UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF MATHEMATICS EDUCATION

USING EXCEL TO IMPROVE THE TEACHING AND LEARNING OF PROBABILITY IN COLLEGES OF EDUCATION: AN ACTION RESEARCH OF GBEWAA COLLEGE OF EDUCATION,

PUSIGA-BAWKU

ALI AYAREBILLAH CLEMENT

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B.ED. (MATHEMATICS EDUCATION)

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A DISSERTATION IN THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION. SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION (MATHEMATICS),

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DECLARATION

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The students of Gbewaa College of Education made me to feel like organizing another research in a different concept. The students were prepared to learn, especially the MS Excel programme. Even students who were not sampled showed ample zeal and interest to participate on non-scoring basis. The study students were happy and proud to be part and parcel of the remedial classes with me. I wish them success in their study and examinations.

DEDICATION

This project was dedicated to my loving wife, Anafo Phebe and my daughter, Atindana Chantelle.

ABSTRACT

Many students in our Colleges of Education have not been exposed to explore MS Excel in solving mathematical problems. The aim of this study was, therefore, set out to explore the various ways for teaching and learning Probability, using the MS Office Excel software programme. The study has explored how tutors and students can use MS Excel to solve problems in probability. The researcher integrated both qualitative (interviews and observation instruments) and quantitative methodologies (pretest and post test instruments) methodologies to obtain the research data. The sampling procedure was purposively targeted on students who performed abysmally low marks in Probability as depicted from the test results. Simple bar charts, pie charts and percentages were employed for the qualitative data and t-tests (Paired and independent) were used for the hypotheses set to answer the quantitative data. Thirty (30) most poorly performed students were selected for the study; 5 from each of the 6 classes. Simple programs in MS Excel such as random sampling, binomial sampling, one way tables and two way tables were taught. The results showed that the performance of the students in Probability did not depend on whether his/her former school was mixed or single-sex, he/she had former school had ICT training or not, he/she had experience in Excel or not, and one was a male or a female. That is, on the whole, the performance of each student had improved significantly after MS Excel was used. The conclusion was that, integration of any kind when considering the introduction of MS Excel software program in the teaching and learning of Probability did not hinder performance of the students. The study in particular, would help policy makers, especially, the Ghana Education Service (GES) to include Information Communication Technology (ICT) at all levels of education.

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CHAPTER 1

INTRODUCTION

1.1 Background to the Problem

Daily decision-making and discussion of social issues are increasingly influenced by statistics and projected outcomes based on probabilities (Lee, 1999; Asiedu-Addo, Ampiah & Awanta, 2004). However, calculations of probability problems are often tedious. It was therefore, untenable when the Mathematics curriculum for Colleges of Education was very silent on the use of any software to enhance computation of statistical data normally encountered during teaching and learning despite the fact that college tutors are required to integrate ICT across the curriculum. Also, ICT has even been introduced as a core course in the new education reforms for the Colleges of Education in Ghana. Of equal concern is the fact that students who always relied on simple scientific calculators to compute for statistical parameters got incorrect and inaccurate results. Worst still, these students cannot use any computer software programme such as MS Excel to compute for these results in Probability either.

This problem was minimize in 1979, when two university graduate business students, Dan Bricklin and Bob Frankston, decided that performing calculation with paper, pencil and adding machine was a complete waste of time. Instead of griping about the tedious work like other university graduate students, they decided to do something about it and wrote the world first spreadsheet program for their Apple II computer. They called this program VisiCalc. The idea behind VisiCalc was that, all you had to do was type in numbers, define how to calculate new results based on those numbers, and let the spreadsheet do the hard work of calculating multiple formulas while you do the easy work of just type in numbers (Wang & Parker., 1996). Even though the task of entering the numbers into a software program now cannot be as simple as described by Wang and Parker, the cardinal point still holds that a software program was needed, still needed, and will be needed, to do the long calculations in Probability and avoid rote memorization of mathematical formulas without understanding these formulas. The ability of Excel to use complex formulas on mathematical probability was thus eased by these brilliant university students.

1.2 Statement of the Problem

Most students in colleges of education usually use simple calculators to do computations in class. Some own personal computers (PCs) and yet, they could not perform operations with them. Most of them do not, however, use them to enter simple statistical data, let alone use them to compute Probability problems.

Statistics and Probability is a course in the first semester of the second year in Colleges of Education, alongside Introduction to Communication and Technology (ICT), and Research Methods, Measurement and Evaluation (Ghana Education Service, 2005). All these courses need a computer software program to ease teaching and learning. Why can't we seize these opportunities to integrate a software program like Microsoft Excel (MS) in the teaching of Probability, so that the students will get the link among these three courses and their applications in their everyday lives? Very few students can analyze their data, when presenting the final reports of their projects in the College. This suggests that students do not have requisite knowledge in any simple computer software to apply in mathematics, statistics, research and any other applicable area, since not much has been stressed on the use of any software program in the syllabus of statistics and probability.

Many challenges cropped up when the researcher, after introducing the concept of Probability, tried to use the simple calculator to do some calculations, whenever very long variable formulas were encountered. Some students failed to recognize that even simple computer programs like the scientific calculators could as easily be used to solve those problems. It was also observed, that students could quote formulas correctly but obtained inappropriate results when substituting and evaluating these problems, especially in probability. The researcher, who was also a tutor in ICT, discovered that the students had little knowledge on the use of software programs to estimate probabilities, apart from the little knowledge they have in using the scientific calculators for simple arithmetic operations in addition, subtraction, division and multiplication. Observation showed that the computers in the college's computer laboratory are mostly used to write only letters, play games and watch movies any time a student entered to practice alone.

The continuous assessment (CA) scores in the class exercises, tests and projects generally showed abysmally lower marks, including the brilliant students. Here again, the researcher's personal observation revealed that some of these students were beaten by time during the tests or quizzes, because they could not operate the scientific calculators they carried in and used in the classrooms. Some of them could not simply switch to statistics mode in their calculators but rather resorted to adding and multiplying the variables in turns, until over fifty numbers given were exhausted. The researcher described this as 'calculator illiteracy'.

1.3 Purpose of the Study

The purpose of this study was to identify the challenges students encounter in solving problems in probability, and explore how the MS Office Excel program can be used to solve these problems.

1.4 General Objectives of the Study

The aims are to:

- Develop the concepts of Random Sampling, using MS Excel.
- Use MS Office Excel stools to estimate probability problems.

1.5 Research Questions

1. Does a student's previous experience in MS Excel improve his/her performance in Probability?

    - 1a). Does a student's performance in probability depend on whether his/her former school was mixed-sex or single-sex?
    - 1b). Does a student's performance in probability depend on whether his/her former school had ICT centre or not?
    - 1c). Does a student's previous experience with MS Excel at his/her former school improve his/her performance in Probability?

2. To what extent does gender have in the use of MS Excel to improve one's performance in Probability?

3. To what extent does the use of MS Excel improve students' performance in Probability?

1.6 Significance of the Study

Researchers and statisticians work with samples, and try to deduce from the sample the population parameters such as means, proportions and standard deviations. Because samples are random, there is no guarantee that the sample selected will be representative of the population. The mechanism used to assess the quality of our inference is probability — the degree of uncertainty and reliability of sample inferences (Hawks, 1995). The real estimates obtained must be computed with an accurate and reliable software programs, such as MS Excel. This research will provide basic software program to compute and interpret sample parameters. This study therefore, bridges the gaps between statistical programming and its applications in probability and statistics for estimating the data needed and used by policy makers and stakeholders in education.

The study could also be useful to all other students and tutors in the Colleges of Education, who might want to learn basic computer programming in MS Excel.

1.7 Delimitations

The research was carried out in only Gbewaa College of Education for the second-year students, and hence cannot be generalized as true situation of all Colleges of Education in Ghana. The study population and sample size 30 students from a total of 208 are not large enough to represent all students in Ghana and Gbewaa College of Education.

1.8 Limitations

The following challenges had occurred, that may not make this report comprehensive and representative of all the thirty-eight Colleges of Education in Ghana in general, and all students of Gbewaa College of Education in particular.

- Level of performance, as described here, was limited to the concept of using MS Excel to estimate probabilities, hence cannot be generalized as the true performance of a student in the entire Statistics and Probability course.
- The closed response instruments such as 'yes or no', 'true or false', 'rating scales' and the 'multiple-choice questions' used as questionnaires coding here, may not offer good options that students felt were ideally matched to their own understanding. The limited detractors given in a question means that only the most common pattern of thinking was likely to be addressed and if possible, diagnosed by the researcher.
- A sample of 30 students, from a population of 209, from one college, means that the sample was not designed to be statistically representative of the population of all students from the college, and all colleges in Ghana.
- The data so obtained was self-reported. That is, students themselves were made the respondents to give these answers. Validity and reliability could have been affected.

1.9 Definitions of Terms

Hypothesis: A prediction of some sort, regarding the possible outcomes of a data

Null hypothesis: A prediction that there is no difference or no relationship between the variables

Alternative hypothesis: A prediction that difference exists between the variables

Level of significance: the probability of obtaining a value of the test statistic that is as likely or more likely to reject H_o as the actual observed value of the test statistic. It is computed assuming that H_o is true.

PC: an abbreviation for Personal Computer

Statistic: an estimate of a sample such as sample mean, sample variance and sample proportion

Parameter: an estimate of the population data such as mean, variance and proportion

Parametric: A statistic that obeys the rules of independent, normal and equal variance of an interval or ratio data. The opposite is nonparametric for nominal and ordinal data.

P-value: abbreviation for probability value. H_o is usually rejected if the p-value is less than the significance level at l5%.

T-statistic: A parametric statistic used to evaluate a dependent and independent variables.

No Statistical Significance: When the research findings are not due to chance/randomness alone but other factors. That is, when we accept Ho. The opposite is statistical significance when we reject Ho.

Validity: The degree to which a test /statistic measures what it supposed to measure

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

The aim of the study was to use MS Excel to solve problems in Probability. It was meant to assess the impacts of students' former school, previous knowledge in ICT and gender to determine whether these factors influence performance in Probability using MS Excel. The literature review here deals with the concepts of probability and MS Excel programme.

2.2 The Concepts of Probability

This section gives a brief history of Probability, Conditional Probability and some ways of defining the concept of Probability.

2.2.1 History of Probability

An Italian mathematician, Galileo threw three dices to predict whether the sum of the outcome at each throw would be more likely ten than nine. His prediction became inconclusive. A French mathematician, Chavelier de Mere entered into a similar bet as to how many sixes he would get in a sequence of four tosses of a die. His results agreed with that of Galileo. De Mere therefore threw this challenge to his two young students, Fermat (1601-1665) and Blaise Pascal (1623- 1662). De Mere research question was simply why he had only two sixes in a sequence of twenty-four (24) tosses of a die. While Fermat struggled to discover the concepts of 'randomness and uncertainty' of the tosses of the die, Pascal came out with the concept of 'probability' from the same tosses of the coin. Since then, the concept of probability has suffered much from different schools of thought. More difficult is the situation when these tosses are so large or even infinity, can we still evaluate the data without any machine such as a computer? We have not also been able to adequately present the true meaning of probability as coming from a very large data of an experiment and not mere single simple data. Moreover, situations where such computer programs are available, they may not meet the primary factors such as cost, convenience, access, knowledge and competence of the ordinary teachers and students. Probability demands a different type of mathematical necessity than the necessity resulting from actions on objects. It is the responsibility of mathematics tutors, and not a choice, to use MS Excel in our schools to teach Probability, and this is what this research seeks to achieve in the shortest time possible, in Probability in particular. Teachers of Mathematics must not forget that as ICT is a course for Colleges of Education and often, it is mathematics departments that are expected to demonstrate uses of excel (Stout, et al., 2000). .

