

## **AN EVALUATION STUDY OF THE PROCESS OF REFORM OF STATISTICS TEACHING AT THE SECONDARY LEVEL IN BENIN: ASSESSMENT AND PERSPECTIVES**

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*The introduction of statistics training course in the secondary school since 1996, has hardly met success. This laudable initiative should help pupils to complete their secondary school education in good conditions. The curricula supported by basic concepts and notions of descriptive statistics are progressively scheduled from third to sixth form in order to provide pupils the faculty to develop reasoning and judgement skills. But unfortunately, 10 years after its launching, we are compelled to notice that there are still serious problems at the secondary school authorities, teachers and pupil's levels. Consequently, all those factors create a lack of rigour in the implementation of the program. The paper strongly suggests some proposals and recommendations in direction of all the actors concerned by the secondary school educational system. Applied, such suggestions should improve the consideration for statistics and give pupils the opportunity to become statisticians in the future.*

### **INTRODUCTION**

The public educational system in the Republic of Benin has crossed various steps, especially during the years 80s with the "New school" program implemented by the Marxist-leninist revolutionary political government. As a result, there is a change in the school curricula leads to the decrease of the level, the non recognition of the diploma delivered by this educational process. In the nineties, with the renewal of the democratic system, the necessity to improve school curricula appeared. Statistics course have been introduced as part of mathematics course from third to sixth forms by authorities in the secondary school level. After some 5 years of implementation with the help of the partners in development of Benin educational system, during which some mathematics teachers have been trained to the teaching of statistics, the new program has been implemented in 1996. Ten years since the beginning up of this process, it is important to evaluate its success, its insufficiency and formulate some recommendations to improve it.

First of all, the process of elaboration and the content of the curricula will be analysed. Then, in the assessment, the brakes of the functioning will be showed. The opinion of teachers and pupils have been collected and analyzed. As a result of this investigation near teachers, two factors appear to have non negligible influence on their productivity: the disconnection between their own training environment (mathematics) and the statistics teaching and the distance between acquired notions and those to be teaching.

The analysis of all those aspects related to the actors of the educational system is of a great help to identify problems and to consider the perspectives of improvement of statistics teaching at the secondary school level by mathematics teachers. That is the specific objective of the recommendations. At the era of the World Wide Web, the introduction of Information and Communication Technology is an element of first importance; this means the priority of modeling and applying development by using computer laboratory tools, web based applications and tools, statistical software, etc. adapted to pupils' environment should be salutary.

### **REFORM OF MATHEMATICS CURRICULA AND INSERTION OF STATISTICS COURSE**

#### *Processes of Elaboration of the Mathematics Curricula in the Secondary School*

The course of mathematics is taught following a curriculum defined by specialists of the National Institute for Training and Research in Education and experienced mathematics teachers. This Institute which is under the authority of the Elementary and Secondary Education Ministry identifies a co-coordinator who is in charge to manage the works of the group of experts.

With the democratic process started earlier in the nineties, and in order to break with the "revolutionary period educational system," a reform of the educational system has been implemented and one of its issues is the insertion of statistics topics in the mathematics curricula

at the secondary school educational level from the third to the sixth form. The reform has got many advantages among which the technical and financial assistance of the United States Agency for International Development through several projects. The current curriculum has been implemented since 1993 with a revised distribution of hours by disciplines. So, the part of mathematic course in the hourly distributions to other discipline is around 20% whatever the form. The teaching of statistics elementary knowledge and concepts, in a first time as experimental process in 1993 has been formalized in 1996 within the project of harmonization of Mathematics curricula in the French speaking language countries of Africa and Indian Ocean. By taking into account the current level of research in didactic of mathematics, these curricula aim at adjusting the dysfunctions of the previous curricula.

The mathematics course follows two axes that are geometric and numeration activities. The chapter on statistics is integrated as a part of the last aspect and introduces preliminary notions of descriptive statistics from third to fourth form, and deep notions appear in upper forms.

The main objectives of the statistics course are to:

- insure the continuity and the progressiveness with notions acquired in the elementary school or the years before;
- give sense and content to the concepts taught in order to give pupils the possibility to draw link with current life situations;
- initiate pupils in relation with their level to the reasoning and judgment spirit;
- get pupils active in order to make them develop individual working and argumentation; capabilities, indeed even autonomy capabilities, and to
- adapt the teaching to the socio-cultural environment of the pupil.

#### *Content of the Statistics Course in Mathematics Curricula*

The curricula are elaborated in order to ensure continuity from a level to another and to progressively give essential notions to pupils. Statistics is introduced in the third form with simple descriptive statistics concepts such as: basic definitions, variable, range, mean, mode, etc.

