A ROLE OF STATISTICS IN COMPUTER APPLICATIONS AND MARKETING

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ABSTRACT

Statistics is a mathematical science involving the collection, interpretation, measurement, enumerations or estimation analysis, and presentation of natural or social phenomena, through application of various tools and technique the raw data becomes meaningful and generates the information's for decision making purpose. It is the systematic arrangement of data and information exhibits their inner relation between the things. Statistics plays a vital role in every fields of human activity and has important role in determining the existing position of per capita income, unemployment, population growth rate, housing, schooling ,medical facilities etc. in a country by which the decision making and development plans of the government becomes concentric. Now statistics holds a central position in almost every field of research like Industry, Commerce, Trade, Physics, Chemistry, Economics, Mathematics, Biology, Botany, Psychology, Astronomy, management of decision making etc. Through this research article, we have tries to discuss about the role and Importance of Statistics in various sociological and applied fields with their limitations also discusses the integration and co-ordination of statistical tools with the computer technology, which makes the calculation and interpretation data in very efficient and effective manner. Computer technology has becomes as lifeline of statistical tools and software's.

Key Words*: *Statistics, Statistical Tools and Techniques, Social Sciences And Research, Computer Application.

I WHAT IS STATISTICS?

Put simply, statistics is a range of procedures for gathering, organizing ,analyzing and presenting quantitative data. 'Data' is the term for facts that have been obtained and subsequently recorded and for statisticians, 'data' usually refers to quantitative data that are numbers. Essentially therefore, statistics is a scientific approach to analyzing numerical data in order to enable us to maximize our interpretation, understanding and use. This means that statistics helps us turn data into information; that is data that have been interpreted, understood and are useful to the recipient. Put formally, for your project, statistics is the systematic collection and analysis of numerical data, in order to investigate or discover relationships among phenomena so as to explain predict and control their occurrence. The possibility of confusion comes from the fact that not only is statistics the techniques used on quantitative data, but the same word is also used to refer to the numerical results from statistical analysis.

In very broad terms, statistics can be divided into two branches – descriptive and inferential statistics.

1. Descriptive statistics is concerned with quantitative data and the methods for describing them. (‘Data’ (facts) is the plural of ‘datum’ (a fact), and therefore always needs a plural verb.) This branch of statistics is the one that you will already be familiar with because descriptive statistics are used in everyday life in areas such as government, healthcare, business, and sport.

2. Inferential (analytical) statistics makes inferences about populations (entire groups of people or firms) by analyzing data gathered from samples (smaller subsets of the entire group), and deals with methods that enable a conclusion to be drawn from these data. (An inference is an assumption, supposition, deduction or possibility.) Inferential statistics starts with a hypothesis (a statement of, or a conjecture about, the relationship between two or more variables that you intend to study), and investigates whether the data are consistent with that hypothesis.

Because statistical processing requires mathematics, it is an area that is often approached with discomfort and anxiety, if not actual fear. Which is why this book tells you which statistics to use, why those statistics, and when to use them, and ignores the explanations (which are often expressed mathematically) of the formulae in which they tend to be articulated, though it does give advice on what you should bear in mind when planning your data collection. One of the major problems any researcher faces is reducing complex situations or things to manageable formats in order to describe, explain or model them. This is where statistics comes in. Using appropriate statistics, you will be able to make sense of the large amount of data you have collected so that you can tell your research story coherently and with justification. Put concisely, statistics fills the crucial gap between information and knowledge.

II HISTORY OF STATISTICS

The word ‘statistics’ derives from the modern Latin term statisticum collegium (council of state) and the Italian word statista (statesman or politician). ‘Statistics’ was used in 1584 for a person skilled in state affairs, having political knowledge, power or influence by Sir William Petty, a seventeenth-century polymath and statesman, used the phrase ′political arithmetic′ for ‘statistics’. (A book entitled Sir William Petty, 1623–1687, written by Lord Edmond Fitzmaurice, and published inLondon in 1895, quotes Petty as saying that ‘By political arithmetic, we mean the art of reasoning by figures upon things relating to government’.) By 1787, ‘statistic’ (in the singular), meant the science relating to the branch of political science dealing with the collection, classification and discussion of facts bearing on the condition of a state or a community. ‘Statists’ were specialists in those aspects of running a state which were particularly related to numbers. This encompassed the tax liabilities of the citizens as well as the state’s potential for raising armies. The word ‘statistics’ is possibly the descendant of the word ‘statist’. By 1837, statistics had moved into many areas beyond government. Statistics, used in the plural, were (and are) defined as numerical facts (data) collected and classified in systematic ways. In current use, statistics is the area of study that aims to collect and arrange numerical data, whether relating to human affairs or to natural phenomena.