2.2.2 Probability as Chance

The only thing in life that is certain is death. Probability is the mathematics of chance, and the terminology used in probability theory occurs many times in daily life (Das, 1989; Gordon & Gordon, 1994; Parks, et al., 1997). The concept of Probability stems from the fact, that human life and the environment within which the human being operates are unpredictable. We can consider the weather within the next ten minutes, and our health status within the next five minutes. We may only succeed in guessing for these and other more events that we cannot foretell their states in the very near future. These guises are either their likelihood or unlikelihood of their occurrence. Even life cannot be predicted! There are many innumerable happenings in nature and in the realm of human activity which are associated with uncertainties. For example, the rising of the sun and the sex of an unborn baby are uncertain. We only know that one day we will die but not the particular day, data, place and time. If we are not certain, do we actually need to know? The answer is yes. The human life depends on predictions of these events which allow us to make decisions.

2.2.3 Probability as Decision-Making

Decision-making is very vital in human life. The human being will always want to stay, and remain focused, and anxious to achieve innumerable set aims, since our dealing with life is limited by time. The commonest use of probability is significance testing. While it is useful to know the basic ideas of probability, many researchers carry out thorough and appropriate analyses of their data without using software other than a few basic notions about probability. Hence, the complexities of mathematical probability theory are of little bearing on the practice of statistical analysis of psychology and social sciences (Devore & Peck, 1997; Asiedu-Addo, Ampiah & Awanta, 2004; Cramer & Howitt, 2004). Therefore, we need a software program to be able to make such vital decisions.

2.2.4 Probability as Frequency

Probability tells us the relative frequency with which we expect an event to occur. That is, if we repeat an experiment over and over, the fraction of times the event occurs should be the probability of the event. Probability can be reported as a fraction, a decimal, or a percentage, but it must always be between zero and one. The greater the probability, the more likely the event is to occur or not to occur (Parks, et al., 1997). Probability, as a concept, deals with empirical numbers, which are 'rational' proper fractions.

There is certainly inconsistency in the best approach to adopt in tackling probability problems. However, the trial process must be random to avoid selection bias of some elements in the sample, and repeated severally to ensure stability and consistency of results. (Ferguson, 1981; Meserve et al., 1989; Cormen, et al., 1990; Gordon & Gordon, 1994; Devoire & Peck, 1997; Lee, 1999; Barnett, et al., 2000; Hoppe, 2000; Ott & Longnecker, 2001; Clarke & Cooke, 2004; Freeman, 2004).

2.2.5 Probability as Sample of Population

There are various methods of reporting probability events from the data — tables, charts and graphs. The most important part is how these figures are interpreted and utilized. Parks, et al., (1997) admit that, graphical and numerical descriptive techniques are presented as a means to summarize and describe a sample. We need to assess the degree of accuracy to which the sample mean, standard deviation and proportion represent the corresponding population values; since sample is not identical to the population from which it was selected. We must meet acceptable criterion to make some valid conclusions about the calculations done. Since the human being is not perfect and the data collected is just a guess of the real situation, we need to safeguard our predicted value by predicting the likelihood of occurrence of the data or the probability that the estimates actually come from the true situation we wish to estimate.

2.2.6 Probability as Equally Likely

Historically, the oldest way of measuring uncertainty is the classical concept of probability. It was developed originally in connection with games of chance, and it lends itself most readily to bridging the gap between possibilities and impossibilities. This concept applies only when all possible outcomes are equally likely. In the application of this rule, however, the terms 'favorable' and 'success' are used rather loosely—what is favorable to one player is unfavorable to his opponent, and what is a success from one point of view is a failure from another. Thus, these terms can be applied to any kind of outcome, even if favorable means that a house gets struck by lightning or success means that a person catches pneumonia. The subjective approach measures one's belief, concerning the uncertainties that are involved. Such probabilities apply especially when there is little or no direct evidence , so that there is really no choice but to consider collateral(indirect) information, 'educated guess', and perhaps intuition and other subjective favors (Freud & Perles, 1999; Haylock, 2001).

According to Haylock, what probability does tell us, however, is that in the long run, if you go on tossing the coin long enough, you will see the relative frequency of heads(or tails) gradually getting closer to 50%. It is therefore important for pupils to do such experiments on a large number of times, obtain the relative frequencies of the various outcomes for which they have determined the theoretical probability and observe and discuss the fact, that the two are not usually exactly the same. We cannot predict an experiment with equally likely, and we support and accept the relative approach of probability. Here, the data is collected by performing an experiment a large number of times (simulation), summarizing the data with MS Excel and interpreting the results. That is what probability is believed to be about.

2.3 The Concepts of Conditional Probability

Here, we will define the concept of Conditional Probability and how it is also interpreted.

2.3.1 Definition of Conditional Probability

Conditional probability shows how the original probability changes in light of new information (Devore & Peck, 1997). In the real life situations, an event cannot happen in isolation. Human beings depend on others for survival and many other means of supports. The probability of a happening should therefore depend on other happenings or non-happenings. For examples; the probability that a student passes an examination depends on whether the student has written the examination, and the probability that one wins an election depends on so many factors that must have taken place such as good campaign messages, finance support and personalities traits of the candidate in question. As noted by Devore & Peck, a change in any supporting factor(s) will definitely affect the probability in question. These auxiliary probabilities are the conditional probabilities of the given event. Sometimes we have some prior knowledge about the probability of an experiment. Conditional probability formalizes the notion of having prior partial knowledge of the outcome of an experiment. The conditional probability of A given that B has occured, is therefore the ratio of the probability of the event $A \cap B$ to the probability of event 'A' (Jenkins & Slack, 1988; Cormen, et al., 1990; Feiner, 2006). The prior probability need not be equal as and afore knowledge is important to the calculations of any probability in context.

2.3.2 Interpretation of Conditional Probability

In educational research, one needs to give as many factors as possible before attempting to define the probability of an event in order to make his or her assessment of a given situation significant. These factors must be significant in explaining the scenario. Significance is the likelihood that differences or relationships have been identified. The probability of small significance value means that the event is less likely to have occurred and the researcher can be more confident about the findings (Graybill et al., 1998; Freund & Perles, 1999; Joseph, 2004; Cramer & Howitt, 2004; Noffke, 2005; Feiner, 2006). Hence, it is misleading to report general probabilities of a particular event occurring if factors (conditions) which greatly change the likelihood are present. A probability can be substantially affected by consideration of the particular antecedent conditions applying. Probability of an event is not isolated. It is dependent on other probabilities.

The conditional probability of an event B is the probability that the event will occur given the knowledge that A has already occurred. In cases where the events A and B are independent (A/B) is simply the P(B). Although the symbols P(A/B) and P(B/A) may look very much alike, there is a great difference between the probabilities that they represent. A given B is the ratio of the objects in the intersection of A and B to the number of objects in B (Callan, 1998; Callan, 1998; Freund & Perles, 1999; Mason, 2006; Wikipedia, 2008).

2.4 MS Excel and Performance in Probability

We are going to consider the possible ways MS Excel software could be unfavourable to students, when used as a tool for teaching and learning Probability in Colleges of Education in Ghana.

2.4.1 MS Excel and former school with ICT

The mathematics curriculum is influenced by mainly professional organizations, textbooks, standardized achievement tests, and state governmental bodies (Spezzano, 1990). The kind of school, therefore, has nothing to do with one's prior knowledge in MS Excel when required to use it to compute data for probabilities. The computer is just a tool to ease teaching and learning. Also, spreadsheet is used in the classroom at all levels of education, whether it is for simple calculation and converting data into charts or for more detailed data analyses. The primary applications of spreadsheets are to deal with numerical data of varying forms (Shinn, 2003).

2.4.2 MS Excel and previous knowledge in ICT

Excel is a spreadsheet application that, lends itself to a wide range of other uses. Once you have set up the spreadsheet to receive the data, a form can be used to enter the data (Awanta & Asiedu-Addo, 2008, pp 40). Therefore, one does not need to carry knowledge learnt in a former senior high school to a College of Education to apply. The uses of Excel might have been different, and with its characteristics of simplicity, one can easily learn and apply it anytime, anywhere, anyhow. Hence, we do not expect students to gain previous knowledge in MS Excel at their former Schools before they use it to estimate problems in Probability.

2.4.3 MS Excel and gender

MS Excel is not gender-sensitive. The manner in which a male learns the software is the same way a female learns it. We cannot attribute the performance of students using MS Excel to their physical and biological body features. *Every spreadsheet program, including Excel 97, owes its existence to Dan and Bob and their VisiCalc program. So if you don't like Excel 97, now you know who to blame* (Wang & Parker, 1996, pp 128).

2.4.4 MS Excel and Experience

Mooney et al., 2003 enumerates the factors of learning mathematics to be the age of children, the ability of children, time for the concept, and complexity of the concept. Even though experience correlates with age, experience is not the factor that can influence learning of MS Excel. Therefore, experience alone, is not so much a strong factor to influence the performance of Probability using MS Excel. It needs constant practice.

2.5 MS Excel and Probability Curriculum

The books prescribed for the new syllabus for Colleges of Education have not made mention of any simple computer program like Excel, to help do the calculations, to say the least. What the entire tutors and students still do is to quote and prove very long formulas in probability, substitute the values of the parameters of the given problem and evaluate for the results. (Amissah, 1992; Martin, 1994; Solomon, 2002; GES; 2005). Goldstein (1994) acknowledged that the fundamental connection between mathematics and IT is very important. Some notable teachers and authors appreciate that computers can enhance many areas of the curriculum and that they can change the teaching methodologies used across the schools (Fosnot, 1990; Spezzano, 1990; Dontwi & Owusu-Ansah 2001; Smith et al., 2001; Tsivigu, 2001; Prairie, 2005). That means the computer has something precious to back the teaching and learning of Probability in our colleges and MS Excel is the most appropriate application software to introduce and maintain for teaching and learning.. It is therefore, important that we add a simple software like Excel program to the mathematics syllabus especially, the Probability aspects. We believe that it is more important for students to know how to arrive at logical certainty than statistical likelihood we witness without good software (Feia, 2007; Lee, 2007).

Recent theories and pedagogies do not support the facts underground. Even though teachers have a varying skills and confidence in the use of computers for teaching and learning but this is being addressed through courses for qualified teachers and within ICT. Computers can be used for whole class teaching as well as for group and individual work (Mooney et al., 2002; GES, 2005). This limited knowledge explains partly the abysmal and low knowledge of students in the software programs for probability.

2.6 MS Excel and Other Computer Software Programs

There are many statistical software programs such as Minitab, S-plus, SAS, Stat, Matlab and Genstat, to mention but a few. However, some of these are relatively complex to apply in exploring Probability. They are case-sensitive and challenging steps to follow and understand. Most statistical software can read data from the major spreadsheets programs. Also, Spreadsheets are commonly used to enter and transmit data. That is not all. Minitab, S-plus, Matlab, SPSS and SAS have MS Excel tool option in their menu bar or programme embedded (Green, 1994; Moore & McCabe, 1999; Feia, 2007).

2.7 MS Excel Environment

We will look at the merits of using MS Excel, the mathematical operators of Excel and perceptions of Excel.

2.7.1 Advantages of Using MS Excel

The major reasons why Excel should be preferred to other statistical software as follows:

- *Excel comes with Microsoft office suite so that any computer that has office* *installed has an Excel program also installed* (Asiedu-Addo, Ampiah & Awanta, 2004, pp 42).

