

**APPLICATION OF MATHEMATICAL CONCEPTS IN THE
TEACHING AND LEARNING OF PHYSICAL EDUCATION IN
SECONDARY SCHOOLS IN FORMER LUGARI DISTRICT,
KAKAMEGA COUNTY; KENYA**

BY

OSUNDWA FATUMA SHABAN

E55/CE/15405/2008

**A RESEARCH THESIS SUBMITTED FOR THE DEGREE OF
MASTER OF EDUCATION IN THE SCHOOL OF
EDUCATION AND HUMAN RESOURCE DEVELOPMENT OF
KENYATTA UNIVERSITY**

OCTOBER 2012.

DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

SIGNATURE..... Date.....

OSUNDWA FATUMA

E55/CE/15405/2008

SUPERVISORS

This thesis has been submitted for examination with our approval as University Supervisors

1. Dr. D. Muindi

Department of Educational Communication and Technology

Kenyatta University

Signature..... Date.....

2. Dr. Karen Oyiengo

Department of Educational Communication and Technology

Kenyatta University

Signature..... Date.....

DEDICATION

This thesis is dedicated to my children Kevin, Melvin, David, Edmond and Mathew for their moral, material and spiritual support during the study.

ACKNOWLEDGEMENT

I thank the Almighty God for his guidance and protection throughout the entire process of this study. “If it wasn’t for the lord.....If the lord had not been on my side.....I would have been consumed”....*by the immensity of this work* (Ps 124-N.I.V Bible).

I am greatly indebted to my supervisors Dr. D. Muindi and Dr Karen Atieno for their guidance, support and positive criticism during the preparation of this thesis, as their wealth of knowledge and experience contributed greatly to the success of this study.

My sincere appreciation also goes to my parents the late Ms Justine Mwimali and Mr. Ali Osundwa, for the values that they gave me in life, especially the wisdom to discern the value of education. I also thank my children Kevin Kamadi, Melvin Lugonja, David Osundwa, Edmond Angweye and Francis Nakweya for their encouragement, moral and spiritual support towards the study.

Pastor Masaya and Brother Odhiambo Charles, your prayers kept me going in the difficult times.

TABLE OF CONTENT

Content	Page
DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENT	v
LIST OF TABLES.....	x
LIST OF FIGURES	x
ABBREVIATIONS AND ACRONYMS	xi
ABSTRACT.....	xii
CHAPTER ONE	
1.0 INTRODUCTION	1
1.1 Background to study	2
1.1.1. Business Studies.....	3
1.1.3 Technology.	4
1.1.4 Humanities	5
1.1.5 Sciences.....	6
1.1.6. Physical Education.....	7
1.2. Statement of the Problem.....	8
1.3. The Purpose of the Study.....	9
1.4. Objectives of the Study	9
1.5. Research Questions.....	10
1.6. Significance of the Study.....	10
1.7. Scope of the Study	11
1.8 Limitations of the Study.....	11
1.9 Assumptions of the Study	11
1.10 Theoretical Framework.....	12

1.11 Conceptual Framework.....	15
1.12 Organization of the Study.....	17
1.13 Operational Definition of terms.....	18
CHAPTER TWO.....	21
LITERATURE REVIEW.....	21
2.0 Introduction.....	21
2.1. Importance of Mathematics.....	21
2.2. Physical Education.....	24
2.3. Importance of Physical Education in School.....	24
2.4. Application of Mathematics across the Curriculum.....	26
2.5. Application of Mathematical Concepts in Physical Education.....	28
2.5.1. Mathematics and Scheduling for competition.....	29
2.5.2. Single elimination or knockout.....	29
2.5.3. Mathematics and Round robin /League.....	31
2.6. Mathematics in determining the winner and Ranking of Teams.....	32
2.7. Mathematics during Play of the Game.....	33
2.7.1 Shooting in Basketball.....	34
2.8. Fields of Play and Mathematics.....	36
2.9. Summary.....	40
CHAPTER THREE.....	41
METHODOLOGY.....	41
3.0 Introduction.....	41
3.1 Research Design.....	41
3.2 Location of the study.....	42
3.3 The Target Population.....	43
3.4.1 Sampling Procedure.....	44
3.4.2 Sample size.....	44
3.5. Research Instruments.....	45

3.5.1. Questionnaire	45
3.5.2. Interview Schedule.....	46
3.5.3 Validity of Research Instruments.....	46
3.5.4 Reliability of the Research Instruments.....	47
3.6. Piloting.....	47
3.8. Data Analysis.....	
3.7. Data Collection Procedure.....	48
3.9. Logical and Ethical Considerations	49
3.10 Summary.....	49
CHAPTER FOUR.....	50
DATA ANALYSIS, INTERPRETATION AND DISCUSSION	50
4.0 Introduction.....	50
4.1.0 Demographic Information.....	51
4.1.3 Students' Demographic Information.....	53
4.1.4 Class of the Respondents	55
4.1.5 Gender of the Respondents	56
4.1.6 Favorite Subject of Respondents	57
4.2.0 Awareness of Teachers and Learners of the Mathematical concepts applied in Physical Education.....	58
4.2.1 Teachers' Awareness of Application of Mathematical Concepts in Physical Education	61
4.2.2: Awareness of Learners of the Mathematical concepts applied in Physical Education	62
4.2.3 Students' Awareness of Application of Mathematical Concepts in Physical Education	65
4.3. Compulsory Mathematics in Secondary Schools	66
4.5. Application of Mathematics in Teaching and Learning Physical Education..	70
4.6. Integration of Mathematics and Physical Education to support Teaching and Learning	73

CHAPTER FIVE	76
SUMMARY, CONCLUSION AND RECOMMENDATIONS.....	76
5.0 Introduction.....	76
5.1 Summary of Findings.....	76
5.1.1 Awareness of Teachers and Students of the Mathematical Concepts Applied in Physical Education.....	76
5.1.2 Compulsory Mathematics	77
5.1.3 Use of Mathematics in Daily Lives	77
5.1.4 Use of Mathematics in Physical Education	78
5.1.5 Integration of Mathematics and Physical Education to Support Learning ...	78
5.2 Conclusion	78
5.4 Recommendations.....	79
5.5 Suggestions for Further Research	80
BILIOGRAPHY	81
APPENDICES	86
APPENDIX A: INTRODUCTORY LETTER	86
APPENDIX B: STUDENT’S QUESTIONNAIRES.....	87
APPENDIX C: TEACHERS’ QUESTIONNAIRE.....	90
APPENDIX D: INTERVIEW SCHEDULE FOR PHYSICAL EDUCATION AND MATHEMATICS TEACHERS.....	93
APPENDIX E: RESEARCH PERMIT.....	96

LIST OF TABLES

Content	Page
TABLE 2.8 KENYA PREMIER LEAGUE	33
TABLE 3.1: LUGARI DISTRICT SECONDARY SCHOOL ENROLMENT	43
TABLE 4.1.0 TEACHERS' DEMOGRAPHIC VARIABLES	51
TABLE 4.1.3 STUDENTS' DEMOGRAPHIC VARIABLES	53
FIGURE 4.3: FAVORITE SUBJECTS.....	57
TABLE 4.2.0: MATHEMATICAL CONCEPTS GIVEN BY THE TEACHERS	59
TABLE 4.2.1: MATHEMATICAL CONCEPTS GIVEN BY THE STUDENTS.....	63
TABLE 4.3.0. TEACHERS' RESPONSES ON COMPULSORY MATHEMATICS.....	66
TABLE 4.4.0. TEACHERS' RESPONSES ON USE OF MATHEMATICS IN DAILY LIVES	69
FIGURE 4.5: TEACHERS' RESPONSES ON USE OF MATHEMATICS IN PHYSICAL EDUCATION	71
TABLE 4.5.0: RESPONSES BY HEADS OF DEPARTMENT ON INTEGRATION OF MATHEMATICS AND P.E.	73

LIST OF FIGURES

Content	Page
<i>Figure 1.1 Conceptual Framework</i>	16
<i>Figure 2.1: Schedule for eight teams,</i>	29
<i>Figure 2.3 Matches played by the teams</i>	32
<i>Figure 2.4: Basketball court</i>	37
<i>Figure 2.5: Soccer field of play</i>	38
<i>Figure 4.1: Class of the respondents</i>	55
<i>Figure 4. 2: Gender of respondents</i>	56
<i>Figure 4.4: Students' Responses on compulsory Mathematics</i>	67
<i>Figure 4.6: Students' Responses on use of Mathematics in Physical Education</i>	72

ABBREVIATIONS AND ACRONYMS

AFC – Abaluhya Football Club

FIFA- Federation Internationale de Football Association

SMASSE- Strengthening Mathematics and Science in Secondary School
Education

SPSS- Statistical Package for Social Sciences

K.C.S.E- Kenya Certificate of Secondary Examination

LDSSAC- Lugari District Secondary School Academic Committee

ABSTRACT

In school, activities in each subject area can identify and draw upon experiences in other subjects; hence mathematics also identifies experiences in other subjects. This study sought to investigate the application of mathematical concepts in physical education in Secondary schools in former Lugari District, Kakamega county; Kenya. Physical education is a popular subject. The same cannot be said about mathematics, yet there is a lot of mathematics in their world. In the teaching and learning of physical education, the mathematics involved is not explicitly mentioned. Students learn physical education in the classroom or on the fields of play and move on to the next classroom for the following lesson which could be mathematics. By delivering the curriculum in this format, subjects lack coherence and students become disconnected.

The main objectives of the study were to establish mathematical concepts applied in physical education, after this to investigate teachers' and students' awareness of these concepts and the opinion of teachers to integration of physical education and mathematics to support teaching and learning. The study was based on the connectionist theory of learning by Edward L. Thorndike which states that "When any response has been connected with many different situations alike in the presence of one element and different in other respects the response is thereby bound to that element so that when that element appears, even in a totally different situation, it will tend to evoke that response." Transfer of learning occurs when a person's learning in one situation influences his learning and performance in other situations. In the literature review the researcher read through books to find the application of mathematics across the curriculum and application of mathematical concepts in physical education. This study adopted a descriptive survey. Qualitative research used interviews to collect information on teachers' opinions and attitude at connection and integration of mathematics and physical education to support learning. Quantitative research used questionnaires to determine awareness of the mathematical concepts applied in physical education.

The target population for this study included teachers and students. Purposive sampling was used to select ten schools for the study because the schools were those teaching at least four ball games. From the ten schools, stratified sampling was used to select four physical education teachers and four mathematics teachers from each school and eight students for each ball game in each of the school. Statistical data was presented using frequency distribution tables and charts and analysis used percentages and mean. The study found out that Mathematical concepts are applied in the teaching and learning of Physical Education and teachers are aware of these Mathematical concepts. However a small percentage of students are aware of the Mathematical concepts meaning that teachers do not draw the attention of learners to the important role of Mathematics in Physical Education, hence the two subjects are taught in isolation. The study recommended that curriculum developers and teachers should come up with ways of making Mathematics more practical and interesting by associating it to Physical Education. Through workshops, teachers should come up with ways of integrating Mathematics with other subjects in the curriculum for learners to realize its crucial importance

CHAPTER ONE

1.0 INTRODUCTION

Chapter one gives an overview of the study. It examines the background of the study and the statement of the problem. It states the objectives of the study, the research questions that guided the study; assumptions of the study, significance of the study, scope and limitations of the study are stated; theoretical framework, on which the study was based, is also highlighted. The conceptual framework and the operational terms that were used in the study are defined.

Mathematics is more than just the science of numbers taught by teachers in school. It plays a significant role in the daily life activities of individuals and the society as a whole. It equips students with skills necessary for achieving higher education, career aspirations, and for attaining personal fulfillment (Cockcroft, 1982). He further acknowledged that mathematics adds an important part in character building, boosting self-esteem, and providing opportunities for developing curiosity and creativity. Mathematics is also a strategic subject in the learning of other subjects and development of science and technology (Owiti, 2001). This study looks at the importance of mathematics in the teaching and learning of physical education in secondary schools.

1.1 Background to study

Many societies have found it inevitable to include mathematics in their formal and informal curricula and other entrepreneurial endeavors thus, a citizen of any country should attain a reasonable level of mathematical literacy if adequate levels of scientific and technological development are to be achieved (Bii, 2006).

The Kenyan government upon realizing the importance of mathematics made it one of the compulsory subjects both at primary and secondary school levels (KIE, 1979).

In school, activities in each subject area can recognize and draw upon experiences in other subjects; hence use of concepts in mathematics is evident in almost all life activities.

One of the most extensive investigation of the links between another subject and mathematics is that provided by Selkirk (1982) dissembling the relationship between mathematics and geography. There is interesting work on measures, coordinates, geometry and statistics. Grevsmuhl (1982) also links mathematics with art, where he explores themes through pictures and computer graphics. Physics, chemistry, biology and business education use mathematics. Students need basic Mathematics concepts in order to do well in these subjects. Proper understanding of the connection between mathematics and the other subjects is necessary because it makes students think about the real world, giving them a practical approach to learning and using mathematics. It is therefore vital for the students to

master basic mathematics concepts in order to excel in other fields (Cockcroft, 1982:2)

Following are some of the subjects that the students study at school and the number of times Mathematics comes in ;(Flock hart, 2009).

Business Studies

Art

Humanities

Technology

Sciences

Physical Education

1.1.1. Business Studies

In business, mathematics is used in;

Accounting

Inventory management

Sales forecasting

Financial analysis

Estimation from spreadsheets

Paper size and dimension

Ratio

Costing

Sum

Production of tables

Interpreting tables

Sampling in market research

Percentage

Deductive reasoning

Graphs

Source: [_hppt://en.wikipedia.org/wiki/business_mathematics](http://en.wikipedia.org/wiki/business_mathematics)

1.1.2 Arts

Mathematics is not just about formulae and logic but about patterns, symmetry, structure, shape and beauty. In art, mathematics is applied during;

Ordering and Sequencing

Symmetry

Three- Dimension drawing

Classification/Analysis of data

Tessellation

Determination of Ratios

Finding Scales

Two-dimension geometry

Source: <http://www.dartmouth.geometry/unit5>

1.1.3 Technology.

Mathematics concepts are used in technology in the following areas.