III WHY STUDY STATISTICS?

Statistics is the science of collecting, analyzing and making inference from data. Statistics is a particularly useful branch of mathematics that is not only studied theoretically by advanced mathematicians but one that is used by researchers in many fields to organize, analyze, and summarize data. Statistical methods and analyses are often used to communicate research findings and to support hypotheses and give credibility to research methodology and conclusions. It is important for researchers and also consumers of research to understand statistics so that they can be informed, evaluate the credibility and usefulness of information, and make appropriate decisions

IV THE IMPORTANCE OF STATISTICS

It is obvious that society can't be run effectively on the basis of hunches or trial and error, and that in business and economics much depends on the correct analysis of numerical information. Decisions based on data will provide better results than those based on intuition or gut feelings. What applies to this wider world applies to undertaking research into the wider world. And learning to use statistics in your studies will have a wider benefit than helping you towards a qualification. Once you have mastered the language and some of the techniques in order to make sense of your investigation, you will have supplied yourself with a knowledge and understanding that will enable you to cope with the information you will encounter in your everyday life. Statistical thinking permeates all social interaction. For example, take these statements:

- 'The earlier you start thinking about the topic of your research project, the more likely it is that you will produce good work.'

'You will get more reliable information about that from a refereed academic journal than a newspaper.'

- On average, my journey to work takes 1 hour and 40 minutes.
- More people are wealthier now than ten years ago.

Or these questions:

- Which university should I go to?
- Should I buy a new car or a second-hand one?
- Should the company buy this building or just rent it?
- Should we invest now or wait till the new financial year?'
- When should we launch our new product?

All of these require decisions to be made, all have costs and benefits (either financial or emotional), and all are based upon different amounts of data, and all involve or necessitate some kind of statistical calculation. This is where an understanding of statistics and knowledge of statistical techniques will come in handy

V WHY YOU NEED TO USE STATISTICS?

Everyday life depends on making forecasts, and business can't progress without being able to audit change or plan action. In your research, you may be looking at areas such as purchasing, production, capital investment, long-term development, quality control, human resource development, recruitment and selection, marketing, credit risk assessment or financial forecasts or others. And that is why the informed use of statistics is of direct importance to you while you are collecting your data and analyzing them. If nothing else, your results and findings will be more accurate, more believable and consequently, more useful. Some of the reasons why you will be using statistics to analyze your data are the same reasons why you are doing the research. Ignoring the possibility that you are researching because the project or dissertation element of your qualification is compulsory, rather than because you very much want to find something out, you are likely to be researching because you want to:

- measure things
- examine relationships
- make predictions
- test hypotheses
- construct concepts and develop theories
- explore issues
- explain activities or attitudes
- describe what is happening
- present information
- make comparisons to find similarities and differences
- Draw conclusions about populations based only on sample results.

If you didn't want to do at least one of these things, there would be no point to doing your research at all.

5.1 What statistical language actually means

Like other academic disciplines, statistics uses words in a different way than they are used in everyday language. You will find a fuller list of the words you need to understand and use in the Glossary.

Variable and constant

In everyday language, something is variable if it has a tendency to change. In statistical language, any attribute, trait or characteristic that can have more than one value is called a variable. In everyday language, something that does not change is said to be constant. In statistical language, an attribute, trait or characteristic that only has one value is a constant. Confusingly, something may be a variable in one context and a constant in another. For example, if you are looking at the spending patterns of a number of households, the number of children (which will vary) in a particular household is a variable, because we are likely to want to know how household spending depends on the number of children. But, if you are looking at the spending patterns of households which have, say, three children, then the number of children is a constant. Strictly speaking, in statistical language, when your variables and constants are categorical. For example, eye color or nationality, they are known as attributes.

Population and sample

In statistics, the term 'population' has a much wider meaning than in everyday language. The complete set of people or things that is of interest to you in its own right (and not because the collection may be representative of something larger) is a population. The number of items, known as cases, in such a collection is its size. For example, if you are interested in all the passengers on a particular plane in their own right and not as representatives of the passengers using the airline which owns that particular plane, then those particular plane passengers are your population. But if you do a statistical analysis of those particular plane passengers in order to reach some conclusion about, say, (1) all plane passengers heading to that destination, or (2) all plane passengers on any route on that day and at that time, then the passengers are a sample. They are being used to indicate something about the population (1) or (2). A sample is therefore a smaller group of people or things selected from the complete set (the population). It hardly goes without saying that you need to be clear about whether your data are your population or a sample. Most of statistics concerns using sample data to make statements about the population from which the sample comes.