- *Excel is relatively user-friendly programme as compared to other data analysis software such as SPSS,Minitab, and SAS* (Asiedu-Addo, Ampiah & Awanta, 2004, pp 42).
- *MS Excel is an excellent tool for producing high quality graphs and charts* (Awanta & Asiedu-Addo, 2008, pp 99).
- *Excel also has an excellent statistical summary function. You will find this in the data analysis option in the Tools menu. This feature is an Add-in and may not be installed on your computer. However, you can use the Add-in command to install this toolkit* (Awanta & Asiedu-Addo, 2008, pp 117).

These merits are very succinct, and indicate that Excel program is easily obtainable as soon as Microsoft Office suite is installed into your PC. Access to MS Excel, cost of obtaining Excel, quality of output, and the practice of Excel are simple, easier, and cheaper for colleges of education to adopt. There can be no further reasons than these that MS Excel software programmes cannot be integrated in the teaching and learning of probability in Colleges of Education, more especially when ICT is now taught as core course in the colleges (GES, 2005).

2.7.2 The Operators in MS Excel

According to Abbot and Well (2001), to have your computer solve certain problems, you need only one instruction, the PRINT command. They contend that computers follow the same rules for the order of operation as you do in basic arithmetic. That is; addition (+), Subtraction (-), multiplication (*), division (/), and exponentiation (^). Excel however, as mentioned earlier, follows a rigid arithmetic protocol than do the other types of computer programs. Division and multiplication are executed simultaneously, depending on which operator comes first, before addition and subtraction, with the same rule. Exponentiation precedes all of them in Excel program. All that we need to do is to play with arithmetic sign and then instruct 'PRINT', and it is done for us. The understanding and use of these basic arithmetic operations are prelude to using Excel in teaching Probability. Hence, very easy to Excel in calculation of Probability .We must note here that some computers such as calculators and mobile phones may not follow this protocol as Excel does. So, Excel is recommended for use.

2.7.3 Misconceptions of MS Excel

The following are some unfortunate misconceptions about MS Excel:

- That in the olden days, accountants wrote long columns of numbers on sheets of green ledger paper divided by lines to make entering and organizing information in net rows and columns easy. Essentially, a computer spreadsheet is just the electronic equivalent of green ledger paper (Wang & Parker 1990; O'Leary & O'Leary, 1994; Oldknow & Taylor, 2003).

- That the Excel worksheet is just like a piece of paper- a very large piece of paper. With 256 columns and 16384 rows, it contains about 4,000,000 characters (Skinner & Skinner, 1991).

- That as students become more familiar with computers, the size of a set of data can be organized more conveniently by computer, rather than by hand, becomes smaller and smaller. Yet, there is still a place for paper and pencil analysis. Manipulating the data on a computer is more impersonal; odd, and therefore important items can be missed (Clarke & Cooke, 2004).

2.7.4 Conceptions of Excel

MS Excel, like any of the spreadsheet tools, must be preferred to the other statistical programs because:

- Its versatility, convenience and reliability make it attractive alternative to specialized statistical software. No prior knowledge of the program is necessary to use. Because Excel is part of an integrated word processing/graphical/database package, data can be easily input from other applications and exported into report form (Hoppe, 2000).
- The power of the spreadsheet is clear. When you change a value, watch all the other values changes (Microsoft Works, 1990).
- You could stay up all night, adding rows and columns of numbers together by using paper and a pocket calculator, but you may as well use MS Office 97 instead (especially because you already paid for it when you bought office 97). Just tell Excel 97 what you want it to calculate, and feed it one or more numbers, within seconds, the program can display the results, besides addition, subtraction and multiplication, Excel 97 also lets you create more complicated calculations (Wang & Parker, 1996).
- Spreadsheet programs allow you to automate what you used to do with paper, pencil and, calculator. They create in memory enormous thousand horizontal rows

and hundreds of vertical columns – a very small portion of which you will be able to see on screen at any one time (Yasuda & Frederick, 1991).

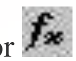
- Spreadsheet is used in the classroom at all levels of education, whether it is for simple calculation or converting data into a chart or for more serious data analysis. The primary applications of spreadsheets are to deal with numerical data such as keeping track of data, data analysis, problem-solving, teaching concepts, keeping students' information planning and record keeping (Shinn, 2003).

- Works spreadsheet functions something like a combination of word processor calculator, with tools for both recording information and calculating data. For this reason, Works spreadsheet is a great tool for organizing and storing all kinds of information (Microsoft Suite, 2000).

- That mimicking the rolling of a die by generating a sequence of digits on a computer is a very simple experiment of the simulation of a physical process. To roll the die hundred of times would be very laborious and time-consuming; to simulate it hundreds or even thousands of times on a computer is quick and easy. Simulation of this sort allow deeper insight into probability theory and, in many cases it is only by using a computer that sufficient repetitions can be made to be more informative (Oldknow & Taylor, 2003; Clarke & Cooke, 2004).

2.8 The MS Excel Window

Bessant (2005) outlines how the spreadsheet contents are organized into text entries, numeric data, and formulae to aid computation in Probability. The main parts of MS Excel window are, from top to down, toolbars, name box / formula bar, top worksheet, sheet selector and status bar (see appendix A). There are three most important parts of the Excel program workbook—columns, rows and cells Green (1994). Cells are the most important parts of Excel workbook, since they contain the four basic features of Excel, namely;

- Numbers; 1, 2 3…
- Texts/Labels; A, B, C…
- Formulas; =A2+B2+C2+….
- Functions e.g. =sum(), =average(), =mode(),…or 

The actual calculations in Excel, however, involve formulas and functions.

2.8.1 MS Excel Formula

A Formula is a calculation performed to determine a value in a specific cell of your Excel worksheet. Three types of formulas can be entered in a worksheet: numeric (=B5+C5-D5*E5), text (=SUM(B5:E5)) and logical (IF(B5>=E5)). To enter a numeric formula, the following arithmetic operators are used: addition (+), subtraction (-), multiplication, division (/) and exponentiation (^). Thus, formulas are a sequences of values (numbers), cell reference (B5, C5, D4), and operators (+,-, *, r ^) that are manipulated to produce a new value. In Excel, a formula always starts with an equal to sign (=), and indeed all formulas start with the equals (=) sign. Examples of Excel Formulas are as follows:

=A2 + A3 (addition)

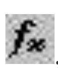
=A1 * A4 (multiplication)

=A2 - A3 (subtraction)

=A1 / A4 (division). (O'Leary & O'Leary, 1994; Wischhusen, Snell & Scales, 2000; Sebok, 2001; Mead, 2006). See appendix B2 for some common MS Excel formulas.

2.8.2 MS Excel Functions

A Function is a predefined formula; one that already exists (e.g., sum, average, count, min, max) for you to use on your data. Functions are pre-defined formulas that perform special or advanced calculations. Each function requires a function name and at least one argument: =function name (argument), for example, =SUM (A2:B2). You can type the function such as SUM (), AVERAGE () and COUNT () directly into the formula bar. Arguments, which appear in parentheses, can consist of numbers, cell references, ranges or text. Use commas when there is more than one argument in a function. That is, on a large business spreadsheet, you might need to add a huge number of contents, and specifying each cell reference as in Excel formulas would not be practicable. This is a quick way to deal with figures by using one of Excel's the built-in functions.

Alternative, there is also a function icon  on the toolbar, with statistical buttons, which offers assistance and useful prompts when entering a function into a spreadsheet cell. Thus, press , select 'most recently used' option, click on 'statistical', click on 'average', or 'sum' or 'BINOMDIST', etc, and complete table of commands, click on 'OK' (O'Leary & O'Leary, 1994; Cameron, 1999; Moore & McCabe, 1999; Microsoft, 2000; Sebok, 2001; Bessant, 2003; Shinn, 2003; Wittwer, 2004; McRitchie, 2006). See appendix B1 for some MS Excel common functions.

2.8.3 MS Excel and Probability Sample Simulation

How a sample is selected from a population and how probabilities are computed are of vital importance in statistical inference because the probability of an observed sample will be used to infer the characteristics of the sampled population. We can think of sampling as an experiment consisting of drawing n elements from a population of N elements, with each different sample representing a sample point of the experiment. To roll the die hundreds of times to obtain samples would be laborious and time-consuming; to simulate it thousands of times on a computer is quick and easy (Devore & Peck, 1997; McClave & Sincich, 2000). Simulation allows deeper insight into probability theory and, in many cases; it is only by using the computer that sufficient repetitions can be made. This simply allows us to sample data using binomial, Poisson, normal and many other probability distributions. Some commands for simulations using MS Excel are: =Random (n), for random number of samples; =BINOMDIST (k, n, p, false), for binomial probability samples; =TINV (2*α, df) for t-distribution probability samples; =NORMDIST (x, μ, σ, false), for normal distribution samples; and =2*(1-NORMDIST(ABS(z)), for sample statistic of the p-value (Hoppe, 2000; Bessant, 2003; Asiedu-Addo, Ampiah & Awanta, 2008). *Throw away your adding machine, pocket calculator, and realms of green ledger paper. You won't need any antiquated tools with Microsoft Excel 97 on your computer. With Microsoft Excel 97, you can create budgets, track inventories, calculate future profits (or losses), and create bar, line, and pie charts so you can see what numbers are really trying to tell you* (Wang & Parker, 1996, pp126).

2.9 Summary of Literature Findings

- The concept of Probability is best described by practical repetitions of an experiment (simulation). This usually generates a very large data that may be challenging for one to use paper and pen or the ordinary scientific calculator to evaluate. This requires a software program such as MS Excel is required to accomplish.
- MS Excel is always attached to every grade of the MS office applications. Excel is therefore easy, cheaper and more reliable as compared to the other statistical software programs.
- There is no discrimination with the use of MS Excel to teach and/or learn Probability. It does not matter whether one is a male or a female, one had previous knowledge in ICT or not, one had learnt MS Excel somewhere or not, or, one former school was a mixed-sex or a single-sex.

CHAPTER 3

METHODOLOGY

This study was set out to explore whether a student's previous experience in MS Excel can improve his/her performance in Probability, to explore to what extent does gender have in the use of MS Excel to improve one's performance in Probability, and to explore to what extent does the use of MS Excel generally improve students' performance in Probability. The subdivisions of this chapter include the research design, the target population, the sample and scoring instruments. The others are the way(s) to assess reliability and validity of data, the data collection procedures and the analyses or interpretations of results. The rest are intervention strategies; the materials and methods used to help minimize the anomaly students faced in the understanding Probability.

3.1 Research Design

The design is principally action research. The researcher taught Probability to about 220 students but 30 students scored abysmally very low marks, judging from the performance of students from the tests and assignments given. It was therefore imperative on the researcher to provide remedial tutorials, using MS Excel as an appropriate intervention tool.

The researcher thoroughly went through a cycle of processes to achieve a successful research report in action research. These include identification of the problem, researching on it, suggesting some actions, evaluating the results, and revisiting the same problem. These are popularly termed Problem-Pretest-Intervention scheme- Post test cycle. The problem of the division between theory and practice was thus, catered for after successfully completing the cycle (Quartey et al., 2002; Noffke, 2005; Awanta & Asiedu-Addo). This type of design gave the researcher many opportunities to revisit always the previous state of the problem as a prelude to the subsequent state(s). Uniformity and consistency of the process were well assured. This report was thus coherent. The researcher must however, concede that the time spent, money, and energy used were inadequate for this kind of design. It is simply too demanding to fully undertake action research of this nature.

3.2 Population

The target population for the research was 208 second-year students of Gbewaa College of Education in the 2008/2009 academic year. This group of students does Statistics and Probability in the first semester of the College. The population is made of 162 men and 46 women. The students were put into 6 classes; an average of 35 students per class, with at least, 7 women in each class.

