

IMPROVING TEACHING AND CAPACITY IN STATISTICS EDUCATION: THE CASE OF GHANA

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This paper aims to contribute to the statistics education literature by reflecting on key issues in developing educational capacity in statistics education in the context of a developing country, using Ghana as a reference. The paper further compares statistics education at the various levels (basic education, secondary education tertiary education.) of education in Ghana. The paper examines the implications for incorporating computer-based training (statistical software) for future research needs and the role of collaborations in improving capacity in developing countries in general, and Ghana in particular.

INTRODUCTION

According to Zewotir and North (2011), statistical topics have been introduced during school education in many countries over the last few decades. Statistics is seen as a vital topic since future citizens in all countries should be able to orient themselves in a data-driven world and hence possess skills and understanding of issues in data collection, organization, analysis or interpretation. The eventual objective of teaching statistics is to nurture citizens thinking capacities about data and constructing educative conclusions built on numerical evidence. Thus, the analysis of data will enhance and contribute enormously to the optimization of school results, and this is a movement that is growing more and more. This is because statistics applied to education is a tool capable of helping administrators and teachers when faced with challenges inside and outside the classroom. It is used for efficient management, differentiated assessment, personalized teaching, as well as determination of school dropout rate.

Again a study as cited by North, D., Gal, I. & Zewotir, T.(2014), indicated that, the need to attend to statistical knowledge has been recognized around the world and many countries have introduced statistics or data analysis (or related topics under labels such as data handling or stochastic or chance) as a topic in national curricula for numerous grade levels. Yet, this does not mean that statistics is actually being taught, or taught well, to all students. In most countries, mathematics teachers are tasked with teaching statistics, but they do not necessarily have the knowledge required to do so (Stohl, 2005). Comparatively little is known about attempts to improving teaching and capacity building for statistics education in developing countries like Ghana, or about factors affecting the quality of statistics education in such countries.

In the light of the above, this paper aims to contribute to the statistics education literature by examining three issues. First, we reflect on key issues in developing educational capacity in statistics education in the context of a developing country, using Ghana as a particular reference. Second, we briefly compare statistics education at the various levels of education in Ghana in relation to three levels viz: basic education (kindergarten, primary school, and junior high school), senior high education (upper secondary school, technical and vocational education) and tertiary education (universities, polytechnics and colleges). Education is compulsory between the ages of four and 15 (basic education). The language of instruction is mainly English. Lastly, we discuss implications for incorporating computer-based training (statistical software) for future research needs and the role of collaborations in improving capacity in developing countries in general, and Ghana in particular.

CAPACITY BUILDING IN STATISTICS EDUCATION IN GHANA

In the Ghanaian context, there is a ministry of education whose overall assignment is to set national policies, norms and standards throughout the system including the particular responsibility for tertiary education (i.e., post-secondary education). The present situation is that the facility of

statistics within the school system is strikingly unbalanced. At the primary school level, the syllabus for Primary and Junior High schools includes topics: collecting and handling data and statistics, which focuses on gathering and presenting information, simple pictorial graphs, column or bar graphs, and pie charts. In Senior High schools(SHS), SHS 1 and 2 consider the following topics in statistics:

Statistics I: (organizing data in frequency tables (i.e. ungrouped and grouped), read, interpret, and draw simple inferences from data/information presented in tables, represent data on a suitable graph and interpret given graphs and calculate the mean using appropriate formula).

Statistics II: (draw a histogram for given data, calculate the mean of a given data, draw cumulative frequency curves (Ogive) and interpret them, calculate and interpret standard deviation and variance of ungrouped data).

Lessons on probability taught in the SHS is continued in

Mathematics (Elective) : SHS 1 to 3 include (define probability as ratio of number(s) in an event to number(s) in the sample space, distinguish between mutually exclusive and independent events, calculate simple conditional probabilities, use idea of combination to calculate simple probabilities, use binomial distribution to calculate simple probabilities, draw the scatter diagram for a given data , identify and explain the various forms of correlation, draw the line of best fit and use it to predict one variable given the other, calculate the correlation coefficient by ranking, and interpret correlation coefficients).

These intended broad objectives are not achieved resulting in low understanding of the statistical concepts leading to undesired outcomes.

A consequence of the inadequate training in Statistics topics at basic and senior high school levels gave rise to the poor performance of students in mathematics at those levels. In the BECE reports, (2013, 2014 & 2015) the Chief Examiners reported that candidates could not or were unable to work out probability questions, as well as to read values correctly from graph, thus contributed to low performances in Mathematics. Also, the Chief Examiners reports, (2014, 2015, & 2016) for WAEC-Ghana, featured prominently the inability of students sitting for WASCE exams to solve probability related problems and problems involving permutation of events, this partly contributed to the unsatisfactory performance in Mathematics for said years.