Discrete and continuous

Quantitative variables are divided into 'discrete' and 'continuous'. A discrete variable is one that can only take certain values, which are clearly separated from one another – for instance, a sales department can have 2 or 15 or 30 people within it. It cannot, however, contain 3& or 48.1 people. A continuous variable is one that could take any value in an interval. Examples of continuous variables include body mass, height, age, weight or temperature. Where continuous variables are concerned, whatever two values you mention, it is always possible to have more values (in the interval) between them. An example of this is height – a child may be 1.21 meters tall when measured on 27th September this year, and 1.27 meters on 27 September next year. In the intervening 12 months, however, the child will have been not just 1.22 or 1.23 or 1.24 and so on up to 1.27 meters, but will have been all the measurements possible, however small they might be, between 1.21 and 1.27. Sometimes the distinction between discrete and continuous is less clear. An example of this is a person's age, which could be discrete (the stated age at a particular time, 42 in 2007) or continuous, because there are many possible values between the age today (42 years, 7 weeks and 3 days) and the age next week (42 years, 8 weeks and 3 days).

Cardinal and ordinal

Cardinal numbers are 1, 2, 3 and so on, and they can be added, subtracted, multiplied and divided. An ordinal number describes position 1st, 2nd, 3rd and so on), and they express order or ranking, and can't be added, subtracted, multiplied or divided. Most of the statistical techniques created for the analysis of quantitative are not applicable to ordinal data. It is therefore meaningless (and misleading) to use these statistical techniques on rankings.

Statistics and the computer

There are two different ways in which the computer is changing the field of statistics. First, computers can help us to do what we did before the advent of the computer but in a more efficient way. Second, computers can help us to do things nobody thought of before the advent of the computer. To the first category belong statistical data analysis by numerical and graphical methods, and simulation; to the second belongs, for example, different computer- intensive methods. Another way to categorize the relation statistics-computer is to list the different ways the computer can be used in statistics. The following are examples of such uses: numerical and graphical data analysis; symbolic computations; simulations; storing statistical knowledge; presentation of results. The close relationship between statistics and computing implies that when one changes the other will also change. The following are some new practical procedures in computing which have turned out to have a great importance for statistics:

(i) The change from mainframe batch computing to personal computing.
(ii) The introduction of multiple dynamic displays.
(iii) The possibility of direct manipulation of graphical objects.

Some trends in statistics are also obviously very much influenced by what has happened in computing. Examples of such trends are:

(i) emphasis on exploratory data analysis instead of hypothesis testing
(ii) the use of computer-intensive methods
(iii) The introduction of new diagnostic methods.

Teaching of statistics and the computer

We are at a conference on the teaching of statistics. It is therefore natural to try to discuss in more detail the opportunities offered by the computer to improve the teaching of statistics. It is, of course, necessary to consider the use of computers in every course in probability and statistics, both at school and university levels. However, the introduction of computers in the teaching process has, in many places, been rather slow. One obvious reason for this is the considerable cost of establishing an effective computer environment to use in the teaching process. Other reasons for the slow development are the many difficult problems to be solved before the computer can be incorporated in the teaching of statistics. Some of these are:

(i) What kind of computer should be used (mainframe, personal, pocket)
(ii) (ii) What make of computers should be used?
(iii) What software should be used?
(iv) What programming language should be used?

(v) What teacher education is needed?

Here only points (iii) and (v) in the above list will be discussed. There exists a tremendous amount of statistical software (see the list in the introduction above). These software packages are usually produced for use in statistical practice rather than for teaching. But very often they can be used for that purpose, especially if they will use the following criteria:

(i) have good supporting material
(ii) have color
(iii) have good graphics
(iv) are interactive
(v) have relevant content