3.3 Sample

Thirty students were used for the study; 18 men and 12 women. 5 students were selected from each class; 3 men and 2 women. The selection procedures were purposive due to the fact that only students who scored below average in each of the 6 classes were sampled for this study. That is, the researcher decided to select 5 worst performed students from each class, based on the pretest results from the previous tests and assignments. That is, 3 and 2 worst performed men and women respectively, from each class. This was to ensure that the performance of each class as well as each sex group, background in ICT, background in MS Excel and the kind of former school were included in the research. This helped the researcher to redesign the intervention strategies to suit necessary categories of the students in the college. It also helped the researcher to answer questions with regards to whether students should be grouped into gender or not; should have previous knowledge or not, and should have previous knowledge in MS Excel or not. And, once the students come from different senior high schools in Ghana and ICT is also taught in their previous schools, knowledge is required of the kind(s) of software used there for Mathematics, if any, so as to help the researcher adjust to the previous knowledge of the students.

3.4 Instruments

Action research incorporates both quantitative and qualitative methodologies. Therefore, both methodologies were used concurrently but independently. However, the qualitative methods dominated the quantitative ones (Quartey et al., 2002; Darlington, & Scott, 2007; Awanta & Asiedu-Addo , 2008). Quantitative methods of questionnaire was used to explore the use of MS Excel for the teaching and learning of Probability in the Colleges of Education, pretest was used to diagnose students problems in Probability, and post test was used to evaluate the effectiveness and efficiency of MS Excel to improving the teaching and learning of Probability in our Colleges of Education in Ghana relative to the pretest. The scores of the tests (Pretest and Post Test) were recorded out of 100 for each studied student.

Observation and interviews were used for the qualitative data obtained. The responses for the interviews were put into categories as yes/no, true/false, or multiple-choice ratings. In all yes/no or true/false responses were designated yes/true 1 and 0 for no/false, where applicable. With the rating scales, the best or highly valued response was coded with the highest numerical value in the category, ranging from 5 to 0.

3.5 Validity and Reliability

The quantitative and qualitative questions were made simple, unambiguous, varied and straight to the points desired for this research work. These ensured that the relevant information as well as the concepts of probability was explicitly and adequately covered. It also ensured that the required information was obtained within the period, under the same conditions of all the students to solve the problem (Tryfos, 1996; Quartey et al., 2002; Awanta & Asiedu-Addo, 2008). The intervention exercise was observed and supervised by the Assessment Officer, the Vice Principal Academic and the ICT coordinator. Validity of the research instruments were thus taken good care of. To ensure reliability of the instruments, the researcher administered the same questions and intervention strategies to all the study students in a number of times (at least 2) to ensure consistency of responses and scores from the same sampled students under this study were correlated. A reliability coefficient of 0.8 was projected and achieved.

3.6 Data Collection

The validated instruments were used to obtain responses from the students about their knowledge or otherwise in Probability and use of MS Excel software. There were 15 qualitative questions on the research topic given to the students to answer. Based on these responses obtained, the researcher established a strong point that lead to using MS Excel as a real and appropriate intervention tool to explain thoroughly the various concepts in Probability. After the interview, the researcher taught the topic using MS Excel, administered content-based questions in Probability to the students, and then guided each student to use the MS Excel to obtain his/her results. The scores of the students after the interventions were compared relative to the pretest, to assess the current state of the students' knowledge in Probability, using the MS Excel. This took the researcher 2 weeks to collect and collate the data from the sampled students.

3.7 Data Analysis

There were two main scales of measurements- descriptive and inferential. The descriptive scales were subdivided into (i). Quantitative (histogram, frequency and cumulative) and (ii).Qualitative (bar and pie charts). The inferential scales were also divided into parametric and nonparametric. The parametric scales are: (i).Quantitative (t-test, t-test paired test and ANOVA) and (ii). Qualitative (chi-square). Both of them were useful in analyzing a data (Hamilton, 1990; Turkman, 1994; Tryfos, 1996; Tsivigu, 2001; Darlington & Scott, 2007; Awanta & Asiedu-Addo, 2008). Therefore, the instruments of data analyses were blended to cater for some of these characteristics. Thus, the researcher used bar charts, pie charts and percentages for the qualitative data. On the inferential scales (quantitative data from pretest and post test), the researcher used t-test paired data for all independent data (males versus females, mixed-sex versus single-sex schools, former schools with and without ICT centres, and women from mixed-sex and single-sex schools) and t-test paired data for all hypotheses requiring pretest and posttest data of the real scores. No nonparametric scales were used, since the researcher did not rank the data.

3.8 Testing of Hypotheses

The researcher tested the research questions for the quantitative data as follows:

1(a).Null hypothesis (H_o): All the students have the same MS Excel knowledge, same experience in ICT, come from same sex former schools, or same performance of males and females in using MS Excel to calculate Probability.

1(b).Alternative hypothesis (H_a): At least, one student was different from a category in calculating Probability using MS Excel.

2(a).Null hypothesis (H_o): Generally, the scores of the pretest and post test are the same.

2(b).Alternative hypothesis (H_a): At least, one student performed significantly different in the post test from each category.

- Significance level (α): 5%
- Test statistics: independent t-test, paired t-test, p-value, mean, standard deviation.
- Rejection criteria: We will reject H_o whenever a t-test statistic is greater than the significance level of 5%, otherwise we will not reject H_o.

3.9 MS Excel Intervention Strategies for Sampling

The steps of the intervention strategies, using the MS Excel software are as follows. These include the concepts of sampling, binomial processes, and calculations of probabilities.

3.9.1 Independent Random Sampling

For example, to sample a size of 30 from a set five {1, 2, 3, 4, 5}

- Type A1 as Class and B1 as Students
- Enter the values 1,2,3,4,5 in A2 to A6
- On Menu Bar: Tools-Data Analysis-Sampling-OK
- On Dialog Box: $AS2:$A$6-Sampling-Random-Number of samples(30)-Output(B2)

- OK

3.9.2 Binary Random Samples

For example, to sample Males (1) and Females (2)

- Type A1 as Males and A2 as Females
- On B4: TYPE, =INT(2*RAND())-FILL to B30 to obtain 1,2,1,2,1,2,…….
- On Menu Bar: Tools-Data Analysis-Random Number Generation
- On Dialog Box: Select Number of Variables(30), Number of Random Numbers(30), Distribution(Bernoulli), P-Value(0.05), Output(C2)
- OK

3.9.3 Binomial Probability Estimates

- TYPE: =BINOMDIST(k,n,p,false)
- ENTER from keyboard

3.10 MS Excel Intervention Strategies for Estimating the Concepts of Probability

The estimations are probabilities of rows, rows and columns, and cells.

3.10.1 One Row Probabilities

- TYPE Names in Columns of the Six Classes
- In each class, TYPE the marks of the students
- Obtain Columns Totals for each class, For Class 'A': =SUM (B2:B6), FILL horizontally to cover Class F i.e. =SUM (G2:G6). All Totals put in column 7 of each class.
- Obtain GRAND TOTAL: =A7+B7+C7+D7+E7+F7 or =SUM(B7:G7), and PRESS Enter

- Obtain Probability for each Class: For Class 'A'; =A7/GRAND TOTAL FOR SIX CLASSES

3.10.2 Rows and Columns Probabilities

- Obtain 6x 2 of Male and Female for Rows and the Six Classes for Columns as above
- Find the Classes Sums, for Class 'A' as: =SUM(B2:C2), ENTER and FILL to Class F i.e. =B7:C7
- Find the Sex Sums, for Male as: =SUM (B2:B7), For Female as; =SUM(C2:C7) and ENTER.

3.10.3 Probability for Each Cell (Conditional Probabilities)

- Obtain the 6x2 Table as above
- Find both Rows and Columns Totals as above
- Copy the Table to another location ie from A4 to A13
- In CELL B14; ENTER =B5/GRAND TOTAL(71), and PRESS Enter
- FILL all CELLS vertically and horizontally for probabilities of each CELL.
- The Conditional Probability a Male from Class 'A' is Male Total to Grand Total. That is; ((male total/ Class 'A' total)/(male total/Grand Total)).

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter presents the analysis and the discussions. The researcher analyzed the results from bar charts, pie charts and percentages for the qualitative data. However, results from tests of hypotheses were used for the quantitative data (pretest and post test). That is, statistical hypotheses have been set to compare the performance of students' scores before and after the intervention. The only comparison used here was the t-test; both independent and matched paired-data. The t-test compared the pretest and post test scores of males and females, mixed-sex and single-sex former schools completed, ladies from mixed-sex and single-sex former schools and former schools with and without ICT tuition. The matched paired-data t-test compared males scores, females scores, mixed-sex scores, single-sex scores, ladies from mixed-sex schools, ladies from single-sex schools, former schools with ICT teaching, and former schools without ICT teaching.

4.2 Analyses of Qualitative Data Findings

These were made up of bar charts, pie charts and tables to answer their respective questions. Analyses have been given to each of these graphs.

Question 1: What computer software are you taught in College?

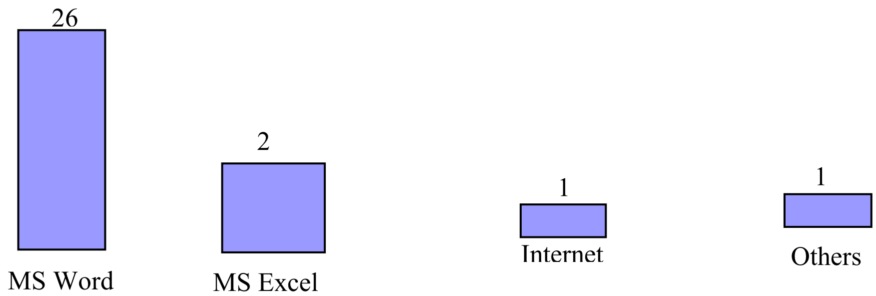


Figure 4.1 Concepts of ICT Taught

The bar chart in table 4.1 shows the computer programmes taught to students in the college. Majority learnt MS Word. Out of 30 students under this study, 26 of them confirmed that they are mostly taught with MS Word and 2 only have been taught with MS Excel. The researcher's observation here showed that this was due to the inability of most students to learn on their own to discover more about MS Excel or most students use the available computers to write letters mostly, or they might have not been taught MS Excel at all.

Question 2: What computer software do you learn most?

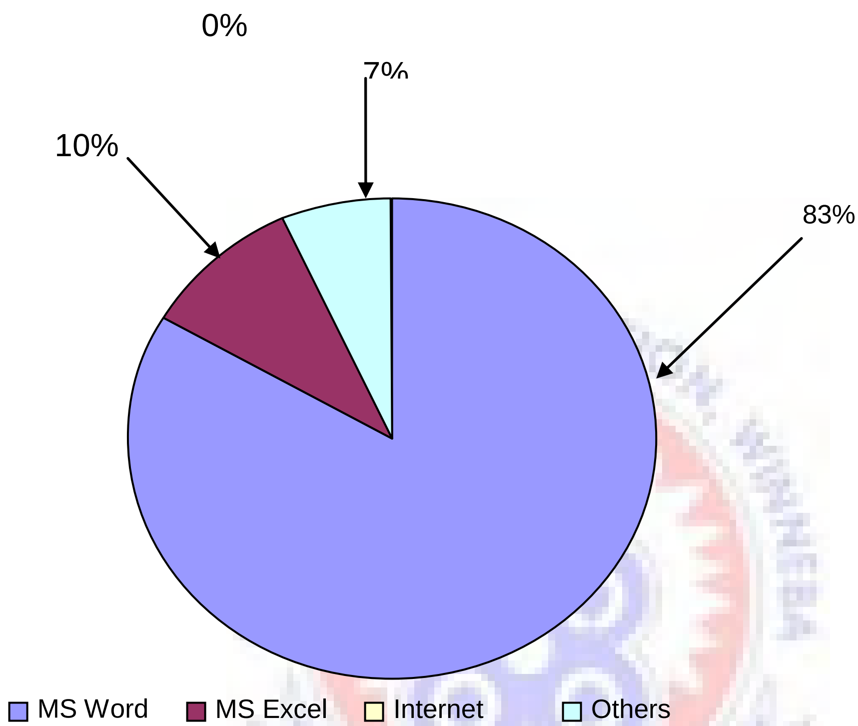


Figure 4.2 A Pie Chart of Programs Students Learn Lost

The pie chart in table 4.2.2 showed the programs college students are supposed to learn in a year. Clearly, most students (83% of them) learned only MS Word and 10% only learned MS Excel. This actually confirmed that students do not go to the computer laboratory to practice to discover more about other programs such as MS Excel, or they simply learn what have been taught by tutors. No student (0%) learned internet browsing and only 7% of them mentioned other concepts such as typing that they learned anytime they went to the computer laboratory to study on their own.