Measurements

Construction of polygons

Estimation

Casting

Use of square/isometrics paper

Taking/Reading/Recording results

Flow charts

Conservation between units

Three-Dimensional drawing

Graphs

Time planning

Weighing

Sampling

Proportion

Scaling

Ratio

Comparative studies

Source: www.mathandtech.org

1.1.4 Humanities

Knowledge of mathematics is required in map work, drawing maps and finding distance. Some of the areas that use mathematics are;

Use of grid reference

Measurements

Scale

Tally charts

Latitudes and Longitudes

Units of Measurements

Graphs

Three-Dimensions drawing

Compass points

Timelines/chronology

Percentages

Charts

Source: (Williams and Mumu, 2005)

1.1.5 Sciences

Mathematics is used in science to measure objects and their characteristics, show relationships between functions and properties of substances. Some of the mathematical concepts used in determining the properties and relationships are shown below.

Nomenclature

Substitution of formulae

Averages

Indices

Inverse and direct proportions

Problem solving

Extrapolation

Recognitions of patterns

Rearranging formulae

Tally charts

Volume

Negative numbers

Graphs

Percentages

Interpretation of graphs

Hypothesizing

Estimation

Units of measurement

Proportion

Accuracy and errors

Rounding off

1.1.6. Physical Education

Mathematics is used in physical education in the following areas;

Ordering

Sequencing

Prediction

Estimation

Measuring

Averages

Rotation and momentum

Classification

Grouping

Patterns

Spatial awareness

Acceleration/Deceleration

Timing and time keeping

Space/Time/Distance

Data collection

Survey

Angles/Planes and Axes

Scoring

Recording results

Geometry

In the teaching and learning of other subjects in the curriculum, mathematical concepts are used but the attention of learners is not drawn to this. For example, using grid references and longitudes and latitudes in geography to locate the position of a place is similar to using coordinates to give the position of a point.

To score in ball games, students apply mathematical concepts like angles, speed, estimation and accuracy.

1.2. Statement of the Problem

Strengthening Mathematics and Science in Secondary School Education (SMASSE) project in 2004 did a survey of the causes of poor performance in mathematics and negative attitude was cited as one of the major factors. There are many students who like physical education and sports but have a negative attitude towards mathematics yet they use a lot of mathematical concept in their day to day life activities. In the teaching and learning of physical education, there is a lot of mathematics involved yet students learn physical education in the classroom or on the field and move on to the next classroom for the next lesson. The mathematics involved in teaching, learning physical education is not mentioned, and each subject is taught in isolation. This does not encourage integration of subjects.

By delivering the curriculum in this format, subjects lack coherence and students become disconnected. One method to help change the attitude of learners towards mathematics is to integrate mathematics with other subjects in the curriculum. Showing the areas where mathematical concepts are applied in physical education will allow students to see the usefulness and importance of mathematics that will enable them to develop new understanding and appreciation for the subject (Chiappetta, 2009). It is in recognizing the importance of mathematical concepts in physical education that the researcher has considered to do a study on

mathematical concepts and physical education. This study looks at the importance of mathematics in the teaching and learning of physical education in secondary schools.

1.3. The Purpose of the Study

The purpose of this study was to establish the mathematical concepts used in the teaching and learning of physical education in order to encourage connection and integration of content in the two subjects to support teaching and learning and improve performance in mathematics. Teachers can draw from this study to integrate mathematics and physical education as they teach.

1.4. Objectives of the Study

The main objective of this study was to establish mathematical concepts applied in physical education. The specific objectives were to:

- i. Identify areas in physical education which use mathematical skills.
- ii. Find out whether both the teachers and learners are aware of the application of Mathematical concepts in physical education.
- iii. Establish the teachers' opinion on transfer of learning from mathematics to physical education to support learning.
- iv. To establish how teachers can incorporate physical education concepts in teaching mathematics.

1.5. Research Questions.

To achieve the objectives above, the study was guided by the following research questions:

- i. Which mathematical concepts are used to mark the fields of play, to start the game, pass the ball, make a score and analyze performance?
- ii. Are teachers and students aware of the application of mathematical concepts in physical education?
- iii. What is the teachers' attitude to integration of mathematics and physical education to support the teaching and learning of the two subjects?
- iv. How can teachers incorporate physical education concepts in teaching mathematics?

1.6. Significance of the Study.

- i. The results of the study could enable secondary school teachers help change the attitude towards mathematics. By showing the various areas of application of mathematics in physical education and vice versa , learners could realize that mathematics is used across the curriculum and in everyday life, giving it a practical approach.
- ii. The outcome of the study may sensitize teachers of physical education on the sports demand of mathematics. This will enable them to draw the attention of learners to mathematical requirements in time and therefore create appreciation in the learners to mathematics.

- iii. The results of the study could help teachers take integration of mathematics with other subjects as an approach that will improve performance

1.7. Scope of the Study

The study confined itself to;

- i. Only ball games because physical education activities are many and covering all of them in the study would require considerable time and resources.
- ii. Only public secondary schools in Lugari.
- iii. Only students in secondary schools who participate in ball games because they understand the activities, the rules and fields of play.

1.8 Limitations of the Study

The games teachers who do not teach mathematics supported application of mathematical concepts in teaching and learning physical education but were not able to state concepts applied in the sports activities given in the questionnaire. They only managed to state basic concepts like speed, measurements, time and angles.

1.9 Assumptions of the Study

The study assumed that:

- i. All respondents would be cooperative to provide reliable responses.
- ii. The physical education teachers studied mathematics in Secondary school and therefore have basic knowledge in the subject hence familiar with mathematics concepts.

1.10 Theoretical Framework

Transfer of learning occurs when a person's learning in one situation influences his learning and performance in other situations. If there was no transfer at all, students would need to be taught specifically every act that they ever were to perform in any situation. Transfer of learning is basic to the whole notion of schooling. Matters being taught today will have some learning value in later times in different situations. Accordingly, the assumption that underlies our entire educational system is that knowledge gained in school will not only be available in the future but will also be applied in some degree to the situation of new problems as they arise in future school and life situations. Thus, transfer of learning is the cornerstone upon which education should ultimately rest (http://education.calumet.purdue.edu/.....edpsy6__transfer.htm).

This study is based on the connectionist theory of learning developed by Edward L. Thorndike and his followers. Its basic thesis is that through conditioning, specific response patterns come to be connected with specific stimuli. The theory of transfer that accompanies connectionism is transfer of identical elements (Morris, 1982). The connectionist theory of transfer means that learning is facilitated in a second situation to the extent that it contains identical factors or elements that occurred in an earlier learning situation. Identical elements may take the form of like contents, procedures, facts, actions, attitudes, techniques or principles. When identical elements occur in two learning situations, transfer from the first to the second is taken to be automatic. Since what one learns basically is

a group of reactive responses to Complex stimulus situations, responses are the elements that are transferred to new situations. However, for transfer to occur, learning situations must be of such nature that they contain some of the same reactions. For example, transfer from mathematics to physical education depends upon the extent to which there are identical elements.

Thorndike stated that “When any response has been connected with many different situations alike in the presence of one element and different in other respects the response is thereby bound to that element so that when that element appears, even in a very different total situation, it will tend to evoke that response”. (Morris, 1982:263)

Transfer from the study of mathematics to the study of physical education depends upon the identical elements such as:

Measurements

The fields of play in physical education are accurately and precisely measured using instruments, to the required standards. Each sport or game uses an area that is well measured and marked using mathematical concepts. The implements used in physical education are of specific weight proportional to the gender and age of athlete.

Speed, accuracy and approximation.

Mathematics requires accuracy and teaches speed and approximation. Good performance in physical education requires the player to have speed and ability to approximate distance.

Angles

In passing the ball to a partner and shooting, the player uses angles for ball control and scoring respectively, which is a mathematics element.

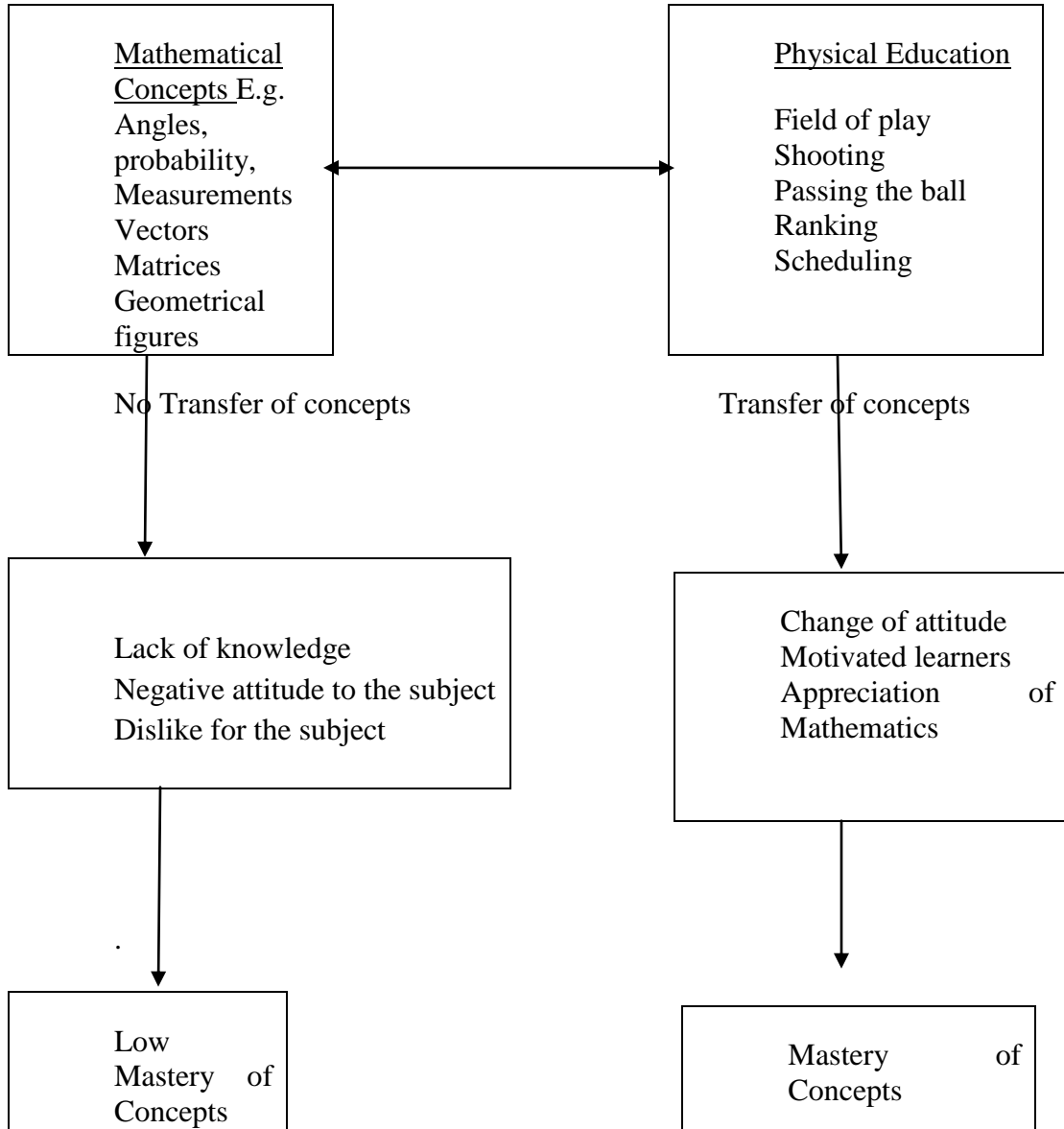
When the teacher connects what he is teaching in physical education to mathematics, he helps students to remember concepts through repetition. Learners see the importance and relevance of the subject in real life hence arousing interest.

1.11 Conceptual Framework

Mathematical concepts are applied in the teaching and learning of physical education. At the start of the game a coin is tossed to determine the sides taken by the teams, which is a probability concept. Measurements and geometry are applied in the preparation of the fields of play. The league table used in the ranking of teams takes the form of a matrix. During play of ball games vectors are applied in throwing the ball and angles in shooting. These examples show the association of mathematics and physical education.

Transfer from the learning of mathematics to the learning of physical education will give Mathematics a practical approach that will make learners realize the importance of mathematics. When the learners appreciate mathematics, they are motivated to learn and concepts are mastered and therefore improve performance.

Figure 1.1 Conceptual Framework



Source: Adapted from Orodho, A. J. (2008)

1.12 Organization of the Study

Analysis, interpretation and discussion of data were covered in The study was organized in five chapters:

In chapter one, the background of the study was covered, which discussed how mathematics is used in different areas of the subjects in the curriculum. The statement of the problem, research questions, objectives of the study, significance of the study, limitations of the study, assumptions of the study, theoretical framework and conceptual framework were discussed.

Chapter two covered the literature review which discussed the importance of mathematics, importance of physical education, application of mathematics across the curriculum and application of mathematics in physical education.

In chapter three, the methodology used in the study was covered, which discussed the research design, location of the study, the target population, sampling procedure, methods of data collection and data analysis.

chapter four, where demographic information of respondents was presented in tables and charts. Analysis and interpretations were done using percentages and mean.

Summary of findings, conclusion and recommendations were discussed in chapter five.

1.13 Operational Definition of terms

The following terms were used in this study to convey the meaning shown.

