APPRAISAL OF THEORETICAL MODELS OF PSYCHOMOTOR SKILLS AND APPLICATIONS TO TECHNICAL VOCATIONAL EDUCATION AND TRAINING (TVET) SYSTEM IN NIGERIA

Okwelle P. Chijioke, Ph.D

Department of Science & Technical Education
Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Abstract
Technical and Vocational Education and Training (TVET) is recognized by many as the greatest weapon that can be used to achieve desirable changes and development of a nation. The learning experiences in TVET may occur in a variety of learning contexts, including educational institutions and work places. Effective human performance in (TVET) consists of the successful interactive effects of skills, knowledge and attitude. TVET programmes, therefore, aim to develop all three of these domains of learning but with greater emphasis on psychomotor domain which deals primarily with practical skill development of an individual. Literature abound with a variety of theoretical models classifying psychomotor skills which can be used in defining instructional objectives in TVET. This paper therefore attempted to highlight each of these models of psychomotor domains and their applicability in defining objectives for skill development of learners in Nigerian TVET system.

Keywords: Appraisal, Psychomotor skills, Theoretical models, Technical and Vocational Education and Training

1 INTRODUCTION
Defining learning or instructional objectives is a major factor for consideration in the process of designing good instructional and assessment instruments in any field of education (Barry & King, 1993). Learning objective also known as behavioural objective is a statement of what learner should be able to do or better as a result of having worked through a course (Rowntree 1992). Similarly, Abdulahi (1980) referred to behavioural objective as the behaviour one would like a learner to be able to demonstrate at the end of an instruction. According to Anaekwe (2004), educational objectives among other things serve as basis upon which teachers and students select desirable learning experiences and content; they form the yardstick upon which a particular educational programme or instruction is evaluated as well as serve useful purposes in test construction. Properly written objectives focus on what the student will be able to do at the end of the learning activity and should focus on observable behaviours - knowledge, skill or attitudes that can be measured (Baker, n.d). Objectives of educational programme therefore can be regarded as those generally concerned with a change in behaviour such as a changed attitude, perception or skill level or an increase in knowledge.

There is a generally recognized classification of learning objectives within education into three domains namely, cognitive (knowledge), affective (attitude) and psychomotor (skills). This classification by educational psychologists is widely referred to as Bloom’s taxonomy of educational objectives (Huit, 2009; Okoro, 1999). The major idea of the taxonomy is that what educators want students to know (encompassed in statements of educational objectives) can be
arranged in a hierarchy from less to more complex levels. The levels are understood to be successive, so that one level must be mastered before the next level can be reached (Huitt, 2009). This classification of educational objectives is very important to the field of technical and vocational education and training. This is so because TVET encourages skills acquisition, knowledge and attitudes needed for professional careers (UNESCO, 2011). Learning in this field at all levels is concerned with equipping the students with the knowledge, attitudes and skills that will enable them demonstrate competence in the tasks they are expected to perform in the world of work.

From the foregoing, it is important to note that a well-designed instructional and assessment instrument will cater for the complete development of students in any field of TVET. Since one of the most important features of TVET is its orientation towards the world of work and the emphasis of the curriculum is on the acquisition of employable skills, therefore the psychomotor domain that deals primarily with physical or practical skills development is most emphasized in TVET. The various forms of the psychomotor skills and how suitable they are applied in writing objectives with consideration to TVET system in Nigeria is the concern of this paper. The paper specifically looked at:

- TVET System in Nigeria
- The concept of Theory
- Theoretical Models of Psychomotor Skills in TVET and applications in Nigeria School System.