Question 3: Have ever learnt MS Excel at your previous school?

Table 4.1 Knowledge of MS Excel in Probability

Response	Yes	No	Don't know	Total
Number of students	5	16	9	30
Percentage (%)	17	53	30	100

Table 4.1 showed the number of students who had previous knowledge in MS Excel. It was realized that 53% (16 out of 30) of the students had no knowledge in MS Excel at all as against 17% who had knowledge in MS Excel. 30 % of the students did not even know that there is a software called MS Excel, let alone use to compute probability. This could mean that they are not either taught MS Excel or no awareness of the importance of this software have been created, especially in Probability.

Question 4: What instrument do you often to estimate probability problems?

Table 4.2 Instrument Used Mainly for Calculating Probabilities

Instrument	Calculator	Texas instrument	Others	Not applicable	Total
Responses	26	0	0	4	30

Table 4.2 showed the instruments (computers) students used to estimate Probability in class. Out of the 30 students, an overwhelming number of 26 of them used scientific calculators to compute probability. None of them have ever used the Texas instrument or any instrument at all. 4 of the students could not mention any instrument, not even the calculator did they seem to have used it before. Other inappropriate (not applicable) tools the students mentioned were word pad, note pad, statistical tables, and mobile phones. But

these instruments are either not computational instruments or not allowed for classroom practices.

Question 5: Which topic in Probability is most difficult to you?

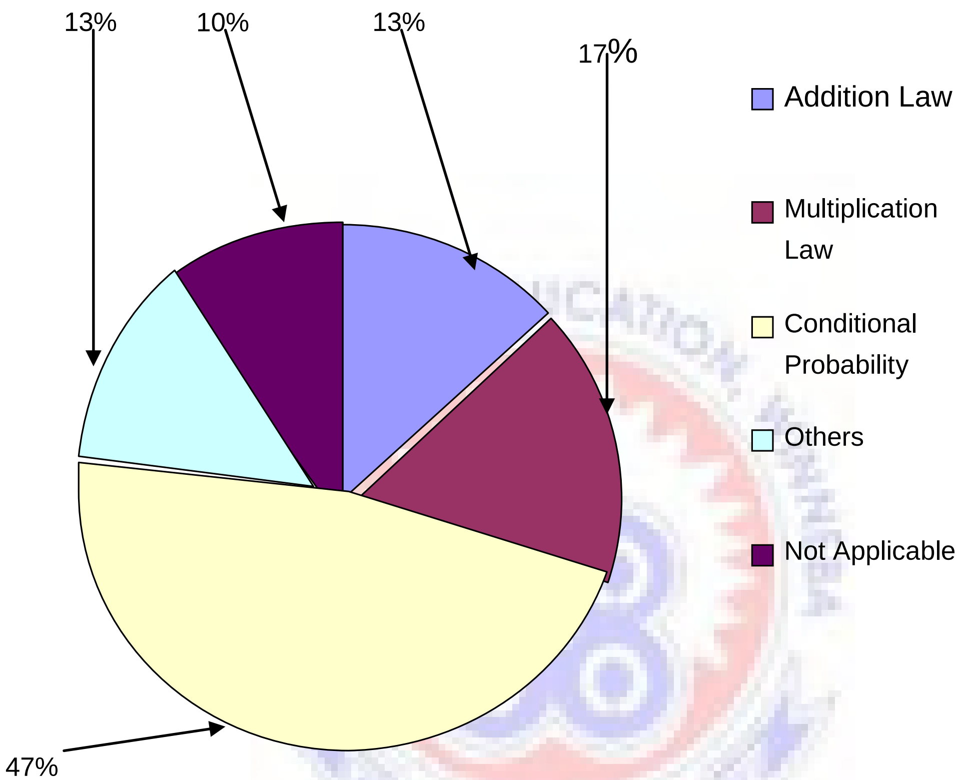


Figure 4.3 Pie Chart of Most Challenging Concepts

The pie chart in the figure 4.3 showed some challenging topics in Probability to students in the College. It is clear from the pie chart that Conditional probability was the most challenging topic to the students, followed by multiplication law, broader concept for which conditional probability is a subtopic. Addition law and other concepts shared the same weight of 13% each. Students who had no idea about the question accounted for

10%. The researcher's observation showed that they simply had challenges in all the concepts in Probability.

Question 6: Had your former senior high school got an ICT center?

Table 4.3 Former Schools with ICT Centres

Status	With ICT	Without ICT	Total
Number of students	22	8	30
Percentage (%)	73	27	100

Table 4.3 showed students' former senior high schools with or without ICT training. An overwhelming percentage of 73 of the students came from previous schools with ICT centres and only 27% came from former schools without ICT centres. It is interesting to note that even though majority had such experience, they did not have much knowledge in MS Excel at their former schools.

4.3 Analyses of Post Intervention Results by Hypotheses

This part is divided into t-Test paired and t-Test independent data. There are many variables that have been computed for. However, the analyses considered the mean, the t-statistic and p-value to determine the performance of the students.

Hypothesis 1. H_0: The pretest and post test scores of males are the same

Table 4.4: t-Test: Paired Two Sample for Means for Males

	Post test	pretest
Mean	54.44	36.11
Variance	26.14	36.93
Observations	18	18
Pearson Correlation	0.26	
Hypothesized Mean Difference	0	
df	17	
t Stat	11.34	
P(T<=t) one-tail	1.19E-09	
t Critical one-tail	1.74	
P(T<=t) two-tail	2.38E-09	
t Critical two-tail	2.11	

Table 4.4 showed paired t-test means for pretest and post test scores of only males. Here, the null hypothesis was rejected for the pretest and posttest performance were the same. The posttest mean of 54 is greater than the pretest mean of 36 and t-statistic of 11.34 is greater than the significance level of 0.05. Therefore, the male students performed better after the intervention, using MS Excel to learn Probability.

Hypothesis 2. H_0: The pretest and post test scores of females were the same.

Table 4.5: t-Test: Paired Two Sample for Means for Females

	Post test	pretest
Mean	36.25	19.17
Variance	50.57	21.97
Observations	12	12
Pearson Correlation	0.307	
Hypothesized Mean Difference	0	
df	11	
t Stat	8.20	
P(T<=t) one-tail	2.58E-06	
t Critical one-tail	1.80	
P(T<=t) two-tail	5.161E-06	
t Critical two-tail	2.201	

Table 4.5 showed paired t-test means for pretest and post test scores of only females. The null hypothesis was rejected since the pretest and posttest values are not the same. The posttest mean of 36 is greater than the pretest mean of 19 and t-statistic of 8.20 is greater at the significance level of 0.05. Thus, the female students performed better too after the intervention. However, scores of the post test were widely dispersed as compared to the pretest scores. Thus, while some female students improved significantly, other female students did not improve much. Some other reasons that might have caused these disparities such as the type of their former schools and previous knowledge of ICT were examined.

Hypothesis 3. H_0: The pretest and post test of students who came from mixed schools were the same

Table 4.6: t-Test: Paired Two Sample for Means for Mixed-Sex Schools

	Post test	pretest
Mean	48.27	30.38
Variance	115.88	103.85
Observations	26	26
Pearson Correlation	0.80	
Hypothesized Mean Difference	0	
df	25	
t Stat	13.69	
P(T<=t) one-tail	2.014E-13	
t Critical one-tail	1.708	
P(T<=t) two-tail	4.028E-13	
t Critical two-tail	2.060	

Table 4.6 showed paired t-test means for pretest and post test scores of only mixed-sex former schools. Based on this findings, the null hypothesis was rejected since the pretest and posttest values were different. The posttest mean of 48 was greater than the pretest mean of 30 and the t-statistic of 14 greater than the significance level of 0.05.

Undoubtedly, we would conclude that there was an improvement after the intervention, with a slight wider variation in the scores. This meant the wide variation of the scores of female students did not come from mixed-sex schools. It may have come from other sources such as single-sex schools or background in ICT of students.

Hypothesis 4. H_0: Pretest and post test of students who came from single-sex schools were the same.

Table 4.7: t-Test: Paired Two Sample for Means for Single-Sex Schools

	Post test	Pretest
Mean	41.25	22.50
Variance	122.92	41.67
Observations	4	4
Pearson Correlation	0.77	
Hypothesized Mean Difference	0	
df	3	
t Stat	5	
P(T<=t) one-tail	0.0077	
t Critical one-tail	2.35	
P(T<=t) two-tail	0.015	
t Critical two-tail	3.18	

Table 4.7 showed paired t-test means for pretest and post test scores of only single-sex former schools. The null hypothesis was rejected since the pretest and posttest values are different. The posttest mean of 41 is greater than the pretest mean of 23 and the t-statistic of 5 greater than the significance level of 0.05. Therefore, students from single-sex former schools also improved after the intervention. However, the variations in post test scores were too large. This means, the scores were not uniform in single-sex schools as did in the mixed-sex schools. The variations of female students' scores came from single-sex schools. We looked at scores from ladies of mixed-sex and single-sex to affirm whether there were wide variations in female students' scores.

Hypothesis 5. H_0: Pretest and post test scores of women who came from mixed-sex schools were the same.

Table 4.8: t-Test Paired Two Samples for Means for Women from Mixed-Sex Former Schools

	Post test	Pretest
Mean	36.11	18.33
Variance	54.86	12.50
Observations	9	9
Pearson Correlation	-0.040	
Hypothesized Mean Difference	0	
df	8	
t Stat	6.4	
P(T<=t) one-tail	0.000105	
t Critical one-tail	1.86	
P(T<=t) two-tail	0.000209	
t Critical two-tail	2.306	

Table 4.8 showed paired t-test means for pretest and post test scores of only women from mixed-sex former schools. The performance of these female students after the intervention had improved more than double! Unarguably, the null hypothesis was rejected since there wide variations in the pretest and posttest values. The posttest mean of 36 was greater than the pretest mean of 18 and t-statistic of 6.4 was far greater at the significance level of 0.05. However, there was wide variation of posttest scores as compared to the pretest scores. The p-value (0.0001) was far less at the significance level of 0.005, testifying that there were indeed very wide differences in pos test and pretest scores.

Hypothesis 6. H_0: Pretest and post test scores of women who came from single-sex schools were the same.

