DEVELOPMENT OF A NEWCURRICULUM OF ERGONOMICS-BASED TECHNOLOGY EDUCATION FOR NIGERIAN UNIVERSITIES

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ABSTRACT

The purpose of this study was to develop a new curriculum of ergonomics-based technology education for Nigerian universities. This study consisted of two phases: needs analysis and modified Delphi technique. The purpose of the needs analysis was to explore the levels of ergonomics awareness and the needs of ergonomics curriculum as well as to determine the lecturers' perception toward the incorporation of ergonomics curriculum. Also, modified Delphi technique was implemented to determine the relevant domains needed for the new ergonomics curriculum using experts' consensus. A sample of 132 lecturers' was selected based on the Krejcie and Morgan's sample size table from the population (N=200) for the needs analysis phase from four selected universities in Nigeria. Participants were selected using stratified random sampling. The second phase involved a Delphi panel which consisted of 11 experts that was selected using snowball technique based on the specific criteria. Instruments used in this study to collect empirical data included questionnaire and an interview protocol. Quantitative data were analyzed using descriptive statistics such as mean, standard deviation, and interquartile range (IQR). The qualitative data were categorized using thematic analysis. The key finding revealed that the overall mean illustrates lecturers strongly agreed (M=4.24, SD=0.45) on the needs to incorporate ergonomics and supported (M=4.19, SD=0.47) the introduction of ergonomics-based technology education in Nigerian universities. At the final round of Delphi analysis, 18 topics and 42 sub-topics gained more than the cut-off point of 70% hence they were accepted. The highest mean scores was 4.82 and lowest score 4.45 which was above the cut-off point of 4.21 therefore strong agreement among the experts was achieved. Also, standard deviations were below one (SD < 1) which showed that a strong consensus has been attained. IQR was one or less than one (IQR ≤ 1) that indicated a higher level of agreement and thus the experts have reached a consensus. In conclusion, a new ergonomics-based curriculum in technology education was constructed based on the needs analysis and verified by experts' agreement. A main implication of this research is that a new curriculum of ergonomics-based technology education program can be offered to Nigerian universities.

PEMBANGUNAN KURIKULUM BAHARU PENDIDIKAN BERASASKAN TEKNOLOGI ERGONOMIK UNTUK UNIVERSITI DI NIGERIA

ABSTRAK

Tujuan kajian ini adalah untuk membangunkan kurikulum baharu pendidikan teknologi berasaskan ergonomik di universiti-universiti Nigeria. Kajian ini terdiri daripada dua fasa: analisis keperluan dan teknik Delphi yang telah diubahsuai. Tujuan analisis keperluan adalah untuk mengenal pasti tahap kesedaran kurikulum ergonomik serta persepsi pensyarah terhadap peintegrasian ergonomik ke dalam kurikulum teknologi pendidikan. Juga, teknik Delphi yang telah diubahsuai dilaksanakan untuk mengenal pasti domain kurikulum ergonomik menggunakan konsensus pakar. Sebanyak 132 pensyarah telah dipilih berdasarkan jadual sampel saiz Krejcie dan Morgan daripada populasi (N=200) untuk analisis keperluan di empat buah universiti di Nigeria. Peserta dipilih menggunakan pensampelan rawak berstrata. Fasa kedua melibatkan Delphi panel terdiri dari pada 11 pakar yang telah dipilih menggunakan teknik bola salji berdasarkan kriteria tertentu. Instrumen kajian terdiri daripada soal selidik dan protocol temubual yang digunakan dalam mengumpul data empirikal. Data dianalisis menggunakan statistik deskriptif seperti min, sisihan piawai, dan julat interkuartil (IQR). Data kualitatif dikategorikan menggunakan analisis tematik. Dapatan kajian utama menunjukkan bahawa pensyarah sangat bersetuju (M=4.24, SD=0.45) mengenai keperluan untuk mengintegrasi ergonomik dan responden juga menyokong (M=4.19, SD=0.47) untuk memperkenalkan pendidikan teknologi berasaskan ergonomi di universiti-universiti Nigeria. Pada pusingan terakhir Delphi, sebanyak 18 topik dan 42 sub-topik yang dicadangkan oleh pakar memperoleh poin lebih daripada 70%; ini menunjukkan topik-topik tersebut diterima. Skor purata tertinggi adalah 4.82 dan skor terendah 4.45 yang berada di atas titik pemotongan 4.21, ini menunjukkan kesepakatan yang kuat telah dicapai. Juga, sisihan piawai adalah di bawah satu (SD < 1) menunjukkan persetujuan yang tinggi. Indeks IQR adalah satu atau kurang (IQR ≤ 1) menunjukkan tahap kesepakatan yang jitu. Kesimpulan kajian adalah kurikulum baharu pendidikan teknologi berasaskan ergonomi telah berjaya dibina berasaskan kajian keperluan dan disahkan oleh pakar. Implikasi utama kajian adalah satu kurikulum baharu pendidikan teknologi berasaskan ergonomi dapat ditawarkan kepada universiti-universiti di Nigeria.

TABLE OF CONTENTS

		Page
DECLARATION OF ORIGINAL WORK		ii
DECLARATION OF THESIS		iii
ACKNOWLEDGEMENTS		iv
ABSTRACT		v
ABSTRAK		vi
TABLE OF CONTENTS		vii
LIST OF ABBREVIATIONS AND ACRONYMS		xiv
LIST OF TABLES		xvi
LIST OF FIGURES		xix
LIST OF APPENDICES		xx
CHAPTER 1 INTRODUCTION		
1.1	Introduction	1
1.2	Background of the Study	12
1.3	Statement of the Problem	17
1.4	Theoretical Framework	19
	1.4.1 Needs Theory	21
	1.4.2 Situation Awareness Theory	22
	1.4.3 Mental Model Theory	23
	1.4.4 Curriculum Change Theory	25

1.4.5 Situated Learning Theory 27

1.5 Conceptual Framework 29

1.6 Purpose and Objectives of the Study 33

1.7 Research Questions 34

1.8 Significance of the Study 34

1.9 Limitations of the Study 36

1.10 Operational Definitions 36

1.11 Summary 41

CHAPTER 2 REVIEW OF RELEVANT LITERATURE

2.1 Introduction 43

2.2 The 21st Century Skills 44

2.3 Technology Education 47

2.3.1 Overview of Technology Education 48

2.3.2 Theories of Technology Education 51

2.3.3 Models of Technology Education 53

2.3.4 Technology Education in Nigerian 57

2.3.4.1 Post-Junior Secondary 58

2.3.4.2 Post-Secondary Schools 59

2.3.4.3 Technology Education in Universities 61

2.3.5 Changing Demands of Technology Education 65

2.3.6 Technology Education and Educational Technology 66

	2.3.7 Related Research Studies in Ergonomics and Technology Education	67
2.4	An overview of Ergonomics	72
	2.4.1 Theories of Ergonomics	78
	2.4.2 Models of Ergonomics	80
	2.4.3 Ergonomics in United States	82
	2.4.4 Ergonomics in Nigeria	84
2.5	Ergonomics-Based Technology Education	85
	2.5.1 Safety	85
	2.5.2 Educational Ergonomics	86
	2.5.3 Productivity	87
	2.5.4 Biomechanics	87
	2.5.5 Ergonomics Cost-Benefit	89
2.6	Ergonomics as a Program in Universities	89
2.7	Needs Analysis	92
	2.7.1 Overview of Needs Analysis	92
	2.7.2 Theories of Needs Analysis	97
	2.7.3 Models of Needs Analysis	99
	2.7.4 Educational Needs of Technology Education	102
	2.7.5 Related Empirical Research Using Needs Analysis	104

2.8	Modified Delphi Technique	107
	2.8.1 Overview of Delphi Technique	107
	2.8.2 Models of Delphi Technique	110
	2.8.3 Characteristics of Delphi Technique	113
	2.8.4 Panel Size of Delphi Experts	115
	2.8.5 Criteria for Delphi Experts	116
	2.8.6 Selection of Delphi Experts	116
	2.8.7 Strengths and Weaknesses of Delphi Technique	117
	2.8.8 Reliability, Validity and Trustworthiness	120
	2.8.9 Related Empirical Research using Delphi Technique	123
	2.8.10 Related Research Studies in Needs Analysis, Delphi Technique and Curriculum Development	130
2.9	Development of a New Curriculum	132
	2.9.1 Overview of Curriculum	132
	2.9.2 Theories of Curriculum	136
	2.9.3 Models of Curriculum	139
	2.9.4 New Curriculum of Ergonomics-Based Technology Education	143
2.10	Past Empirical Studies in Ergonomics and Curriculum Development	144
2.11	Summary	149

