPROVING WESTERN ORCHESTRAL INSTRUMENTS FOR STUDENTS

S/N	ITEM	SA	A	D	SD	U
1	The most important point to consider in assigning an instrument is the student's desire.					
2	It is proper to administer physical check, drill or adaptability test on the students before approving orchestral instruments for them					
3.	Orchestral instruments should be approved for students using random sampling to ensure no instrument is left out					
4.	Students with thick fingers should avoid playing the violin					
5.	Students with an underbite (lower teeth in front of upper) or crooked teeth should be guided away from brasses.					
6.	Small students should not try large instruments					
7.	Students whose pitch sense is below average should especially avoid strings, piccolo, French horn, and trombone					
8.	Lecturers should guide students in instrument selection but should not require that a student take a particular instrument or none at all.					
9.	A student can become proficient on an instrument while appearing to defy all the physical qualifications					
10.	The number of students encouraged to begin on each instrument should be in proportion to instrumentation needs of the Music Department					
11.	There is usually a high incidence of dropping out among students who begin on an instrument other their first choice					
12.	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later					
13.	Students with shallow breaths should avoid the woodwinds and brasses					
14.	Students with short arms should be guided away from the cello and string bass.					
15.	Students should first attempt every other Western orchestral instrument before choosing one					

SECTION D: SOME TEACHING AND LEARNING METHODS AND THEIR RELEVANCE TO THE TEACHING AND LEARNING OF WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	Poor teaching and learning methods hamper effective teaching and learning of Western orchestral instruments					
2.	The first approach to effective teaching and learning of Western orchestral instruments is to provide the 'right environment'(instrument rooms and practice chambers with proper acoustics)					
3.	Carl Orff's emphasis on pre-band instruments (recorder, harmonica, marimba) to weed out the less talented and less interested students should be applied in the Music Department of Nnamdi Azikwe University, Awka					
4.	Teaching musical Instruments should involve rhythmic activity, rudiments of music, record listening, aural training, sight reading, and sight playing					
5.	Rote learning (learning or memorizing abstract concepts in whole without immediate attention to meaning) has little or no relevance in learning orchestral instruments					
6.	It is possible to master an orchestral instrument informally without any formal teacher-student setting					
7.	The Suzuki approach of commencing string teaching from infancy (3years) may not be applicable in teaching Nigerian undergraduate music students					
8.	Instrumental music teaching can be considered successful only if it produces students who can play their instruments expressively, read music readily, play by ear, and who have musical understanding					
9.	Lecturers should not give students so much attention on their orchestral instruments but should teach the basics of the instruments and allow them to take control of their learning experiences (Active learning)					
11.	Students should be left on their own with their orchestral instruments so they can make personal discoveries on their instruments (discovery learning)					
12.	One can ignore teaching and learning methods and still improve on his orchestral instrument if he concentrates on his talent and giftedness					

SECTION E: THE EFFICACY OF THE MODES OF EVALUATING PERFORMANCE IN WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	It is proper to assess or evaluate students' performance on their orchestral instruments periodically					
2.	There appears to be no standard mode of evaluation for students' performance on their orchestral instruments in Nnamdi Azikiwe University, Awka					
3.	Generally students should be assessed on their orchestral instruments based on these fundamental criteria: fingering, articulation, phrasing, accuracy, attack, and sightreading					
4.	The aformentioned modes of evaluation are not always reliable in assessing students' competence					
5.	Lecturers can assess their students' performance using other modes of evaluation of their choice					
6.	Even when there are acceptable modes of evaluation among adjudicators in a panel of evaluation or examination, the respective assessments of the adjudicators become too subjective to yield a reliable result					
7.	The lack of a standard mode of evaluation and the unreliability of the respective adjudicators assessments pose serious difficulties in grading students' performance on Western orchestral instruments in Nnamdi Azikiwe University, Awka					
8.	Enthusiastic students can still improve on their orchestral instruments irrespective of evaluation					
9.	Monitoring supervisor-student contacts and ensuring inter-adjudicator objectivity during final evaluation should be taken seriously					
10.	The impressions gathered by lecturers of individual student's progress during periodic scheduled contacts does not properly reflect the semester's continuos course assessment (CA) score for the student's performance on his orchestral instrument					
11.	Each lecturer should provide the continuous assessment (CA) score for each student assigned to him for final computation of evaluation grades based on the student's performance while in contact with him as scheduled and not by the panel of adjudicators					

SECTION F: THE PROSPECTS OF TEACHING AND LEARNING WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	Every student can adapt to learning a Western orchestral instrument					
2,	Sometimes a student who shows little promise or motivation turns out to be a fine instrumentalist a few years later					
3.	Students still forge ahead in learning and mastering their Western orchestral instruments despite the challenges					
4.	Although there are no instructors for some Western orchestral instruments in the Music Department, but there is improvement in the handling of some of the available ones					
5.	Students should be encouraged to take up voice, piano, or any Western orchestral instrument for their stress area to foster mastery					
6.	Students will improve quite well in their orchestral instruments if they are provided with adequate practice rooms with sound proof cubicles and recordings for playback of their given pieces					
7.	Students will not improve on their orchestral instruments if there is no motivation and scheduled contact with their respective tutors					
8.	Some students can do well on their orchestral instruments if they change their negative attitude toward learning					
9.	The University can aid the teaching and learning of Western orchestral instruments if provision is made for the unavailable Western orchestral instruments and employ lecturers specializing in those instruments					
10.	The Music Department can facilitate students' improvement on orchestral instruments by engaging them in concerts and performances within and outside the University					