2 TVET SYSTEM IN NIGERIA

The success of TVET in any developing country can be considered a key indicator of the country’s advancement in development. UNESCO (2011) recognizes this fact when it stated that technical and vocational education and training is a prerequisite for sustaining the complex structure of modern civilization and economic and social development. Thus, any country that evolved into a technologically advanced one, TVET must have played an active and vital role as skilled manpower would have been required, also to enable its sustainability. According to Atchoarena & Delluc (2001), TVET refers to education which is mainly to lead participants to acquire the practical skills, know how and understanding, and necessary for employment in a particular occupation, trade or group of occupations. Uwaifo (2010) defined TVET as the training of technically oriented personnel who are to be the initiators, facilitators and implementers of technological development of a nation by adequately training its citizenry on the need to be technologically literate, leading to self-reliance and sustainability TVET as defined by UNESCO (2001) and adopted by the Federal Republic of Nigeria in her National Policy on Education (2004: 29) is:

“referring to those aspects of the educational process involving in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life”

TVET is further understood in the national policy on education to be:

* An integral part of general education;
* A means of preparing for occupational fields and for effective participation in the world of work;
* An aspect of lifelong learning and a preparation for responsible citizenship;
* An instrument for promoting environmentally sound suitable development;
* A method of alleviating poverty.

The goals of TVET in Nigeria as further stated in the national policy on education are to:
+ Provide trained manpower in the applied sciences, technology and business particularly at craft, advanced craft and technical levels;
+ Provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development;
+ Give training and impart necessary skills to individual who shall be self reliant economically.

A glean from the above, TVET broadly refers to deliberate interventions to bring about learning which would make people more productive (or simply adequately productive) in designated areas of economic activity (e.g., economic sectors, occupations, specific work tasks. TVET thus equips people not only with vocational and technical skills, but with a broad range of knowledge, skills and attitudes that are now recognized as indispensable for meaningful participation in work and life. It is the goal of TVET to prepare learners for specific jobs or types of work, often including practical and/or procedural activities. Such practical skills or know how can be provided in a wide range of settings by multiple providers both in the public and private sector and in the globe differ from one nation to nation.

TVET can take place either in formal schools including primary through post primary schools/ technical colleges and polytechnics, or informally by means of training at the workplace, enterprise and apprenticeship training centers as well as increasingly by distance media. In Nigeria in particular, traditional apprenticeship offers the greater opportunity for the acquisition of employable skills in the informal sector, while formal TVET programmes are school-based.

The Federal Government of Nigeria in her national policy on education (1981, 1998, 2004 editions), presented technical and vocational subjects at all levels of education. The duration of the school-based TVET in the 6- 3-3-4 educational system, is nine years pre-vocational skills at primary and junior secondary schools. Higher vocational skills are offered at three years senior secondary school and four years tertiary institutions respectively. Developing effective school-based curriculum for the various levels of TVET delivery is based on psychomotor theoretical concepts..

3 THE CONCEPT OF THEORY

The term *theory* means too many different things to too many people. It is used with surprising frequency in everyday language. It is often used in to mean a guess, hunch or supposition. You may even hear people dismiss certain information because it is "only a theory." It is important to note as you study psychology and other scientific topics, that a theory in science is not the same as the colloquial use of the term (kendra, n/a). She went further to state that a theory is a fact-based framework for describing a phenomenon. Bacharach (1989) defined theory is a statement of relations among concepts within a set of boundary assumptions and constraints, and a linguistic device to organize a complex empirical world. Poole and Van de Ven, (1989) point out that theories attempt to capture a multifaceted reality with a finite, internally consistent statement, that they are a limited and fairly precise picture, and are reliant on a limited, carefully prescribed set of assumptions and explanatory principles that specify what can be explained or understood. Also, Weick (1995) argues that theory is not data, not references, not a list of variables not a diagram, a story or a stand alone hypothesis. He seems to agree that a theory is a continuum rather than a dichotomy and that the word theory belongs in the family of words that includes guess, speculation, supposition, conjecture, proposition, hypothesis, conception, explanation, and model. Gregor (2002) in developing a classification theory of theory defines theory to include conjecture, models, framework or body of knowledge. She also argues that theory should include generalizations to some degree and that causality is central to many conceptions of theory.
Theory consists of a set of statements or propositions, which are made in order to explain natural phenomena. Theory provides needed data about a given subject-matter and instructions about the method of relating one part of the data to another (Nwachukwu, 2001). In the same vein, Nwaogu (2001) asserts that a theory presents a concept or idea that is testable. It is indeed a pool of tested ideas and knowledge from which one can draw an inspiration. Kim (2012) argues that a theory must include statements that have observational consequences. According to Kendra (n/a), a psychological theory has two key components: (1) it must describe a behavior and (2) make predictions about future behaviors.