Table 4.9: t-Test Paired Two Samples for Means for Women from Single-Sex Former Schools

	Post test	Pretest
Mean	41.25	22.5
Variance	122.92	41.67
Observations	4	4
Pearson Correlation	0.77	
Hypothesized Mean Difference	0	
df	3	
t Stat	5	
P(T<=t) one-tail	0.0077	
t Critical one-tail	2.353	
P(T<=t) two-tail	0.015	
t Critical two-tail	3.18	

Table 4.9 showed paired t-test means for pretest and post test scores of only women from single-sex former schools. Straight away, the null hypothesis was rejected since there were wide variations in the pretest and posttest values. The posttest mean of 41 is greater than the pretest mean of 23 and the t-statistic of 5.0 was far greater at the significance level of 0.05. Even though there was an improvement of scores after the intervention, the wide variation in the post test scores showed that single-sex schools performed disproportionately than their mixed-sex schools counterparts. Thus, female students from single-sex schools seem to have more challenges in understanding Probability than their mixed-sex counterparts.

Hypothesis 7. H_0: Pretest and post test of students who came from former schools with ICT centers were the same.

Table 4.10: t-Test Paired Two Samples for Means of Former Schools with ICT

	Post test	Pretest
Mean	46.59090909	27.04545455
Variance	89.01515152	75.37878788
Observations	22	22
Pearson Correlation	0.525180533	
Hypothesized Mean Difference	0	
df	21	
t Stat	10.35675774	
P(T<=t) one-tail	5.22502E-10	
t Critical one-tail	1.720742871	
P(T<=t) two-tail	1.045E-09	
t Critical two-tail	2.079613837	

Table 4.10 showed paired t-test means for pretest and post test scores of former schools with ICT training. Therefore, the null hypothesis was rejected since remarkable improvements were seen after the interventions. That is, the posttest mean of 47 is greater than the pretest mean of 27 and the t-statistic of 10.36 was far greater at the significance level of 0.05. The improvement in the scores of all students after the intervention was very remarkable. The variations in the post test and pretest scores too were narrower as compared to those who came from former schools without ICT knowledge. The p-value is also much smaller than that of those without ICT knowledge. These justified highly excellent estimates of the parameters estimates.

Hypothesis 8. H_0: Pretest and post test of students who came from former schools WITHOUT ICT centers were the same.

Table 11 t-Test Paired Two Samples for Means of Former Schools without ICT

	Post test	Pretest
Mean	47.50	28.125
Variance	121.43	106.70
Observations	8	8
Pearson Correlation	0.86	
Hypothesized Mean Difference	0	
df	7	
t Stat	9.73	
P(T<=t) one-tail	1.28E-05	
t Critical one-tail	1.89	
P(T<=t) two-tail	2.56E-05	
t Critical two-tail	2.36	

Table 4.11 showed paired t-test means for pretest and post test scores of former schools without ICT training. Here too, the null hypothesis was rejected as the results improved after the interventions. That is, the posttest mean of 48 is greater than the pretest mean of 28 and the t-statistic of 10.0 was far greater at the significance level of 0.05. Students who came from schools without ICT experience performed well after the intervention. The variation in the posttest scores was however, much higher than those from ICT schools.

Hypothesis 9. H_0: Pretest and post test of students with Excel experience were the same.

Table 4.12: t-Test Paired Performance of Students with Excel Experience

	Pretest	Post Test
Mean	34.16667	50.83333
Variance	64.16667	94.16667
Observations	6	6
Hypothesized Mean Difference	0	
df	5	
t Stat	-10	

Table 4.12 showed paired t-test means for pretest and post test scores of students' background in MS Excel. The null hypothesis was rejected since the results improved after the interventions. That is, the posttest mean of 50 is greater than the pretest mean of 34 and the t-statistic of 10.0 was far greater at the significance level of 0.05. Students performed well after the intervention.

Hypothesis 10. H_0: Pretest and post test of students who had NO Excel experience were the same.

Table 4.13: t-Test Paired Performance of Students without Excel Experience

	Pretest	Post Test
Mean	29.34783	45.43478
Variance	121.1462	136.166
Observations	23	23
Pearson Correlation	0.391605	
Hypothesized Mean Difference	0	
df	22	
t Stat	-6.16278	
P(T<=t) one-tail	1.67E-06	
t Critical one-tail	1.717144	
P(T<=t) two-tail	3.34E-06	
t Critical two-tail	2.073873	

Table 4.13 showed paired t-test means for pretest and post test scores of students without knowledge in MS Excel. The null hypothesis was rejected since the pretest and post test results were not the same. That is, the posttest mean of 45 is greater than the pretest mean of 29 and the t-statistic of 6.16 which is far greater at the significance level of 0.05. Thus, the students without MS Excel experience performed well after the intervention.

Hypothesis 11. H_0: Pretest and post test of students were the same.

Table 4.14: t-Test: Paired Two Sample for Means of General Performance

	Post-test	Pre-test
Mean	29.33	1.13
Variance	101.26	0.12
Observations	30	30
Pearson Correlation	-0.27	
Hypothesized Mean Difference	0	
df	29	
t Stat	15.20	
P(T<=t) one-tail	1.19E-15	
t Critical one-tail	1.70	
P(T<=t) two-tail	2.39E-15	
t Critical two-tail	2.05	

Table 4.14 showed paired t-test means for pretest and post test scores of all the 30 students under study. There was a general improvement after the intervention. Post test mean score of 29 was far higher than the pretest mean score of 1.13, with the smallest p-value and the t-statistic of 15.20 which is far greater at the significance level of 0.05. However, post test scores still possess the usual high variance. This could be due to the number of students who came from the single-sex schools we observed earlier to have highly varied scores.

Hypothesis 12. Males and females scored the same marks, assuming unequality of gender.

Table 4.15: t-Test Two-Sample Assuming Unequal Variances of Pretest for Males and Females

	Females	Males
Mean	19.17	36.11
Variance	21.97	36.93
Observations	12	18
Hypothesized Mean Difference	0	
df	27	
t Stat	-8.60	
P(T<=t) one-tail	1.63E-09	
t Critical one-tail	1.70	
P(T<=t) two-tail	3.25E-09	
t Critical two-tail	2.05	

Table 4.15 showed independent t-test means for pretest and post test scores of all the 30 male and female students used for the study, assuming unequal variances. Thus, the null hypothesis was rejected as the mean values were not the same. The scores of the pretest for both males and females were different. That is, the mean performance of females was 19 and that of males was 36. The t-statistic of 8.60 showed that females' performance correlated negatively with males. Male students performed better than the female students after using MS Excel to teach Probability. This may be due to the large number of female students who came from single-sex schools, as compared to the male students who mainly came from mixed-sex schools. In fact, no male student came from single-sex school.

Hypothesis 13. Males and females scored the same marks, assuming equality of gender.

Table 4.16: t-Test: Two-Sample Assuming Equal Variances Post Test for Males and Females

	Females	Males
Mean	36.25	54.44
Variance	50.57	26.14
Observations	12	18
Pooled Variance	35.74	
Hypothesized Mean Difference	0	
df	28	
t Stat	-8.17	
P(T<=t) one-tail	3.43E-09	
t Critical one-tail	1.70	
P(T<=t) two-tail	6.86E-09	
t Critical two-tail	2.05	

Table 4.16 showed independent t-test means for pretest and post test scores of all the 30 male and female, assuming equal variances. The null hypothesis was rejected as the mean values still different. Thus, the scores of the post test for both males and females were different. That is, the mean performance of females was 36 and that of males was 54. The t-statistic of 8.17 showed that females' performance was not the same as males. The performance of male students and female student would never be the same. The mean score of male students continued to be greater than that of female students after the MS Excel was used.

Hypothesis 14. H_0: Students from mixed-sex and single-sex scored the same mean mark.

Table 4.17: t-Test Two-Sample Assuming Equal Variances for Mixed-Sex and Single-Sex Former Schools Pretest Scores

	Single-Sex	Mixed-Sex
Mean	22.5	30.38
Variance	41.67	103.85
Observations	4	26
Pooled Variance	97.18	
Hypothesized Mean Difference	0	
df	28	
t Stat	-1.49	
P(T<=t) one-tail	0.07	
t Critical one-tail	1.70	
P(T<=t) two-tail	0.15	
t Critical two-tail	2.05	

Table 4.17 showed independent t-test means for pretest and post test scores of single-sex and mixed-sex former schools before the MS Excel was used to teach Probability, assuming equal variances. The null hypothesis was rejected and was therefore, concluded that the mean values are not the same. The scores of mixed-sex are greater than that of single-sex schools. But, there was wider variation in the pretest scores of mixed-sex students than single-sex students. Thus, most single-sex students scored lower marks before the intervention was administered.

Hypothesis 15. H_0: Women from single and mixed schools score the same mark in the pretest.

Table 4.18: t-Test Two-Sample Assuming Equal Variances for Performance of Women from Mixed and Single-sex Schools Pretest

	Single-sex	*Mixed-sex*
Mean	22.50	18.33
Variance	41.67	12.50
Observations	4	9
Pooled Variance	20.45	
Hypothesized Mean Difference	0	
df	11	
t Stat	1.53	
P(T<=t) one-tail	0.08	
t Critical one-tail	1.80	
P(T<=t) two-tail	0.153	
t Critical two-tail	2.201	

Table 4.18 showed independent t-test means for pretest and post test scores of women from mixed and single-sex former schools before the intervention, assuming equal variances. The null hypothesis was rejected, as the mean values were different. Female students from single-sex former schools performed better than those from mixed-sex schools before the intervention. Ladies who came from single-sex schools performed slightly better than those who came from mixed-sex schools prior to the intervention. The ladies also gained from the good and appropriate intervention strategies used for teaching probability.

Hypothesis 16. H_0: Women from single and mixed schools score the same mark in the post test.

Table 4.19: t-Test Two-Sample Assuming Equal Variances for Women from Mixed and Single-sex Schools Post Test

	Single-sex	Mixed-sex
Mean	41.25	36.11
Variance	122.92	54.86
Observations	4	9
Pooled Variance	73.42	
Hypothesized Mean Difference	0	
df	11	
t Stat	0.998	
P(T<=t) one-tail	0.17	
t Critical one-tail	1.80	
P(T<=t) two-tail	0.34	
t Critical two-tail	2.20	

Table 4.19 showed independent t-test means for pretest and post test scores of women from mixed and single-sex former schools before the intervention, assuming equal variances. The null hypothesis was rejected, as the mean values were different. Even though both improved after the intervention, mixed-sex ladies improved marginally better than the single-sex ladies. The old-fashion critique on ladies of single-sex schools still account for the slow improvement in their performance even after the intervention.

4.2 Discussions of Research Findings

MS Excel has encouraged many students to develop more interest in the study of probability. The kind of former school, therefore, has nothing to do with understanding MS Excel when required to use it to compute data for probabilities. One important fact of MS Excel is that it has properly laid down instructions, called commands, in the form of formulas and functions for a student to practice. The student just needs to observe how the rows and columns obey some computer arithmetic protocol (O'Leary & O'Leary, 1994; Wischhusen, Snell & Scales, 2000; Sebok, 2001; Asiedu-Addo, Ampiah & Awanta, 2004; Mead, 2006). The computer is just a mathematical tool to ease teaching and learning. Probability is just mathematical interpretation of figures for decision-making (Lee, 1999; Asiedu-Addo, Ampiah & Awanta, 2004). The study, therefore, showed that teachers will be able to use MS Excel to teach Probability, and students will equally replicate it in the learning of Probability at any level of their education.