CHAPTER 3 THE RESEARCH DESIGN AND METHODOLOGY

3.1	Introduction	151
3.2	Research Design	152
3.3	Phase One: Need Analysis	155
	3.3.1 Participants of the Needs Analysis	156
	3.3.2 Criteria for Selection of Participants in the Needs Analysis	158
	3.3.3 Instrumentation and Data Collection for Needs Analysis Phase	158
	3.3.3.1 Questionnaire for Needs Analysis	159
	3.3.3.2 Interview Protocol for Needs Analysis	160
	3.3.4 Reliability and Validity of Instrument	161
	3.3.5 Data Analysis for Needs Analysis	162
3.4	Phase Two: Modified Delphi Technique	164
	3.4.1 Expert Selection for Modified Delphi Technique	165
	3.4.1.1 Experts' Criteria	166
	3.4.1.2 Procedures for Selecting Delphi Experts	167
	3.4.2 Instrumentation for Modified Delphi Technique	170
	3.4.2.1 Instrumentation	170
	3.4.2.2 Questionnaires for the Modified Delphi Experts	171
	3.4.2.3 Interview protocol for Modified Delphi Experts	172
3.5	Pilot Study	173
3.6	Rounds for Modified Delphi Technique	175

3.6.1 First Round 176

3.6.2 Second Rounds 177

3.6.3 Third Rounds 178

3.6.4 Data Analysis for Modify Delphi Technique 178

3.7 Summary 180

CHAPTER 4 FINDINGS

4.1 Introduction 182

4.2 Demographic Information 183

4.3 Research Question One 187

4.4 Research Question Two 189

4.5 Research Question Three 198

4.6 Research Question Four 209

4.6.1 Modified Delphi techniques Round 1 210

4.6.2 Interview Findings for Round 1 220

4.7 Research Question Five 226

4.7.1 Modified Delphi Techniques Round 2 226

4.7.2 Modified Delphi Techniques Round 3 234

4.8 Summary 259

CHAPTER 5 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1	Introduction	261
5.2	Conclusion	262
5.3	Implications of the Research	265
	5.3.1 Theoretical Implication	265
	5.3.2 Practical Implication	269
5.4	Contribution of the Research	275
5.5	Recommendations	276
5.6	Suggestions for Future Research	279
REFERENCES		281
APPENDICES		312

LIST OF ABBREVIATION AND ACRONYMS

ATBU	Abubakar Tabawa Balewa University
BUK	Bayero University, Kano
CIEHF	Chartered Institute of Ergonomics and Human Factors
DOE	Department of Energy
FUTM	Federal University of Technology, Minna
HFE	Human Factor and Ergonomics
HFES	Human Factors and Ergonomics Society
HPT	Human performance Technology
HRD	Human Resources Development
IAT	Industrial Arts Education
IEHF	Institute of Ergonomics and Human Factors
IEA	International Ergonomics Association
ILO	International Labor Organization
ITE	Industrial Technology Education
LTC	Learning Teaching Centre
MAUT	Modibbo Adama University of Technology
MCDEM	Ministry of Civil Defense & Emergency Management
NPE	National Policy of Education
NUC	Nigerian Universities Commission
NVQF	National Vocational Qualification Framework

PA	Performance Analysis
TA	Task Analysis
TE	Technical Education
TTNA	Tabletop Needs Analysis
TVET	Technical and Vocational Education and Training
UNESCO	United Nations Organization for Education, Science and Culture
USAID	United States Agency for International Development
USED	United State Department of Education
UPSI	Universiti Pendidikan Sultan Idris (Sultan Idris Education University)
VTE	Vocational and Technical Education

LIST OF TABLES

Table No.		Page
1.1.	Prominent definitions of industrial arts and technology education	4
2.1	TVET Institutions offering accredited programs and their ownership structure	60
2.2	Technology education areas of specializations	62
2.3	Related study in technology education and Ergonomics	71
2.4	Definition of Ergonomics and Human Factors	74
2.5	Samples of Ergonomics as a course or program in universities	90
2.6	Definition of needs	103
2.7	Applications of needs analysis	106
2.8	Delphi definitions	108
2.9	Related empirical research using Delphi technique	127
2.10	Historical definitions of curriculum	134
2.11	Overview of theories affected curriculum development	138
2.12	Empirical studies related Ergonomics and curriculum	147

3.1	Procedure for selecting experts	170
3.2	Scale ranges for the mean	180
3.3	Scale ranges for the standard deviation	180
4.1	Demographic information	185
4.2	Ergonomics awareness among technology educators	188
4.3	Needs for the incorporation of ergonomics-base technology education	190
4.4	Reasons why Ergonomics-based technology are needed	192
4.5	Ways for Ergonomics-based technology enhance technology education program	193
4.6	Expected barriers to integrate Ergonomics-based technology	194
4.7	Perception on the introduction of ergonomics-based technology education	199
4.8	Suggestions to expedite the development of a new curriculum of Ergonomics-based technology in Nigerian universities	201
4.9	Additional issues related to ergonomics in technology education	202
4.10	Experts for modified Delphi technique	208

4.11	Experts' responses on topics and sub-topics in Round 1	213
4.12	Experts suggested additional topics or sub-topics in Round 1	217
4.13	Experts responses on module objectives in Round 1	218
4.14	Frequency, means, standard deviation, and Interquartile Range (IQR) for topics and sub-topics in Round 2	230
4.15	Frequency, means, standard deviation, and Interquartile Range (IQR) for module objectives in Round 2	233
4.16	Frequency, mean, standard deviation, and interquartile Range (IQR) for topics and sub-topics in Round 3	236
4.17	Frequency, mean, standard deviation and interquartile Range(IQR) for module objectives in Round 3	240
4.18	Consensus on topics and subtopics: Changes in percentage of agreement among Delphi experts in Round 3	241
4.19	Consensus on module objectives: Changes in percentage of agreement in Round 3	245
4.20	Topics and subtopics means differences and percentage change between Round 2 and Round 3	247
4.21	Module objectives: Means differences and percentage change between Round 2 and Round 3	251
4.22	Comparison of standard deviation changes of topics and subtopics between Round 2 and Round 3	252
4.23	Comparison of standard deviation changes of module objectives between Round 2 and Round 3	255

LIST OF FIGURES

Figure No.		Page
1.1	Conceptual framework of the study	32
2.1	Development of school technology literacy model	55
2.2	Model for technical teaching and learning	56
2.3	Ergonomics domains of specialization	76
2.4	General dimensions of ergonomics discipline	76
2.5	Effect of HFE design on performance and well-being	88
2.6	Process of needs analysis development	96
2.7	Expert consensus in academia model	112
2.8	Tyler model	140
2.9	Thematic curriculum framework model	142
3.1	Research process of the study	154
3.2	Modified Delphi technique methodology framework	165

LIST OF APPENDICES

1	General courses of Master's degree in technology education
2	Core courses of area of specialization in technology education of Master's degree
3	Ergonomics cost benefits
4	Ergonomics-based technology education needs analysis questionnaire
5	Interview protocol and transcription for needs analysis
6	Invitation letter for the Delphi technique
7	Modified Delphi technique questionnaire Round 1
8	Modified Delphi technique questionnaire Round 2
9	Modified Delphi technique questionnaire Round 3
10	Interview protocol and transcription for modified Delphi experts
11	Theoretical Framework to Ergonomics Curriculum Domains
12	Letter of permission to conduct pilot study at University of Nigeria, Nsuka
13	Letter of permission to conduct research at Abubakar Tafawa Balewa University, Bauchi, Nigeria
14	Letter of permission to conduct research at Bayero University Kano, Nigeria
15	Letter of permission to conduct research at the Federal University of Technology, Minna, Nigeria
16	Letter of permission to conduct research at Madibo Adama University of Technology, Yola, Nigeria
17	Permission to carry out a doctoral study
18	Validation of Instruments Results

CHAPTER 1

INTRODUCTION

1.1 Introduction

The history of formal technology education would be dated back to the earliest forms of systematic curriculum building in vocational education in the 18th century. Early manual training can be attributed to Pestalozzi's ideas about the importance of a vocational component in the school curriculum for all students (Gordon, 2014). This ideology spread across Europe and into United States. History has shown that Henry Barnard (1811 – 1900) is credited with popularizing Pestalozzi's method in the United States. Pestalozzi (1746 – 1827) believed that a sound education needed to include both vocational and general education (Westerink, 2016).