A generally quoted theory is based upon a hypothesis and backed by evidence (Kendra, n/a; Weick, 1995; Kim, 2012). On how a theory is developed, Whetten (1989) explains that a theory is developed by first building a model made up of the factors which logically should be considered as part of the explanation of the social or individual phenomena of interest. The model should explain how the factors are related, but most importantly theory development involves explaining the underlying psychological economic or social dynamics that justify the selection of the factors and the proposed relationships. He calls this last attribute ‘why’. Bacharach (1989) stated that a collection of constructs and variables does not necessarily make a theory. He goes on to say that a theory is not data, typologies, categories, metaphors, or descriptions, not the features or qualities of individual things, acts or events, but rather they explain and predict events and objects. He provides a line and box picture of the components of a theory which includes constructs, variables, propositions and hypotheses bounded by assumptions. Weick (1999) reports that theory construction is to include the concurrent development of concepts, propositions that state a relationship between at least two properties, and must be designed to highlight relationships, connections and interdependencies in the phenomenon of interest. Theory building, he claims, is virtually indistinguishable from problem solving. In an attempt to distinguish a theory from a law, Kim (2012) posits that a few theories do become laws, but theories and laws have separate and distinct roles in the scientific method. He further stated that a theory is an explanation of an observed phenomenon, while a law is a description of an observed phenomenon.

Hooker (1991), in his argument against the possibility of design theories, defines a theory as an explanatory account. A theory needs to be substantiated, it is an account of the way things are, and not the things actually are; it is not a conceptual framework, but rather uses one to make claims; in other words, a framework or tool is not a theory because it is neither true nor false. A theory uses a framework, it tells why things are, and formulae are not theory unless they explain why ideas are related. Similarly, Geothals, 1966 (as cited in Ogbazi, 2001) views a theory as a tool by which explanation is furthered, and being a tool it is not something which can be said to be good or bad, true or false. According to Kim (2012), one feature of a good theory is that it formed from a number of hypotheses that can be tested independently. Eisenhardt (1989) defines good theory as parsimonious (explains more with less), testable, and logically coherent. For the assessment of theory-building she asks have the investigators followed a careful analytical procedure, does the evidence support the theory, have the investigators ruled out rival explanations? This suggests theory is an explanation that is supported by evidence. Weick (1999) sees a good theory as a plausible theory, needing to be interesting, novel, a source of unexpected connections, high in narrative rationality, aesthetically pleasing, and corresponding to presumed realities. Steffire and Matheny (1968, as cited in Nwachukwu, 2001) proposed five attributes of a good theory to include;

1 A good theory is clear. It is easily understood and its principles do not contradict each other.
A good theory is comprehensive. A theory which attempts to relate a number of phenomena to one another is to be preferred to a type, which is restricted.

Explicitness is the hallmark of a good theory. Terms used must be precise and should be such that lend themselves to testing.

A good theory is parsimonious. It does not indulge in diversions and provides simple explanations for data, and

Theory generates much useful research and fact-findings.

Based on the foregoing, the author recognizes the fact that theories are bodies of information (or, as psychologists and linguists sometimes say, bodies of knowledge) about a particular domain. It is a dimension rather than a category, and as an ordered set of assertions about a generic behaviour or structure assumed to hold throughout a significantly broad range of specific instances. In science, a theory is not merely a guess. Each theory has helped contribute to our knowledge base of the human mind and behavior. Also, in psychology such theories have been posited to explain numerous psychological capacities used to provide a model for understanding human thoughts, emotions and behaviors. When applied in teaching – learning activity, it is expected that a good theory should provide the principles which directly govern the teaching - learning process.