Application: The relevance or value that something has, especially when it is applied to a

Specific field or area.

Application of Mathematical Concepts in Physical Education: The relevance and use that mathematics has to physical education.

Bye: The practice of allowing a team to advance to the next round of play without playing when the number of entrants in the competition is not a power of two.

Co-educational School: A mixed school with both boys and girls.

Court: Ground where children can play.

Curriculum: Set of courses and their content offered at school.

Icosahedrons: A regular polyhedron with twenty identical and equilateral triangular faces, thirty edges and twelve vertices.

Mathematics: The study of the measurement, properties, quantities, sets, shape and space; and their relationships using specialized notations, numbers and symbols.

Mathematical concepts: Numbers, terms, formulae, charts and graphs as used in mathematics

Physical education: It is an education process that uses physical activity as a means to help individuals acquire skills, fitness, knowledge and attitudes that contribute to their optimal development and wellbeing.

Round robin: A tournament in which each contestant meets all other contestants in turn.

Seeding: Arranging contestants in a game according to their skill and talents and the act of drawing for positions in a tournament

Transfer of learning: When learning in one situation assists learning in another situation.

1.14 Summary

In this chapter the background of the study, the statement of the problem, purpose, objectives, limitations, theoretical framework and conceptual framework of the study were discussed. According to Miheso, O. (2002), the role of mathematics in a country's development demands that every effort be put in place to promote meaningful learning. The purpose of this study was to establish mathematical concepts used in the teaching and learning of physical education and encourage connection and integration of content in the two subjects to improve learning and performance.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Mathematics is widely perceived as being useful; in the real world, in everyday life, in one's present or future career and in the study of other subjects. This perception is often translated into reasons for teaching of mathematics (Orton 1994). Wain (1994) concurs that irrespective of your status in life and however basic your skills are, you apply mathematics. Roper (1990) in his mathematical gazette asserts that the usefulness of mathematics contributes towards making it an essential part of the curriculum in its own right and a growing component of other subjects across the curriculum. This chapter covers the importance of mathematics, concept of physical education, importance of physical education, application of mathematics across the curriculum and application of mathematics in physical education.

2.1. Importance of Mathematics.

Mathematics is more than just the science of numbers taught by teachers in school. It plays a significant role in the daily life activities of individuals and the society as a whole. It equips students with skills necessary for achieving higher education, career aspirations, and for attaining personal fulfillment (Cockcroft, 1982).

Through the study of mathematics, problem solving and analysis skills are enhanced. Problems enable students to apply their skills to both familiar and unfamiliar situations. By developing problem solving strategies, students learn to understand problems, devise plans, carryout plans, analyze and review the accuracy of their solutions. The methods involved in problem solving develop use of reasoning, careful and reasonable argument and decision making.

Wain (1994) says that irrespective of your status in life and however basic your skills are, you apply mathematics. Daily activities are reliant on how to count, add or multiply. You encounter numbers everyday in memorizing phone numbers, buying food, cooking food, balancing a budget, paying bills, estimating fuel consumption, measuring distance and managing your time. In the fields of business and economics, including the diverse industries existing around you, basics to complex mathematics are crucial.

Everywhere in the world, mathematics is employed as a key instrument in a diversity of fields such as medicine, engineering, natural science, social science, physical science, business and commerce. Application of mathematical knowledge in every field of study and industry produces new discoveries. Statistics provides the theory and methodology for the analysis of wide varieties of data. It is also essential in medicine for analyzing data on the causes of illness and on the utility of new drugs. Travel by aeroplanes would not be possible without the mathematics of airflow and of control systems. The development of

computers was initiated by mathematicians and logicians, who continue to make important contributions to the theory of computer science.

Every branch of mathematics has distinct applications in different types of careers. The skills enhanced from practicing mathematics such as analyzing patterns, logical thinking, problem solving and the ability to see relationships can help you prepare for your chosen career and enable you to compete for interesting and high paying jobs. With a Mathematics degree, you should be able to turn your hand to finance, statistics, engineering, computers, teaching or accounting.

Mathematics can be used to present information in many ways. It uses figures and letters, tables, charts, diagrams, graphs, geometrical drawings and technical drawings. This makes interpretation and synthesis of information simple and clear reality is brought out.

It provides a means of communication, which is concise and unambiguous by making extensive use of symbolic notation. Mathematics conveys information in a much more precise and concentrated way than in the case of spoken or written word. (Cockroft, 1982).

Problem solving strategies and analysis skills from mathematics are used to solve problems in physical education. Tables, charts and letters are used in presentation, analysis and interpretation of results in physical education. This is done in isolation without connecting to mathematics. The aim of this study is to

encourage teachers to help learners appreciate mathematics by showing them the areas where it is used in the curriculum.

2.2. Physical Education

Physical Education is an education process that uses physical activity as a means to help individuals acquire skills, fitness, knowledge and attitudes that contribute to their optimal development and wellbeing. Physical education is the only subject that is directly concerned with motor behavior (Kiganjo et al 2005:3).

2.3. Importance of Physical Education in School.

Physical education, which is part of the curriculum at school level, includes training in the development and care of the human body and maintaining physical fitness. Physical education is also about sharpening overall cognitive abilities and motor skills via athletics, exercise and various other physical activities like martial arts and dance, thus plays a vital role in the students' development and growth (Fitzgerald, 2008). The value of physical fitness can never be overstated. It's only in physical education classrooms that students learn the value of taking care of themselves through proper grooming, healthy eating and regular exercise. Many doctors today agree that obesity is a serious health risk. Without any form of diet management and control, with numerous processed food students take every day compounded by a sedentary lifestyle, a student's health can easily be at risk to many diseases like chronic heart disease, hypertension and diabetes.

Physical education in school is a preventive measure to teach students the value of regular exercise.

Through physical education, students develop motor skills and hand-eye coordination. The upper body muscles are developed through activities like push-ups, as well as the lower body muscles through jumping and running. Physical health allows students to function even better in classrooms. A good cardiovascular system developed from regular exercise promotes excellent blood and oxygen circulation. This circulation produces longer attention span during classes, allowing longer concentration and absorption.

Indulging in sports be it team sports or dual and individual sports, leads to a major boost in self-confidence. The ability to go on the field and perform instills a sense of self-confidence, which is very important for the development of a person's character. Every victory achieved on the field, helps to boost a person's self-confidence. Moreover, the ability to accept defeat on field and yet believe in your own capabilities brings a sense of positive attitude as well. Thus participation in sports, martial arts or even dance and aerobics, is always a positive influence on a student's overall personality (Fitzgerald, 2008). Students who are active in physical activities like basketball, football, and volleyball and running are more confident with themselves. It's probably because of the self-discipline and dedication to excel in a sport that brings out the best in students, hence building self-esteem.

In Physical Education classes, students develop cooperation, teamwork and sportsmanship. Most of the programs are holistic. They allow students to interact together to a common goal, and that is to win and excel physically. It brings out the competitive sides of students working together both in body and mind and promoting sportsmanship.

According to Bishop (2005), through physical education students demonstrate respect and positive communication skills with others. They use appropriate communication to negotiate, resolve conflict and settle disputes, which may arise while in class or play. Learners develop problem-solving skills analyzing data, drawing conclusions and applying information. The students learn to apply core content, skills and knowledge to real world issues and problems

2.4. Application of Mathematics across the Curriculum

According to Wain (1994), there is no branch of knowledge that does not summon mathematics to its service. Relentless users of mathematics are engineers that include Genetic Engineers and Bio technologists. Communications revolution symbolized by Internet and mobile cell phones would not have been possible without application of mathematics. To study economics and management sciences one must possess stout mathematical heart.

Mathematics is like shorthand of thinking process. What takes six months by non-mathematical thinking can be expressed, discussed and conclusions arrived at in

half a day. Mathematics is therefore a utilitarian subject because its concepts are used in other subjects and in everyday life activities.

Chiappetta (2009) says that Mathematics should be integrated into the other subjects to make students think about the real world. She says that integration will make students start to think about why things happen, giving them a practical approach to learning and using mathematics. This integration also allows students to see the usefulness and importance of mathematics, which therefore enables them to develop new understanding and skills. Chiappetta asserts that current brain research points out that the human brain looks for patterns and interconnections as its way of making sense of things.

Unfortunately in many schools, students learn one subject in one classroom and then move on to the next classroom for the next subject. By delivering the curriculum in this format, subjects lack coherence and therefore students become disconnected. Educators presume that students will miraculously make the associations between subjects by themselves and will see how the subjects fit together and into the real world.

Teaching mathematics in isolation does students a disservice. One goal of mathematics teachers is to produce a mathematically literate nation where people can use the concepts from this subject to solve real-life problems. When mathematics is connected with other subjects, students can develop the intellectual scaffolding they need that will aid them and the nation for the future.

2.5. Application of Mathematical Concepts in Physical Education

Although not always realized, mathematics plays a very important role in sports. Werra (1988:47) says, people think about mathematics being applied in the sciences and engineering. Yet mathematics plays a large role in efficiency of sports. Coaches constantly try to find ways to get the most out of their athletes and sometimes they turn to mathematics for help.

The theme for the mathematics awareness month in the year 2010 was mathematics and sports. The objective of this theme was to help focus the public's attention on the nature of mathematics and the way it affects our daily lives and fosters the development of new tools to solve problems for individuals, business and governments.

Malkevitch (2010) hopes that when you sit to watch your favorites sport's star or team, you will recognize the behind the scenes role that mathematics is playing in bringing these events to you and making it possible to have fair competition and efficient sports events.

Mathematics concepts are used during scheduling to determine the number of matches per team and for the whole game, during play of the game, determining the winner and ranking of the teams and preparation of the fields.

2.5.1. Mathematics and Scheduling for competition.

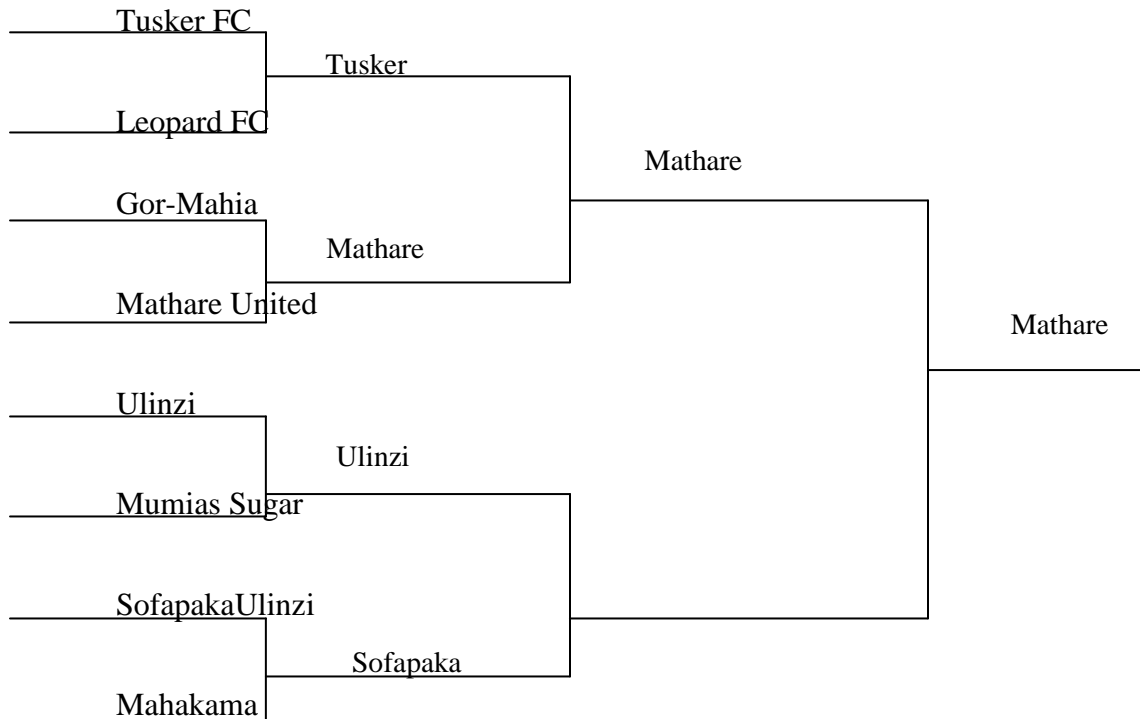
There are many ways teams or individuals can compete. The type of tournament to be used will depend on the activity, the facilities, and the time for competition, number of competitors, financial status and the personnel or officials present.

To see application of mathematical concepts in sports we are going to look at two types of tournaments (Kiganjo et al, 2005)

2.5.2. Single elimination or knockout.

This is the type of tournament where teams or players are eliminated after losing only once. It's used when time is limited and when there are few facilities, officials and equipment. Participating teams or individuals are placed in the brackets using the power of two such as 2, 4, 8, 16, 32..., as shown in figure 2.1.