SECTION G: THE CHALLENGES OF TEACHING AND LEARNING WESTERN ORCHESTRAL INSTRUMENTS IN NNAMDI AZIKIWE UNIVERSITY, AWKA

S/N	ITEM	SA	A	D	SD	U
1.	Instrumental teachers face conditions different from those encountered by choral music teachers					
2.	Instrumental music involves a conglomeration of fingerings, embouchures, bowings, and other specialized techniques and knowledge					
3.	The string teacher must be familiar with these bowing techniques for efficacy: *pizzicato, spiccato, vibrato, detache', staccato,tremolo, portato, col legno, sul ponticello,*double stop etc.					
4.	The brass teacher should be familiar with these techniques before he can effectively motivate his students: embouchure, tonguing, breath control, double tonguing, triple tonguing, flutter tonguing, transposition, range, split tone, pedal tone, microtones, and overtones					
5.	Teaching woodwinds demands similar knowledge in the brasses but for reed types and their relative sizes,					
6.	In teaching the percussions, one should be knowledgeable in all orchestral percussion instruments such as, timpani/kettledrums, glockenspiel, xylophone, celesta, chimes, cymbals, mallets, bass drum, snare drum etc.					
7.	Each orchestral instrument should be taught by a lecturer who specializes in that.					
8.	When there is no teacher for a given orchestral instrument, the instrument should be handled by any other teacher					
9.	Any lecturer can teach any orchestral instrument provided it is of the family of his specialized instrument. That is, the trumpet teacher can teach trombone or tuba, and the violin teacher can also teach viola, cello, or string bass.					
10.	Teaching Western orchestral instruments in the University is usually very difficult because most students had no instrumental learning in their primary and secondary schools					
11.	Instrumental instruction should be conceived as a continuous process from nursery school and kindergarten on to the completion of tertiary education					
12.	Audition tests should be run for students applying for music in Nnamdi Azikiwe University, Awka to weed out untalented students					
13.	Some of the lecturers are not competent on their Western orchestral instruments					

What is your overall rating of the teaching/learning of Western orchestral instruments in the department: very poor/poor/ fair/good/improving/promising/excellent?

What is/are your suggestion(s) to improve the teaching/learning of Western orchestral instruments in the university?

(a)_____

(b)_____

(c)_____

(d)_____

(e)_____

APPENDIX V

Reliability Test for the Instrument

Reliability test was designed to determine the suitability and adequacy of research instrument in any empirical study that would use primary data for analysis. In this regard, this study used a method known as test re-test to determine the reliability of the instrument developed for the study. The method involved administering 20 copies of the instrument on a group of music lecturer's ad students in another university. After an interval of two weeks, the same instrument was administered on the same people and the two set of responses were analyzed with the application of spearman rank order correlation coefficient. The procedure is outlined below:

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Where:

r = the coefficient to be determined

n = number of response options

d = difference in rank

1 and b = constants

The value of the coefficient ranges between -1 to + 1

Reliability Estimation for Research Question I

Response Options	Results of 1st responses (x)	Result of 2nd Responses (y)	R_x	R_y	R_x-R_y (d)	D_2
Strong agree	7	7	1	1	0	0
Agree	6	6	2	2	0	0
Disagree	3	4	4	3	1	1
Strongly disagree	4	3	3	4	-1	1
Total	20	20				2

$$r = 1 - \frac{6(2)}{4(4^2-1)} = 0.80$$

Reliability Estimation for Research Question II

Response Options	Results of 1st responses (x)	Result of 2nd Responses (y)	R_x	R_y	R_x-R_y (d)	D_2
Strong agree	8	6	1	2	-1	1
Agree	6	8	2	1	1	1
Disagree	3	4	3.5	3	0.5	0.25
Strongly disagree	3	2	3.5	4	-0.5	0.25
Total	20	20				2.5

$$r = 1 - \frac{6(2.5)}{4(4^2-1)} = 0.75$$

Reliability Estimation for Research Question III

Response Options	**Results of 1st responses (x)**	**Result of 2nd Responses (y)**	**R_x**	**R_y**	**R_x-R_y (d)**	**D_2**
Strong agree	9	8	1	1	0	0
Agree	6	6	2	2	0	0
Disagree	3	3	3	3.5	-0.5	0.25
Strongly disagree	2	3	4	3.5	-0.5	0.25
Total	20	20				1

$r = 1 - \frac{6(1)}{4(4^2-1)} = 0.90$

Reliability Estimation for Research Question IV

Response Options	**Results of 1st responses (x)**	**Result of 2nd Responses (y)**	**R_x**	**R_y**	**R_x-R_y (d)**	D_2
Strong agree	8	6	1	2	-1	1
Agree	6	8	2	1	1	1
Disagree	3	4	3.5	3	0.5	0.25
Strongly disagree	3	2	3.5	4	-0.5	0.25
Total	20	20				2.5

$r = 1 - \frac{6(2.5)}{4(4^2-1)} = 0.75$

Reliability Estimation for Research Question V

Response Options	**Results of 1st responses (x)**	**Result of 2nd Responses (y)**	**R_x**	**R_y**	**R_x-R_y (d)**	D_2
Strong agree	7	7	1	1.5	-0.5	0.25
Agree	6	7	2	1.5	0.5	0.25
Disagree	3	4	4	3	1	1
Strongly disagree	4	2	3	4	-1	1
Total	20	20				2.5