In fourth form, the statistics course covers the chapter four of numeric activities. This chapter is intended to provide a remind of notions more or less studied in third form and to make clear that in every statistical study, the following three steps are essential: organization of data, processing data, graphic representation of data. It is important to notice yet here that the use of scientific calculator appears as essential for pupils. But do they all often have means to buy one? Do teachers have really some time to organize some exercises, in order to make them taking the habit of use of this tool? Such questions will have some answers in the following.

According to the distribution of the fourth form curriculum of mathematics, it appears that only five hours are given to the chapter on statistics over the 118, let be 4.24%. The notions to be taught are the grouping of set of data in classes of equal range and the draw of histograms.

The curriculum of the fourth form is organized in continuity with that of the third form as following: I Recall (1. Vocabulary; 2. Data organization; 3. Modal, Mean; 4. Representation of the modalities of a statistic series); II Size and cumulated frequencies; III Grouping in classes (1. Procedure; 2. Modal class; 3. Representation by diagrams); IV Recapitulation exercises.

Thus, that is both notions grouped in 3 sections (the first a revision of the third form) that the pupil is supposed to assimilate in 5 hours. This situation shows yet a view of some of the problems that teachers and pupils are facing. Generally, the statistics course included in the mathematics curricula should enable the pupil to assimilate notions apparently difficult but which nevertheless are parts of their current life.

As what shows the table below, the curricula of fifth form gives to the pupil the occasion to work with the concepts learned the years before as well for the data organization as for their representation. Afterwards, new characteristics of a statistics series are introduced as well as new types of representations. In the same way, the curricula of lower sixth increase the ranking of data in sizes of statistics series, the graphic representation and then strengthen with the concept of numbers and cumulated frequencies, position characteristics (modal class, mode, mean, median, class density). The chapter ends on more complex notions of dispersion characteristics that are the variance, standard deviation regression and correlation.

Table 1: Highlights of the statistics of statistics curricula in secondary school

<i>Form</i>	<i>Curricula</i>
<i>Third</i>	1. Organization of data; 2. Treatment of data (Modal, Mean, Median); 3. Graphic representation of data.
<i>Fourth</i>	1. Study of qualitative variable; 2. Study of Quantitative variable; 3. Grouping data into classes.
<i>Fifth</i>	1. Statistics series presentation; 2. Graphic representation; 3. Measures of central tendency and dispersion.
<i>Sixth (lower)</i>	1. Constructing a frequency distribution; 2. Characteristics of statistics series grouped into classes; 3. Introduction to bivariate data.
<i>Sixth (upper)</i>	1. Bivariate data; 2. Graphic representation; 3. Adjustment and linear correlation.

Ten years after the starting of this process, it appears necessary to make an evaluation that will contribute to its improvement through 3 aspects: 1) difficulties due to the structural environment; 2) analysis of the teachers' difficulties; 3) evaluation of learners' problems.

## EVALUATION OF THE STATISTICS TEACHING AT THE SECONDARY SCHOOL

### *The Structural Handicap to the Success of Statistics Teaching in Secondary School*

First of all, it is capital to look into the appropriateness between the statistics notions and concepts to be taught and the timetable allowed. As had shown the example of fourth form level curriculum, only 4.24% of the mathematics course timetable are intended to statistics. In addition, in several schools, and that is general in both private and public education, this minimum is not observed. The main causes of this situation are:

- lack of infrastructures such as laboratories, didactic materials, libraries and computers in most of the schools;
- lack of qualified teachers in mathematics. Then, some college authorities decide to divide the time allocated to mathematics in two or more;
- lack of means or the need to have the maximum of profit often conduct school authorities not to respect the official and recommended timetable;
- secondary school authorities don't take enough time to implement the new program. As a result, since the beginning of this new program, many schools don't really teach the statistics program and there is no control.

For example, a study in a sample of colleges of Cotonou shows that whatever the form, there is automatically a diminution of hourly mass, particularly in scientific disciplines. As a result, in most of the cases, the chapter of statistics is not really taught. And the secondary school authorities do not have any system of control of the statistics course taught in those schools. There is also a problem of adequacy of the curricula of mathematics (particularly statistics) with what is taught in developed countries. It is really a great problem that penalises those of the pupils who choose to continue their studies in foreign universities after completing school education.

Another important problem is the respect of the academic program of studies. In fact, each year in Benin, there are many teachers' strikes and this stops courses at least for more than 20% of the school year. Particularly, the last four years (2001-2005) the crisis was very hard with an interruption of courses representing between 40 and 80% of the school year.