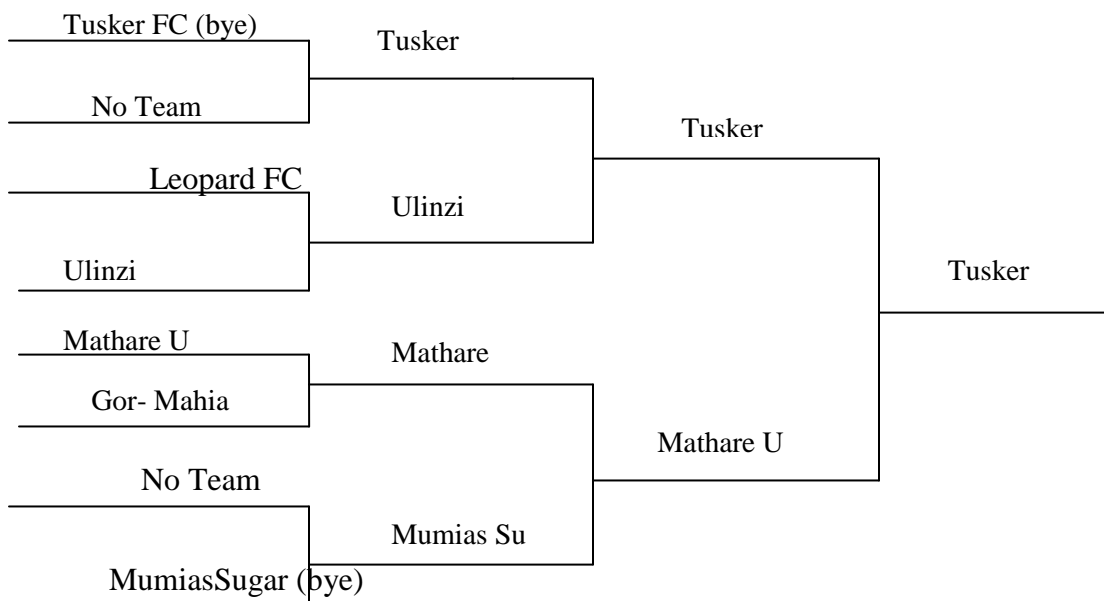
Figure 2.1: Schedule for 8 teams;



This gives three rounds of matches. The number of teams is 8 which is a power of 2. I.e. $8 = 2^3$ hence 3 matches which is the index.

If the number of teams participating in the tournament is not a power of two, a “bye” is given to some of the teams so that they do not compete in preliminaries round of the competition. Byes are given to teams that are seeded so that they are not eliminated in the earlier rounds. Figure 2.2 shows scheduling for 6 teams.

Figure 2.2: Schedule for 6 teams



Source: Kiganjo et al, 2005

Indices will assist in determining the number of rounds, as the chart shows how many matches will be played to get the winner. This information is used to determine the number of fields of play and officials, time and the finances required for the tournament. Kiganjo et al, (2005) uses this method to schedule for sports

but no connection to mathematics is done. Attention of learners to these mathematical concepts of indices and tree diagrams used in scheduling sports will go a long way in making learners see the importance of mathematics and its relevance in physical education therefore appreciating the subject.

2.5.3. Mathematics and Round robin /League

In round robin, team/player plays every other entry. The play for the entries that take place once is called single round robin or league play for all entries and those that take place twice(home and away) is called double round robin/league. Round robin is suitable when there is enough time. It can be used in all ball games.

To determine the number of games to be played, the following formula is used:

$$M = \frac{N(N-1)}{2} \quad (\text{Werra, 1988})$$

2

Where M is the number of games to be played, N is the number of participating teams.

Thus if number of teams are 8,

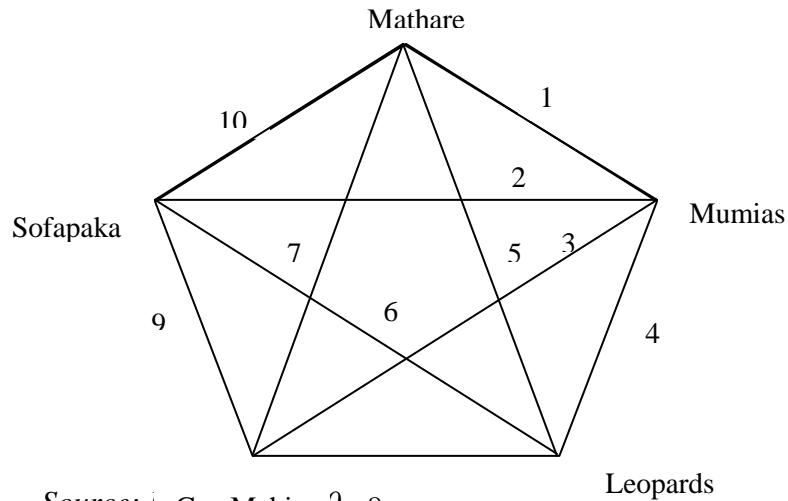
$$M = \frac{8(8-1)}{2} = \frac{8 \times 7}{2} = 28$$

There will be 28 matches.

If the number of teams is 5, the number of matches is

$$\frac{5(5-1)}{2} = \frac{5 \times 4}{2} = 10, \text{ OR geometrically using a polygon as shown in figure 2.3;}$$

Figure 2.3 Matches played by the teams



Source: 1 Gor-Mahia 2. 8

The lines joining two teams show the number of matches. The lines are 10 hence 10 matches.

2.6. Mathematics in determining the winner and Ranking of Teams

The winner in a football league is decided on the basis of points scored by the respective teams. Table 2.8 shows the Kenya premier league performance by 10th August 2010.

Points are awarded as follows;

Win=3 points Draw=1point Loss=0points

Table 2.8 Kenya Premier League

Team	P	W	D	L	F	A	Ps
Ulinzi Stars	18	9	8	1	22	11	35
Tusker	19	9	6	4	22	13	33
Sofapaka	19	8	8	3	30	15	32
Mathare United	19	6	12	1	21	13	30
GorMahia	18	8	6	4	19	13	30
Karuturi Sports	19	6	8	5	16	15	26
N. City Stars	19	5	10	4	18	19	25
Western Stima	19	6	6	7	21	22	24
Thika United	19	6	6	7	19	23	24
AFC Leopards	19	6	6	7	18	25	24

Source: Daily Nation Tuesday, 10/8/2010

P stands for matches played

W matches won by the team

D matches drawn by the team

L Matches lost by the team

F Goals for the team

A Goals against the team

Ps Points for the team

To determine the total points, matrices can be used. Tables are also used to show each teams standing.

2.7. Mathematics during Play of the Game

Barrow (2008) says that sports are just experimental mathematics. Whether we are looking at the swing and spin of cricket balls, leaps of high jumpers, shooting

netball or kicking a penalty, all are movements that can be understood by the application of simple mathematics.

He says that we can assume that our football is perfectly spherical and neglect air resistance to its motion. The football is a truncated icosahedron.

2.7.1 Shooting in Basketball

When shooting a basketball you want the ball to hit the basket at as close to a right angle as possible. For this reason, most players attempt to shoot the ball at a 45° angle. To find the velocity at which a player would need to throw the ball in order to make the basket we would want to find the range of the ball when it is thrown at a 45° angle.

The formula for the range of the ball is:

$$\text{Range} = \frac{V^2 \sin(2\alpha)}{32}$$

But since the angle at which the ball is thrown is 45° , we have

$$\text{Range} = \frac{V^2 \sin(2\alpha)}{32} = \frac{V^2 \sin(2 \times 45)}{32} = \frac{V^2}{32}$$

Now, if a player is shooting a 3 point shot, then he is approximately 25 feet from the basket. So, by solving the formula knowing that the range of the shot must be 25 feet. We have

$$25 = \frac{V^2}{32}$$

$$V^2 = 800$$

$$V = 28.2843$$

so in order to make the 3 point shot, the player must throw the ball at approximately 28 feet per second, 19mph.(Barrow, 2008).

2.7.2. Mathematics and The unstoppable free kick.

The revolution in tactics and playing formations that swept through team football in the 1950s was mirrored by the development of individual playing skills. One of the most important remains the ability to make the ball swerve in flight. The skill is most often used in direct free kicks, especially from the dangerous frontal positions around the edge of the penalty area (Bray, 2006).

In its most conventional form a wall is set up by defenders to cover 75 percent of the goal line. The goal keeper lines up with the near edge of the wall, leaving him, in theory at least, a clear view of the shot. For many years the tactic was simply to blast the ball at the wall, hoping that the defenders would separate, leaving a gap. What is actually needed is a technique that allows the ball to be struck at a rapid pace of about 27metres per second while avoiding the damaging effects of backspin. An action that produces sidespin is required. A Brazilian midfielder, Waldir Pereira was the first player to exploit it and gave his team a narrow victory over Peru in 1958 world cup competitions in Sweden. Waldir struck the ball hard enough with sidespin following a curling trajectory. Aware or unaware of the mathematics applied, he struck the ball to rotate and form a curve around the wall and avoid the goalkeeper. He also applied speed and force to go against force of gravity and air resistance. His technique has been practiced exhaustively by

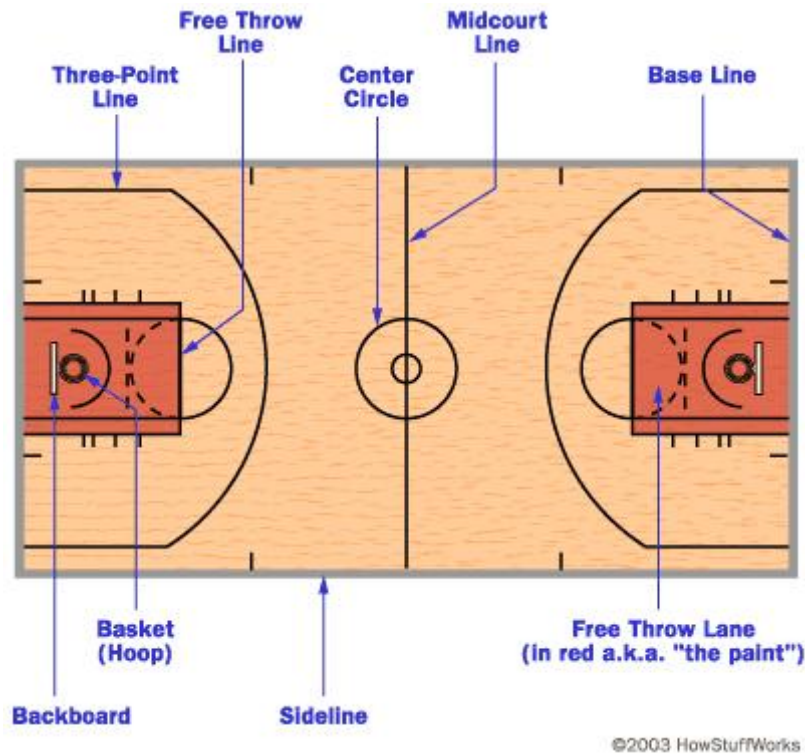
today's elite performers such as David Beckham and Zinedine Zidane. (Bray, 2006).

2.8. Fields of Play and Mathematics

All the fields of play in physical education are geometrical figures which are divided into other geometrical shapes. The courts are divided into rectangles, circles, squares, semi-circles, arcs, lines, trapeziums etc. To draw these fields of play, you need the knowledge of geometrical constructions as learned in mathematics. The fields are rectangular; hence the end line and side line are perpendicular. An angle of 90° is measured where the two lines meet. We are going to look at some of the fields and the mathematical concepts applied on it.

2.8.1 Basketball Field of Play.

Figure 2.4: Basketball court



Source: [en.wikipedia.org/wiki/Basketball.court](https://en.wikipedia.org/wiki/Basketball_court)

The sideline of the court of play is (24-28) meters long and the End line is (13-15) meters long.

We have a midcourt line which divides the court into two equal parts (halves).

The center circle has a radius of 1.8 meters and the Free Throw line is 3.6 meters long. In the preparation of this court, the concept of measurement is applied. The measurements must be accurate and to the international standards.

The basketball court is divided into rectangles, circles, arcs of circles, and lines. The field marker must be able to use geometrical instruments and also improvise to draw these mathematical figures. To draw the Center line, the marker has the concept of fractions because he is dividing the court into halves. The goal post and the Backboard are perpendicular to the ground.

2.8.2. Soccer Field of Play

Figure 2.5: Soccer field of play



Source; <http://www.soccer-fans-info.com>

The International Federation of Football Association (FIFA) standard dimensions of the football field are (90-120) meters long by (45-90) meters wide. It must be of rectangular shape.

A small field layout will allow for a faster game, potentially more opportunities and it would give the more technical players an advantage over fast runners. On the other hand, some players will prefer a longer and wider soccer field in order to fully stretch out. This favors fast and enduring players that can make their move in the big chunks of empty field behind the opposing team.

From the literature reviewed, many writers have shown mathematics to be used in physical education. Kiganjo et al (2005) uses indices and tree diagrams in scheduling for sports to determine the number of matches and rounds to be played. In the round robin tournament, Werra (1988) uses the formula $N(N-1)/2$ to find the total number of matches in the tournament. Malkevitch (2010) uses polygons to find the total number of matches where each vertex represents a team. The number of sides of the polygon is equal to the number of teams.

Trigonometry is used by Barrow (2008) to calculate the speed at which the ball must be thrown in basketball during scoring given that the number of points earned depends on the position of the player on the court of play. In the execution of free kicks and penalty kicks, individual playing skills must be developed. Brazilian mid-fielder Waldir Pereira in 1958 developed the sidespin that forms a curling trajectory. The sidespin causes the ball to rotate and curve around the wall

of players and the goal keeper. In this kick force, speed, rotation, curves and distance are mathematical concepts applied. The fields of play are geometrical figures divided into other geometrical shapes like circles, squares, trapezia, arcs and so on. Mathematical concepts of angles, perpendicular lines, parallel lines, fractions and measurements are used in preparation of the fields of play.

The writers seen in the literature review have applied mathematical concepts but none of them has connected it to mathematics as a discipline or discussed how physical education can be used to enhance teaching and learning of mathematics. Both subjects are taught in isolation yet there are many concepts that are shared. This study is aimed at encouraging transfer of knowledge from mathematics to physical education to enhance mastery of content and improve performance.

2.9. Summary

This chapter looked at the importance of mathematics and physical education and application of mathematics across the curriculum.