4 THEORITICAL MODELS OF PSYCHOMOTOR SKILLS IN TVET AND APPLICATIONS IN NIGERIA SCHOOL SYSTEM.

Many theories have been developed and used over the years in an attempt to define psychomotor skills which could be used as basis for writing learning objectives in TVET. A theory of psychomotive skill enhances the effectiveness of the TVET instruction as it serves as a means of systematizing information which is contained in area of knowledge, skill and attitude, thereby leading to the discovery of unknown facts. Different situations call for different psychomotor skills. Using known criteria, an appraisal of the most popular theoretical models and their applicability in TVET system in Nigeria is examined below.

Seymour (1966) proposed a classification of psychomotor skills as follows: (1) Hardwork, (2) Hardwork with tools (3) Single purpose machine (4) Group purpose machine (5) Non repetitive. This model is based on studying a skill in industrial set up. It explains psychomotor skills in terms of categories of tools and machine used with total negligence to the individual learner’s perception and understanding level in making use of the tools and machines. In Nigeria, this model appears partially applicable in the informal TVET system where skill acquisition is achieved through the apprenticeship mode of learning. The model appears partially inapplicable in the formal TVET system because the model is not explicit in the dimension of skills involved in using the tools and machines.

Miller (1967, as cited in Garba, 1993) developed a theory for explaining skills in a hierarchical order structured as “TOTE” which means: Test; Operate; Test; and Exit. The first stage is based on “test” in which the learner assesses whether there is any difference between the actual state of the system and its required state. Any observed difference requires the “operate” phase followed by further “test” again. The cycle is “TOTE” will continue until the desired state is achieved, after which the activity ends. Time used by an individual learner may be longer since the cycle will only come to an end when the skill acquired is considered satisfactory. Like Seymour’s theory, in Nigeria, this model appears applicable in the informal TVET system where skill acquisition is achieved through the apprenticeship mode of learning. The model to a large extent appears inapplicable in the formal TVET system because time is a major factor in instruction and
assessment of learners’ achievement in addition to the absence of other salient stages in skill acquisition in this theory.

**Hauenstenin (1970)** developed a model of psychomotor skills organized on the sequence of learning practical skills to include: *Observing; Imitation; Manipulating; Performing and Perfecting*. In this model, the sequence of learning skills starts with observing the skill, and then followed by imitating through perfecting. The model is not comprehensive enough because it does not specify aspects of psychomotor skills of these sequences. This theory seems applicable to prevocational training offered to students at the Junior Secondary School level. The Federal Republic of Nigeria (FGN), (2004; 30) stated the objectives of TVET at this level to include;

- Introduction into world of technology and appreciation of technology towards interest arousal and choice of a vocation at the end of Junior Secondary School and professionalism later in life;
- acquiring technical skills;
- exposing students to career awareness by exploring usable options in the world of work; and
- enabling youths to have an intelligent understanding of the increasing complexity of technology.

Therefore, the Hauenstenin model where the sequence of learning skills starts with observing the skill, and then followed by imitating through perfecting, seems to a great extent, applicable to achieving the goal of TVET at the prevocational training level in Nigeria.

**Simpson (1972)** classified the psychomotor domain into seven major subdivisions: *Perception* - becoming aware of objects and materials; *Set* - mental adjustment or readiness to perform a particular task; *Guided response* - performance of the tasks guided by the teacher or a model; *Mechanism* - appreciation of the mechanism and the development of some degree of proficiency in performing the task; *Complex overt responses* - development of complex skills which can be performed automatically; *Adaptation* - alteration of learned skills to suit new situation; *Organization* - creation of new motor activities and development of new skills.