The effect of technology education development a as result of industrial revolution which started around 1750 to 1850 shows almost at that period most British mechanics had been trained as apprentices. According to Mustapha (1999), during the middle of the1800s, European states were establishing hundreds of trade and technical schools as a result of industrial revolution. Therefore, this indicates the influence of industrial revolution toward the development of technology education. Furthermore, the influence of the industrial revolution in Europe was also felt in the American education system through the philosophies of two Swiss Educators - Johann Heinrich Pestalozzi (1746-1827) and Philip Emanuel Von Fellenberg (1771-1844) (Mustapha, 1999).

The main difference between Pestalozzi and Von Fellenberg is that Pestalozzi believed on learn to work, education must be comprehensive and in harmony with nature. In addition, Pestalozzi recognized three basic aspects of education: intellectual, moral, and practical education (Mustapha, 1999). Whereas Von Fellenberg believed that society represented a natural separation of people according to their abilities and individuals could be best educated and trained within their own groups. Therefore, Von Fellenberg selected skills that were necessary to the efficient operation of the school and its farm (McClure, Chrisman, & Mock, 1995; Mustapha, 1999).

Another influence can be attributed to Victor Della Vos in 1876. At the Philadelphia Centennial Exposition of 1876, Della Vos demonstrated a new approach to teaching the mechanical art that had become a catalyst for vocational education in the United States (Finch & Crunkiliton, 1999). Della Vos proposed several principles in vocational education

such as mechanics, carpentry, joinery, blacksmithing and metal turning. In the year 1909, Russell proposed that industrial arts to be the third area of formal study besides humanities and science (Luetkemeyer & Martin, 1979). By the year 1916, a Manual and Industrial Arts were introduced in American schools (Griffith, 1924). Between 1930s to 1950s industrial arts curriculum was widely taught in the United States (Bonser, 1930; Warner et al., 1933; Wilber, 1954; Olson, 1957).

In the development of industrial arts in the United States, one cannot overlook about the external influence of some of the European programs which preceded industrial arts that influenced the development of technology education in the United States such as the study of handicrafts that was prevalent in Europe since the introduction of Swedish Sloyd, British Arts and Crafts, and the more vocationally oriented Russian's Factory Workshop Training Schools (Movsovic, 1959). Also, industrial arts was one of the fields of study in colleges and universities which contributed to technology and enhanced human resource development, therefore the term Industrial Arts, can be defined according Hales and Snyder (1982) as a comprehensive education program that concerns with technology utilization and is designed to meet the industrial needs. Table 1.1 shows key definitions of industrial arts and technology education. The definitions of the industrial art and technology education both shared similar characteristics in the usage of the terms "educational program" as well as "technology" in which Mill (1981), and Wright, Israel, and Lauda, (1993) used in their definitions. However, there are some differences in the definition of the industrial arts and technology education such as Bonser and Mossman, (1923) focused on the value improvement whereas International Technology Education Association -

ITEA (2000) described technology education as a field of study that shapes and changes the physical world in order to meet people needs. Therefore, the definition of the industrial arts and technology education are quite similar in the sense that they both focused on educational program that uses technology to make improvement.

Table 1.1

Prominent definitions of industrial arts and technology education

Domains	Authors	Definitions
Industrial Arts	Bonser and Mossman (1923)	Industrial arts is a study of the changes made by man in the forms of materials to increase their values.
	Mill (1981)	Industrial arts is a comprehensive educational program concerned with technology.
Technology education	ITEA (2000)	Technology education is the study of technology, in which students learn about the processes and knowledge related to technology. As a field of study, it covers the human ability to shape and change the physical world to meet needs by manipulating materials and tools with techniques.
	Wright, Lauda, & Israel (1993)	Technology education is an educational program that helps people to develop an understanding and competence in designing, producing, and using technology products and systems.

Source: Adapted from Foster (1994)

In addition, Wright and Lauda (1993, p. 3) defined the term technology education as:

> "A body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment."

According to Wicklein (2006), a significant contributor that helped the development of technology education was William E. Warner. In 1947, he wrote *Curriculum to Reflect Technology* as a basis for an industrial arts program. The program was further developed and evolved into curriculum areas of communications, construction, manufacturing, power, and energy transportation (Philip, & Lefor, 2002).

Furthermore, Delmar Olson's *Technology and Industrial Arts* in 1958 proposed eight categories of technology education, namely construction, manufacturing, power, transportation, electronics, research, personnel management, and service (Olson, 1958). Further, he broke down each category into subcategories and proposed to study each category in relation to technical, cultural, and social "functions" (Herschbach, 1997). Another giant step in the history of technology education was in 1965 where the *Industrial Arts Curriculum Project (IACP)* was developed by Lux and Ray (1970). The project provided a broader understanding of the human-made world (Wicklein, 2006). Subsequently followed by *The Maryland Plan* in 1973, where Donald Maley, from the University of Maryland, has implemented industrial arts programs in schools (Lewis &

Zuga, 2005). However, the transformation from industrial arts to technology education was published by Paul DeVore in 1964 in which he believed that technology education was more relevant for schools.

The transition from industrial arts, industrial education and industrial technology gradually continues, DeVore (1964; 1968) theorized that technology could best be conceived of as a "discipline" to be studied similar to other school disciplines. It has been observed that one of the first to suggest that technology should be called a discipline was credited to DeVore (Householder, 1989). In addition, Kassel (2012) noted that DeVore advocates a fundamentally new, and perhaps radical, type of technology education. Also, the publication of the Jackson Mill's *Industrial Arts Curriculum Theory* in 1981 was the starting point of the modern era of technology education (Foster, 1994; Wicklein, 2006). In 1986, the American Industrial Arts Association (AIAA) changed its name to the International Technology Education Association (ITEA) and rallied about teaching technology as recommended by Mill. This change of name has improved the focus toward technology education.

A conceptual framework for technology education was published by Savage and Sterry (1990) and has a wider acceptance at that time. The concept provides students with ideas and knowledge about ability to deal with technology change in the future both personally and professionally. Another milestone in the development of technology education was the formation of ITEA's *Technology for All Americans Project* (TfAAP) in

1994. By the completion of the project, Standards for Technological Literacy was published (ITEA, 1996; ITEA, 2002). This project was used to promote and standardize the technology education especially in term of the concept of technology, and the ability to use, manage, understand and assess technology.

Having briefly discussed about the origin and the development of technology education at the international level, the present study would focus at a national level about the historical development of technology education in Nigeria which dated back to 1940s and 1950s when technical institutions were established at Yaba, Zaria, Ibadan and Enugu (Osami, 2013; Ojebiyi, & Sunday, 2014). The 1960s to 1970s have witnessed the periods of the establishment of polytechnics and in 1980s to 2000 was the period of the establishment of advanced technical colleges and federal universities of technology. From 2000 to date more of universities of technology and polytechnics were established (Ebenehi, & Baki, 2015; Okolocha, & Baba, 2016).

In the 1980s, technology education was introduced at Nigerian Junior Secondary School (JSS). Osami (2013) states that Introductory Technology subject was introduced as a compulsory subject at the Junior Secondary Schools (JSS) in Nigeria. Also since 1970s to date, the prominent awarding certificates in technology education were Bachelor of Technical/Technology Education (B. Tech) and National Certificate of Education Technical (NCE Tech) were introduced across the nation.

However, despite the introduction of technology education in Nigeria for the past 50 years there are deficiencies in the contents of the program and substantial evidence in literature review shows that there is skills mismatch especially among technology education university graduates in Nigeria and it remains an alarming issue therefore, there is a need to review the present curriculum. Thus, several scholars have called for the need to overhaul technology education program in Nigeria (Uwaifo, 2010; Pitan, & Adedeji, 2012; Ebenehi & Baki, 2015). Furthermore, changing demands of technology as a result of new technologies and the short supply of skilled workers will affect what types of graduates that universities have to produce (Bresnahan et al., 1999; Acemoglu & Autor, 2012; Wang, 2012). All these factors constitute a strong rationale for this research to develop a new curriculum of ergonomics-based technology education in Nigeria. Having analyzed about technology education, the discussion is now focused on the ergonomics and its importance to technology education.