This study was an important extension of existing literature because it analyzed specific mathematical concepts as applied in physical education activities. The main difference between this study and others was that it sought to establish the awareness of these mathematical concepts and the opinion of teachers to integrating mathematics in physical education. It was aimed at creating a positive attitude towards mathematics through relating it to other disciplines and therefore improving performance.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter discusses the area in which the research was carried out, the methodology that was used, the procedures and modalities of data collection. It also covers determination and identification of the population sample size, sampling design, sampling procedures, the instruments of data collection, validity and reliability of instruments, sources of data and methods of data analysis.

3.1 Research Design

This study was a descriptive survey that attempted to establish mathematical concepts used in the teaching and learning of physical education, opinions, attitudes and perceptions of teachers and students to integration and transfer of learning between the two subjects to support each other. This descriptive survey used questionnaires and interviews to gather information. This information was then summarized, presented and interpreted using frequency distribution tables, percentages, and means.

The study used both qualitative and quantitative research approaches. Qualitative research used interviews and expanded discussions to collect data on teachers' awareness of mathematical concepts applied in teaching and learning of physical education and their opinions and perceptions on connection and integration of mathematics and physical education to support learning. Quantitative research

used questionnaires to assess awareness of mathematical concepts applied in physical education and the attitude towards integration to help improve performance of mathematics.

3.2 Location of the Study

The study was conducted in former Lugari district of Kakamega county of Western Province in Kenya. The district borders Uasin Gishu to the south and south-east, Bungoma to the north, Malava to the west and Nandi North to the south-west. The district lies between longitudes $34^{\circ} 28'$ and 35° east and between latitudes $0^{\circ} 25'$ and 1° north of the equator. It occupies an area approximately 670.2km.

Former Lugari district was divided into three districts, namely, Likuyani, Lugari and Matete in the year 2011. The climate is equatorial with long rains occurring between March and September while the short rains occur between October and November. Subsistence farming and small scale business are the main economic activities in the area. Because of its favourable climate and fertile soils, the area has attracted many people from all corners of Kenya, making it a cosmopolitan region. The main cash crop grown is maize (Lugari District Development Plan 2002-2008).

The district has 53 public secondary schools of which three are boys' schools, seven are girls' schools and 37 are co-educational schools. The district has no national school.

3.3 The Target Population

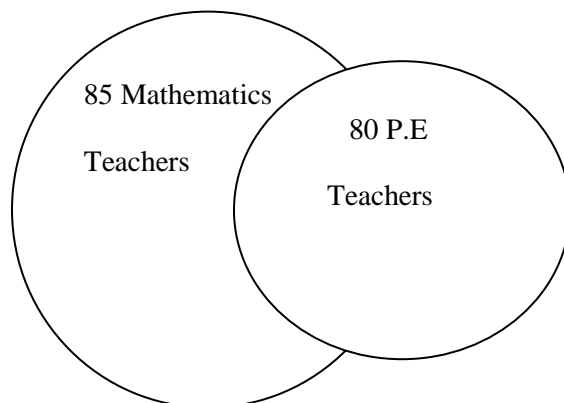
The target population included Physical education teachers, coaches, mathematics teachers and students who participate in sports as shown in table 3.1.

Table 3.1: Lugari district secondary school enrolment

<i>Item</i>	<i>Total</i>
Number of students	12536
Number of teachers	378
Physical education teachers and coaches	80
Mathematics teachers	133
Students in ball games	1600

Source: Likuyani Zone sports coordinator and SMASSE trainers' representative.

The target population is 1765 which consists of 80 Physical Education teachers, 133 Mathematics teachers and 1600 students in daily physical activity. Forty eight mathematics teachers also teach physical education and are coaches of different games. Eighty five teachers teach mathematics only, while thirty two teach physical education with other subjects..



3.4.1 Sampling Procedure

Sampling is a procedure of selecting a part of a population on which research can be conducted and which ensures that conclusions from the study can be generalized to the entire population. The researcher employed purposive sampling as well as stratified sampling techniques to ensure that the sample had at least four of the six ball games. The ball games under study are six, namely soccer, basketball, volleyball, netball, handball and hockey.

Purposive sampling was used to select ten schools for the study because the schools had to be teaching at least four of the ball games under study. From the ten schools the researcher used stratified sampling to select eight teachers from each school and eight students for each ball game in each of the schools. The target population was divided into six strata, that is, Mathematics teachers, Physical Education teachers and groups of students in four different ball games. From each stratum, simple random sampling was used to select a sample size of four physical education teachers, four mathematics teachers and eight students for each ball game. This gave a total of eighty teachers and three hundred and twenty students.

3.4.2 Sample size

A sample size of eighty teachers and three hundred and twenty students was used in the study. This consisted of four mathematics teachers and four physical education teachers per school and eight students in four ball games in each school as shown in the table 3.2 below;

Table 3.2: Sample Size

	<i>Target Population</i>	<i>Sample Size</i>	<i>Percentage</i>
Teachers	165	80	48.5
Students	1600	320	20
Total	1765	400	22.7

3.5. Research Instruments

In this study data was collected by use of questionnaires and interviews. The two instruments were to supplement one another in order to gather information that would probably be left out if one instrument was used.

3.5.1. Questionnaire

Questionnaires were the main instrument for data collection in this study. The researcher constructed one questionnaire for physical education and mathematics teachers (See Appendix C) and one questionnaire (See Appendix B) for students. The questionnaires had both open-ended and closed items. The open-ended items were meant to give the respondents a greater freedom of expression of ideas and opinions and the closed items would enable the researcher get specific responses. The questionnaire was used to collect information on mathematical concepts that guide the players in throwing the ball, preparation of the fields, intercepting the ball, passing the ball and shooting.

3.5.2. Interview Schedule.

The interview method of collecting data involves the interviewer asking questions in a face-to-face contact with the respondent. This method of data collection enabled the researcher to get more information and in greater depth. The researcher had the opportunity to restructure the question to the level of the respondent and also minimize non-response (Kothari, 2004). Structured interviews were considered appropriate for obtaining information on mathematical concepts that guide the teaching and executing of spiking, heading, penalty-kick, and shooting. The researcher also got information on the teachers' and students' awareness of these mathematical concepts and the possibility of encouraging players to integrate mathematics and physical education so that they support each other and their opinion on transfer of learning from mathematics to physical education.

3.5.3 Validity of Research Instruments

According to Mugenda and Mugenda (1999) validity refers to the accuracy and meaningfulness of inferences, which are based on the research results. It is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study. The content validity of the instruments was determined by the researcher discussing the items in the instruments with the supervisors, colleagues and other lecturers in the department of Educational Communication and Technology.

3.5.4 Reliability of the Research Instruments.

According to Mugenda and Mugenda (1999), the reliability of an instrument is the measure of the degree to which a research instrument yields consistent results or data after repeated trials. A test – retest method was used in a pilot study to estimate the degree to which the same results could be obtained with repeated measure of accuracy of the same concept in order to determine the reliability of the instrument. The instruments were administered to two secondary schools, which were not used in the final research. This was done within a span of two weeks. Scores obtained from the first and second test were analyzed. The tools were later refined in terms of clarity of language and any ambiguity detected was clarified.

From the two responses, a Pearson's Product Moment formula for test – retest was used to compute the correlation – coefficient at confidence levels of 0.05 and 0.01 in order to establish the extent to which the items of the questionnaire were consistent in eliciting the same responses every time they were administered. A high coefficient meant the instrument was reliable. The reliability test generated a correlation coefficient of 0.5973, which is considered rationale enough for the instruments to be used for data collection.

3.6. Piloting

A pilot study was done in which fifteen initial questionnaires were administered randomly in two schools. The results were subjected to a preliminary analysis in

order to determine validity and reliability of the research instruments. The respondents who participated in the pilot study did not participate in the final study. Their input was used to revise and upgrade the final instruments that were administered to the 400 respondents.

3.7. Data Collection Procedure

Data was collected in the sampled schools. The researcher first visited the schools to familiarize herself with the schools' authority and explain the purpose of the study. During the visit, the researcher identified one teacher in each school, preferably the Subject Head of physical education who acted as the coordinator. This teacher assisted in administering the questionnaire in order to minimize the Hawthorn effect.

The coordinating teacher gave the questionnaires to the students and the teachers in the school. After the questionnaires were completed, the coordinator collected them and handed them over to the researcher. The researcher administered the interview to the Physical education Head of subject and the mathematics head of department in each school.

3.8. Data Analysis

The data collected was categorized into groups based on the research questions and objectives for analysis. Both qualitative and quantitative methods were used in the analysis. Quantitative analysis involved presentation of statistical data in form of frequency distribution tables and charts. Percentages, mean and mode

were used to analyze qualitative data, whose explanations were descriptive. Statistical Package for Social Sciences (SPSS) was used in drawing of the charts and tables and in calculation of the percentages and means.

3.9. Logical and Ethical Considerations

A letter from the department of Educational Communication and Technology was written to request for permission to be granted from the Ministry of Education to allow the researcher collect data in former Lugari District (See Appendix E). Permission was sought from the Head teachers of the sampled schools before talking to the teachers and students. A request for the assistance of the physical education head of subject was made.

The consent of the physical education teachers, mathematics teachers and students was sought before administering the questionnaire and interview. The information collected was treated with a lot of confidentiality.

3.10 Summary

The study was conducted in ten schools in former Lugari district, Kakamega county; Kenya. Purposive and stratified sampling was used to select eighty teachers and three hundred and twenty students. The main methods of data collection were questionnaires and interview and piloting was conducted to establish reliability of the instruments. The data collected was analyzed using SPSS which produced frequency distributions, charts, measures of central tendency and percentages.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

4.0 Introduction

In this chapter statistical analysis and interpretation of data collected using the research questionnaires and interview schedule is discussed in various sections following the research questions. The findings are presented, analyzed and interpreted sequentially as per the research questions with meanings and inferences drawn from the findings of data analysis as compared with the concepts in the literature review. In this research a total of 378 questionnaires were retrieved out of the 400 questionnaires issued. This was 94.5% response rate.

The data is presented in frequency distribution tables beginning with the respondent's demographic information and then followed by the specific research information, which addresses the study's objectives.

The collected data was classified into meaningful categories called codes. This was necessary so as to carry out the subsequent operations of tabulating and analyzing primary data. It was therefore necessary to reduce large numbers of heterogeneous responses into sequential classes or groupings. The responses from open-ended questions in the interview schedule were not coded but understood, and used to qualitatively make meaning of the numbers of the non-specified responses.

4.1.0 Demographic Information

The respondents' demographic information is broken down into gender, teaching subjects, professional qualifications and working experience for the teachers, and form, gender, best subject and favorite sport for the students. Percentage and frequency of each of the demographic variables were computed, and results summarized as in table 4.1.0 below.

Table 4.1.0 Teachers' Demographic Variables

N=76

Variables	Frequency	Percentage
<i>Gender</i>		
Male	59	77.6
Female	17	22.4
<i>Teaching Subjects</i>		
Mathematics	48	63.16
Other subjects	28	36.84
<i>Professional qualifications</i>		
Graduate teacher	54	71.05
Diploma	14	18.42
Untrained teacher	6	7.89
Others	2	2.63
<i>Teaching experience</i>		
0-5 yrs	28	36.84
6-10yrs	17	22.37
>10yrs	31	40.79

Table 4.1.0 above indicates that majority 59(77.6%) of the investigated teachers were male thus implying that the schools involved in the study had higher number of male teachers teaching mathematics and physical education compared to their female counterparts 17(22.4%).

In terms of education level, a majority of the teachers had undergraduate degree 54(70.1%) compared to those who had a Diploma 14 (18.2%). Besides, a big number of the teachers 31(40.8%) had a teaching experience of more than 10 years, compared to those with a teaching experience of between 1-5 years, 28(36.8%) and those who have taught for 6-10 years 17(22.4%). Teachers with a long teaching experience are more likely to apply mathematics to physical education because of long exposure to content.

The table further shows that among the teachers used in the study, 48(61.16%) teach mathematics while 28(36.84%) do not teach mathematics. From the findings, mathematics teachers had greater knowledge of the mathematical concepts applied in physical education than the other teachers.

4.1.3 Students' Demographic Information

The respondents' demographic information is broken down into Form, gender, favorite subject and favorite sport for the students. Percentage and frequency of each of the demographic variables were computed, and the results summarized in table 4.1.3 below.

Table 4.1.3 Students' Demographic Variables

N=320

Variable		Frequency	Percentage
<i>Form</i>	Form 1	10	3.3
	Form 2	52	16.9
	Form 3	125	41.4
	Form 4	114	37.7
<i>Gender</i>	Male	130	43
	Female	172	57
<i>Favorite Subject</i>	Mathematics	114	37.7
	Others	185	61.3
<i>Favorite Sport</i>	Soccer	116	38.8
	Volleyball	63	20.9
	Netball	43	14.2
	Basketball	40	13.2
	Handball	28	9.3
	Hockey	9	3.0

Table 4.1.3 indicates that 10(3.3%) Of the students used in the study were from form one, 52(16.9%) were in form two, 125(41.4%) were in form three and 114(37.7%) were in form four. 239(79.1%) had been in secondary school for at least three years and therefore have learned Mathematics.

The sample used in the study had 172(57%) female and 130(43%) male students. The number of girls was higher because the schools used in the study were four girls' schools, four mixed schools and two boys' schools.

