Effectiveness measure of an educational system.

The Senegalese Case

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Abstract: Many governments, having large pain to balance their budget, note a strong disparity between their efforts in favour of education on the one hand and, on the other hand, the result of this effort, which can be measured by the proportion of well trained pupils or by the general instruction level of the population. It is this observation which places the problem of the effectiveness of teaching at the centre of the research tasks. It imports us here to see in what extent the objectives laid down for the education system are reached. With this intention, we will try to go further than the usual indicators, like the rates of success to the examinations or rates of completion, in order to apprehend better the effectiveness of the educational system.

Key words: Education, indicator, objective, school effectiveness, statistics of education, Senegal.

Résumé :
Beaucoup de gouvernements, ayant grand peine à équilibrer leur budget, constate une forte disparité entre leurs efforts en faveur de l'éducation d'une part et, d'autre part, le résultat de cet effort, qu'on peut mesurer au nombre d'élèves bien formés ou/et au niveau général de l'instruction de la population. C'est cette constatation qui place le problème de **l'efficacité** de l'enseignement au centre des travaux de recherche pédagogique dans les pays industrialisés.
Il nous importe dans l'article qui suit de voir dans quelle mesure les objectifs fixés pour le système éducatif sont-ils atteints. Pour ce faire, nous essayerons d'aller au-delà des indicateurs habituels, comme les taux de réussite aux examens ou taux d'achèvement, pour mieux appréhender l'efficacité

Mots-clés : Éducation, indicateur, objectif, efficacité scolaire, statistique de l'éducation, Sénégal.

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Introduction.

One notes over the past few years a renewed interest on efforts to promote education. We realize more and more clearly that, especially in developing countries, educational investments play a crucial role in the economic and social development of the nation. Education statistics reflect the struggle through the world to spread education and improve its quality.

However, this documentation concerns more the financial and human resources than the statistical performances of educational system. That is because many governments, which have difficulties in balancing their budgets, note a sharp disparity between their efforts to promote education on the one hand and, on the other hand, the results of this effort measurable in terms of number of students trained or the general level of education reached by the population. This finding places the issue of effectiveness and efficiency of expenditure at the center of research in education (Levin Henry M. (1983)).

There is no doubt that this topic can be tackled in quantitative or qualitative terms. But here we try to know the proportion of persons who left school successfully. That is to say, the number of those who carried out the length of schooling required and acquired the level of cognitive skills expected in the group hosted at the school.

To examine this problem, in order to determine student skills at some level, the external evaluations are often used. Some countries take part in international tests for the establishment of comparable indicators. Those of International Association for the Evaluation of Educational Achievement (IEA) trying, since 1964, to gauge the level of students knowledge in mathematics (First International Mathematic study: FIMS), and those of OECD, named PISA (Program for International Monitoring Student Assessment) are the most famous. We can add to these ones, the CONFEMEN evaluations (Conference of the Ministers for the education of the countries having French in share), concerning a group of French-speaking African countries. Tests in mathematics and French, involving students from five French-speaking African countries, (See Fig Vbis annexed) show that, only one over three Senegalese pupil (30.77%) acquires the minimum basic knowledge at the end of primary school. That is to say, they are the weakest pupils among those tested from the five countries. Hence, we can say that a good school enrolment does not necessarily mean a good proportion of well trained pupils (Katharina Michaelowa, 2001).

These standardized tests, despite the criticism, permit to have ideas about the skill levels of pupils from different countries, which is useful for comparing the educational systems. But, at the national scale we must have most accurate measures. So we have to address this issue by using the data published in the statistical yearbooks. The results of national examinations widely distributed, with some assumptions, can help to produce better scholar indicators.

For example, if we consider that the certificate of elementary education completion (CFEE) as a real indicator of competency level, that the pupils who obtained this graduate are definitively able to read, to write, to count and to speak correctly, we can estimate the number searched by the number of certified pupils by generation. From this hypothesis, one could evaluate the performance of the educational system at the

elementary level to measure the effectiveness of a school system. That is to see in what extent the School achieved its objectives. These ones are defined from educational aims of the nation. At this level, the school must contribute to the formation of a "social being" by giving the children the minimum knowledge and skills to facilitate their social integration. From this point of view, the School, as a project of society, varies necessarily from a country to another.