The post test results of the 30 students also showed that gender, former schools and previous knowledge of students do not hinder the use of MS Excel. The factors that determine the successful teaching and learning of mathematics are the age of children, the ability of children, time for the concept, and complexity of the concept (Mooney et al., 2003). MS Excel software does not embed negative micros, pictures and images (see appendix D). What we see are simply lines, which include text, numeric formulas and functions (Bessant, 2005). These are very necessary parts to enter and estimate data. The text helps us enter letters (Ali, Kofi, Adu, Salla, and so on) ; the numeric helps us enter numbers (0, $-\frac{1}{6}$, 27, and so on); formulas help us to enter relatively shorter variables or digits into the cells (=4+5, =7-2, =5*9,=72/5, =7^2, and so on); and the functions help us to enter relatively longer variables or digits (=SUM(A1:A1095), =BINOMDIST(100,9000,0.001, 1), =Rand(A4:G5678), and so on. Entering them is simple, easy and interactive for the students. A student does not need highly skilled training to be able to enter these operators and estimate for probability.

Undoubtedly, we saw improved performance by the study students after the MS Excel was used as a mathematical tool. Of course, MS Excel is not the only statistically-based computer application software. We have other software programmes such as Minitab, S-plus, SAS, Stat, Matlab and Genstat (Green D., 1994; Moore & McCabe, 1999; Awanta & Asiedu-Addo, 2008). However, MS Excel is the most appropriate for students of Colleges of Education in Ghana because it is embedded in the MS Office suites. The MS Office suite is readily available to computer-consumers, less costly, user-friendly and most desirable. All the other statistical software have the MS Excel tool option, can import and export data in MS Excel into their windows. It will be challenging for teachers to use any other software, taking into consideration, the availability of the software, cost and time to use and learn such software. These explain why students were able to cope and practice the software. They understood and applied it in the learning and solving probability problems. The ultimate is what we witnessed in the improvement of their performance in Probability (see appendix C6)..

The improvement in performance of the students in Probability showed that MS Excel can be used. Almost all the students had post test scores higher than the pretest scores (see appendix C). This is a clear case to show that the students could have performed relatively better if the MS Excel had been used to teach the Probability concepts (Wang & Parker, 1996; Shinn, 2003; Oldknow & Taylor, 2003; Clarke & Cooke, 2004). Males and females improved, students with and students without MS Excel experience improved, and those who came from schools with ICT facilities and those without ICT knowledge improved. Discrimination and differentiation of the students in teaching MS Excel cannot be a factor to improve the students' performance (Wang & Parker, 1996; Mooney et al., 2003). Students need to have access to the computer, with the MS Excel software installed. They would then need to follow instructional commands and do more practice to be familiar with the MS Excel environment. What are then left are mere usual arithmetic computations of the Probability concepts of random sampling, simulation and parameter estimates. These had not posed a serious challenge to the students.

4.5 Summary of Results

The following facts came out after the intervention with MS Excel to students:

- Male students and female students performed separately better in the post test than the pretest. Male students performed better than the female students jointly in both the pretest and post test.

- Students who came from former schools with or without ICT improved after the intervention. However,

- Students from both mixed-sex and single-sex former schools improved after the intervention. Single-sex students improved more than the mixed-sex students.

- Women from both mixed-sex and single-sex schools saw significant improvement in their performance after the intervention. Women from single-sex schools performed better than those from mixed-sex schools after the intervention.

- Students who have not had experience in MS Excel and those who have experience improved after the intervention.

Generally, there were improvements after the intervention strategies. Gender, type of former school and previous ICT and MS Excel knowledge did not influence so much, the outcome of the intervention. Thus, the intervention strategies yielded the desired results in teaching probability. Therefore, MS Excel, as statistical software, can be used to improve the teaching of Probability, in Colleges of Education in Ghana.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study involved 30 students who performed below average in Probability. These students had no better alternative rather than the scientific calculator to help them solve the challenges they encountered. This research study, therefore, explored the extent to which MS Excel helped to improve their performance in Probability. Qualitative (observation and interviews) and quantitative (pretest and post test) methods were used to gather the data, present tables and graphs, analyze the findings and report the outcomes from this study. This chapter has, therefore, been subdivided into summary of major findings, implications for practice, recommendation, suggestions for future research and conclusion of the study.

5.1 Summary of Findings

This study revealed that:

- A student's performance in Probability using MS Excel did not depend on whether a student was from a mixed-sex or a single-sex former schools.
- A student's performance did not depend on whether or not his or her former school had ICT training centre or not.
- A student's performance did not depend on whether or not one was a male or a female.
- A student's performance did not depend on whether or not a student had an experience in the use of MS Excel.

- On the whole, the post test results have been significantly different from the pre-test results. The scores of pretest and post test had never been the same and each student improved after the researcher used MS Excel to teach Probability.

5.2 Conclusions

- Students have developed and understood the concepts of Random Sampling, using MS Excel, and have used MS Office Excel to estimate Probability problems. We would be happy to conclude, that from Alaska to Zimbabwe, spreadsheets have become ubiquitous computer tool; you can embed objects from many applications into Excel. From the menu bar, a Tool menu will be used to calculate or organize data (Vaughan, 2001; Asiedu-Addo, Ampiah & Awanta, 2004).
- An easy to use software package with excellent graphical capabilities, Excel is an ideal way to teach and learn statistics at the introduction level. By organizing data into spreadsheets, Excel allows for easy analysis and graphical exploration. Its versalities, convenience, and reliability make it an attractive alternative to specialized statistical software. No prior knowledge of the programme is necessary to use (Hoppe, 2008).

5.3 Recommendations

- Colleges of Education in Ghana should include MS Excel in the teaching and leaning of Probability. Every final-year student should be encouraged to use MS Excel for the tables, graphs and other statistical analyses from his or her data of the project work reports. Since computers, including scientific calculators, are not meant for only engineers, researchers and highly-placed professionals, stakeholders in education, government departments (including Schools and offices), nongovernmental organizations and community-based organizations should be trained and encouraged to use MS Excel for presenting their reports and analyzing their data. Computers have many other uses in the classroom. They can be used for whole class teaching as well as for group and individual work (Dontwi & Owusu-Ansah, 2001; Mooney et al., 2002; Asiedu-Addo, Ampiah & Awanta, 2004; Awanta & Asiedu-Addo, 2008).

5.4 Implications for Practice

The pre-intervention responses showed that even though some students would have had encounter with the computer in diverse ways, it is clear from their own responses, that the students used those computers for doing other things other than computing Probability and Mathematics problems. The students did not put relevance of learning the ICT to their everyday life. Also, it was true that some students had access to the college's computer laboratory, but with a limited period of time of once a week. Even with this limited time they had to the computer laboratory, the students had not utilized it purposefully enough, at least for MS Excel. Assignments, exercises, quizzes and ICT practical should involve MS Excel in one way or the other. The tutor in charge of ICT must always be present and willing to help students when the students go to the computer laboratory to practice on their own. These will make the learning of Excel meaningful to the students.

The students did not gain so much in the knowledge of MS Excel in any field of its applications especially in Probability. They mostly resorted to engaging themselves or being engaged in other computer applications programs when they got access to the computer laboratory. Even though ICT is a core course in the senior high school (SHS), the students have not had enough basic knowledge in MS Excel, especially in Probability. The GES, Teacher Education Division and Institute of Education, University of Cape Coast should include MS Excel in students' textbooks, examination questions and chief examiners' written reports in MS Excel. All parameters of statistics should always be accompanied by an MS Excel software programme.

The post intervention results found an improvement in performance of Probability when MS Excel was used. There was no disparity in performance, with respect to whether a student is a male or female, whether a student came from a former SHS with or without ICT training or centre, whether a student had ever used MS Excel or not, and whether a student came from a mixed or a single-sex former SHS. It was, however, revealed that males' performance after the intervention was quite higher than females' performance, mixed-sex former schools students performed significantly better than the single-sex schools. That notwithstanding, we can integrate teaching and learning of ICT to promote relational learning in Colleges of Education.

5.5 Suggestions

The researcher suggests that other researchers could investigate into the possibility of bringing Mathematics (Probability) and ICT courses into one course, and use the MS Excel as the main tool of computations and interpretations of the results. Also, a further research could go into amalgamating every topic in Probability with MS Excel programme for Colleges of Education in Ghana.

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APPENDICES

Appendix A1: Pre-Survey Questionnaires

CLASS:……………… SEX:………….. FORMER SCHOOL:………………………………………………………….

1 .Do you owe a personal computer? a).Yes b).No c).Don't know

2. Which area do you mostly use your computer for? a). Writing letters b).Playing games c).Working Maths d).Watching Movies

3. Have you been taught computing or ICT? a).Yes b). No c). Don't know

4. What topic have you learnt most in the ICT? a).MS Word b). MS Excel c). Internet d). Any other, specify:…………………………………………..

5. How many times do you go to the computer laboratory to study in a week? a). Once b). Twice c). Three times d). More than Three times

6. If you go to the computer laboratory, what program do you always learn most? a). Word b). Excel c). Internet d).Others, specify:……………………………….

7. Have you been taught MS Excel program? a). yes b). No c). Don't Know

8. Do you have any knowledge in the use of the Excel program? a). Yes b). No

9. Do you know that Excel can be used to calculate Probability problems? a). Yes b). No c). Don't know

10. Have you ever used Excel to estimate probability or any other mathematical problem? a). Yes b). No

11. If you do not use Excel, what instrument(s) do you normally use to calculate probability problems? a). Scientific Calculator b). TI Instrument c).Any other, specify:……………………………………………

12. Do you know any instruments or computer software one can use to calculate probability problems, apart from the scientific calculator? a). Yes b). No

13. If yes, mention one:……………………………………………………….

14. Which aspect of Probability do you find most difficult to learn? a).mutually inclusive b). Independent Events c). Conditional Probability d). Any other, specify………………………………

15. Had your former school got computer laboratory? a). Yes b). No

16. Did you learn MS Excel at your former school? a). Yes b). No c). Don't Know

17. How many times did you use Excel at your former school: a).Sometimes b).Always c). Never

Appendix A2: Questionnaire Coding Scheme

ITEM NUMBER	VARIABLE	CODING SCHEME
i.	Class	1=A,2=B,3=C,4=D,5=E,6=F.
ii.	sex	1=male, 2=female
iii.	Former school	1=mixed sex,2=single sex
1.	Owing a PC	1=yes, 2=no
2.	Most use of a PC	1=letters,2=games,3=maths,4=movies
3.	Being taught ICT in school	1=yes, 2=no
4.	Concept most taught	1=word,2=excel,3=internet,4=others
5.	Number of times students practice	1=once,2=twice,3=thrice,4=more than thrice
6.	Private ICT learning	1=word,2=excel,3=internet,4=others
7.	Being taught excel	1=yes, 2=no, 3=don't know
8.	Previous MS excel knowledge	1=yes, 2=no
9.	Previous excel knowledge in probability	1=yes, 2=no, 3=don't know
10.	Previous use of excel in probability	1=yes, 2=no
11.	Any other instrument used for probability	1=calculator, 2=TI instrument, 3=others
12.	Any other software for probability	1=yes, 2=no
13.	If 'yes' in 12	1=any software, 0=N/A
14.	Difficult aspect of probability	1=addition law, 2=multiplication law, 3=conditional probability, 4=others
15.	Former school with ICT	1=yes, 2=no
16.	Knowledge of excel at former school	1=yes, 2=no 3=don't know
17.	Practice at former school	1=sometimes,2=always,3=never