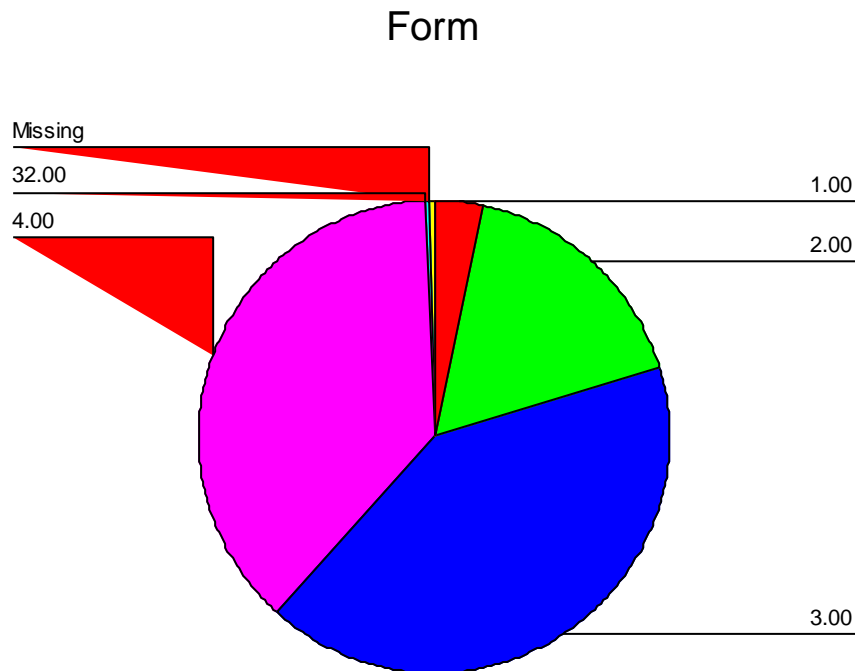
The favorite subjects of the respondents were sought because those students who liked Mathematics were more likely to use it in daily life activities and during sports. It was established that 114(37.7%) of the students had Mathematics as their favorite subject while 185(61.7%) had other subjects.

4.1.4 Class of the Respondents

The study sought to establish the education level of the students since long period of schooling may expose the learner to more knowledge and learning resources.

The class level make up of the respondents is depicted in figure 4.1 below;

Figure 4.1: class of the respondents



It was established from the study that most of the respondents were Form 3, 125(41.4%), followed by Form 4, 114(37.7%). Form 2 was 52(16.9%) and Form 1 was 10(3.3%).

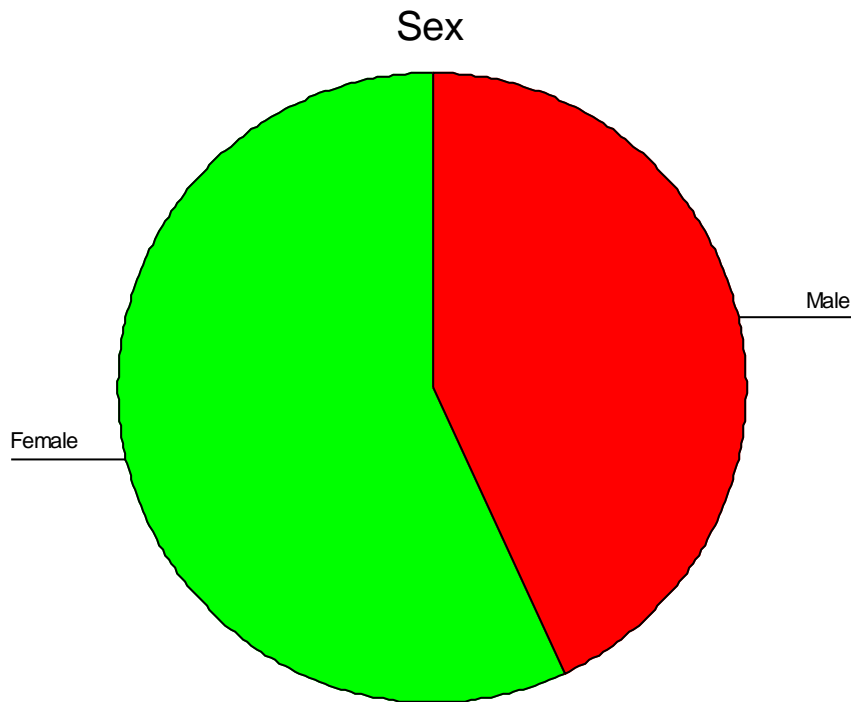
Form three students have been in the schools longer and have joined different sports activities. Students from Form four were reducing their involvement in daily sports activities as they prepare for the national examination. The number of

form one students was the lowest since they had only been in secondary school for two months at the time of this study and many were not actively involved in the different ballgames offered in the schools.

4.1.5 Gender of the Respondents

Gender of the respondents was also looked into because it is a determining factor of the sport and physical activity the students engaged in. The gender make up of the respondents is shown in figure 4.2 below

Figure4. 2: Gender of respondents

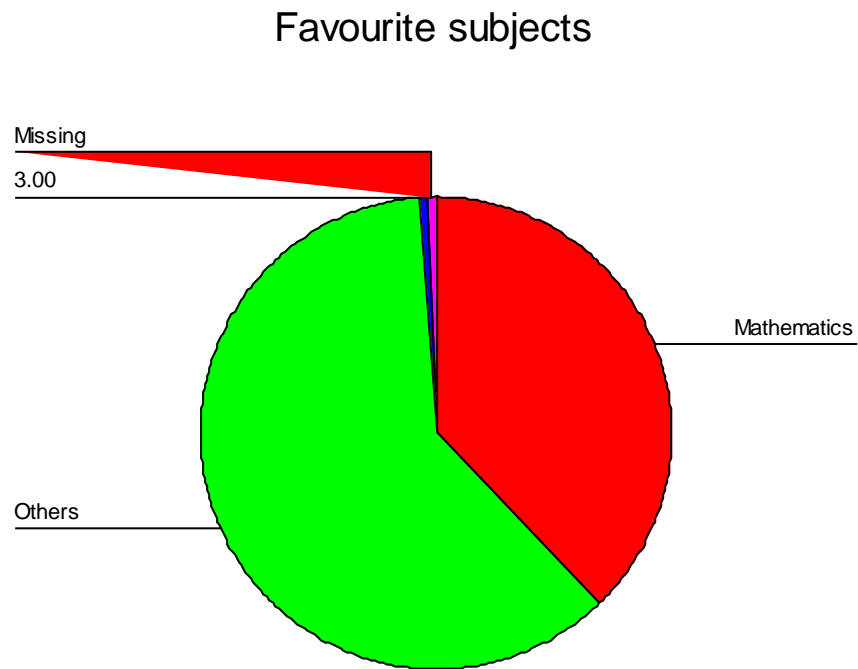


The students used in the study were 172(57%) female and 130(43%) male. The number of girls was higher than boys because the sample was taken from four girls' schools, four mixed schools and two boys' schools.

4.1.6 Favorite Subject of Respondents

The learners' favorite subject was sought in the study because interest and knowledge of mathematics will determine the student's application of mathematical concepts in physical education. Those who perform well in mathematics are likely to apply the knowledge in other spheres of life. The population of students who have mathematics as their favorite subject is shown in figure 4.3 below.

Figure 4.3: Favorite subjects



The study established that 114(37.7%) of the students used in the study had Mathematics as their favorite subject while 185(61.3%) gave other subjects. Students with a positive attitude to mathematics are likely to use the knowledge

learned in Mathematics in Physical Education giving Mathematics a practical approach and this will enhance mastery of content. On the other hand, learning of skills and executing them will be better because of logical thinking and application of Mathematics.

4.2.0 Awareness of Teachers and Learners of the Mathematical concepts applied in Physical Education

The teachers and the learners were asked to state mathematical concepts applied in the teaching and learning of different skills in different sports activities in six ball games. This was to find out the knowledge of teachers and students about the mathematics concepts applied in physical education.

Table 4.2.0 shows the responses given by the teachers and the number of teachers who gave a particular response.

Table 4.2.0: Mathematical concepts given by the Teachers

N=76

<i>Physical Education Activity</i>	<i>Mathematical Concepts</i>	<i>Number of Teachers</i>	<i>Percentage</i>
<i>1.Preparation of fields of play</i>	Measurements	73	96.05
	Angles	50	65.79
	Area	48	63.16
	Geometry	42	55.26
<i>2.Throwing the ball</i>	Vectors	42	55.26
	Measurements	41	53.95
	Angles	38	50
	Loci	11	14
	Linear motion	6	7.9
<i>3.Penalty kick</i>	Measurements	52	68.42
	Angles	43	56.58
	Probability	25	32.9
	Loci	22	29
	Linear motion	9	11.84
<i>4. Interception</i>	Measurements	26	34.21

<i>Physical Education Activity</i>	<i>Mathematical Concepts</i>	<i>Number of Students</i>	<i>Percentage</i>
	Approximation	28	36.84
	Coordinates	9	11.84
<i>5. Stopping the Game</i>	Time	68	89.47
	Statistics	41	53.95
<i>6. Goal keeping</i>	Measurement	46	60.53
	Angles	43	56.58
	Speed	29	38.16
	Area	32	42.11
<i>7. Ranking Performance</i>	Statistics	43	56.58
	Integers	14	18.42
	Matrices	13	17.11
<i>8. Shooting</i>	Vectors	38	50
	Angles	35	46.05
	Loci	18	23.68
	Speed	28	36.84
<i>9. Designing of Balls</i>	Surface Area	42	55.26
	Weight	32	42.11

4.2.1 Teachers' Awareness of Application of Mathematical Concepts in Physical Education

From table 4.2.0, Measurements were the mathematical concept given by the highest number of teachers. 73(96.05%) said that it is used in the preparation of fields of play. 52(68.42%) gave measurements as being applied in throwing the ball, while 46(60.53%) stated that it is applied by the goal keeper in preventing a score.

Angles were the second common concept stated by the teachers as being applied in ball games. 50(65.79%) said that it is applied in preparation of fields of lay, 43(56.58%) said that it is applied by a player taking a penalty kick in increasing the angle of ball movement, and 43(56.58%) said its applied by the goal keeper to narrow the angle of ball movement.

Other mathematical concepts given by the teachers were Area (63.16%), Geometry (55.26%), Vectors (55.26%), Time (89.47%) and Statistics by 56.58% for ranking performance.

More complex mathematical concepts applied in sports were given by a small percentage of teachers. These include:

- Loci which was given by 18(23.68%) to be applied in shooting for a score
- Coordinates by 9(11.84%) is applied during interception of the ball during play
- Linear motion 11(11.84%) said it is applied while executing a penalty kick and
- Matrices 13(17.11) is applied in ranking performance.

The findings concur with Werra (1988; 47) who says that mathematics plays a very important role in the efficiency of sports and Barrow (2008) who says that sports are experimental mathematics.

4.2.2: Awareness of Learners of the Mathematical concepts applied in Physical Education

The students were asked to state Mathematical concepts applied in learning different skills in different sports activities in six ballgames. This was to find out the awareness of students about Mathematical concepts applied in Physical Education.

Table 4.2.1 shows the responses given by the students and the number of students who gave a particular response.

Table 4.2.1: Mathematical concepts given by the students

N=302

<i>Physical Education Activity</i>	<i>Mathematical Concepts</i>	<i>Number of Students</i>	<i>Percentage</i>
<i>1.Preparation of fields of play</i>	Measurements	204	67.55
	Angles	150	49.67
	Area	88	29.14
	Geometry	52	17.22
<i>2.Throwing the Ball</i>	Vectors	75	24.83
	Measurements	51	16.89
	Angles	48	15.89
	Loci	11	3.64
	Linear motion	6	2
<i>3.Penalty kick</i>	Measurements	92	30.46
	Angles	88	29.14
	Probability	25	8.28
	Loci	22	7.28
	Linear motion	0	0
<i>4.Intercrption</i>	Measurements	66	21.85

<i>Physical Education Activity</i>	<i>Mathematical Concepts</i>	<i>Number of Students</i>	<i>Percentage</i>
	Approximation	48	15.89
	Coordinates	9	2.98
<i>5.Stopping the Game</i>	Time	68	22.52
	Statistics	41	13.58
<i>6.Goal keeping</i>	Measurement	46	15.23
	Angles	43	14.24
	Speed	109	36.09
	Area	32	10.6
<i>7.Ranking Performance</i>	Statistics	92	30.46
	Integers	44	14.57
	Matrices	13	4.3
<i>8.Shooting</i>	Vectors	38	12.58
	Angles	35	11.59
	Loci	18	5.96
	Speed	28	9.27
<i>9.Designing of Balls</i>	Surface Area	22	7.28
	Weight	32	10.6

4.2.3 Students' Awareness of Application of Mathematical Concepts in Physical Education

The study sought to establish awareness of learners on application of mathematical concepts in various activities of Physical Education. Two hundred and four (67.55%) of the student gave measurements as a mathematical concept used during preparation of the field of play, 51(16.89%) said it is applied when throwing the ball, 92(30.46%) applied it at penalty kick, 66(21.85%) at interception and 46(15.23%) said it is applied by the goalkeeper in estimating his area of play. The percentage of students who gave the concept was less than that given by teachers.

Angles were the second common mathematical concept given by the students. 150(49.67%) gave it as being applied in preparation of the fields of play, 48(15.89%) for ball throwing, 88(29.14%) for penalty kick, 43(14.245) for goal keeping and 35(11.59%) said it's applied when shooting the ball for a goal

Other mathematical concepts that were common were; area 88(29.14%), geometry 52(17.22%), approximation 48 (15.89%), time 68 (22.52%), speed 109 (36.09%), statistics 92(30.46%) and vectors 38(12.58%).

Concepts that are more complex were given by much smaller percentages of students as follows:

- Loci were given by 11(3.64%) as being used during throwing of the ball.
- Linear motion by 6(2%) in ball throw.

- Coordinates by 9(2.98%) when intercepting the ball.
- Probability by 25(8.28%) in penalty kick.
- Matrices by 13(4.3%) while ranking performance.

These percentages of students with knowledge of mathematical concepts applied in physical education were found to be less than that of teachers.

4.3. Compulsory Mathematics in Secondary Schools

Both teachers and students were asked to give their opinion on whether mathematics should remain compulsory in secondary school or not. They were required to respond using any of the responses below.