In order to build indicators related to the proportion educated within a population, one considers training as a statistical process (Philippe Hugon, 1972). So, to measure the effectiveness of a school system, we must assess its performance at each stage. This can be done with the methods approved in term of statistic. Therefore, we begin this article with the presentation of a method largely used in the similar cases: Reconstructed Cohort Method. After that, we expose the flux models, the data processing and we finish by applying the found model on Senegal.

2) Reconstituted Cohort Method (Unesco IBE. 1972)

At beginning, we suppose, in a given year, that a group of young people,named cohort, enters the education system, . If we want to know all about the schooling of these youths, we have to follow this cohort throughout its life. That is to say, we must follow all the members from the first day of the cohort in the school until his last one. Obviously, it would be, for most countries, too laborious and very expensive to follow in this manner the schooling of a group. In addition, official statistics of education give rarely elements about a life of a cohort ; often they contain only data about the number of students, including repeaters, distributed by grade and school year. The Reconstituted Cohort Method, to study the story of a students group starting their training at the same time, the computer science helping, enables one to escape this difficulty (Unesco, 1975). The basic theory of this method is now very well understood. The school system is regarded here as a series of activities represented by a flow chart.

3) Representation System

The system is based on a need to provide education in order to facilitate the life in society and to make the members of this society accepting the ideal of common life. Thus, crossing the offer, constituted by the number of places available, with the number of applications to get in school, gives the number of registered children (see fig.1). From there, the process begins with the training. During this process, the initial number of pupils might decrease as a result of a habitation change, the needs of help from the parents, for natural reasons (illness, death,...) or as a result of parents decisions who are not satisfied by the given education. We have to note that the latest reason might be attributed to the system.

At the end of the school year, the council of teachers, taking into account the opinion of the departmental inspection, decides from the results of the pupil, whether he should be promoted, permitted to repeat or excluded. Hence, the enrollment of the following year would be composed by promoted pupils, repeaters and some new entrants. Knowing that, all the "failures" are not attributable to the system, we consider here only three possible outcomes for the process of education.

A) Promotion,

B) Repetition of a study level

C) Exclusion.

In many countries the number of repetitions is limited; often it can't be more than two times for cycle. Here we take into account this reality.

As we see, one assumes that all the above events are mathematically functions of teacher judgment and other factors which can't be measured exactly. Hence, the events A, B, C can be taken as random. Therefore, one can reasonably approximate the measure of these events in terms of probabilities:

$$P(A),\ P(B) \text{ et } P(C)$$

Theses probabilities are function of study year (level) and school year. Hence

$$\sum_{x\in\{A,B,C\}} p(x) = 1$$

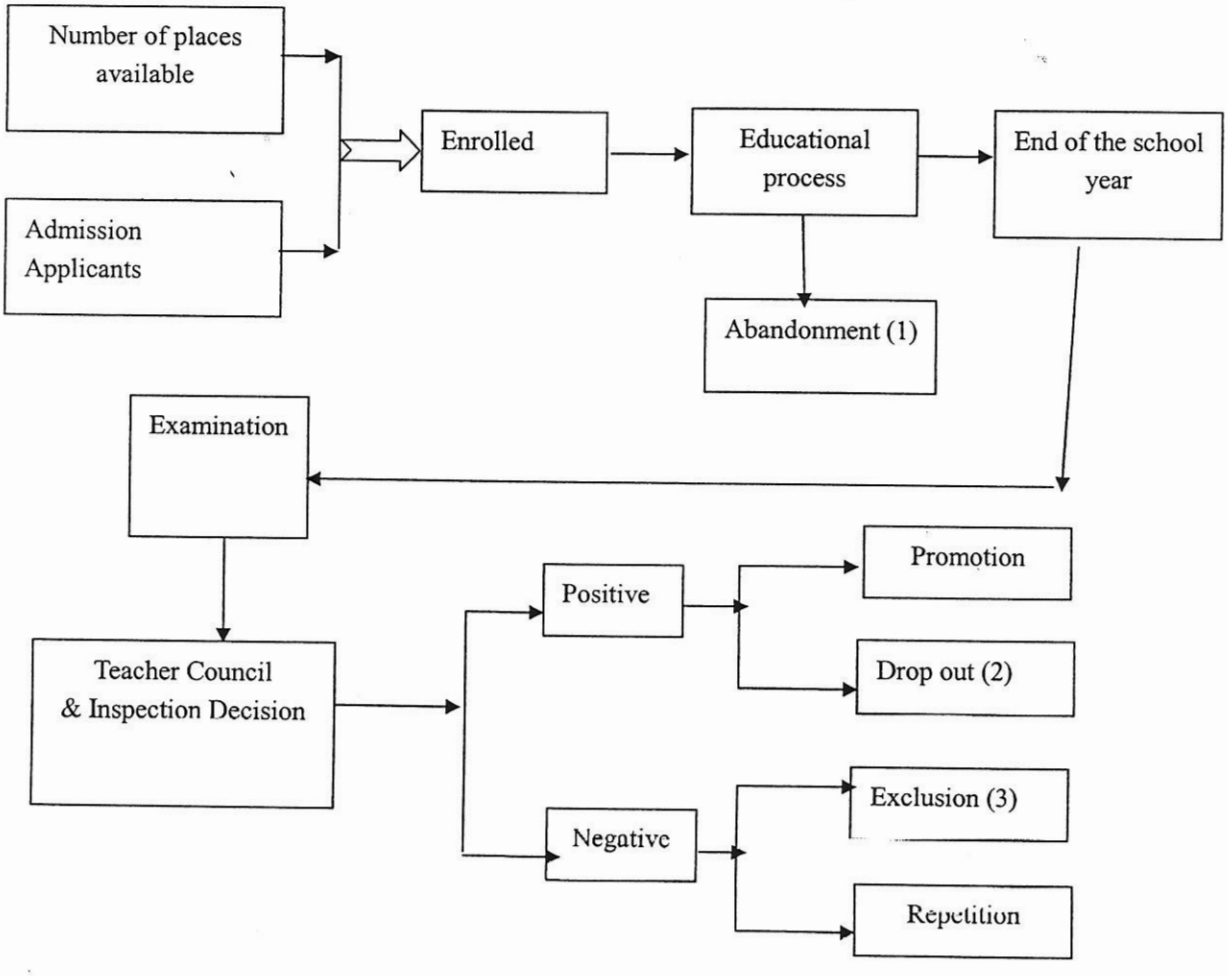
That means:

1) No student can jump a level.

2) The initial enrollment can't increase, all members of the cohort got in the school at the same year

These assumptions enable one to address mathematically the question studied.

Fig. 1: Flow diagram of an Education System



4) Mathematical model of cohort behavior

Let's suppose that a group of the pupils, having reached the level i at the school year t for a cycle with c years of studies. The parameters $P_{i,t}$; $r_{i,t}$; $d_{i,t}$, indicate respectively the rates of promotion, of repetition and that of exclusion/drop out particular to the level i for the year t.

$$s_{i,t} = \begin{cases} p_{i-1,t-1} * s_{i-1,t-1} + r_{i,t-1} * s_{i,\,t-1} & t \geq i \\ 0 & \text{sinon} \end{cases} \qquad (1)$$

Hence, knowing $s_{1,1}$, the dimension of the cohort, one can calculate by recurrence the successive enrolments. The size of the cohort at the year i registered at the c levels is:

$$s_t = \sum_{i}^{C} s_{i,t} \qquad (2)$$

The size of the cohort at the level i, for the members registered during T school years is :

$$s_i = \sum_{t}^{T} s_{i,t} \qquad (3)$$

The sum of the school years that the members of the cohort have carried out at the school:

$$K_{C,T} = \sum_{i}^{C} \sum_{t}^{T} s_{i,t} \qquad (4)$$

If the cycle counts six levels (C=6) and it is allowed to repeat at most twice (T=8), the total volume of the **pupils -years** (real inputs) consumed by the cohort will be equal to:

$$k_{6,8} = \sum_{i}^{6} \sum_{t}^{8} s_{i,t} \qquad (5)$$

The number of graduates is equal to:

$$s_d = \sum_{t=6}^{8} (1 - r_{6,t} - d_{6,t}) * s_{6,t} \qquad (6)$$

The number of pupils-years consumed by the graduates of the cohort:

$$k_d = \sum_{t=6}^{8} t * (1 - r_{6,t} - d_{6,t}) * s_{6,t} \qquad (7)$$

The number of graduates in a normal duration is equal to:

$$s_{dn} = (1 - r_{6,6} - d_{6,6}) * s_{6,6} \quad (8)$$

The number of pupils-year consumed by the graduates in a normal duration:

$$k_{dn} = (1 - r_{6,6} - d_{6,6}) * s_{6,6} * 6 \quad (9)$$

Inference

Rate of Certification (*RC*) or Gross return:

$$TC = \frac{(s_d)}{(s_{1,1})} \quad (10)$$

Net return: $$\frac{(s_{dn})}{(s_{1,1})} \quad (11)$$

Index or coefficient of inefficiency $$\frac{1}{6} \times \frac{(k_{6,8})}{(s_d)} \quad (12)$$