$r = 1 - \frac{6(2.5)}{4(4^2-1)} = 0.75$

Reliability Estimation for Research Question VII

Response Options	**Results of 1st responses (x)**	**Result of 2nd Responses (y)**	**R_x**	**R_y**	**R_x-R_y (d)**	D_2
Strong agree	8	8	1	1.5	-0.5	-.25
Agree	7	8	2	1.5	0.5	0.25
Disagree	3	3	3	3	0	0
Strongly disagree	2	1	4	4	0	0
Total	20	20				0.5

$r = 1 - \frac{6(0.5)}{4(4^2-1)} = 0.95$

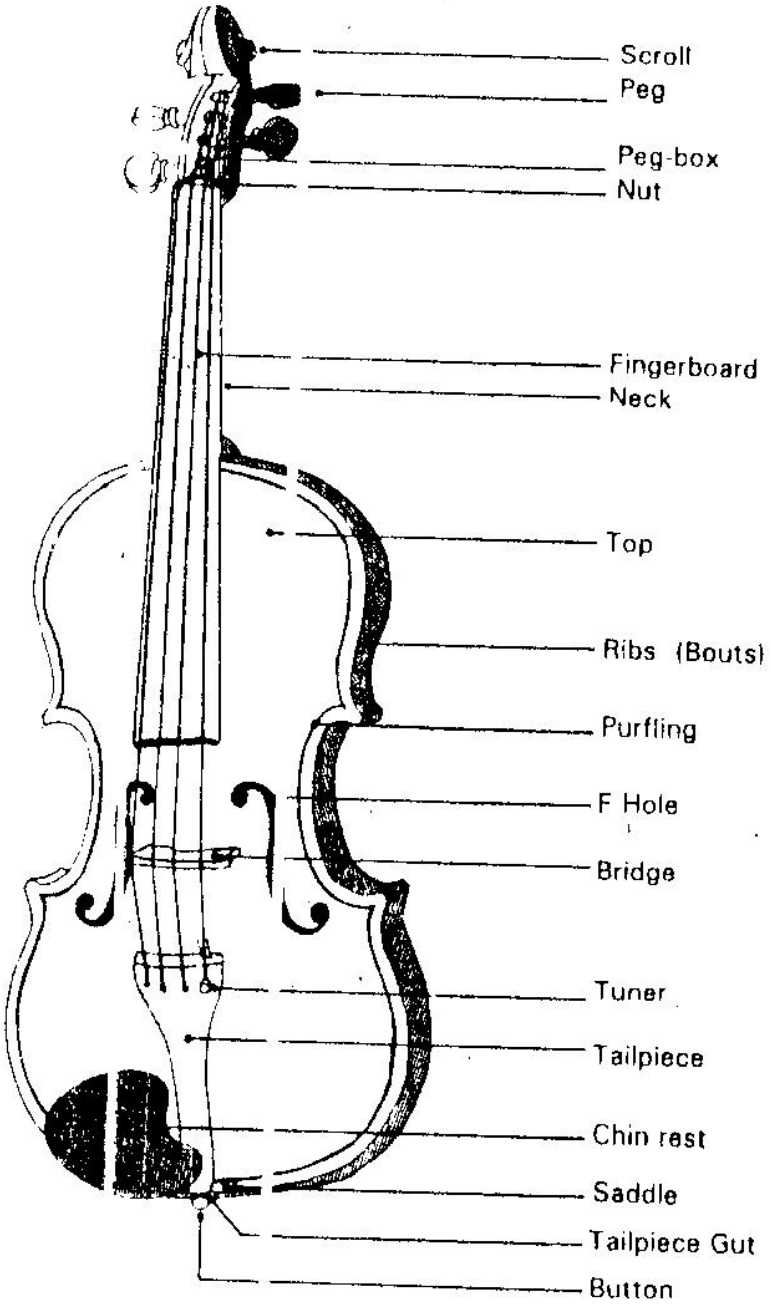
Average coefficient for the six research coefficient (reliability coefficient)

Research Questions	**Coefficient**
I	0.80
II	0.75
III	0.90
IV	0.75
V	0.75
VI	0.75
Total	0.82