IV SOFTWARE FOR SYMBOLIC CALCULATIONS

I A new important feature of computation is the advent of software for symbolic calculations. These computing packages (e.g. Macsyma, Reduce, SMP, Derive, Maple, and Mathernatica) are intended for mathematical calculations but they can turn out to be extremely useful in probability and statistics as well. A package like Mathernatica offers a large number of mathematical tools for both numerical and graphical computations and contains a lot of useful mathematical knowledge. It also contains some statistical packages for statistical data analysis, with information on statistical distributions. The number of such packages will probably increase rapidly in the future. These packages can perform algebraic manipulations, integration, differentiation, finding and inverting Laplace and Fourier transforms, linear algebra operations and so on, all of which are important in applied probability and statistics (some examples will be presented in the lecture at ICOTS 3

V THE FUTURE

This is an exciting time for statistics and for the teaching of statistics. Modem technology offers new very useful tools both for the theory, the practice and the teaching of our subject. Extremely powerful software for probability and statistics theory and practice and also software for making software will appear in the future and will be readily available on personal computers. (Expert systems have not been discussed in this paper as the author lacks experience of such systems.) Parallel computers will be of importance, for example, for simulations. The computer will surely find its way into the classroom. As we today take it for granted that a classroom is equipped with an overhead projector, so will it in the future be taken for granted that classrooms have access to computers both for student use and for demonstration of software action? Some teachers might prefer to do all their teaching with the computer, but there will probably be some place for chalk and black- board as well. The computer will be the daily working environment both in our theoretical and practical work. In the following statement from the report by Demana et al. (1990), the word "mathematics" has been replaced by "statistics".

"In the final decade of this century, paper and pencil will take its last stand in statistics."

VI THE IMPORTANCE OF STATISTICS IN MANAGEMENT DECISION MAKING

Whether designing new products, streamlining a production process or evaluating current vs. prospective customers, today's business managers face greater complexities than ever before. Running a shop on instinct no longer suffices. Statistics provide managers with more confidence in dealing with uncertainty in spite of the flood of available data, enabling managers to more quickly make smarter decisions and provide more stable leadership to staff relying on them.

Focusing on Big Picture

Statistical analysis of a representative group of consumers can provide a reasonably accurate, cost-effective snapshot of the market with faster and cheaper statistics than attempting a census of very single customer a company may ever deal with. The statistics can also afford leadership an unbiased outlook of the market, to avoid building strategy on uncorroborated presuppositions.

Backing Judgments

Statistics back up assertions. Leaders can find themselves backed into a corner when persuading people to move in a direction or take a risk based on unsubstantiated opinions. Statistics can provide objective goals with stand-alone figures as well as hard evidence to substantiate positions or provide a level of certainty to directions to take the company.

Making Connections

Statistics can point out relationships. A careful review of data can reveal links between two variables, such as specific sales offers and changes in revenue or dissatisfied customers and products purchased. Delving into the data further can provide more specific theories about the connections to test, which can lead to more control over customer satisfaction, repeat purchases and subsequent sales volume.

Ensuring Quality

Anyone who has looked into continuous improvement or quality assurance programs, such as Six Sigma or Lean Manufacturing, understands the necessity for statistics. Statistics provide the means to measure and control production processes to minimize variations, which lead to error or waste, and ensure consistency throughout the process. This saves money by reducing the materials used to make or remake products, as well as materials lost to overage and scrap, plus the cost of honoring warranties due to shipping defective products.

Considerations

Know what to measure, and manage the numbers; don't let the numbers do the managing for you, or of you. Before using statistics, know exactly what to ask of the data. Understand what each statistical tool can and can't measure;

use several tools that complement one another. For example, don't rely exclusively on an "average," such as a mean rating. Customers using a five-point scale to rate satisfaction won't give you a 3.84; that may indicate how the audience as a group clustered, but it's also important to understand the width of the spread using standard deviation or which score was used by the greatest number of people, by noting the mode. Finally, double-check the statistics by perusing the data, particularly its source, to get a sense of why the audiences surveyed answered the way they did.

How Are Statistics Applied in Marketing?

Statistics are applied in marketing to identify market trends, and to measure and evaluate the potential and success of marketing programs. The secret to successful marketing is to identify the target market accurately and to use effective marketing communications channels and tactics to reach it. Statistics can help the marketer achieve both of those goals as well as evaluate the success of the marketing effort and provide data on which to base changes to the marketing program.

Data Source

The most basic use of statistics in marketing is as a source of data. Statistics provide demographic information such as the number of potential customers in a geographical area, their ages, income levels and consumer preferences. Used as part of competitor analysis, statistics can identify the major competitors, their market share and trends in the longevity of their products. Industry sector data helps marketers understand the trends governing supply and demand of the product category and fluctuations in its popularity.