The term “Ergonomics” is synonymous with “Human Factor”. In Europe and other countries the term “ergonomics” was used while in United States and few countries “Human Factors” was used. The history of ergonomics dated back to 1949 when National Ergonomics Society of England was founded. International Ergonomics Association (IEA) Executive Council (2000) defined Ergonomics (also called Human Factors) as a scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and a profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance. According to Dul et al. (2012), ergonomics focuses on systems in which humans interact with their

environment. Furthermore, there are three main ergonomics domains of specialization namely Physical Ergonomics, Cognitive Ergonomics and Organizational Ergonomics (Dul & Weerdmeester, 2008). In general, ergonomics is about the user, the product and the task. In other words it is a user-centered design.

Ergonomics as a field of study has many elements such as safety, educational ergonomics, office ergonomics, workstation design, control process, and human-computer interaction. Even some products have associated their names with ergonomics such as: ergonomics chair, ergonomics mouse and so on. At present, ergonomics is widely taught as a course or a program in universities and schools as well as in practice in the industries and offices in many countries (Karwowski, 2001; Žunjić et al., 2015).

Another strong rationale for this research study was that the Nigerian National Policy on Education (NPE, 2004) clearly indicated the needs for university education to make optimum contribution to the national development by: (a) intensifying and diversifying its programs for the development of quality human resource within the context of the needs of the nation, and (b) making professional course contents to reflect our national agenda. Two critical elements in the agenda are program development and professional course contents. According to Ismaila (2010), most of the Nigerians academics are not conversant with the benefits derivable from ergonomics. Having discussed about ergonomics in general, this study is now looked into curriculum as an important aspect in this study.

Even though there is no unanimous definition of curriculum, Kerr (1968: 16) defined curriculum as, "all the learning experiences, which are planned and guided by the school, whether it is carried out in groups or individually, inside or outside the school". The term curriculum was associated with so many additives such as development, model, change, reform, review, evaluation, adaptation and so on. This study focuses on "curriculum" because it is a concept in which the research intend to develop a new curriculum of ergonomic-based technology education. A curriculum may be developed differently depending on the needs and purpose. In addition, there are other definitions of curriculum such as the one defined by Taba (1962). Taba (1962) said that a curriculum is a plan for learning. Several scholars were in support of this definition simply because it was brief and concise. Thijs and Akker (2009) emphasized that Taba definition of curriculum is quite adequate and is reflected in other languages including the classical Dutch term *leerplan*, the German *Lehrplan*, and the Swedish *läroplan*. Armstrong (1989) defined curriculum as a plan or a program for all the experiences which the learner encounters under the direction of the school. The definition is an elaborate from the Taba's definition.

Furthermore, curriculum should focus on the improvement and innovation of education (Thijs & Akker, 2009). According to O'Neill (2010), curriculum helps educators to systematically and transparently map out the rationale for the use of particular teaching, learning and assessment approaches. Fullan (2000) believes that curriculum reform can happen in three areas such as in the use of new or revised contents, or in the use of new teaching approaches as well as in the alteration of beliefs and understandings about

curriculum and learning practices. Curriculum adequacy in technology education is imperative to impact necessary knowledge and skills for Nigerian national transformation. Eze (2012) observed that the inability of the present technology education to meet the curriculum needs of students is one of the major handicaps to the effective skills acquisition in Nigeria. This type of problems and challenges is what the current research study intends to address. Above all it has been stated in the Nigerian's National Vocational Qualification Framework - NVQF (2015) that the quality of technology education is maintained through a process of curriculum development.

In addition, quality issue relating graduates of technology education is quite alarming. The need to reduce or eliminate dysfunctional barriers in the curricula, is critical in order to make technology education relevant (Uka, 2012). According to Ogbuanya and Izuoba (2015), present technology education curriculum is not relevant to the current situation in Nigeria. Consequently, the lacking of ergonomics in the technology education program in Nigerian is assumed to be a major hindrance in producing quality technology graduates. Therefore, this study intends to develop a new curriculum of ergonomics-based technology education in Nigerian universities.

1.2 Background of the Study

Technology education field has faced with evolutionary changes and various issues ranging from the rapid technology development to the changes of the program course contents due to the changing demands of labor and industries. Over several decades, ergonomics was incorporated into technology education in universities in several countries across the world. Historically, in the 20th century, a new field in technology domain called ergonomics or human factors was introduced by a Polish natural scientist Jastrzebowski in 1857 (Edholm & Murrell, 1974). Subsequently, Hugh Murrell officially proposed the name ergonomics at a 1949 meeting of the British Admiralty (Mokdad & Abdel-Moniem, 2017). The name "Ergonomics" officially accepted in 1950.

The name Ergonomics was derived from the Greek words: Ergon - work; Nomos - natural law (Sluchak, 2014). In Britain, the Ergonomic Society was formed in 1952 with members coming from the fields of psychology, biology, physiology, and design. Meanwhile in the United States Human Factors Society was formed in 1957 where human factors engineering and engineering psychology was emphasized by the United States military. The society name was changed to the Human Factors and Ergonomics Society (HFES) in 1992 (Karwowski, 2005; Shaver, 2009). Since then, starting in the mid-1960s to date, the discipline continued to grow and develop in various areas in many countries. In Britain, the discipline's importance was recognized officially by the award of a Royal Charter to the Institute of Ergonomics and Human Factors (IEHF) in 2014. The Institute changed its name to the Chartered Institute of Ergonomics and Human Factors (CIEHF).

It was the first such 'Chartered Ergonomist and Human Factors Specialists' in the world (CIEHF, 2018). Ergonomics and Human Factors continues to be an area of rapid growth and is also becoming a household name with a commercial phrase "ergonomically designed" as buzz word (Bush, 2012).

Ergonomics is often taught in engineering and technology programs at many universities. For example, in Loughborough University, postgraduate module includes Vehicle Ergonomics as a part of an MSc in engineering (Karwowski, 2005). Similarly, Coventry University offered Ergonomics and Human Factors as a module for MSc in Industrial Product Design and Design and Transport, respectively (Coventry University, 2015). In addition, the University of Botswana in its Bachelor program of Design (Design and Technology Education) offered Ergonomics as one of the core courses (University of Botswana, 2014). Likewise Purdue University offered Human Factors for the MSc program in the Engineering and Industrial Product Design. There are several universities that are offering Ergonomics or Human Factors in the engineering and design programs. For example, Taylor University in Malaysia is offering Engineering Design and Ergonomics as a three-credit-hour module to all engineering students in their first year (Al-Atabi & Namasivayam, 2013). Even though several universities in the world have offered ergonomics-based program, the Nigerian universities have not yet embarked on the offering of ergonomics especially in technology education. Nigerian higher education system has been severely criticized for not been able to produce graduates that are highly employable. In addition, inadequate skilled workers and low productivity is seen as a great challenge to change the education system.

Curriculum reform in Nigeria needs to integrate ergonomics in order to produce adequate skilled workers. Ergonomics, in terms of an adaptation of working conditions to the human conditions of performance, are normally seen as a basic prerequisite for a working system promoting learning (Maclean & Wilson, 2009). Moreover, Human Factor and Ergonomics (HFE) focuses on systems in which humans interact with their environment. The environment is complex and consists of the physical environment ('things'), the organizational environment (how activities are organized and controlled), and the social environment (people and culture) (Dul et al. as cited in Wilson, 2000). There are three categories of ergonomics as a field of study in universities: (i) ergonomics as a complete program that is offered at a degree, masters or PhD level. (ii) ergonomics as course/module in a program (for example, in Industrial Design, Engineering, Health, and Psychology), and (iii) ergonomics as a topic in a course/module/model (for examples in design, occupational safety, and complex operation).

In Nigeria, ergonomics subject is lacking in technology education programs in universities and higher education institutions (Ismaila, 2010). Therefore, there is a need for an intervention to integrate ergonomics into technology education curriculum. Adding or removing a program in educational system is a normal process as mentioned by Williams (2011). A new program can be added if there is a need. There are many emerging issues in science and technology such as ergonomics which in one way or the other might have a vital role to play in technology education curriculum. According to Ismaila and Samuel (2014), ergonomics being the primary discipline for the scientific study of human interaction with any system has profound implications for training the current and future

generations of technology educators if it is introduced into technology education curriculum. Hence the technology education curriculum must be responsive to new development in the industry (Hardy & Barlex 2013). Recent development has witnessed a rapid change in the industrial sectors so there is a need to have a relevant and updated curriculum that meets the need of the stake holders. Technology education curriculum is closely related to technical and vocational education and training (TVET) program. As an umbrella domain, TVET program would oversee technology education in term of its quality and effectiveness.