1.00 Strongly disagree

2.00 Disagree

3.00 Agree

4.00 Strongly agree

The frequency and percentages of their responses are shown in table 4.3.1 below:

Table 4.3.0. Teachers' Responses on Compulsory Mathematics

<i>Teachers' responses</i>	<i>Frequency</i>	<i>Percent</i>
Strongly disagree	0	0
Disagree	0	0
Agree	14	18.4
Strongly agree	62	81.6
TOTAL	76	100

Sixty two teachers (81.6%) strongly agreed that Mathematics should remain compulsory in Secondary schools while the remaining 14 teachers (18.4%) agreed. No teacher disagreed. The mean was 3.82 meaning that teachers strongly agreed. The teachers said mathematics is applied in everyday life and in the learning of the other subjects hence it should remain compulsory.

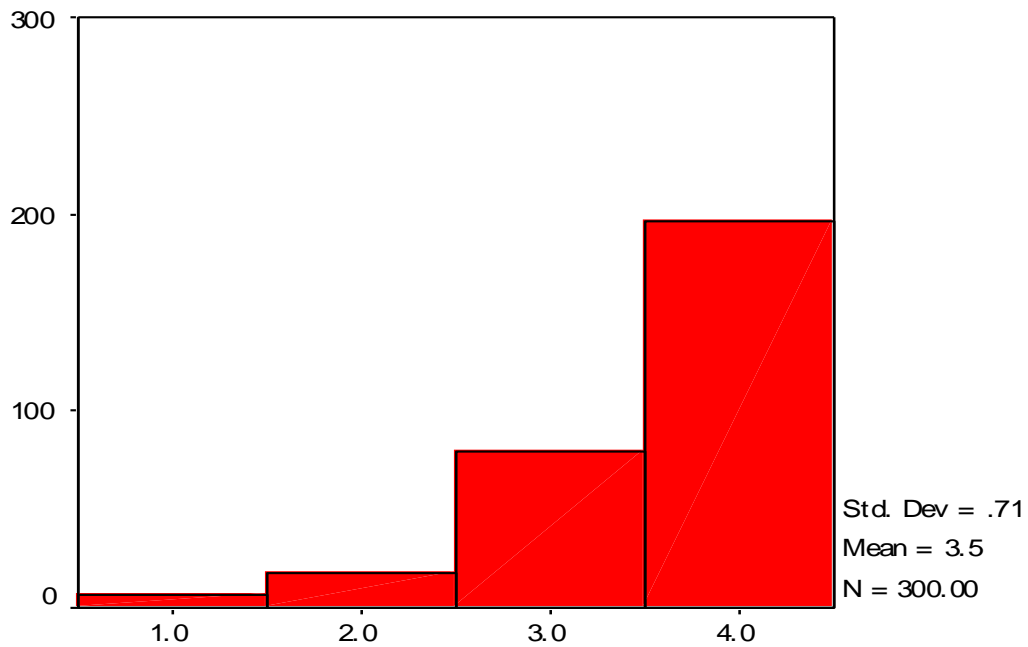
4.3.1 Students' Responses on Compulsory Mathematics

Students were asked to give their opinion on whether mathematics should remain compulsory in secondary school or not. They were required to respond using any of the responses below.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

The frequencies of their responses are shown in the histograms below;

Figure 4.4: Students' Responses on compulsory Mathematics



Mathematics should remain compulsory in secondary school

One hundred and ninety six students (64.9%) strongly agreed that Mathematics should remain compulsory in Secondary Schools, 79 students (26.2%) agreed, 18 students (6%) disagreed while 7 students (2.3%) strongly disagreed. The Mean was 3.5 meaning that on average students feel that Mathematics should remain compulsory

4.4 Use of Mathematics in Daily Lives

The study sought to establish if the teachers and students applied mathematics in their daily lives. The following options were available to the respondents;

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree.

The frequencies of their responses are presented in table below:

Table 4.4.0. Teachers' Responses on Use of Mathematics in daily Lives

<i>Teachers' responses</i>	<i>Frequency</i>	<i>Percent</i>
Strongly disagree	0	0
Disagree	0	0
Agree	11	14.47
Strongly agree	65	85.53
TOTAL	76	100

Sixty five (85.53%) teachers strongly agreed that they use mathematics in their daily lives, while eleven (14.47%) agreed. The teachers said it is used in the following ways;

- Time spend in daily movement from home to school
- Budgeting for the family
- Planning for the future

-Determining agricultural inputs and profits

-Shop keeping

-Preparation of meals

These findings support Wain (1994), who says that irrespective of your status in life and however basic your skills are, you apply mathematics. Daily activities are reliant on how to count, add or multiply. You encounter numbers everyday in memorizing phone numbers, buying food, cooking food, balancing a budget, paying bills, estimating fuel consumption, measuring distance and managing your time.

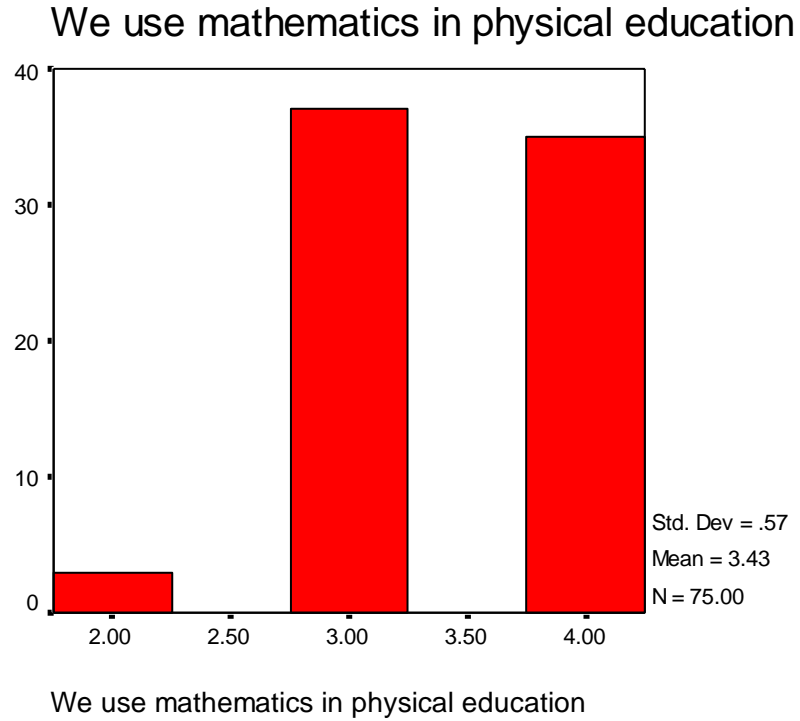
4.5. Application of Mathematics in Teaching and Learning Physical Education

The study sought to establish if the teachers and students applied mathematics in the teaching and learning of physical education. The following options were available to the respondents;

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree.

The frequencies of their responses are presented in figure 4.5

Figure 4.5: Teachers' Responses on use of Mathematics in Physical Education



Thirty five (45.5%) teachers strongly agreed that they use mathematics in teaching physical education, 37(48.1%) agreed, while 3(3.9%) disagreed. The mean was 3.43 meaning that teachers apply mathematics in physical education. These findings concur with Malkevitch (2010) who hopes that when you sit to watch your favorite sports star or team, you will recognize the behind the scenes role mathematics is playing in bringing these events to you and making it possible to have fair competition and efficient sports events.

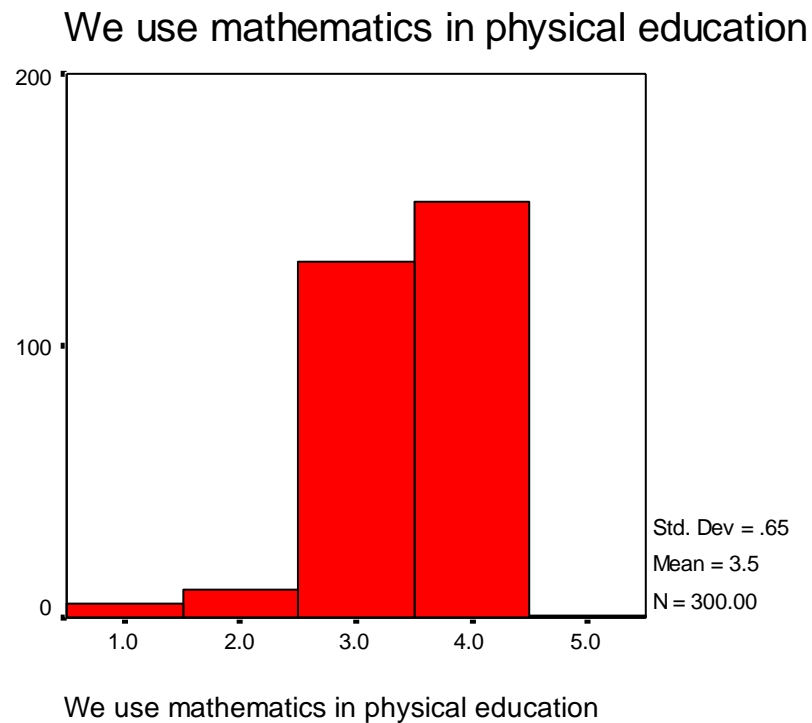
4.5.1 Students Responses on Applying Mathematics in Physical Education

The study sought to establish if students applied Mathematics in the learning of physical education. The following options were available to the respondents;

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree.

The frequencies of their responses are presented in figure 4.6

Figure 4.6: Students' Responses on use of Mathematics in Physical Education



One hundred and fifty three (50.7%) students strongly agreed that mathematics is used in physical education, 131(43.4%) agreed, 10(3.3%) disagreed and 5(1.7%) strongly disagreed. The mean was 3.5 meaning that students agreed that mathematics is used in physical education.

4.6. Integration of Mathematics and Physical Education to support Teaching and Learning

Through the interview schedule, the Heads of departments of mathematics and games of the ten schools in the sample were asked to state their opinion on integration of mathematics and physical education to support teaching and learning. They were required to respond using Yes or No and give reasons for their response. The frequencies and percentages of their responses are shown in table 4.5.0 below:

Table 4.5.0: Responses by Heads of Department on Integration of Mathematics and P.E.

Responses	Number	Percentages
Yes	16	80
No	3	15
None	1	5
Total	20	100

Sixteen (80%) of the Heads of Departments of Mathematics and Physical Education agreed to integration of mathematics and physical education. They said that it was necessary because mathematics was abstract to many students and relating it to physical education activities will give it a practical approach. When they use the sense of sight and touch, concepts will be internalized and mastery of content will be high. Mathematics will become real and meaningful because learners will relate it to real life situations and not a set of imaginary ideas found in school only. The games teacher will make mathematics more interesting and simpler because he will bring out some concepts clearly and in simpler terms.

Integrating Mathematics and Physical Education will create critical thinking in the players and this will allow scoring. The teachers noted that the quality of games will also improve making sports more interesting and enjoyable. Analysis of games results will be easier and more accurate.

Three (15%) of the Heads of Departments said No to integration of Mathematics and Physical Education. They said that many players were poor in mathematics and will be unable to comprehend the mathematical concepts. They said that mathematics teachers may not the time to come up with the activities that are related in both subjects. Teachers may require new training and workshops.

From the findings above, teachers support integration of mathematics and physical education because it will give mathematics a practical approach and

enhance learning and mathematics will help develop good players and improve quality of games.

The study established that physical education concept can be used in the teaching of mathematics. Some of the examples given by the teachers are;

-Courts can be used to teach areas of circles, triangles, rectangles, sectors and segments; and perimeters of the same figures.

-Ranking performance can be used to illustrate matrices and statistics.

-Shooting can be used to teach velocity and angles.

-Knockout schedule is a good example of a tree diagram as used in probability

4.7 Summary

There are many areas in physical education which require application of mathematics right from preparation of the fields of play, during play, up to analyzing performance. Mathematical concepts applied range from simple ones like measurements, angles, area and time to complex ones like loci, coordinates, linear motion and matrices. The teachers and students are aware of application of mathematics in physical education though the percentage of learners who are aware is less than that of teachers. Teachers support association and integration of the two subjects in order to give mathematics a practical approach and improve quality of games.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This study investigated the application of mathematical concepts in the teaching and learning of physical education in secondary schools in former Lugari district, Kakamega county, Kenya. A survey was done to find out the Mathematical concepts applied in different sports activities in Physical Education, teachers' awareness of these mathematical concepts and their opinion on integration of mathematics and physical education to support teaching and learning of the two subjects.

This chapter makes a summary of the key findings, draws conclusions and makes recommendations on the same. The summary is based on the research questions of the study.

5.1 Summary of Findings

This section summarizes the key findings of the study, based on the research questions.

5.1.1 Awareness of Teachers and Students of the Mathematical Concepts Applied in Physical Education

Both teachers and students are aware of mathematical concepts applied in physical education. The teachers stated different mathematical concepts applied in physical education, starting from simple concepts like measurements, time, angles

and estimation to more complex ones like linear motion, loci, coordinates and matrices. The students are also aware of mathematical concepts applied in physical education because they stated the same concepts given by the teachers. However, the percentage of students who stated the concepts was less than that of teachers.

5.1.2 Compulsory Mathematics

Sixty two (80.5%) of the teachers strongly agreed that mathematics should remain compulsory in secondary school while the remaining 14(18.2%) agreed. No teacher disagreed. The mean was 3.82 meaning that teachers strongly agreed. The teachers said mathematics is applied in everyday life and in the learning of the other subjects hence it should remain compulsory.

One ninety two (64.9%) students strongly agreed that mathematics should remain compulsory in secondary school, 79(26.2%) agreed, 18(6%) disagreed while 7(2.3%) strongly disagreed. The mean was 3.5 meaning that students agreed that mathematics should remain compulsory.