Evidently, the teaching of statistics at school level in Ghana appears to share the same approach as some of the European countries reviewed by Holmes (1994). At the tertiary level, statistics courses up to at least first degree (bachelor) level are offered by most of the public/ private universities in Ghana, with the better endowed institutions offering MPhil/MSc and PhD programs. Courses in applied statistics are also provided for students pursuing majors in education, psychology, sociology, business studies, medicine, and natural sciences in these universities.

Although statistics education has been a concern for statisticians over a century, it was only following the establishment of the Educational Committee within the International Statistical Institute at the end of 1948 that serious efforts began to stimulate international research and debate on the needs for education and training in statistics, as well as measures and programs to meet these needs. A detailed survey of how actively this committee and its recent successor, the International Association for Statistical Education, took up this challenge appears in Vere-Jones (1995).

In this paper, examination of the role of technology in statistics education from the viewpoint of a developing country was considered. Firstly, a brief overview of the developing region in question. Secondly, provide a definition of statistics education which, in the view of this article, may be used to identify in general who needs statistics education, who should provide it, and at what level statistics education should begin.

The role of statistics education was explored in relation to three broad areas where it plays an important role, namely, in business and industry, some aspects of government, and overall socioeconomic and scientific progress. Following these, technologies for effective teaching and learning statistics at different levels were explored. This paper ends with a discussion of the questions to be addressed regarding the role of technology in statistics education. Again, the education system

aims to provide "equal opportunities to all irrespective of race, colour, sex, class, language, age, religion, geographical location, political or other opinion" and is directed toward "the full development of the individual and the community" (African National Congress, 1994, p. 60).

STATISTICS EDUCATION

The term statistics is used to mean the branch of scientific method that deals with the study of the theory and practice of data collection, data description and analysis, and the making of statistical inferences. It follows, therefore, that statistics education refers to the art of, guiding, facilitating, assisting or teaching and learning these statistical activities. In this definition, data collection is taken to comprise both the design and execution of data collection activities as well as data editing; data description refers to the summarizing data by quantitative measures of central tendency, including weighted indexes, measures of dispersion, or by means of tables and frequency distributions or pictorial means such as histograms, line graphs, bar graphs, pie charts, and so on. Data analysis refers to exploring data tables, trends, and shapes, as well as statistical modeling; statistical inference refers to point and interval estimation and hypothesis testing, as well as decision theory in so far as the latter deals with the set of actions or decisions open to the statistician.

To all and sundry, statistics is regarded as a branch of the older discipline of mathematics and takes its place alongside analysis, calculus, number theory, topology, and so on. This view, parallel to the idea that statistics education is a component of mathematics education. Recently, however, statistics education has come of age (Vere-Jones, 1995) and it is recognized internationally as an identifiable and important field of knowledge, one which is not simply a subset of either statistics or education. It is certainly more than "methodology" and embraces such important matters as the nature of statistics, its place in human life, its function in schooling, how students acquire statistical concepts, as well as strategies for teaching and learning statistics and evaluating the results. With this in mind, together with the insights afforded by the mathematics education community (e.g., Burton, 1978; Howson, 1977), this paper suggests that the art of teaching and learning in our definition of statistics education should additionally include activities that attempt to:

- Understand how statistical methods are created, developed, learned, communicated, and taught most effectively at different levels of schooling, student ability, student attitude, and student needs.
- Design statistics curricula that recognizes the numerous constraints induced by the students, their society, and its educational system.
- Effect changes in curricula (where curricula are taken to include not only content, but also teaching methods and procedures for assessment and evaluation).

From the preceding definition of statistics education, this article confidently identifies the wider issues involved in statistics education in a modern society. In turn, this allows us to put forward fundamental reasons for introducing statistics to learners from the primary level through the tertiary level. This sets the stage for addressing the question of effective means of improving teaching and capacity in statistics education both the theory and practice of statistics. Statistics education should involve making statistics education fun by using models such as cartoons and songs to improve student learning at the basic levels to whip up the interest in learning the subject.

CONCLUSION

Over the 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 programme, and outwards, through training for a wide range of academic and technical disciplines, to programmes of adult or community education" (Vere-Jones, 1995, p. 16). Accordingly, 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 nonstatisticians, 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 propose 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.

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