Appendix A3: Questionnaire Coding Summary Sheet

ID	class	sex	Former school	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1	2	2	2	1	1	1	1	1	1	1	1	2	1	1	0	4	2	2	3
2	1	2	2	2	4	1	2	1	1	1	2	2	2	1	1	1	4	2	2	3
3	1	1	1	2	0	1	1	1	1	1	2	3	2	1	1	0	3	2	2	3
4	1	1	1	2	1	1	1	1	1	1	1	1	2	0	1	1	4	1	2	3
5	2	2	2	2	1	2	1	1	1	2	2	2	2	0	2	0	0	2	2	3
6	2	1	1	2	4	1	1	1	1	1	1	1	1	1	2	0	1	1	2	3
7	2	1	1	2	4	1	1	1	2	1	1	1	1	1	2	0	3	1	2	3
8	2	1	1	2	3	1	2	1	2	2	1	1	2	1	2	0	3	1	2	2
9	2	2	1	2	4	2	1	2	2	1	1	2	1	0	2	0	2	1	1	1
10	3	2	1	2	1	1	1	1	1	2	2	2	2	1	0	0	0	2	2	3
11	3	2	1	2	2	1	1	1	1	2	2	3	2	1	2	0	3	1	2	3
12	3	2	1	2	2	1	1	1	1	2	2	2	2	1	2	0	3	1	2	3
13	3	1	1	2	1	1	1	2	1	2	2	3	2	1	2	0	3	2	3	3
14	3	1	1	2	1	1	4	1	4	2	2	2	2	1	2	0	3	1	2	3
15	4	2	1	2	1	1	1	1	1	2	2	2	2	1	2	0	1	1	2	3
16	4	1	1	2	0	1	1	1	1	2	0	2	2	1	2	0	3	1	1	1
17	4	1	1	2	0	1	1	1	1	2	2	3	2	1	2	0	3	1	2	3
18	4	1	1	2	0	1	1	1	1	2	1	2	2	1	2	0	3	1	1	1
19	4	1	1	2	0	1	3	1	1	2	2	2	2	1	2	0	3	1	2	3
20	4	2	1	2	0	1	1	1	1	2	2	3	2	1	2	0	2	1	3	1
21	4	2	1	2	1	2	1	1	1	2	2	3	2	1	2	0	1	1	2	3
22	5	2	1	2	1	1	1	4	1	2	2	2	2	1	1	1	3	1	2	3
23	5	1	1	2	0	1	1	1	1	2	2	2	2	1	2	0	2	1	2	3
24	5	1	1	2	2	1	1	1	4	2	2	3	2	1	2	0	0	2	2	3
25	5	2	1	2	4	1	1	1	1	2	2	3	2	0	1	1	3	1	2	3
26	5	1	1	2	0	1	1	1	1	2	2	2	2	1	2	0	2	2	1	3
27	6	2	1	2	0	1	1	1	2	2	2	2	2	1	2	0	4	1	2	3
28	6	1	1	2	1	1	1	1	1	2	2	3	2	1	2	1	2	1	2	3
29	6	1	1	2	0	1	1	1	1	2	2	2	2	1	2	0	3	1	1	3
30	6	2	1	2	0	1	1	1	1	2	2	2	2	1	2	0	1	1	1	3
TOTAL	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Appendix B: Excel Environment

Appendix B1 Some Built-in Functions in Excel

Function	Result Displayed:	Example
AVERAGE	The mean of the cells referred to in parentheses	=AVERAGE(A3:A6)
COUNT	The number of *numerical* values in the cells referred to in parentheses	=COUNT(A3:A6)
COUNTA	The number of *non-empty cells* among those referred to in parentheses	=COUNTA(A3:A6)
MAX	The highest value among the cells referred to in parentheses	=MAX(A3:A6)
MIN	The lowest value among the cells listed in parentheses	=MIN(A3:A6)
SUM	Total of all the numbers in a range	=SUM(A3:A6)
TODAY	Today's date	=TODAY()

Appendix B2: Some Common Formulas in Excel

Operator	What it does	Example	Result
+	Addition	=5+3.4	8.4
-	Subtraction	=54.2-2.1	52.1
*	Multiplication	=1.2*4	4.8
/	Division	25/5	5
%	Percentage	=42%	0.42
^	Exponentiation	=4^3	64
=	Equal to sign	=6=7	False
>	Greater than	=7>2	True
<	Less than	=9<8	False
>=	Greater than or Equal to	=45>=3	True
<=	Less than or Equal to	=40<=2	False
<>	Not Equal to	=5<>7	True

Appendix C: Post Test and Pretest Scores

Appendix C1: Males versus Females Results

S/no	Males		Females	
	Pretest marks	Post marks	Pretest marks	Post test marks
1	35	50	30	45
2	40	55	15	30
3	25	55	20	35
4	30	60	20	35
5	45	50	15	45
6	40	60	20	50
7	35	55	25	30
8	40	50	15	30
9	35	60	15	35
10	30	55	20	30
11	30	50	20	40
12	35	50	15	30
13	30	55		
14	40	60		
15	35	50		
16	50	65		
17	40	55		
18	35	45		

Appendix C2: Mixed and Single-Sex Former Schools Results

S/NO	Mixed-Sex		Single-Sex	
	Pretest Marks	Post Test Marks	Pretest Marks	Post Test Marks
1	35	50	30	45
2	40	55	15	30
3	30	60	20	35
4	45	55	25	55
5	20	35		
6	15	45		
7	20	50		
8	25	30		
9	40	60		
10	35	55		
11	15	30		
12	40	50		
13	35	60		
14	30	55		
15	30	50		
16	15	35		
17	20	30		
18	20	40		
19	35	50		
20	30	55		
21	15	30		
22	40	60		
23	35	50		
24	50	65		
25	40	55		
26	35	45		

Appendix C3: Women from Mixed and Single-Sex Schools

S/No	Mixed-Sex		Single-Sex	
	Pretest Marks	Post Tset Marks	Pretest Maks	Post Test Marks
1	20	35	30	45
2	15	45	15	30
3	20	50	20	35
4	25	30	25	55
5	15	30		
6	15	35		
7	20	30		
8	20	40		
9	15	30		

Appendix C4: Former Schools with ICT Centres

S/No	With ICT		Without ICT	
	Pretest Test	Post Test	Pretest	Post Test
1	40	55	30	45
2	25	55	15	30
3	30	60	35	50
4	45	50	20	35
5	20	45	15	45
6	20	50	40	60
7	25	30	30	55
8	35	55	40	60
9	15	30		
10	40	50		
11	35	60		
12	30	55		
13	30	50		
14	15	35		
15	20	30		
16	20	40		

Appendix C5: Background with MS Excel

S/NO	Without Experience		With Experience		
	Pretest	Post Test	Pretest	Post Test	
1	30	45	20	35	
2	15	30	40	60	
3	35	50	30	50	
4	40	55	40	60	
5	20	35	40	55	
6	25	55	35	45	
7	30	60			
8	45	50			
9	15	45			
10	20	30			
11	25	30			
12	35	60			
13	15	50			
14	35	30			
15	30	40			
16	20	50			
17	20	30			
18	35	40			
19	30	50			
20	15	55			
21	40	30			
22	50	60			
23	50	65			

Appendix C6: General Tests Results

ID	CLASS	SEX	FORMER SCHOL	PRETEST	POST TEST
1	1	2	2	30	45
2	1	2	2	15	30
3	1	1	1	35	50
4	1	1	1	40	55
5	2	2	2	20	35
6	2	1	2	25	55
7	2	1	1	30	60
8	2	1	1	45	50
9	2	2	1	20	35
10	3	2	1	15	45
11	3	2	1	20	50
12	3	2	1	25	30
13	3	1	1	40	60
14	3	1	1	35	55
15	4	2	1	15	30
16	4	1	1	40	50
17	4	1	1	35	60
18	4	1	1	30	55
19	4	1	1	30	50
20	4	2	1	15	35
21	4	2	1	20	30
22	5	2	1	20	40
23	5	1	1	35	50
24	5	1	1	30	55
25	5	2	1	15	30
26	5	1	1	40	60
27	6	1	1	35	50
28	6	1	1	50	65
29	6	1	1	40	55
30	6	1	1	35	45

Appendix D: MS Excel Window

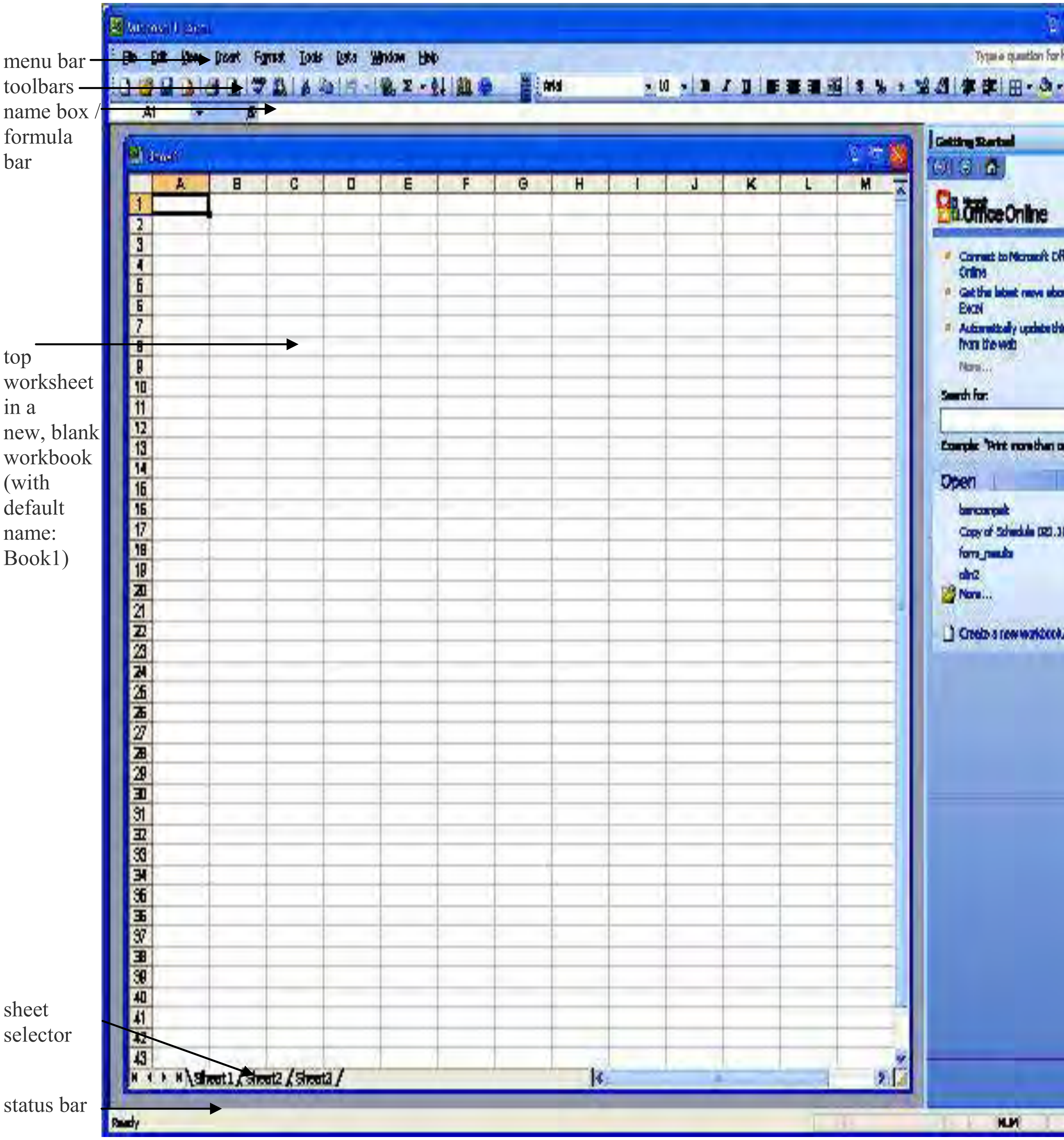

Figure 5.1: Excel 2003/Xp (Window/Environment) Picture