Simpson arranged his model in a learning sequence or stages, which require a trainee encountering a new skill for the first time to go through the stages one after the other until mastery is attained. In Nigeria, research findings seem to support the applicability of this theory in TVET for providing trained manpower at craft, advanced craft and technical levels, where one of the major goals (FGN, 2004), is to train personnel with technical knowledge and vocational skills necessary for agricultural, commercial and economic development. Garba (1993) in his study on the development of an instrument for evaluating practical projects in woodworking at technical level used the Simpson theory to classify learning objectives and assessment process. Similarly, Yalams (2001) applied this theory in his study on the development of metal work process evaluation scheme at technical level. However, it is observed that this model is not explicit on levels of complexities of skills, so the model could not be said to possess all-inclusive applicability in defining psychomotor domains for TVET instruction.

**Harrow (1972)** arranged her taxonomy of psychomotor domain into seven different levels as follows: *Reflex movements* – Reactions that are not learned; *Fundamental Movements* – Basic movements such as walking, or grasping. *Perception* - Response to stimuli - such as visual, auditory, kinesthetic, or tactile discrimination. *Physical abilities* - Stamina that must be developed for further development such as strength and agility; *Skilled Movements* - Advanced learned movements as one would find in sports and acting; *Non-discursive Communication* - Effective body language, such as gestures and facial expressions.
Harrow’s classification of the psychomotor domain appears to be the most popular and relates most to the other domains. In Nigeria, Ezeudu (1987, 1992) employed this theory in his study of development and validation an instrument for evaluating psychomotor outcomes in senior secondary geography. Also, Chiejile (2006) applied this theory in his study on the development and validation of an instrument for assessing technical students’ practical performance in electrical installations. However, Mkpa (1984, as cited in Okwelle, 2011) observed that the categories defined by Harrow are not strictly mutually exclusive rather; there is some form of overlapping among the categories and subcategories. As a result of these lapses, this model is considered not comprehensive enough to define psychomotor learning.

**Cratty (1973)** developed a psychomotor skill model which he classified into: *Simple movement; Complex task; Complex movement and Skill families.* This model is similar to Seymour’s (1966) model because it relates to complexity of the tasks rather than the process involved in learning each task. Response to stimuli on the part of the learner is not considered in this model. As such, this theory appears partially applicable in the informal TVET system and appears partially inapplicable in the formal TVET system in Nigeria.

**Dave (1975)** defined psychomotor skills in terms of five major components namely; *Imitation* - Observing and patterning behaviour after someone else; *Manipulation* - Being able to perform certain actions by following instructions and practicing; *Precision* - Refining, becoming more exact. Few errors are apparent; *Articulation* - Coordinating a series of actions, achieving harmony and internal consistency; *Naturalization* - Having high level performance become natural, without needing to think much about it.

The model explains psychomotor domain in terms of stages in building perfection. Even though the model focuses on stages involved in building perfection of skills, it fails to incorporate some important stages such as observation, perception and motivation. The model to some extent seems applicable to achieving the goal of TVET at the prevocational training level in Nigeria.

**Hoover (1980)** also classified psychomotor skills based on learning sequence into four, namely: *Observation; Imitation; Practice and Adapting.* Hoover’s model is similar to Hauensteinin theory in the sense that acquisition of practical skills is sequential, starting with observation of skill, and then followed to adapting the skill. This model is not all-embracing as it does not specify aspects of psychomotor skill of each sequence, as such is considered partly applicable to pre-vocational training offered to students at the Junior Secondary School level in Nigeria.

In 1984, Ezewu proposed a psychomotor model called Psycho productive domain with three broad levels: low level, middle level and higher level. Under the low level is *Understanding* - of terminologies, scope of job or task, job specification, instruments and materials. The *middle level* has two components; *Task Identification* - Identifies tasks in a job and breaks job into tasks; and *Task* - Elements Specification - Identifies task -elements, selects appropriate materials and instruments. Similarly, the *high level* has two components: *Execution* - Identifies task elements, handles instruments and materials properly, executes with required speed, executes according to specification, co-operates with necessary others, persevere; as well as *Out-put* - Meets standard or specification, functions according to standards.