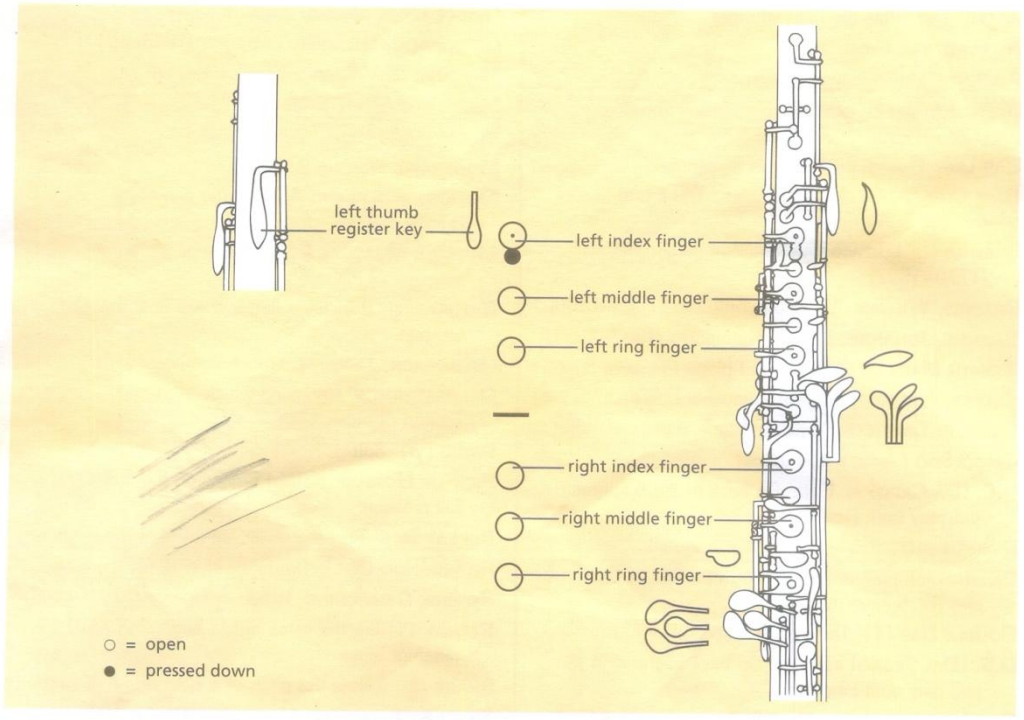
Thus, reliability coefficient is o.82 or 82%.

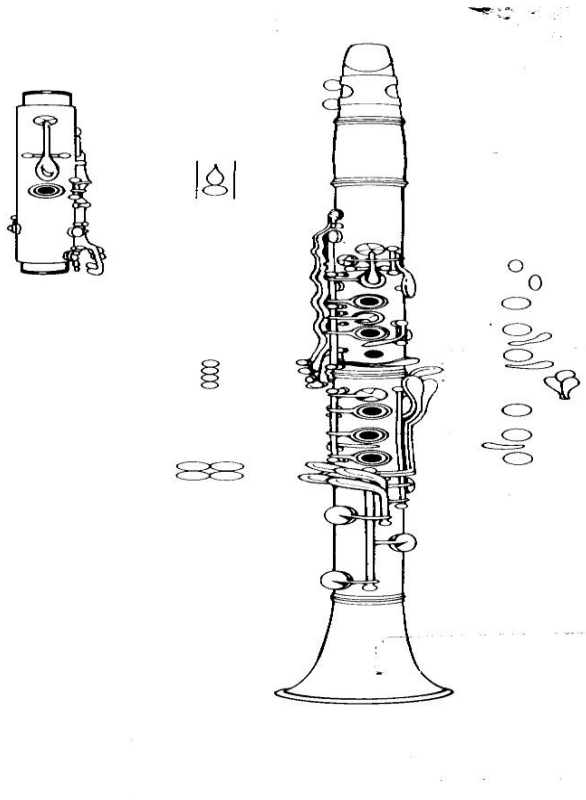
APPENDIX VI

SOME WESTERN ORCHESTRAL MUSICAL INSTRUMENTS AND THEIR CHARTS



The Violin


left thumb
register key
left index finger
left middle finger
left ring finger
right index finger
right middle finger
right ring finger
○ = open
● = pressed down