A report by UNESCO – UNEVOC (2015) stated that TVET is not, and cannot be, unaffected by new fields of studies such as ergonomics. According to Grollmann (2008), ergonomics was considered in the initiatives of UNESCO-UNEVOC, the United TVET Network on Innovation and Professional Development (UNIP), and its Hangzhou Declaration on an international framework curriculum for a Master's degree for TVET teachers and lecturers. There is a renewed sense of urgency and a need for TVET to adapt, respond and transform itself so as to be relevant in the present and future endeavors. The transformation is a result of changes in demands and the transformation can be achieved through adding relevant courses and removing the outdated ones. One of the relevant domains in TVET and technology education is ergonomics. According to Pitan and Adedeji (2012), Nigerian universities should incorporate in their TVET program is the inculcation of ergonomics skills that are in high demand by the labor market. This can be achieved by placing greater emphasis on the incorporation of ergonomics into TVET and technology

curricula. The ergonomics-based curriculum could produce relevant graduates for the industries in Nigeria.

In education, ergonomics played a vital role in designing classroom/buildings, designing teaching process and designing educational materials to enhance learning (Darius, 2015). Also, one of the benefits of ergonomics is to improve safety and productivity (Nurmianto, & Ciptomulyono, 2015; Zare et al., 2015). Despite the ergonomics benefit, the integration of ergonomics into technology education curriculum would satisfy the international standard such as international qualification framework and international benchmarking. That is in accordance to the current international qualification framework and international benchmarking (Hargreaves & Shirley, 2012).

In Nigeria, several universities face problems in producing quality graduates because of the lacking of ergonomics curriculum. Most of the selected universities in this study are aiming to produce higher quality graduates because is in line with the vision and mission of the selected universities in focus namely: Abubakar Tabawa Balewa University (ATBU), Bayero University, Kano (BUK), Federal University of Technology, Minna (FUTM), and Modibbo Adama University of Technology (MAUTECH). An in-depth literature review shows a common expression across these universities in terms of their vision and mission is that the university should produce high quality graduates that can compete at national and international level (MAUTECH 2011; ATBU, 2014; FUTM 2014; BUK 2016).This study assumed that integration of ergonomics into a new universities curriculum would improve quality of the graduates.

Integration of ergonomics in technology education was established in many countries such as the USA, UK, Germany, Botswana, Malaysia and China (refer to Table 2.5). According to Woodcock and Flyte (1998), ergonomics courses should be integrated in TVET programs including business, technology, and engineering program. The programs train students to conduct their own human factors investigations. The purpose of this study was to develop a new ergonomics-based technology education curriculum for Nigerian universities. Having discussed and analyzed the issues and the problems, it has been recognized that lacking of ergonomics in the technology education in Nigerian universities is evident. Specific problems regarding technology education and ergonomics are further discussed in more details in the next section.

1.3 Statement of the Problem

The technology education programs in Nigerian universities were characterized by various deficiencies, inadequacies and weaknesses. Current technology education curriculum is deficient in terms of the lacking of ergonomics in the technology education programs of Nigerian universities. There is disadvantage for technology educators if they lack ergonomics knowledge (Ismaila & Samuel, 2014). The inadequacies refer to inability of the technology education programs in Nigeria to integrate ergonomics in their programs. The slow pace of the technology education program in Nigerian universities to integrate ergonomics in their programs despite the fact that was in practice in many countries. Many universities in both developed and developing countries are offering ergonomics as a field

of study such as in the USA, UK, Malaysia and China (Karwowski, 2005; Dul et al., 2012; Bridger, 2012; Zare et al., 2015) except a few countries. Nigeria is one of the countries that has not embark on offering ergonomics as a field of study.

Another weakness is the incompetence of technology education graduates. They do not meet the needs of the labor market/industries (Barsky & Glazek, 2014). This weakness pinpoints the discrepancies in terms of course contents of technology education curriculum in Nigeria. The lacking of ergonomics in the curriculum of technology education program of the Nigerian universities would affect the quality of Nigerian technology graduates.

It was also observed that the low pace of industrialization and technological growth in Nigeria could be attributed to the widening gap between science and technology as a result of the low quality of technology education graduates to adequately utilize the scientific ideas to produce new products and services. This suggests the need to overhaul technical education curricula in Nigeria (Ojimba, 2012). Naeini and Mosaddad (2013) observed that the inability of the technology education lecturers to teach ergonomics to their students is a major barrier among technology educators. Therefore, there is need for technology education graduates to learn ergonomics because it would be useful in their future workforce.

In addition, there are deficiencies in the technology education program for Master's degree in Nigeria despite periodic review of the programs. It is clear that Master's degree in technology education does not meet the needs of the current labor market and industries

(Olajide, 2015). This could be due to lack of ergonomics knowledge among technology educators. Therefore, this study intends to fill the gap that exists as a result of the lacking of ergonomics in the technology education program. In response to this problem, the study was designed to develop a new curriculum of ergonomics-based technology education in Nigerian universities. Next, a theoretical framework is discussed to explain the related theories that are the bases for the present study.

1.4 Theoretical Framework

The theoretical framework of this study comprises theories and models which related to the needs analysis, ergonomics and curriculum development. For needs analysis, the Maslow's needs theory was adapted (Maslow, 1970; Anderson, 2014; Wong & Musa, 2014; McLeod, 2016). Specifically, stage two of the Maslow's needs theory that is related to the safety needs. The Maslow's needs theory is a guide in developing the needs analysis questionnaire items. The next theory is the situational awareness theory by Endsley (1995). She stated that situation awareness theory is the perception of the importance of the environment within a volume of time and space; the comprehension of their meaning and the projection of their status in the near future. Situation awareness theory (Endsley, 1995; Smith & Hancock, 1995; Patrick & Morgan, 2010; Winsen et al., 2015) is related to ergonomics domains such as movement, task, handling and design. In designing ergonomics curriculum, Fullan's (1982) theory of curriculum change was utilized. Fullan (2007) asserted that curriculum change theory is important in driving education reform if

stakeholders have a deep knowledge on how carry out change process in order to yield a desired results. The curriculum change theory is relevant because it lays emphasis on curriculum development especially curriculum change. Fullan (2007) stressed that curriculum change is highly complex process and it involves various stakeholders.

Situated learning theory (Billett, 1994; Billett, 1996) was adapted because it is related technology education learning environment which would guide the study in curriculum development. According to Billett (1994), situated learning theory is defined as a learner executing tasks and solving problems in an environment which reveals the various intended uses of the knowledge. In this study, ergonomics domains would include educational ergonomics such school and classroom environment. Finally, mental model which explains about internal constructs that map human behaviors such as human-machine interaction (Gentner, 2001; Trafton, 2004; Schaffernicht & Groesser, 2011). Mental model was employed in order to guide the study in the development of ergonomics domains such as basic biomechanics, anthropometric, posture, work organization and ergonomics approach (refer to Appendix 11). An elaboration of the relevant theories and models that follows serves to explain the building blocks of the theoretical framework for new curriculum of ergonomics-based technology education. Next, the relevant theories are discussed in details.

1.4.1 Needs Theory

In this study, one of the theories adapted and used is the Maslow's hierarchy of needs which was originally developed by Abraham Maslow - an American renowned psychologist. The theory was selected because it is appropriate to explain the importance of the needs analysis and to develop the needs analysis questionnaire items. To be specific, Maslow's theory in stage two of the needs is about safety and health. Safety is one of our basic, evolutionary needs. Most of our decisions and actions are based on sustaining or improving our circumstances including safety and health (Komnnios, 2010). Despite criticism the Maslow's hierarchy of needs, it remains among the major theories that has been adapted and applied by researchers across different disciplines (Wang & Musa, 2014). For examples, Maslow theory was used in a hierarchy of user needs both in usability on the product design process and interacting with products. Jordan (1999) proposed a hierarchy of user needs in order to establish a constructive basis that can help to broaden and extend the scope of ergonomics beyond usability on the product design process. Also, Bonapace (2002) applied Maslow theory to develop a hierarchy of user needs to analyze the usefulness of a product.