Cost, in duration, of the end studies certificate: $$\frac{(k_{6,8})}{(s_d)} \quad (13)$$

The Rate of Education by Generation (***REG***): $RGE = \frac{s_d}{p_{t_o,7}} = RC * RAG$ (14)

Where $p_{t_o,7}$, is the seven year old population at the year t_0 and RGA the Rate of Admission by Generation?

Indicators

From what precedes, one can estimate

- The total number of repetitions and abandonments ascribable to the system, because decided by the teacher. And one calculates then the ascribable loss with the system.
- Count of newcomers on a given level of the system, and outgoing ones from this level.
- The number of pupils-years invested on the outgoing prematurely, after a normal duration or late.
- The ratios between these various indicators to determine statistics on the system effectiveness.

4) Application to the data of Senegal

The reading of the flow matrix (Table I), resulting from the mathematical model, permits to have an idea of the formation process of the Senegalese education system. It is characterized by a very chaotic progression. The rates of loss are high.

13,5% of the group do not reach the level five(CM1), 40,4% only of them obtains the Certificate of elementary studies end (CFEE). The rhythm of the production is slow; 13.78% only of the group makes a course without fault; that is 6 years of formation, the system took 7 years to rise this ratio to 35.23% and in the long term one obtains only 40,4%. It is obvious that these performances are very poor.

Indicators of effectiveness

Since the Certificate of elementary studies end (CFEE) attests at least the acquisition of the awaited technical skills, one will measure the system with by its certification capacity. Usually, we gauge this capacity by the rate of success obtained from the examination of Certificate of elementary studies end organized at each end of school year. This last indicator is built by considering all the population of the successful candidates among those who have taken part in the examination. In this case, one doesn't know the steps of training which have led the candidates at the final stage of the formation nor their cohort. Hence, we will have some difficulties to know the behaviour of the system upstream the result of examination.

Is it a system which prepares well its candidates for the examination only? Or is it a system which takes care its pupils, in all steps of the formation, to achieve the definite goals? The time of the training being not elastic, the two systems are inevitably different. A specific evaluation at the end of the training cannot measure what is acquired during all the process. Only the intermediate results, generated by the system, make possible to answer these questions.

Table I: Estimated evolution of the pupils enrolled in Public primary education : [94-2004]

Level	CI	CP	CE1	CE2	CM1	CM2	CFEE	%	Pupils-years consumed
Scholar year									
I	290258								290258
II	50723	239535							290258
III		82550	198844						281394
IV		7111	107455	159916					274482
V			19319	115184	131150				265653
VI				31081	127358	98257	39993	13,78%	256696
VII					49183	152969	62263	21,45%	202153
VIII						36848	14998	5,17%	36848
Drop out	8864	8120	11403	10765	20586	113265	117254		
%	3,05%	2,80%	3,93%	3,71%	7,09%	39,02%	40,40%		
Progression	290258	281394	273274	261871	251105	230520	117254		1 897 741
%	100,0%	96,95%	94,15%	90,22%	86,51%	79,42%	40,40%		

The number of net useful pupils-years (k_{dn}):	239960	2,70	**Inefficiency index**
The number of useful pupils-years (k_d): :	795785	1,194	**Mean Graduates Late**
The number of pupils-years provided ($k_{6,8}$):	1897741	16,185	**Cost of Certificate**
Rate of Certification (*RC*)	40,40%	5,11	**Under graduated Mean level**
Rate of performance (RP)	13,78%	6,538	**The average duration of school stay**
the average Duration of Certification	6,79		

Reading: The principal part of the diagram shows the schooling progression, school year after school year, of a cohort of 290 258 pupils enrolled in the School. The line intituled **progression** shows the evolution of this cohort per level of studies. In the cells one indicates the number of pupils which, early or late, arrives at the given level (for example 273 274 out of 290 258 new entering, do reach the level three (CE1) whereas 8120 of them fail in the second level (CP) and leave the School...)