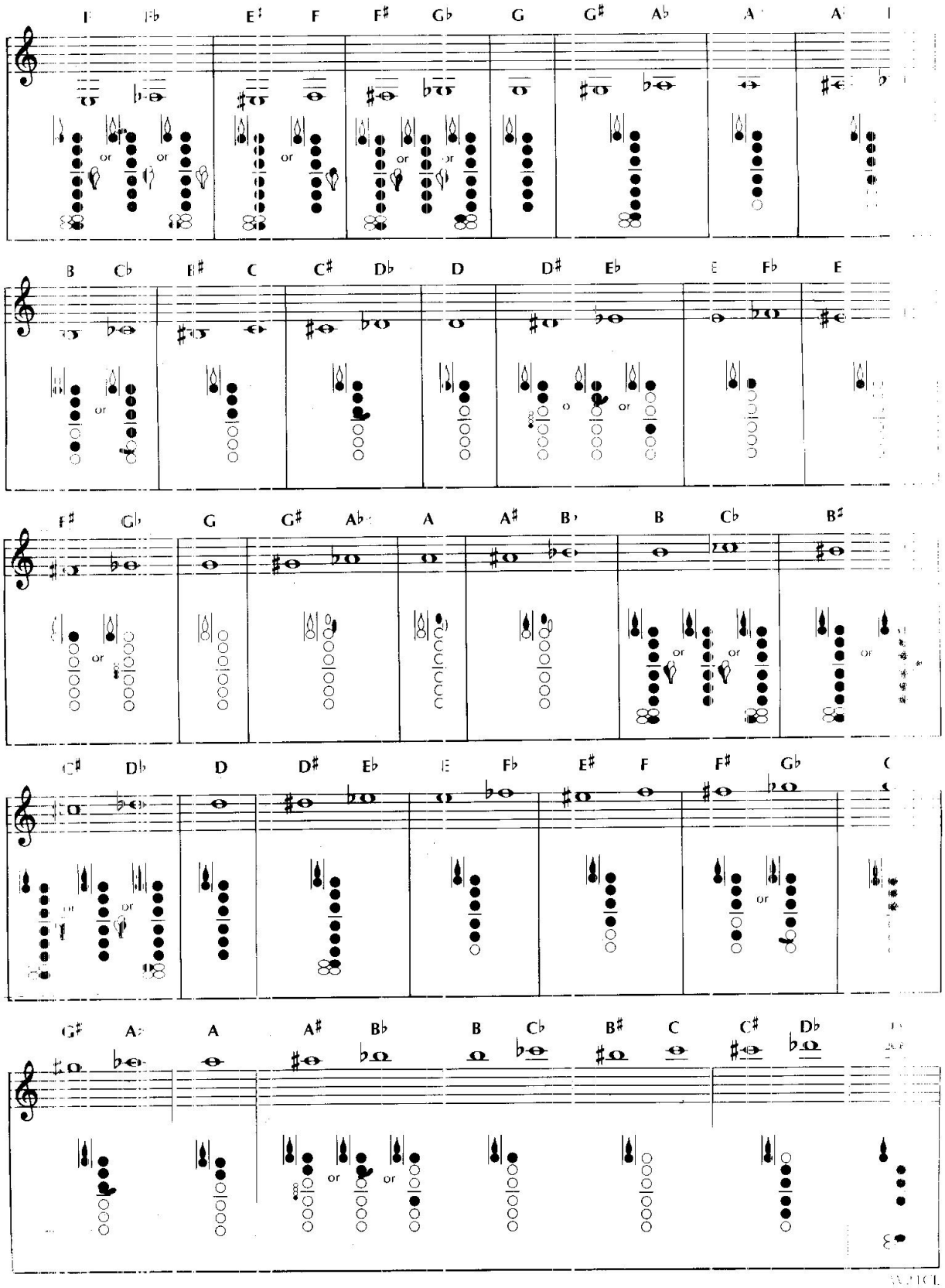


B^{b} Clarinet

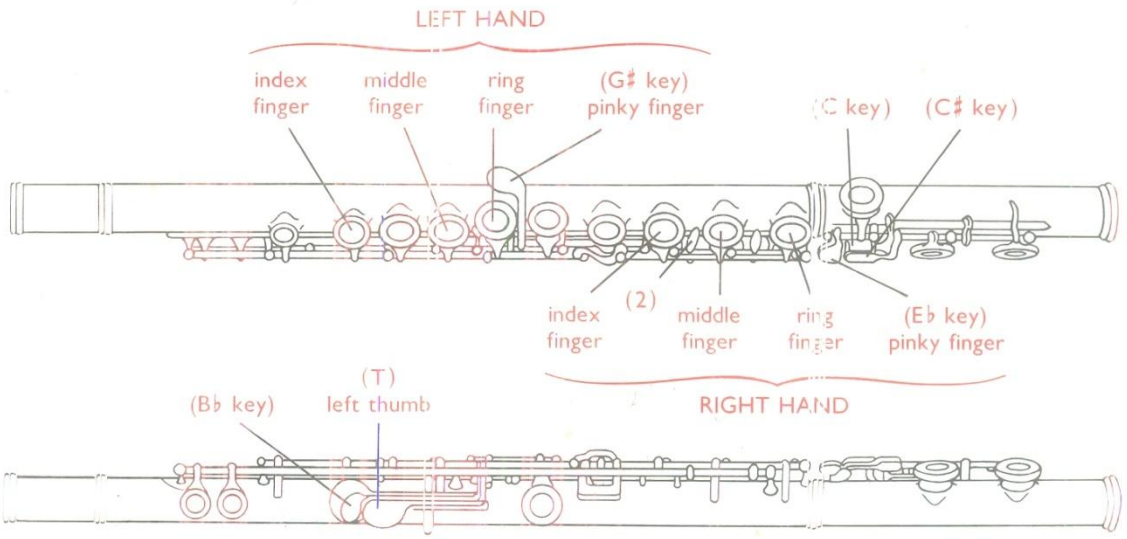
B♭ Clarinet Fingering Chart

○ = open ● = pressed down

When more than one fingering is shown, the first is the most commonly used. Additional fingerings, known as "alternate" fingerings, are used in certain situations to allow for better technique.