### *Problems with Mathematics Teachers*

Before starting the new mathematics program, teachers were not sufficiently prepared, and the lack of mathematics teachers is crucial in the country. Teacher's preparation is very important in the success of the new program implemented since 1996. Two problems are basically crucial to resolve. First, most of teachers don't follow solid statistics and probability courses (value units) in their own training. Therefore, they have some handicap to teach the chapters concerning statistics in their classes, since they haven't been well prepared to do so. Of course, with the help of partners of developed countries, such as United States Agency for

International Development (USAID), the secondary school authorities through the Training and Research in Education Institute trained some of them. But this training is just a workshop to give them directions about how to teach the curricula. Not only a few of them took benefits of this assistance, but scarcely have they started the statistics chapters in their classes or superficially they do it. The great majority of those who do not have the background to teach statistics ignore the statistics curricula or they do not take into account the basic concepts and notions.

The second problem concerns the remuneration of teachers. In fact the majority of school authorities don't pay consequently their employees. Then, these one choose to intervene in two, three or more schools in order to maximise their outcome. So they can't have enough time to prepare and concentrate themselves efficiently on their courses.

According to the sample study realised in one of the greatest schools of Cotonou, the General Secondary College Aupiais, more than 70% of mathematics teachers recognized that they have difficulties to teach statistics, even if most of them think that these difficulties concern the pupils and the discipline. In fact, they think that statistics is more abstraction than reality and that it is not so easy to introduce the concepts and notions to the learners by taking examples of their current life. Also, they don't receive recycling training in order to improve their results and don't have access to recent publications in the field.

Most of colleges in Benin don't have access to informatics (such as computer laboratories) and even if some of the teachers know internet, they use it just-when time is available- to send and to receive e-mail, but not to do research concerning teaching mathematics or statistics, having information about curricula in other countries for example. And they are scarcely informed about statistical software. Fortunately, the college Aupiais, with the assistance of a local Non Governmental Organization is enough advanced in setting a laboratory of 80 computers with approximately 1800 pupils, let be at least 22 pupils per computer.

#### *Problems Related to the Learners*

Statistics concepts and notions are new for most of the pupils in the secondary school. So they are not enough prepared to receive and to assimilate them. In addition, the inappropriate qualification of some teachers conducts pupils to neglect this noble discipline. Nevertheless, nowadays with the context of globalisation of affairs, pupils are facing a sound quantity of data coming from different environments. Since then, statistics become part of people current life, from elementary to secondary school.

The sample study near pupils of college Aupiais shows that most of them can't even define the word statistics. And according to popular adage, statistics is abstraction, not technique, not real such as medicine, physics, biology and statisticians are viewed as dreamers etc. So that, pupils neglect the course. Some of them don't follow the course or don't participate actively to it. They also take into account the topics of their curricula that are not evaluated. For example in fourth form, since 1999 at least, the subject of mathematics at the GSCE certificate has one exercise on statistics chapter. Then pupils pay more attention to follow it as revealed the study. But, the situation is different in the other classes such as upper sixth form. Pupils have noticed that they never have questions on statistics at school leaving certificate. So they don't hesitate to give to the probability of occurrence of statistics item the score epsilon, for not say zero. So doing (and they are doing a kind of statistics and probability), they don't take care to the statistics topics in their curricula.

According to the study in college Aupiais, whatever the form, more than 70% of pupils can't give a clear idea of statistics. They have no interest in the course. They don't even realise that the marks they need to pass is obtained by statistical operation: the arithmetic or weighted means of their marks by discipline depending on the form.

The concepts and notions they have most difficulties to assimilate are among others: linear regression and correlation, standard deviation, variance, ranking set of data into classes of frequencies and calculation of central tendency; characteristics such as modal class, median, mean etc., graphic representations: circle diagrams, histograms ...

The real problem of pupils is to understand the meaning of the concepts. They need to interpret, to comment the results of calculations. They scarcely understand the usefulness of statistics in the other areas of their studies or their life. They also assert that teachers don't address

the course in a manner they can easily understand or be passionate. When the learner seems to have in front of him someone who is not convincing of his art, it is not simple for him to be interested. The access to computer science at the 21<sup>st</sup> century era is still a crucial problem. Less than 30% of schools insert computer course in their curricula. Between 5 and 45% of pupils (depending on schools and on regions in the country) have access to the internet in the public cybercafés. But, unfortunately most of them prefer surfing pornographic sites. For instance, few of them are interested in efficiently using this helpful technology to improve their knowledge.

**PROPOSALS AND RECOMMENDATIONS TO IMPROVE STATISTICS TEACHING AT THE SECONDARY SCHOOL LEVEL**

These recommendations are some tentative to find solutions to the problems related to the statistics teaching in secondary school in Benin. First, proposals should be addressed to the institutional authorities and headmasters of colleges. Then some ideas should be voiced in direction of teachers and pupils.