In developing this model, Ezewu was concerned with the extent to which this model could be applied to the scope of learning outcomes in technical and vocational subjects/courses. The model
explains psychomotor behaviour in terms of low level of understanding technologies and task analysis to high level of execution and output. However, it does not embrace certain aspects of psychomotor skills such as affective behaviour. Nevertheless, it is noteworthy that Ezewu’s psycho productive theory came about based on the goals of TVET in Nigeria.

The psychomotor skills acquisition model proposed by Padelford (1984) comprised six stages: *Perceiving* - Perception of the wanted skill - perceptual component of psychomotor domain; *Motivation* - Involves the resolve to take part or wish to learn. It also requires setting goals on solving a problem - perceptual and affective component of psychomotor domain; *Imitating* - This stage requires the individual to be involved in some mental manipulation of forms and pattern, and for mimicking a series of events, patterns or procedures to be used. This stage represents perceptual cognitive and affective component of psychomotor domain; *Performing* - Practice of the wanted skill by moving parts of the body according to the pattern the mind has visualized-perceptual, affective cognitive aspect of psychomotor domain; *Adapting* - Adapting new motor skills to new situations based on personal creativity, perceptual, affective, and cognitive as well as creativity aspect of psychomotor domain; *Innovating* - Ability to experiment and create new forms of the learned skill, perceptual, affective, cognitive creativity aspect of psychomotor domain.

This model explains the stages involved in learning skills or exhibiting various aspects of psychomotor domain. Each stage influences the subsequent one. The model appears comprehensive in stating learning objectives because it conforms to the requirement of psychomotor behaviour in terms of diversities i.e. cognitive and affective. For instance, Padelford observed that the perceiving stage involves: sensing symbols; cue selections; translating and internalizing. These belong to the perceptual cognitive domain. The second stage of motivation involves externally and internally directed satisfaction, which belong to the perceptual and affective domain. The third stage of imitating involves mentally manipulating the forms, patterns or sequence of actions and mimicking a series of events, patterns of procedures followed. This contains perceptual, affective and cognitive domains. The fourth stage also reflects perceptual, affective, cognitive and psychomotor domains. The fifth stage of adapting involves diagnosing, reaching, adjusting and problem solving. This also contains affective, cognitive and psychomotor domains. The sixth stage of innovating involves experimenting, expressing and symbolizing. This also contains affective, cognitive and psychomotor. Therefore, analyzing the Padelford’s model it could be said that the first three levels are internal while the remaining three are externally observable and each stage leads to the other. Also, it could be said that the model has taken care of the fact that psychomotor behaviour contains affective and cognitive behaviour. This agrees with the observations by Okorie and Ezeji (1988) and Ezewu (1984) that for a skill to be psychomotor it must have cognitive action, the receiving and use of perceived symbols, and of value system and physical action to facilitate it.

In Nigeria, Bukar (2006) employed this theory when he developed and validated laboratory-based tests for assessing practical skills of HND students in electronic maintenance and repair. Similarly, Okwelle (2011) applied this theory in his study on the development and validation of instrument for assessing practical skills in radio and television systems in technical colleges.

5 CONCLUSION.

More generally, a theory is viewed as an explanation of why and/or how things happen. Based on the theoretical review in this discourse, it is the opinion of the author that there is a lot of evidence in the literature to show that there are many theoretical models to lean towards in defining practical
skills in technical and vocational education and training system in Nigeria. It is expected that practitioners in TVET should be very discrete in their selection, use and application of these models in defining objectives. However, Mkpa (1984) and Turton (1983) observed that the choice of any model depends on the subject, objectives, and the assessing instruments to be used.

The author therefore recommends that such models which are comprehensive and fulfils the requirement that psychomotor objective contains affective and cognitive domains should be applied in the writing of behavioural objectives for TVET programmes for effective TVET delivery process. This is important since one attribute of a good theory is that it should be comprehensive, relating a number of phenomena to one another.

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