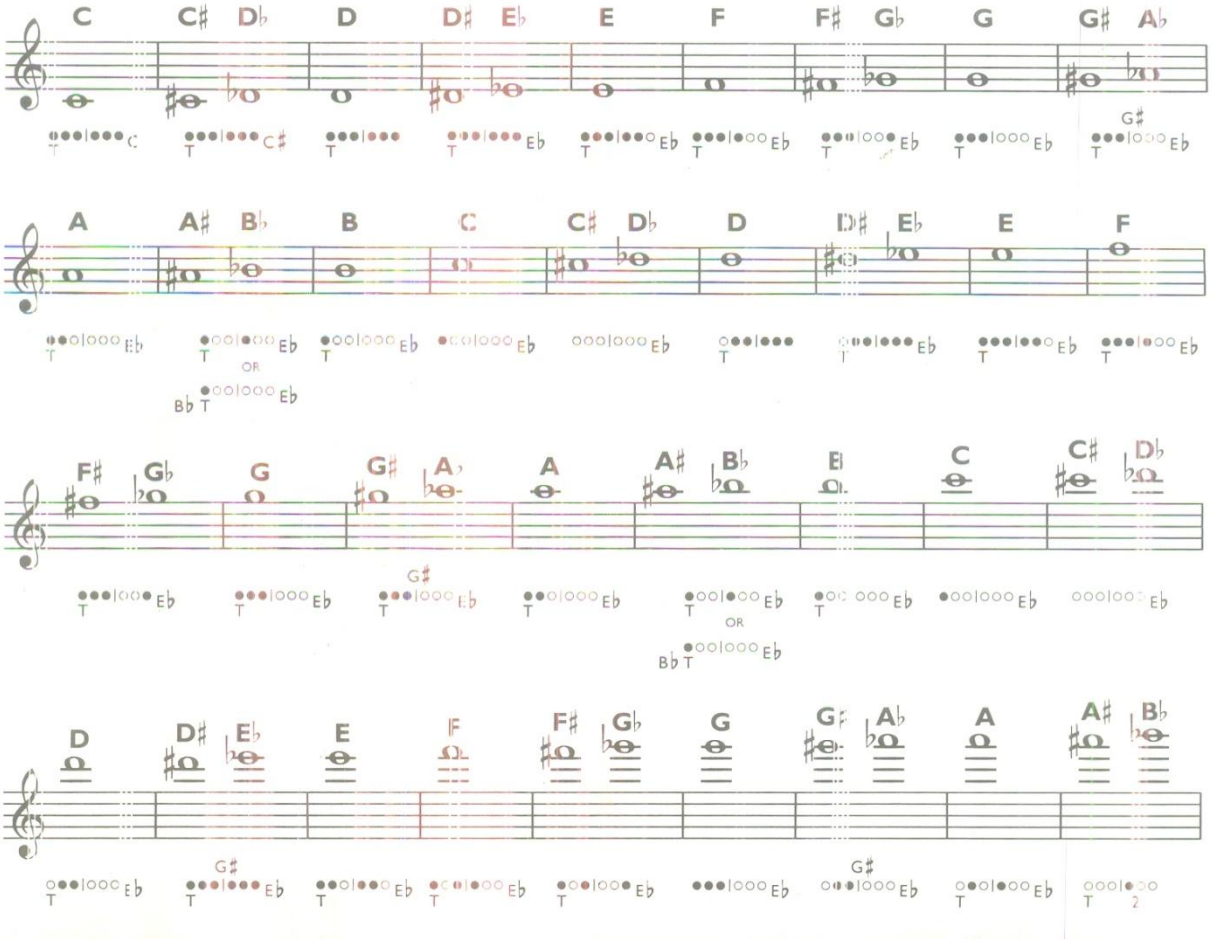
FLUTE FINGERING CHART



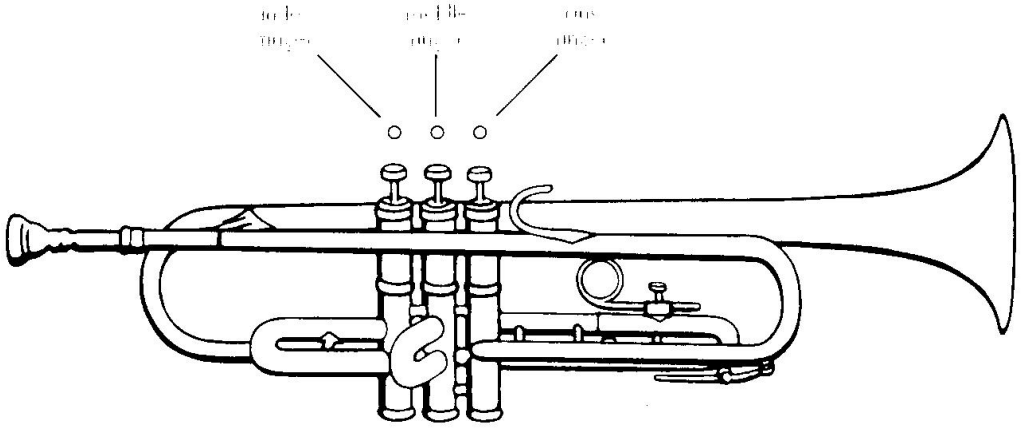
● indicates a key pressed down.

○ indicates a key left open.

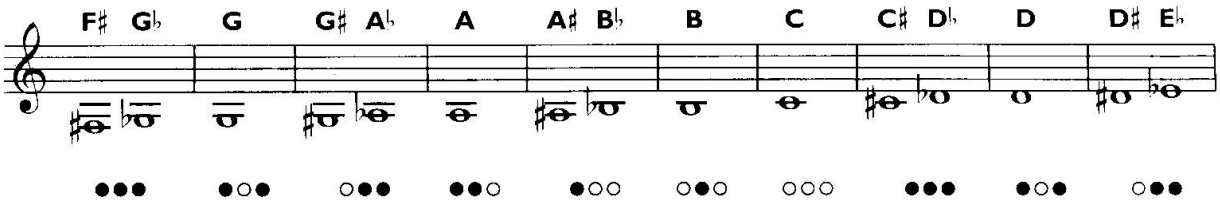
Letters indicate other keys to be pressed down.