Marketing Mix Modeling

The use of marketing mix modeling helps marketers identify the correct combination of marketing communications channels to use to reach the target market and provide the best return on the marketing investment. Modeling works by analyzing information and using the technique of statistical regression to determine the effectiveness of sales on the market. The formula for modeling includes creation of a model using sales volumes and value as a dependent variable, and then using various marketing channels to represent the independent variables.

Market Tracking

Statistics are applied in market tracking to measure customer satisfaction, brand loyalty and support, and to assess the relationship of the marketer's company with its customers. To implement a market-tracking program, the marketer needs access to company as well as industry statistics. The tracking program then analyzes the sales statistics across all brands in the market to ascertain which brand enjoys the highest levels of customer support and loyalty.

Cross-sell Parameters

Marketers use statistics on household parameters to target buyers for customized promotions or to cross-sell secondary products. For example, Wal-Mart's loyalty card gives the store the ability to record all purchases of baby powder by its customers. By analyzing the statistics generated by these records, Wal-Mart is able to identify those households that buy baby powder but do not buy other baby products. This makes it possible to target those households as potential customers for a new brand of organic body powder, because they appear to use powder but do not have babies in the home.

Limitations of Business Statistics

Business statistics can be a powerful tool for diagnosing problems in your business. However, statistics are not a panacea. Limitations in the ability of statistics to answer question about our businesses and the inherent limitation in our ability to understand statistics reduce their applicability. Understanding some common pitfalls of business statistics can help you identify where these figures could be leading you astray in your company

Difficulty of Understanding

Research has shown that people have a difficult time thinking statically. The idea that a statistic is part of a distribution of possible figures is relatively unintuitive. As such, business owners tend to neglect characteristics such as base rates. Say a company has designed a test to detect fraud that is 99 percent accurate. If the proportion of fraud in the entire population is only 1 in 1,000, the chance that you have detected fraud is much lower. In fact, the probability of fraud existing, given a positive test result, is only 9 percent. Because the base rate of fraud is so low, a positive test result cannot give us much insight into the actual chance that fraud has occurred.

Frequency

Statistical tests in business are often conducted from a frequentist approach, which may not be representative of the questions we are asking. In production processes, this often takes the form of a tolerance for error. Say a company produces sheets of metal that are 3 mm thick. The company may say that sheets within the 2.95 mm to 3.05 mm range of thickness are acceptable. If the company is producing 3.02 mm thick sheets, the sheets are acceptable based upon the company's quality standards and, statistically speaking, this may be not be significantly greater than 3 mm. However, overweighting in production could cost the company money.

Small Sample Sizes

In general, people tend to poorly determine the effect of sample size when the sample size is small. For example, a foreman may have the choice to complete a small production run of bottles daily or a larger run every other day. The company considers a production run successful when fewer than 1 percent of bottles are defective. All else constant, most think that it is equally likely to exceed the 1 percent threshold using either size of production run. However, in smaller production runs, random fluctuations have a larger effect of the total number of defects. In larger runs, these fluctuations tend to even themselves out.

Outcome Bias

When using statistics as a business diagnostic tool, managers tend to suffer from outcome bias. For example, managers may use the percentage of defective products to determine if a production process is sound. If many defects are found, managers will usually investigate the process and try to determine the source of the problem. However, it does not make sense to investigate low numbers of defective products. When the defective product count is inconclusive, the manager has to choose whether to investigate. Research has shown that if the manager investigates the defects and finds no systematic problem in production, management will be less satisfied with the manager's performance than if he uncovered a problem. This occurs even though the manager had no notion of the outcome of his investigation before he started it.

Misuses of statistics

Statistics consists of tests used to analyze data. You have decided what your research question is, which group or groups you want to study, how those groups should be put together or divided, which variables you want to focus on, and what are the best ways to categorize and measure them. This gives you full control of your study, and you can manipulate it as you wish. Statistical tests provide you with a framework within which you can pursue your research questions. But such tests can be misused, either by accident or design,and this can result in potential misinterpretation and misrepresentation. You could, for instance, decide to:

- alter your scales to change the distribution of your data;
- Ignore or remove high or low scores which you consider to be inconvenient so that your data can be presented more coherently.
- Focus on certain variables and exclude others.

Present correlation (the relationship between two variables, for example, height and weight – the taller people in the sample are thinner than the shorter people) as causation (tallness results in or is a cause of thinness).