The application of Maslow's theory to technology education is very wide for this study. The stage that is directly relevant to this research is the stage two that is the needs of safety. According to Anderson (2014), well planned, controlled and emergency procedure would provide the basic needs of safety. McLeod (2016) states that safety need comprised emotional and physically stability to reach full potentiality. Maslow (1970)

adopts a holistic approach that need for safety was acknowledged as a basic human need in the 'Hierarchy of Needs'. Therefore, Maslow theory, specifically stage two - needs of safety was employed in this study to guide the formulating the needs analysis questionnaire items. In the subsequent section, situation theory is discussed in details.

1.4.2 Situation Awareness Theory

The situation awareness theory by Endsley (1995) was selected because it is related to the ergonomics domains such as movement, task, handling and design. This theory was used to guide in developing the ergonomics domains for the curriculum contents. The term "situation awareness" (SA) has a major effect on both the practice of, and research into, ergonomics, human factors, and the like (Patrick, & Morgan, 2010). Situation awareness is a conception that received much attention (Smith & Hancock, 1995). Also, Hancock, and Diaz (2002) observed that situation awareness has been a pragmatically useful construct and has followed up on a number of comparable notions. Patrick and Morgan (2010) suggested that awareness can be decomposed into various hierarchical levels and even though any descriptive level will necessarily be approximate, it should be selected so that sufficient psychological detail can be captured for a solution to be developed. Endsley (1995) in her situation awareness theory states three levels of information processing: (1) perception of the elements of the environment; (2) understanding the current situation; and (3) predicting (projecting) the situation's future development.

The situation awareness should guide this study toward achieving the research objectives. Winsen et al. (2015) argued that the situation awareness theory provides a substratum of knowledge for ergonomics domains to take up and manifest upon. The interaction between the two components (i.e., human and other elements of a system) is of a crucial importance for any ergonomic analysis. Based on these assumptions, several scholars discussed about the probability of human errors depending on specific situation in which human-machine interaction occurs (Cañas, Velichkovsky, & Velichkovsky, 2011). This directly related to ergonomics domains such as tasks (i.e., operational tasks), design and movement. Also, situation awareness theory focusses on dynamic situation and in order to function effectively as well as to meet the changing demands of the current situation. In support of this assertion, Endsley (1995) stated that every activity calls for a dynamic update of the situation to function effectively. For example, one of the ergonomics domains - design industrial workplace is always dynamics.

1.4.3 Mental Model Theory

Mental model is the third theory employed to guide this study. According to Trafton (2004), the term “mental model” has been used by many different researchers to mean different things. Gentner (2001) describes a mental model as “a representation of some domain or situation that supports understanding, reasoning, and prediction” and has used mental model to explore how dynamic systems unfold. Also, mental model is defined as mental representations of humans, systems, artifacts, and situations formed by experience,

observation, and training (Endsley, 1995; Wilson, 2000; Schaffernicht & Groesser, 2011). Looking into the dynamism of knowledge and in particular technology education and ergonomics the mental model would guide in the development of ergonomics domains such as basic biomechanics, anthropometric, posture, work organization and ergonomics approach for a new ergonomics curriculum. Smith, Racine, and Bhuanantanondh (2001) indicated that to develop an accurate mental model, people must understand the consistent relationship between the input and the resulting output. Furthermore, mental model is a form of cognitive structure that allows humans to interact effectively with their environment by organizing knowledge into meaningful patterns (Reynolds & Blickensderfer, 2009).

According to Jones et al. (2011), the notion of a mental model was originally postulated by the psychologist Kenneth Craik (1943) who proposed that people carry in their minds a small-scale model of how the world works. Later Johnson-Laird (1983) further developed Craik's idea in his research on human reasoning. The concept of mental model has been widely used in human factors research to study user learning and interaction with complex system (Wilson & Rutherford, 1989; Rutherford & Wilson, 1991). Also in support of this view, mental model has been studied in applied psychology and ergonomics from different perspectives (Cheung et al., 2011).

In addition, various researchers have shown the relevancies of mental model in the investigation of ergonomics issues. The investigation of mental model is one of the central

themes in ergonomics domains (Takano, Sasou, & Yoshimura, 1997; Cañas, Antolí & Quesada, 2001). Mental model facilitates the development ergonomics domains such as biomechanics and manual skills for dealing with a physical system (Cheung et al., 2011). This aspect of manual skills is one of the bed rocks of ergonomics-based technology education.

1.4.4. Curriculum Change Theory

Fullan (2007) asserted that a wide representation of stakeholders such as lecturers and experts in the curriculum development is recommended. All participants are change agents. This is a theory that focuses on the collective effectiveness of a group to raise the bar and close the gap of students learning. Power, Whitty, Gewirtz, Halpin, and Dickson (2004) defined curriculum innovations as initiatives that are perceived to be new by those who introduced and experienced them. The theory on educational change is described by Fullan (1991) as a theory of probing and understanding the meaning of multiple dilemmas. He characterizes the current knowledge base as a situation in which “no one knows for sure what is the best” (p.110). Fullan’s change theory was selected as appropriate and relevant in developing ergonomic-based curriculum. In developing a new curriculum, the curriculum designers should consider the changes in the field. Curriculum change theory applies to the development of a new ergonomics-based technology education curriculum.

There are varied curriculum change definitions even though the term "change" may refer to review, reform, innovation, modification or adaption. In other words, curriculum change is a multi-dimensional and it could be top-down, bottom-up or both (Fullan, 2000; Adams, 2000; McNeil, 2009). McNeil (2009) identified several types of curriculum change according to its complexity: substitution, alteration, perturbations, restructuring, and value-orientation changes.

> Substitution occurs when a new element substitutes the other which is already present and alteration exists when new content, items, materials, or procedures are added up into existing materials and programs. Perturbations are changes that may at first interrupt the existing program but later it can be attuned accordingly. Restructuring occurs when the changes modified the whole school system, such as, schools introduce a new curriculum to their teachers and pupils. Value-orientation changes take place when teachers or school staffs are sought to adopt the new fundamental philosophies or curriculum orientations (McNeil, 2009, p.161).

Wideen (1994) examined the areas of educational change and distinguished the following five domains: curriculum development, school improvement, school effectiveness, teacher research and teacher development. Each area or perspective has its own approach to change. Furthermore, according to Fullan (2000), educational reform can happen in three areas such as in the use of new or revised materials (curriculum materials or technologies), or in the use of new teaching approaches (teaching strategies or learning activities) as well as in the alterations of beliefs and understandings about curriculum and learning practices (pedagogical assumptions or perceived relevance). In addition, Nyangah (2010) specified three types of curriculum change as minor change, medium change and major change.

According to Fullan (2007), educational change is technically simple but socially complex. It is socially complex because it involved different stakeholders such as lecturers, students, and experts. Educational change depends on what the stakeholders such as lecturers and experts do and think. Therefore, the theory could be used to develop a new ergonomics curriculum through Delphi expert's consensus. This study intends to introduce new module/subject of ergonomic-based technology education into an existence curriculum/program of master's degree of technology education.

1.4.5 Situated Learning Theory

Situated learning theory was selected in this study because it is appropriate to explain the importance of the development of ergonomic-based technology education curriculum and it emphasizes on vocational and technology education learning environment. Situated learning is focus on the importance of proper environment in order to enhance learning (Billett cited Brown, 1989). This theory seems to imply that ergonomics domains such as educational ergonomics is important to design proper schools and classrooms environment. Situated learning theory is also concerned about domain-specific knowledge in designing learning and curriculum. According to Billett (1994), a number of studies provided evidence that the presence of a comprehensive and well-structured knowledge base is pertinent to ensure the success of situated learning.

In addition, the situated learning is dependent on a community of practice which is aimed to facilitate learning in a context - specific environment (Billett, 1996). One of the goals of situational learning theory is to construct vocational knowledge. Ergonomics is the vocational knowledge which involves human-machine interaction. The main challenging of learning process is the workplace learning which this theory suggests such as authentic activities, experts' contribution, and active engagement of skilled personnel to enhance effective learning in workplaces (Billett, 1995). Also, Billett (1996) argued that the concept of curriculum needs to be re-conceptualized with a focus on learning rather than teaching. Furthermore, Billet (1994) emphasized that a number of studies provided evidence that the presence of a comprehensive and well-structured knowledge base distinguished experts from novices such as the involvement of Delphi experts in the development of the new ergonomics-based technology education curriculum. Therefore, the development of a new ergonomics curriculum is in line with Billett's perspective so that a comprehensive and well-structured knowledge-based curriculum is needed before a new curriculum is built.