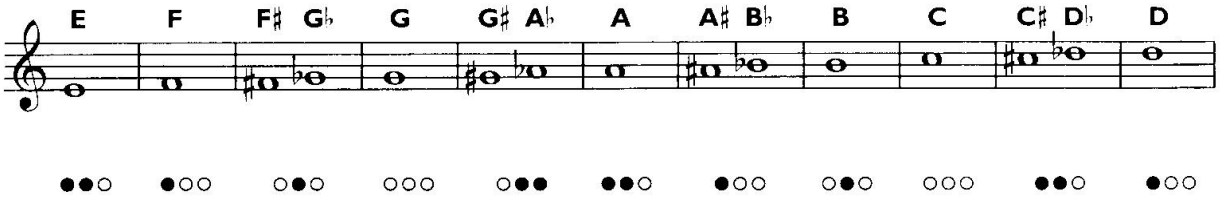


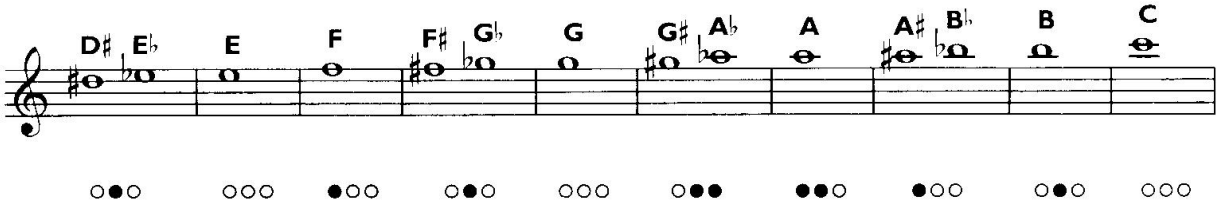
TRUMPET FINGERING CHART



○ = valve up
● = valve down







INSTRUMENTATION: RANGES CLEFS AND TRANSPOSITIONS OF SOME WESTERN ORCHESTRAL INSTRUMENTS

Instrumentation: Ranges, Clefs, Transposition

Range

The range given for each instrument is approximately that ordinarily used by the average player. Neither the lowest nor the highest note playable by the instrument is necessarily included. These ranges will be found satisfactory for purposes of this text.

Clef

Each instrument regularly uses the clef or clefs found in the musical illustrations under "Range." Exceptions or modifying statements are found under the heading "Clef."

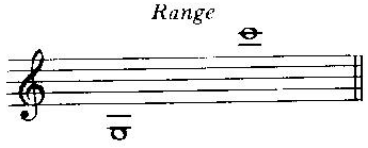
Transposition

Unless otherwise indicated under this heading, pitches given under "Range" sound concert pitch when played. (Concert pitch: $A^1 = 440$ vibrations per second; the note A^1 on the piano keyboard is concert A). All transposing instruments sound their name when written C is played; for example, a Clarinet in B♭ sounds B♭ when it plays a written C.

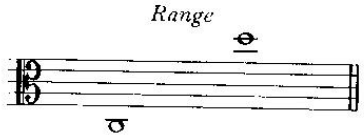
STRING INSTRUMENTS

Violin

Range

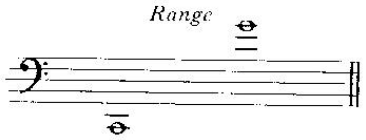


Viola



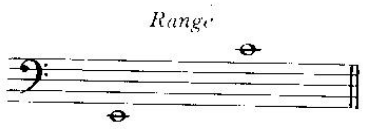
Clef. Alto clef is used almost exclusively. Treble clef is used occasionally for sustained high passages.

Violoncello ('Cello)



Clef. Bass clef is ordinarily used. Tenor clef is used for extended passages above small A. Treble clef is used for extreme upper range (not shown).

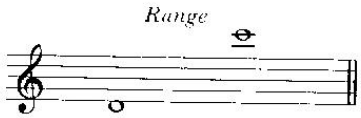
Double Bass (Bass Viol, Contrabass)



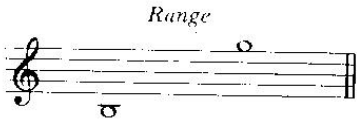
Transposition. Notes sound an octave lower than written.

WOODWIND INSTRUMENTS

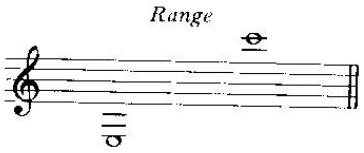
Flute



Oboe



Clarinet: B♭ and A

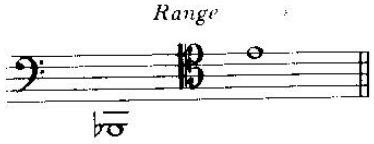


Transposition.

a) Clarinet in B♭. Notes sound a major second lower than written. Use signature for the key a major second *above* concert pitch.

b) Clarinet in A. Notes sound a minor third lower than written. Use signature for the key a minor third *above* concert pitch.

Bassoon

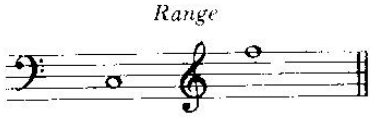


Clef. Bass clef is ordinarily used. Tenor clef is used for upper range.

English Horn (Cor Anglais)

Transposition. Notes sound a perfect fifth lower than written. Use signature for the key a perfect fifth *above* concert pitch.

Horn (French Horn)

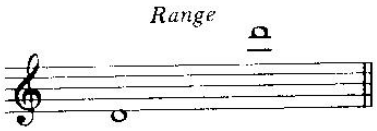


Clef. Treble clef is commonly used.

Transposition. Notes sound a perfect fifth lower than written. Key signatures are not ordinarily used. Write in all accidentals. In many published horn parts, notes written in the bass clef sound a perfect fourth higher than written. Consult with player of instrument before writing horn part in bass clef.

Horn parts are occasionally written in D, E♭, and E.