It goes without saying that, because research is based on trust, you must undertake your research in an ethical manner, and present your findings truthfully. Deliberately misusing your statistics is inexcusable and unacceptable, and if it is discovered by your supervisor or examiner, retribution will be severe. Because you are inexperienced in research, the main errors which you might make are bias, using inappropriate tests, making improper inferences, and assuming you have causation from correlations.

Bias

In ordinary language, the term 'bias' refers simply to prejudice. It could be that when the data you are using were collected, the respondents were prejudiced in their responses. You might get this kind of thing if you are eliciting attitudes or opinions. In statistical language, bias refers to any systematic error resulting from the collection procedures you used. For example, in a questionnaire, if the non-respondents (those who haven't answered the questionnaire) are composed of, say, a large percentage of a higher socio-economic group, it could introduce bias (systematic error) because you would have an under-representation of that group in your study. Often the people with the strongest opinions, or those who have a greater interest in the results of the research, who may derive some benefit from the results, or who have a loyalty or allegiance to express, are more likely to respond to the questionnaire than those without those views or interests. There are procedures that can deal with non-response in questionnaires and interviews. It would benefit your research if you read up about these and included them in your research design if you are collecting data specifically for your research project (primary data) rather than reanalyzing data that have already been collected for some other purpose (secondary data).

Using inappropriate tests

We'll come back to this, but here we need to warn you that one of the ways in which to misuse statistics is to use the wrong tests on your data. All statistics textbooks will tell you that non-parametric tests are to be used on nominal and ordinal variables (we'll explain these terms more fully in Chapter 2) and that parametric tests are reserved for interval and ratio variables. You will find, however, that researchers, who should know better, use parametric tests on ordinal variables. But now you know better, and you won't do that.

Improper inferences

Much of statistical reasoning involves inferences about populations from data observed in samples. The reasoning may be inductive, in other words, reasoning from the particular (the sample) to the general (the population). However, to avoid improper inferences, you'll need to define the population carefully and use an appropriate probability sampling technique.

VII CONCLUSION

Over the last 50 years statistics education has grown "from a narrow focus on training professional staff for government departments, to a movement which stretches downward into the primary and even the kindergarten programmes, and outwards, through training for a wide range of academic and technical disciplines, to programmes of adult or community education" Consequently, statistics education has few boundaries and is appropriate for students at elementary, secondary, and tertiary levels of education and beyond. However, in today's modern world, much work involving data collection and data analysis is being conducted by non-statisticians, many of whom have little knowledge of the range of appropriate methods of data collection, are unaware of the basic assumptions underlying the statistical methods of analysis they choose, and are unable to provide sensible interpretations of the results of their analyses. Only a relatively small proportion of datasets are collected and analyzed by professional statisticians. This situation is the result of the failure in the past of statistical communities worldwide to assert themselves and convince government authorities to recognize the need for a coherent statistics education curriculum. It is generally recognized that mathematics is the basis of quantitative disciplines; therefore, formal learning of mathematics should begin at the elementary school level. For this reason, it is a compulsory subject for everyone in virtually all countries. We wish to submit that the learning of statistics should also begin at the elementary school level and be made part of the school curriculum for all, because as argued above, statistics now plays an essential role in developing the ability and competence of the scientist, technician, manager, government worker, and ordinary citizen to use data and information constructively and effectively

REFERENCES

[1] The following list contains references to works mentioned above and also to some other reports, books and papers. A special reference should be given to the report by Biehler (1988) which contains a more complete list of references to works in this field. See also Schleiffer (1989).

[2] Merbach, L (1990) Statistik-Praktikummitdem ZBM PC. In: F Faulbaum, R Haux and K H Jockel (eds) SOFTSTAT '89, Fortschritte der Statistik-Software

[3] BieNer, R (1988) Computers in Probability Education. Occasional Paper 108, Institut fur Didaktik der Mathematk der Universitat Bielefeld.

[4] Biehler, R and Rach. W (1990) Software tools for statistical data analysis in education and teacher training? In: F Faulbaum, R Haux and K H Jockel (eds) SOFTSTAT '89, Fortschritte der Statistik-Software 2. Guskav Fischer Verlag, Stuttgart, New York.

[5] Bowman. A W and Robinson, D R (1990) Teaching statistics: Microcomputer graphics and computer illustrated texts. In: F Faulbaum, R Haux. K H Jockel (eds) SOFTSTAT '89. Fortschritte der Statistik-Sof~are 2. Gustav Fischer Verlag. Stuttgart, New York.