Authorities of the secondary school level have to implement a system of monitoring and evaluation of the teaching in schools. This system will intend to verify the effectiveness of hourly timetable applied by school responsible and teachers reevaluate the statistics curricula in concert with the National Statistical Council. The authorities with the assistance of partners should build relevant and appropriated infrastructures to strengthen statistics teaching in Benin.

Teachers should receive scholarships in order to strengthen their ability to teach mathematics and particularly statistics. It is important to create consistent value units in statistics and probability at university for mathematics teachers. Another crucial point is to pay interesting substantial wages to teachers in order to motivate them and to increase their results.

The assistance of partners in development should provide schools in didactic and pedagogic manuals and take into account the retraining course for teachers and allow them to share experiences with their colleagues of developed countries. Teaching the chapters on statistics earlier in the school year and explaining the openings of statistics professions should be a factor of motivation and incitation for pupils. For example, the National Institute for Training and Research in Education should, with the help of specialists, edit pedagogic and didactic manuals for teacher’s orientation. These manuals must assist them in approaching statistics concepts and notions in a way to eliminate the anxiety often associated to statistics by pupils. In the manuals, a certain number of aspects should be emphasized. At the begining of the course or of any basic concept, a set of goals must inform pupils of what they should be able to do after completing them. Simple examples with detailed solutions are useful for pupils just afer introduction of statistical techniques. Definitions and formulas should be boxed or highlighted in color for emphasis.

The exercises should follow with an increase in the level of difficulties. First, simple exercises should give pupils the opportunity to work on problems similar to the course examples and then more complexious exercises based on real-world situations should improve their understanding. Finally, one or two computer data exercises should help pupils to have skills during laboratory workshops, with the use of statistical software or others tools.

Table 2: Proposal of pupils’ evaluation scheme

<i>Types of evaluation</i>	<i>Objectives</i>
Direct application exercises	The aim is to bring pupil having automatically comprehension of notions and concepts teaching
Consolidation exercises	Bring pupils having more complex examples based on real-world and their environment
Computer laboratory studies	Bring pupils familiar with computer science and having adapted ICT skills

The assistance of partners in development should also and especially be used to provide schools in appropriate documentation rooms and computer laboratories. To annihilate the lack of interest in statistics course from pupils, it is important for teachers to introduce the course by

using example from their own socio-cultural environment and to make them actively participate to the lessons by finding examples from their current life to illustrate the concepts and notions they learn. Then they can acquire skills in interpreting, analyzing and commenting statistics observations according to their level of course. At the era of Information and Communication Technology, pupils should be-and that is crucial- initiated to computers and to internet. They should have some notions of statistical software and workshops in laboratories should be developed to give them easiest comprehension of statistics. Several studies show how it is useful to introduce software learning to teach statistical concepts. Nowadays, with development of computer sciences and new technologies for information and communication, it is very useful to introduce software learning to teach statistical concepts.

The approach of development of visualization tools has the advantage to put statistical science more easy, more accessible and understandable to the pupil. Sometimes, and even often, pupils want to stress visuals displays rather than numbers, equations, and formulas. Then, the concern is to choose the most suitable software that will promote active self-discovery learning, i.e., inductive learning, as well as to support the instructor in the traditional lecture or laboratory setting, i.e., deductive learning. By improving this association of software in statistic teaching, experimentation will be encouraged and can use replication to stimulate the “experimental” side of statistics. These same features can be effectively used by the teachers in the classroom or the computer laboratory. The teacher can use a software module to illustrate a concept such as the relationship between two variables (correlation regression analysis), between the central tendency measures (mean, mode, median) etc. Therefore, the concept can be reinforced with a simulation experiment. The schools must develop research journals for the higher forms. The development of the technologies of information and communication must be used as well as possible. With the World Wide Web, and teachers can, for example, exchange their views about subjects, by electronic mail (e-mail). Teachers can also use the news groups in order to discuss precise themes. They can exchange files; it is easy to seek to consult and order a book.

## CONCLUSION

In the nineties, the secondary school authorities have implemented since 1996, new mathematics curricula including statistics through the project of harmonization of mathematics curricula in african and indian ocean frenchspeaking language countries. Descriptive statistics course has been inserted in the educational system from third to sixth form. Ten years after, the assessment evaluation of this program is not so promising since several crucial problems have been picked out and are related to the following main actors of the system: authorities, teachers and pupils.

First, secondary school authorities have to monitor the teaching of statistics, increase the teaching conditions, and provide schools with adapted and necessary infrastructures and technology. Then teachers have to improve their level and qualification and particularly the way they introduce statistics course and address the training to pupils. Finally, pupils themselves have to change their behaviour towards statistics and take actively part to the course. So, the use of information and communication technology and the assistance of partners into development should considerably strengthen statistics course training in secondary school educational system.

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