1.5 Conceptual framework

The conceptual framework for this study is based on several relevant theories and models namely Maslow's Needs Theory (Maslow, 1970); Situational Awareness Theory (Endsley, 1995; Smith & Hancock, 1995; Winsen et al., 2015); Curriculum Change Theory (Fullan, 1991 & 2000; McNeil, 2009); Situated Learning Theory (Billett, 1994; Billett, 1996) and Mental model (Wilson, 2000; Gentner, 2001; Trafton, 2004; Schaffernicht & Groesser, 2011). Specifically, Maslow's theory of needs is a motivational theory that argues that while people aim to meet basic needs, they seek to meet successively higher needs in the form of a pyramid (David, 2014). Needs theory is relevant for the needs analysis development in this study. The next theory is relevant to this study is situational awareness theory. Situational awareness theory is the invariant in the agent-environment system that generates the momentary knowledge and behaviors required to attain the goals specified by an arbiter of performance in the environment such as workshops (Smith & Hancock, 1995). Situation awareness theory was used to guide in developing the ergonomics domains for the curriculum contents. Also, this theory was selected because it is related to the ergonomics domains such as movement, task, handling and design.

This study also focused on curriculum development hence curriculum change theory (Fullan, 1991) was relevant. Curriculum change theory is defined as the substitution occurs when a new element substitutes the other which is already present and alteration exists when new content, items, materials, or procedures are added up into existing materials and programs (Fullan, 1991; McNeil, 2009). This definition seems to imply that

a new course was added such as ergonomics-based technology education into existing program such as technology education is relevant to the development of a new curriculum. In order to develop a new ergonomics curriculum, situated learning theory was selected because it lays emphasis on the technology education learning environment. Billett (1994) defined situated learning as workplace leaning in which job training and experience in real environment is important for the learners (Billett 1994; Billett, 1996). In addition, mental model theory was used in this study. Mental model is defined as mental representations of humans, systems, artifacts, and situations formed by experience, observation, and training (Endsley, 1995; Wilson, 2000; Schaffernicht & Groesser, 2011). This mental model was selected because it is relevant for the development of the ergonomics domains such as biomechanics, anthropometric, posture, work organization and human-machine interaction.

Based on the underlying theories and models presented in Figure 1.1, the study is concerned with four variables namely: awareness of ergonomics (Endsley, 1995; Smith & Hancock, 1995; Winsen et al., 2015), needs of ergonomics (Maslow, 1970; Anderson 2014 & McLeod, 2016), perception for introduction of ergonomics (Wilson, 2000; Gentner, 2001; Trafton, 2004; Schaffernicht & Groesser, 2011) and curriculum constructs (Fullan, 1991; McNeil, 2009). The conceptual framework is also guided by two phases. Phase one is the needs analysis and phase two is the modified Delphi technique.

Figure 1.1 shows the two phases: Phase one - needs analysis and phase two - modified Delphi technique. In phase 1, needs analysis variables are awareness of

ergonomics, needs of ergonomics, and perception for introduction of ergonomics. The outcomes of the need analysis would lead to the application of modified Delphi technique which is the next phase of the research study. Next, Phase 2 of the modified Delphi technique is a process to determine and to develop the domains needed for a new ergonomics-based curriculum based on the experts' agreement (Helmer, 1967; Linstone & Turoff 1975; Okoli & Pawlowski, 2005). Also, the modified Delphi technique was run for the three (3) rounds to obtain the experts consensus on the relevant ergonomics domains as shown in Figure 1.1. Furthermore, the draft of the new curriculum of ergonomics-based technology education would be documented and developed based on the Delphi experts' consensus.

Finally, this study proposes new curriculum with the guide of the relevant theories and models. Basically, the final outcome of this study is the new curriculum of ergonomics-based technology education. In sum, the main contribution of this study is that it has put forward experts' consensus on the new curriculum of ergonomics-based technology education for Nigerian universities.

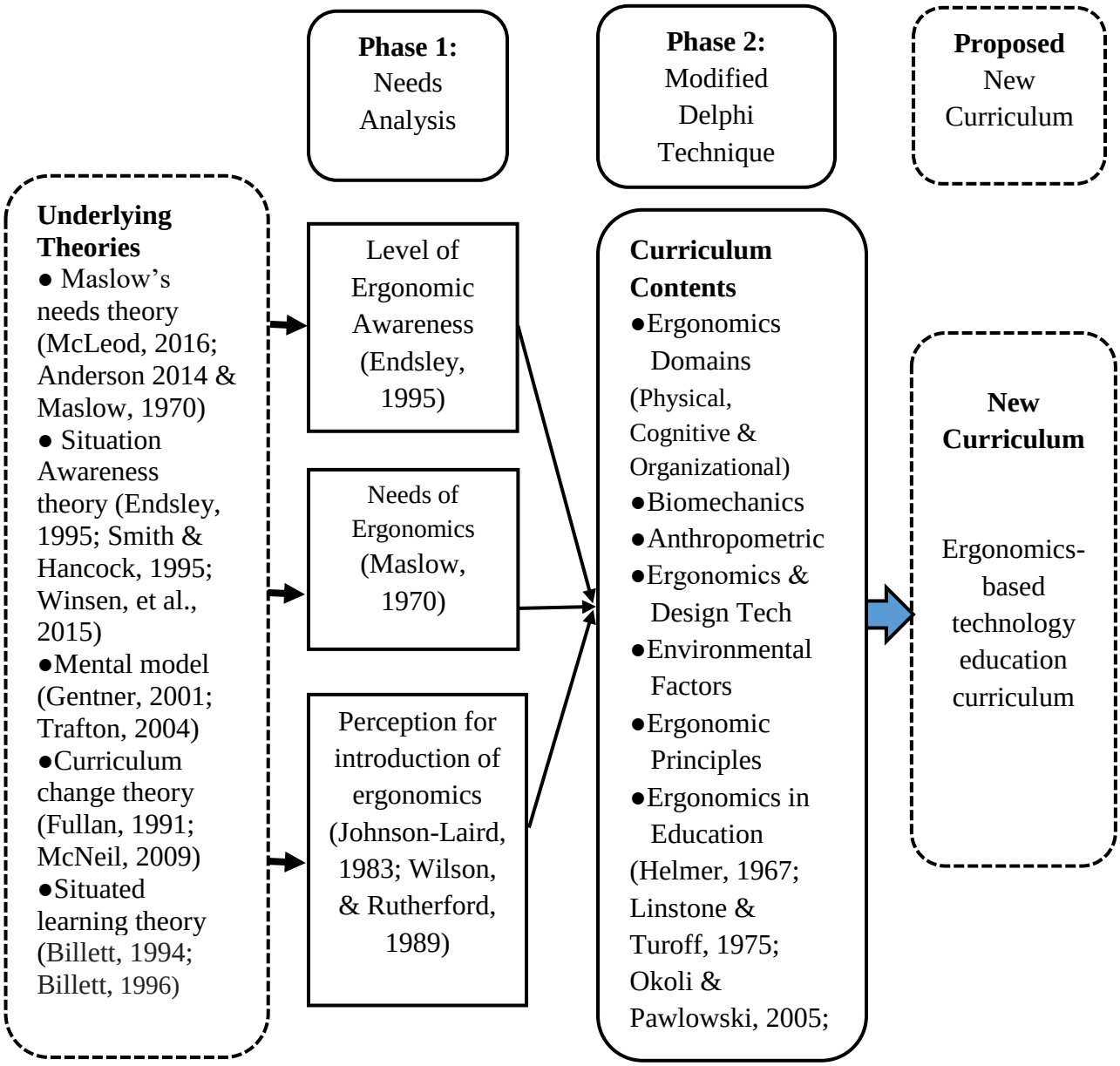

Figure 1.1. Conceptual framework of the study

1.6 Purpose and Objectives of the Study

The purpose of this study was to develop a new curriculum of ergonomics-based technology for Nigerian universities using needs analysis to identify the needs of ergonomics to be integrated in a technology education program. Furthermore, this study would determine constructs or domains needed for the development of new curriculum of ergonomics-based technology education using experts' consensus through the application of modified Delphi technique. Specifically, the objectives of the study were as follows:

1. To identify the level of ergonomics awareness among technology educators of the Nigerian universities.
2. To explore the needs for the incorporation of ergonomics-based technology education into technology education programs of the Nigerian universities.
3. To determine the perception of technology education lecturers toward the introduction of ergonomics-based technology education in Nigerian universities.
4. To determine constructs needed for the development of new curriculum of ergonomics-based technology education in Nigerian universities.
5. To develop the new curriculum of ergonomics-based technology education for Nigeria universities

1.7 Research Questions

The following research questions were formulated to guide the study:

1. What are the levels of ergonomics awareness among technology educators of the Nigerian universities?
2. What are the needs for the incorporation of ergonomics-base technology education into technology education programs of the Nigerian universities?
3. How do technology education lecturers perceive the introduction of ergonomics-based technology education in Nigerian universities?
4. What are the constructs needed for the development of new curriculum of ergonomics-based technology education in Nigerian universities?
5. What are the procedures to be employed towards a development of the new curriculum of ergonomics-based technology education for Nigerian universities?