1) **Number of net useful pupils-year,** corresponds to the number of school years devoted to the pupils which made a normal duration (6 years) to obtain the certificate (CFEE).

2) **Useful pupils -year number,** is t the effort devoted to all the pupils succeeded in school year.

3) **pupils-year provided number;** all the effort invested on the cohort in school years

4) **the rate of certification** is the proportion of the pupils who have obtained the Certificate in a cohort

5) **rate of performance** is the proportion of the pupils who have obtained the Certificate at the end of the normal duration (6ans)

6) **the average Duration of Certification** is, on average, the number of years spent for obtaining the Certificate

7) **the index of inefficiency or rate of loss** is the relation between the effort provided to arrive at the result obtained and the minimum effort necessary for that.

8) - **The Certificate Cost,** is the equivalent, in school years, of the effort authorized on each certified.

9) - **The average duration of school stay,** it is, on average, the duration of the time passed to the school through each member of the cohort.

➢ **The Rate of Certification (RC):**

This indicator represents the proportion of the pupils who have obtained the Certificate in a cohort. It measures the certification capacity of the system. It is built from the model of behaviour allowing to follow a cohort during a given period. It is thus possible to consider the whole of the intermediate results of the system in order to measure the effect of the school establishment.

The data of **table I** mean that the number of pupils obtaining the Certificate in a cohort is lower than that the number of men who fell. In other words, the rate of failure is higher than that of certification. That is to say, if our initial postulate is preserved, those who leave the system without acquiring awaited cognitive competences are more numerous than the others. In other words, the establishments of Senegal bring to Certificate 40 pupils only out of 100 enrolled. More clearly, if one follows a group of 100 pupils since their first year to the school until the end of their eighth school year, there will be approximately only forty among them who would obtain the Certificate. At the end of normal duration, only fourteen pupils will obtain this graduate, at after seven years they will be twenty-one and five after eight school years.

This rate of production, plus the mediocrity of the output, is too slow. Let's add that, to arrive at this result, the pedagogical investment is multiplied by 2.7. Thus, considering the number of pupils who do not arrive at the end of the formation, the system resembles a factory of under products rather that other thing. Its pupils have not assimilated the entire school program. So, to go further in the search for an indicator of effectiveness, it would be better to appreciate the global effect of the school results. The measurement of the degree intensity and the diffusion of the school culture within the population would be more useful. What we can do by comparing the current production in certificate by the system to what it should be in the case of education for all, corresponding to the real need for the country in formation. In fact, the aim is, in a short term, the reduction of the difference between the proportion of certified children and that of the population to be enrolled. Otherwise, the Education For All (EFA), much preached, will be less meaning.

The Rate of Education by Generational (REG)

This indicator, complement of the precedent, enables to appreciate the power of the educational machine. Owing to the fact that, here the result is brought back not only to the proportion of children who are in the school, but to that of the population who should be there. In other word, it makes possible to measure the importance of the "good schooling" within the population.

For example, in Table II, it appears that, only one child on approximately three is certified by the public school system. This is not a surprise, being given the rate of admission by generation (RAG) and the rate of Certification (RC) (See graphic II). Meaning that the School is far, for the moment, to determine the principal national culture. If the force of the system does not vary, the raising of the educational level of the population will always revolve around 31% per generation. That is to say, the school culture will make much more time to be diffused in the country. To arrive at an instruction of completed primary education level for all in 2015, it will be necessary, at least, to have 13,5% of annual growth of certified. To reach 50% of certified per generation, one needs an annual growth of 7, 31% (See table II & IV). But these results vary from an area of the country to the other.