Saxophones: E♭ Alto, B♭ Tenor, and E♭ Baritone



Transposition.

a) E♭ Alto Saxophone. Notes sound a major sixth lower than written. Use signature for the key a major sixth *above* concert pitch.

b) B♭ Tenor Saxophone. Notes sound a major ninth (an octave plus a major second) lower than written. Use signature for the key a major second *above* concert pitch.

c) E♭ Baritone Saxophone. Notes sound an octave plus a major sixth lower than written. Use signature for the key a major sixth *above* concert pitch.

BRASS INSTRUMENTS

Trumpet or Cornet, B♭ and C

Range

Transposition.

a) Trumpet or Cornet in B♭. Notes sound a major second lower than written. Use signature for the key a major second *above* concert pitch.

b) Trumpet or Cornet in C. Non-transposing—sounds as written.

Trombone

Range

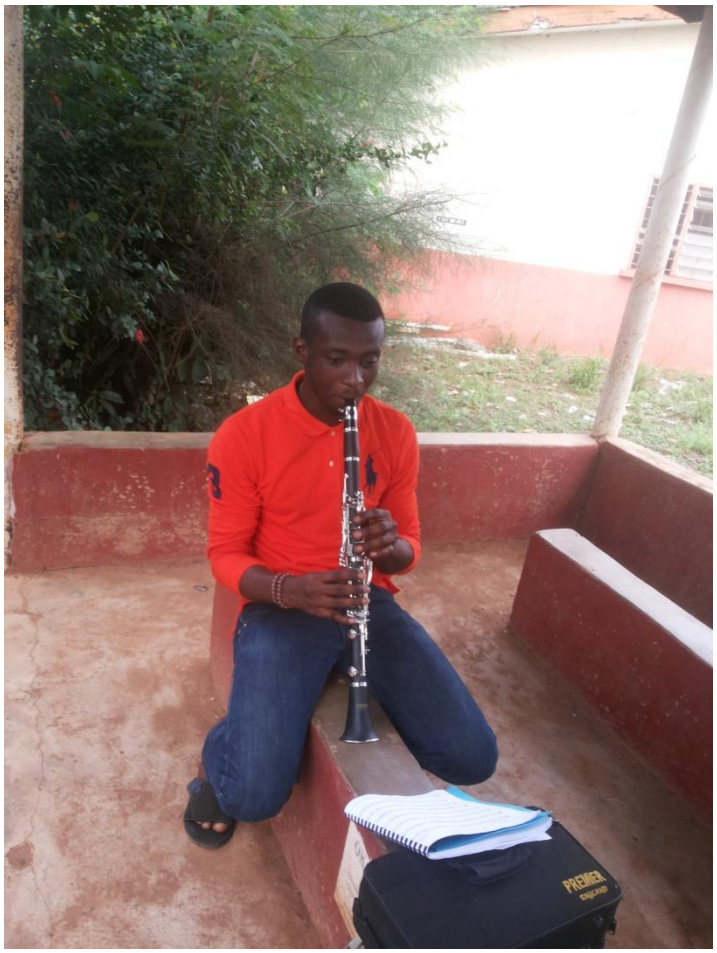
Clef. Both tenor and bass clefs are commonly used.

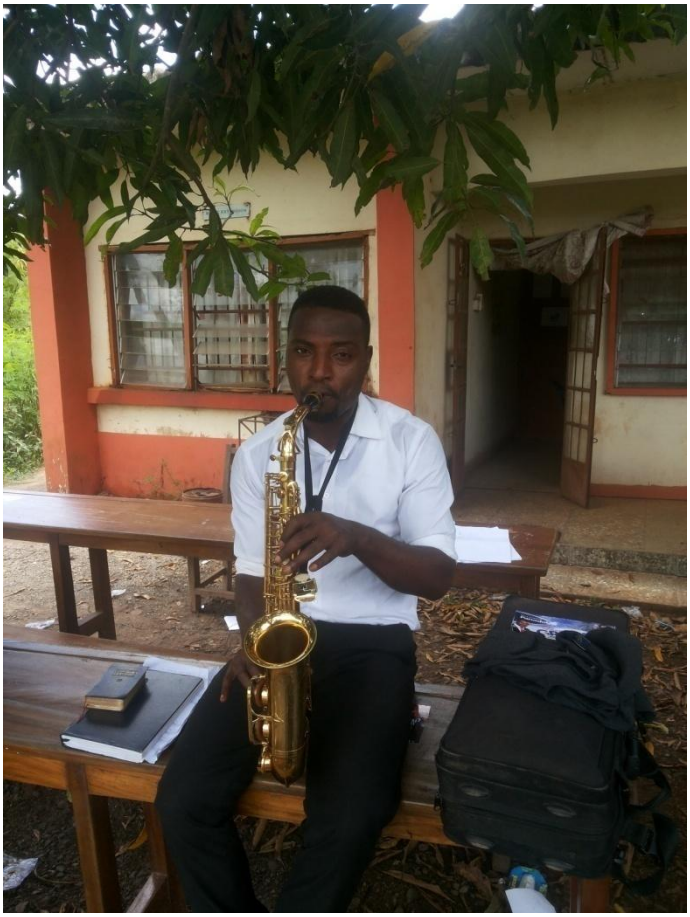
Tuba

Range

APPENDIX VII

PLATES





Students practicing on their Western orchestral instruments (Discovery learning)

Personal Practice.

The researcher stressing a point to a student on the trumpet