5.1.3 Use of Mathematics in Daily Lives

Sixty five (85.53%) teachers strongly agreed that they use mathematics in their daily lives, while eleven (14.47%) agreed. Daily activities are reliant on how to count, add or multiply. You encounter numbers everyday in memorizing phone numbers, buying food, cooking food, balancing a budget, paying bills, estimating fuel consumption, measuring distance and managing your time.

5.1.4 Use of Mathematics in Physical Education

Thirty five (45.5%) of the teachers strongly agreed that mathematics is used in physical education, 37(48.1%) agreed, and 3(3.9%) disagreed. 153(50.7%) of the students strongly agreed, 131(43.3%) agreed, 10(3.3%) disagreed and 5(1.75%) strongly disagreed with mathematics being used in physical education. Mathematics is applied in preparation of the fields, during the game, designing and production of equipment and ranking performance.

5.1.5 Integration of Mathematics and Physical Education to Support

Learning

Sixteen(80%) of the Heads of Departments of Mathematics and Physical Education supported integration of mathematics and physical education because it will give mathematics a practical approach and make it less abstract. Mathematics will improve quality of games and make sports more interesting

Three (15%) disagreed because many players are poor in mathematics and will not comprehend the concepts. They also noted that the teachers don't have the time to come up with related activities in both disciplines.

5.2 Conclusion

Mathematics as a subject in secondary school should remain compulsory because of its crucial role in the curriculum and in everyday life activities of individuals. In physical education, there are many areas which require application of mathematics right from preparation of the fields of play, during play, up to

analyzing performance. Mathematical concepts applied range from simple ones like measurements, angles, area and time to complex ones like loci, coordinates, linear motion and matrices. The teachers and students are aware of application of mathematics in physical education and support association of the two subjects in order to give mathematics a practical approach and improve quality of games.

The teaching subjects of the teachers are a factor affecting application of mathematical concepts in physical education because mathematics teachers are better placed to integrate the two subjects than those who don't. The level of education and teaching experience of the teachers will also affect the extent to which teachers are able to integrate subjects. A teacher who has been exposed to the content for a long time will be able to transfer knowledge from one subject to another because of mastery of content.

5.3. Recommendations

The teacher training institutions should emphasize on the teachers stating the rationale of each topic in the mathematics syllabus for learners to realize its importance in everyday life activities and in the learning of other subjects.

Educational administrators need to assist mathematics teachers to set up mathematics learning resource centers. In these centers there should be charts showing mathematical concepts applied in physical education together with other teaching aids, to make mathematics practical and interesting.

Textbooks should use content that applies mathematics across the curriculum by using examples from other subjects and from real life situations to make mathematics relevant.

Through workshops like SMASSE, teachers should come up with methods and approaches of integrating subjects so they are not taught in isolation to encourage transfer of learning from one subject to another to increase mastery of content.

5.4. Suggestions for Further Research

In light of the findings of this study, there are various areas in mathematics education that the researcher felt need to be investigated in order to improve teaching and learning. The following are a few of the areas that the researcher recommends for further investigation.

1. Hindrances to transfer of learning from one subject to another and the possible remedies to the hindrances.
2. From the teachers' responses, it was suggested that integration will make mathematics more practical and interesting. A research should be done on how to make mathematics more practical and interesting at secondary school level.

BILIOGRAPHY

Allen, K. (1988). *Language and the learning of Mathematics*, NCTM Annual meeting, April 1988, Chicago. <http://www.mathematicallycorrect.com/allen4.htm>.

Barrow, D. J. (2008). *Mathematics and sports: Millennium Mathematics Project Motivate Conf.* for schools. www.motivate@maths.org.

Bishop, S. (2005). *A guide to Importance of Physical Education Programs*.

<http://ezinearticles.com>. Liverpool

Bray, K. (2006). *How to Score; Science and the Beautiful Game*. London: Granta Books

Bii, J. (2006) *Factors Influencing the Performance of Students in Mathematics in the Kenya Certificate of Secondary Education in Selected Secondary Schools in Bureti District, Kenya*. Unpublished M. Phil Thesis, Moi University.

Chiappetta, C. (2009). *Why is it Important to Integrate Mathematics with other Subjects*. www.k12academics.com

Cockroft, H.W. (1982). *Mathematics Counts*. London: HMSO

Cohen, L. and Manion, L. (1994). *Research Methods in Education* (4th Ed). New York: Croom Helm Ltd

Daily Nation Newspaper: Tuesday 10th August 2010

Fitzgerald, J. K. (2010). *Importance of Physical*

Education. www.buzzle.com/articles

Flockhart, D. (2009). *Mathematics Across the Curriculum.* [http:](http://www.nctm.org/resources/Content.aspx)

[www.nctm.org/resources/](http://www.nctm.org/resources/Content.aspx) Content.aspx

Glosser, G. (2010). *Connecting Mathematics to other Subjects.* [http:](http://www.mathgoodies.com)

www.mathgoodies.com

Grevsmuhl (1982). *Mathematics and Art.* <http://books.google.co.ke/books>

<http://www.soccer-fans-infor.com>

<http://www.basketball.com/nba/rules/rule1/shm>

<http://jwilson.coe.uga.edu/EMA>. *Mathematics in Sports*

<http://wiki.answers.com> (2010). *How mathematics is related to other subjects.*

http://education.calumet.purdue.edu/.....edpsy6_transfer.htm.

<http://www.dartmouth.geometry/unit5>

<http://www.en.wikipedia.org/wiki/Business> mathematics

International bible Society,(1820). ***Holly Bible: New International Version.***

Jerusalem Drive, Colorado Springs, U.S.A.: New Life League Publishers Japan.

K.I.E (1979). ***A Report of Mathematics Sub-Committee.*** Nairobi: K.I.E

Kiganjo, G., Kamenju, J. and Mwathi, L. (2005). *Physical Education: A Teachers Guide for Form Four*. Nairobi; Jomo Kenyatta Foundations.

Kombo, D. K. and Delno, A. L. (2006). *Proposal and Thesis Writing; An Introduction*. Nairobi: Paulines Publications Africa.

Kothari, C. R. (2004). *Research Methods; Methods and Techniques* (2thEd). Jaipur Rajasthan: New Age International Ltd.

Lock, H.R. (2002). Mathematics and Sports. *A journal of the American Statistical Association* 97

Kurtus, R. (2007). *Using Mathematics in Physical sciences*. <http://www.school-for-champions.com/science/math.htm>.

Malkevitch, J. (2010). Mathematics and Sports. York College, malkevitch@york.cuny.edu

McCabe, M. (2007). *Mathematics and Physical education: A natural combination*. <http://juggling.org>.

Miheso, K. M. (2002). *Factors affecting Mathematics Performance among Secondary School Students in Nairobi Province, Kenya*. (Not published)
Master of Education Thesis, Kenyatta University.

Mohammed, I. M. (c.AD 820). *History of Mathematics*. [en.wikipedia.org/wiki/history_of Mathematics](http://en.wikipedia.org/wiki/history_of_Mathematics)

Morris, B. L. (1982). *Learning Theories for Teachers* (4thEd). New York: Harper and Row.

Mugenda, M. and Mugenda, O. (1999). *Research Methods- Quantitative and Qualitative Approaches*. Nairobi: Act Press.

Mutunga, P. and Breakell, J. (1987). *Mathematics Education*. Nairobi: Kenyatta University.

Orodho, A.J. and Kombo, D. K.(2002). *Research Methods*. Nairobi: Kenyatta University.

Orodho, A.J. (2008). *Techniques of Writing Research Proposals and Reports in Education And Social Sciences*. Maseno: Kanezja HP Enterprises.

Orton, A. and Wain, G. (1994). *Issues in Teaching Mathematics*. London: Cassell.

Owiti, D.S.O. (2001). *Gender Differences in Attitude towards Mathematics: A Case of Secondary School Students in Eldoret Municipality*. Unpublished M.Phil Thesis, Moi University.

Selkirk, (1982). *Mathematics and Geography*. www.flaguide.org/extra/download/mat/___/Compactness.pdf

Werra, D. (1988). *Scheduling Sports Competitions: Discrete Applied Mathematics*, Amsterdam: Elsevier Science.

Williams. W and Mumu, J. (2005). *Comprehensive Geography; Book 3*. Nairbi:
Longhorn publishers

APPENDICES**APPENDIX A: INTRODUCTORY LETTER**

Dear respondent,

I am a student at Kenyatta University pursuing a Master of Education Degree in Mathematics Education and carrying out a research on Application of Mathematical Concepts in the teaching and learning of Physical education in Secondary Schools in former Lugari District, Kakamega county.

I am requesting for your assistance by filling in the questionnaire provided. The information will help me accomplish the research objectives and will be treated with total confidentiality.

Thank you in advance,

Yours faithfully.

OSUNDWA FATUMA

APPENDIX B: STUDENT’S QUESTIONNAIRES

Introduction

The aim of this questionnaire is to find out the application of mathematics concepts across the curriculum; particularly physical education in Secondary schools in Lugari district.

Instructions

- i. There are no correct and wrong answers
- ii. The information you give concerning your view about Mathematics and physical education will be confidential.
- iii. Respond to all questions by putting a tick in bracket corresponding to your answers or filling in the blank spaces.

Do not write your name anywhere in the questionnaire.

SECTION A: General Information about the Student

1. School..... 2.
 Form.....
 3. Male [] Female []
 4. Favorite subjects
 i. ii.
 iii. iv.
 5. Favorite sports i. ii.

SECTION B

PART 1:

What is your opinion about the following statements?

Statements	Strongly Agree	Agree	Disagree	Strongly Disagree
1. I like Mathematics				
2. If mathematics was not compulsory I would drop it when registering for examination				
3. Mathematics should remain compulsory in secondary school				
4. People who have not been to school know mathematics of some kind				
5. People who have not been to school use mathematics				
6. We use mathematics in daily lives				
7. Not all people need mathematics in their daily lives				
8. We use mathematics in Physical education				
9. We need some mathematical knowledge in some sports skills/activities				
10. Knowledge of mathematics can make me a better player				

PART II

From the ballgames listed, choose the game you play and list down any mathematical concepts applied in performing the physical education activities stated in the table: Soccer, volleyball, netball, basketball, handball and hockey.

<i>Physical Education Activity</i>	<i>Mathematical concepts</i>
1. Preparation of fields of play	
2. Throwing the ball	
3. Penalty kick	
4. Interception	
5. Stopping the game	
6. Goal keeping	
7. Ranking the performance	
8. Shooting	
9. Designing of balls	

APPENDIX C: TEACHERS' QUESTIONNAIRE

The purpose of this questionnaire is to find out the application of mathematical concepts in physical education in secondary schools.

Instructions

- i. There are no correct and wrong answers
- ii. The information you give concerning your view about mathematics and physical education will be confidential
- iii. Respond to all questions by putting a tick in the bracket corresponding to your answer or filling the blank spaces

Section A: General information about the Teacher

1. School.....
2. Male [] Female []
3. Teaching subjects (i).....
(ii).....
4. Teaching Experience 1-5 yrs [] 6-10yrs []
10yrs+ []
5. Professional qualifications: Graduate teacher []
Diploma []
Untrained teacher []
Others []

Section B**PART 1**

What is your opinion about the following statements?

Statements	Strongly agree	Agree	Disagree	Strongly disagree
1. Mathematics should remain compulsory in secondary school				
2. People who have not been to school know mathematics of some kind				
3. People who have not been to school use mathematics				
4. We use mathematics in our daily lives				
5. We use mathematics in physical education				
6. We need some mathematics in physical education				

PART II

Choose one of the ballgames below and list down any mathematical concepts applied in performing the physical education activities stated in the table; Soccer, Volleyball, netball, basketball, handball and hockey.

<i>Physical Education Activity</i>	<i>Mathematical concepts</i>
1.Preparation of fields of play	
2.Throwing the ball	
3.Penalty kick	
4. Interception	
5. Stopping the game	
6. Goal keeping	
7. Ranking the performance	
8. Shooting	
9. Designing of balls	

**APPENDIX D: INTERVIEW SCHEDULE FOR PHYSICAL EDUCATION
AND MATHEMATICS TEACHERS**

Ball game coached by the teacher.....

1. What are your teaching subjects?

.....
.....

2. Should mathematics remain compulsory in the secondary school curriculum?

.....
.....
.....
.....

3. Give your reason for question 2 above

.....
.....
.....
.....

4. Do you use mathematics in your daily life?

.....
.....
.....

5. What are some of the uses of mathematics in your daily life?

.....
.....
.....

6. Are mathematical concepts used in physical education?

.....
.....
.....

7. Which mathematical concepts guide you when teaching the following skills

i.)Mark the fields of play

.....
.....
.....

ii.)Throwing the ball to a partner

.....
.....
.....

iii.)Penalty kick

.....
.....
.....

iv.)Interception of the ball

.....
.....

8. Can you state instances when minimizing probability of interception is crucial?

.....
.....
.....

9. State instances when speed is required during play

.....
.....
.....
.....

10. Which criteria do you use to stop the game?

.....
.....

11. How do you rank your teams after competition?

.....
.....
.....
.....

12. Is mathematics important to you as a coach?

.....
.....
.....
.....
.....

13. Do you think all players require basic mathematics knowledge?

.....
.....
.....
.....

14. Give reasons for your answer in question 12 above

.....
.....
.....

15. Do you think knowledge of mathematics can make skill execution better?

.....
.....
.....

16. What is your opinion on linking areas where mathematical concepts are used in game to mathematics as a subject?

.....
.....
.....

17. What is your opinion on integrating basic mathematics to explain physical education activities in support of learning of mathematics?

.....
.....
.....