1.8 Significance of the Study

The study would be beneficial to the Nigerian Universities Commission (NUC) as being a supervisory and accreditation body of all the universities in Nigeria. The new ergonomics curriculum would be a model for NUC to assess the existing technology education program. Also, the findings, of the study may provide universities in general and

faculties/department of technology education in particular with a proposed new curriculum of ergonomics-based technology education which would be useful for them to upgrade their technology education programs.

Moreover, the findings could be helpful to the policy makers and administrators of universities, faculties and departments of technology education to determine the needs and importance of ergonomics-based technology education. The findings of this research may serve as a guide to the lecturers in technology education to implement ergonomics-based technology education curriculum. Furthermore, the study is significant as it is expected to produce a new curriculum that could enhance the competency of technology education students. In addition, the findings could be used to enhance the ergonomics awareness among technology educators and students.

In conclusion, the results of the study would contribute to the development of a new curriculum called "ergonomics-based technology education curriculum" based on the needs analysis and the experts' consensus. In summary, the new curriculum of ergonomics-based technology education could offer a new perspective to the stakeholders in technology education vis-a-vis: lecturers, students, administrators, policy makers and industrialist in general.

1.9 Limitations of the Study

This present study has several limitations. The study was limited to lecturers and students of federal public universities offering technology education in northern Nigeria at Masters' degree level. Private universities and colleges in Nigeria were excluded. Also, only lecturers of technology education in the selected universities in northern Nigeria were involved in the study. The research study used the term "curriculum" throughout to avoid any ambiguity with program which are relative term of curriculum. The selected experts were limited to the fields of technology education, ergonomics, engineering education, as well as in medical fields.

1.10 Operational Definitions

1.10.1 Anthropometric – is study concerned with the size and proportion of the human body that is the measurement of human body especially in relation to ergonomics of postures and movements (Dul et al., 2008).

1.10.2 Biomechanics - is concerned with the mechanical behaviors of the musculoskeletal system and component tissues when physical work is performed. In other words, it is the field studies of the human body in terms of its mechanical system (Bush, 2012; Chaffin, Anderson, & Martin, 1999).

1.10.3 Curriculum – is a plan or program in which all the experiences that the learner encounters under the direction of the school. In practice, the curriculum consists of a number of plans, in written form and of varying scope and detail that delineate the desired learning experiences. The curriculum, therefore, may be a unit, a course, a sequence of courses, and the school's entire program of studies and encountered inside or outside class or school when directed by the personnel of the school (Oliver, 2009, p. 7). In this study, curriculum means a new ergonomics-based technology education curriculum.

1.10.4 Curriculum change theory - is the educational reforms refer to the introduction of completely new curriculum aspects or development and reform implies a general improvement of what is already existing such as contents or program (Fullan, 1982; Fullan, 2007).

1.10.5 Delphi technique - is in essence a series of sequential questionnaires or 'rounds', interspersed by controlled feedback, that seek to gain the most reliable consensus of opinion of a group of experts (Linstone & Turoff, 1975).

1.10.6 Environmental factors – is concerned with the study of physical, biological, and chemical factors such as noise, lighting, temperature and humidity, vibration, climate, radiation, microbiological pollution (e.g., bacteria moulds) and chemical substances can affect people's safety, health and comfort (Dul & Weerdmeester, 2008).

1.10.7 Modified Delphi technique - is simply refer to modification form of the full or traditional Delphi technique. In general Delphi technique refer to a systematic interactive forecasting method which relies on a several rounds of experts' consensus (Dalkey & Helmer, 1963; Brown, 1968; Sackman, 1974). The modified Delphi technique is a technique designed to gather input from experts without requiring them to meet face to face. Modification to the Delphi is that it (a) typically improves the initial round response rate, and (b) provides a solid grounding in previously developed work (Custer, Scarcella, & Stewart, 1999). In this study, modified Delphi technique consisted of eleven (11) experts and three (3) rounds.

1.10.8 Expert - is a person with the capacity to provide strong justifications for a range of propositions in a domain or the capacity to perform a skill well according to the rules and virtues of a practice (Weinstein, 1993). In this study, the expert is the person with experience and specialization in the field of technology education (such as Building Tech, Electrical Tech, Metal Tech, Woodwork Tech, Drafting Tech, Computer Tech, Agriculture Tech), or engineers with ergonomics background, or medical doctors with ergonomics expertise.

1.10.9 Ergonomics – is a scientific discipline concerned with the understanding of the interactions among human and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance (IEA Executive Council, 2000).

1.10.10 Human Factors - is concerned with the application of understanding about people, their abilities, characteristics, and limitations to the design of equipment they use, environments in which they function, and jobs they perform (Ross, 2017).

1.10.11 Ergonomics-based Technology education – is the field of study that integrates ergonomics aspects in a technology education curriculum.

1.10.12 Mental model - is mental representations of humans, systems, artifacts, and situations formed by experience, observation, and training. Mental model can be thought of as internal constructs that explain human behaviors (Endsley, 1995; Wilson, 2000; Schaffernicht & Groesser, 2011).

1.10.13 Needs Analysis - is the gap between an individual's present level of competence and his or her future level required for effective performance (Sava, 2012). In other words, need analysis is between the present deficit or shortfall and future planning and programming (Cohen, Manion, & Morrison, 2011).

1.10.14 Situation awareness theory - is a theory that describes perception of the elements in the environment within a volume of time and space; comprehension of their measuring and projection of their status in the near future (Endsley, 1987).

1.10.15 Situated learning theory - is defined as a learning take place in an authentic context (such as workplace) as it is applied.

1.10.16 Technical and vocational education and training (TVET) - is a form and level of 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 (NPE, 2004).

1.10.17 Technical Education - is defined as that aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge. In this sense, it forms a practical segment of education that involves skill acquisition. Therefore, technical education is a subset of vocational education (NPE, 2004).

1.10.18 Technology education - is the study of technology, in which students learn about the processes and knowledge related to technology. As a field of study, it covers the human ability to use technology to meet the human needs, by manipulating materials and tools with certain techniques (ITEA, 2000).

1.11 Summary

The purpose of this study was to develop a new curriculum of ergonomics-based technology education for Nigerian universities. An overview about the transformation from industrial arts to technology education were discussed in brief. This chapter discussed the background of the study which highlighted the rationale for undertaking the research related the development of a new curriculum of ergonomics-based technology education. One of the main problems of the present curriculum of technology education was the lacking of ergonomics in the curriculum of technology education program of the Nigerian universities which would affect the quality of Nigerian technology graduates. Furthermore, the theoretical framework employed for this study was discussed. The underlying theories and models selected for this research were Maslow's needs theory, situation awareness theory, curriculum change theory, situated learning theory and mental model theory. In addition, conceptual framework was presented based on two phases namely: Phase 1- needs analysis and Phase 2 - modified Delphi technique. In Phase 1 - needs analysis - the variables are awareness of ergonomics, needs of ergonomics, and perception for introduction of ergonomics. The variables for phase two are ergonomics-based technology education curriculum constructs based on modified Delphi technique to obtain experts' consensus regarding the constructs for a new ergonomics-based technology education curriculum.

Moreover, a new ergonomics-based technology curriculum is expected to benefit Nigerian Universities Commission (NUC) in terms that this new curriculum could be a

model to assess the existing technology education program and to provide Nigerian universities in general and faculties/department of technology education in particular with a proposed new curriculum of ergonomics-based technology education which would be useful for them to upgrade their technology education programs. Finally, the study was limited to include only federal public universities offering technology education in northern Nigeria, thus the findings of this study have limited generalization.