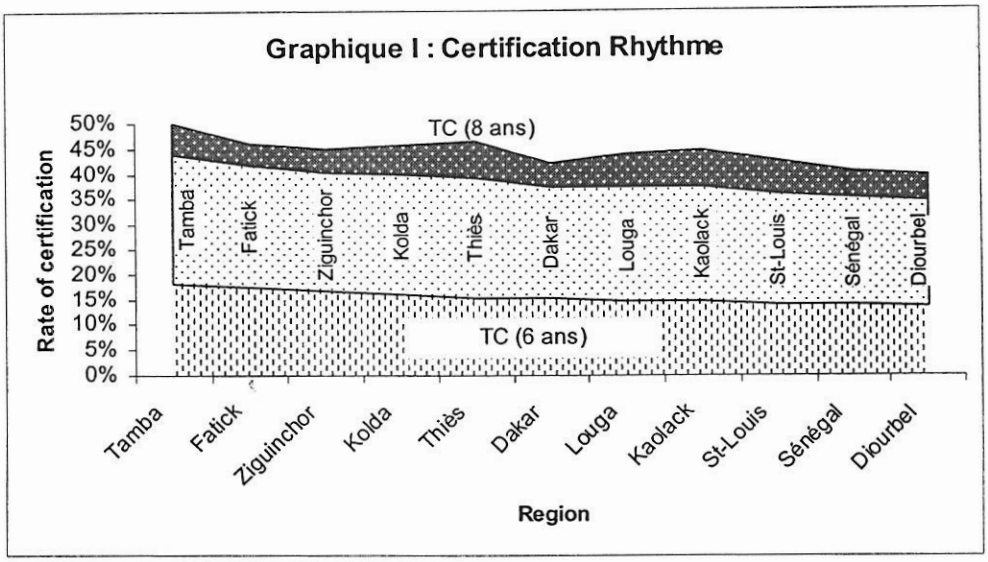
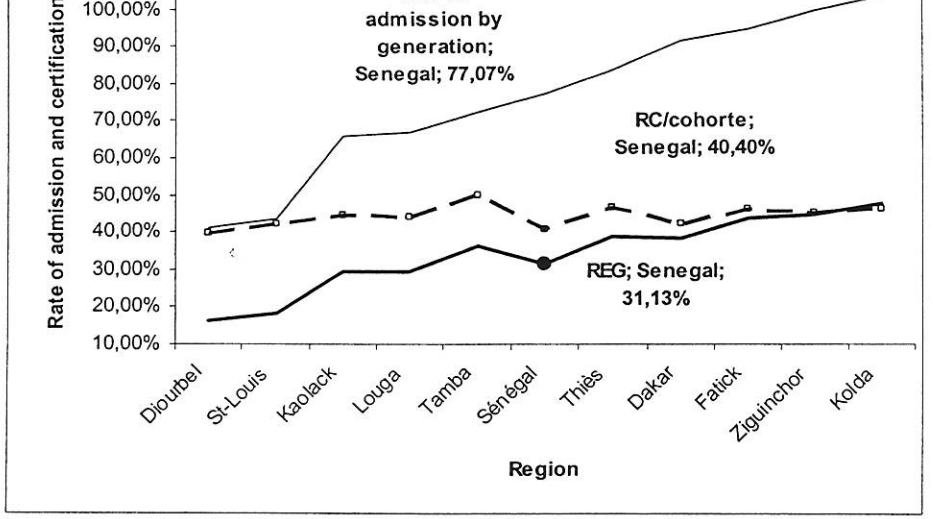


Table II: Rate and capacity of Certification of the System							
Region	CFEE6	CFEE7	CFEE8	RC/ Cohort	REG	Necessary annual Rhythm to reach at 2015 a REG equal to	
						50%	100%
Dakar	15,08%	22,35%	4,65%	42,08%	38,24%	2,26%	8,34%
Diourbel	13,35%	21,10%	5,09%	39,54%	16,21%	9,84%	16,37%
Fatick	17,42%	24,15%	4,52%	46,08%	43,29%	1,21%	7,23%
Kaolack	14,33%	23,10%	7,26%	44,69%	29,31%	4,55%	10,77%
Kolda	16,01%	23,92%	5,88%	45,82%	47,14%	0,49%	6,47%
Louga	14,48%	22,93%	6,53%	43,94%	29,39%	4,53%	10,74%
St-Louis	13,83%	22,19%	6,20%	42,22%	18,32%	8,73%	15,19%
Tamba	18,18%	25,70%	6,06%	49,95%	36,04%	2,77%	8,88%
Thiès	15,13%	23,87%	7,52%	46,53%	38,78%	2,14%	8,21%
Ziguinchor	16,50%	23,60%	4,75%	44,85%	44,23%	1,03%	7,04%
Senegal	13,78%	21,45%	5,17%	40,40%	31,13%	4,03%	10,21%

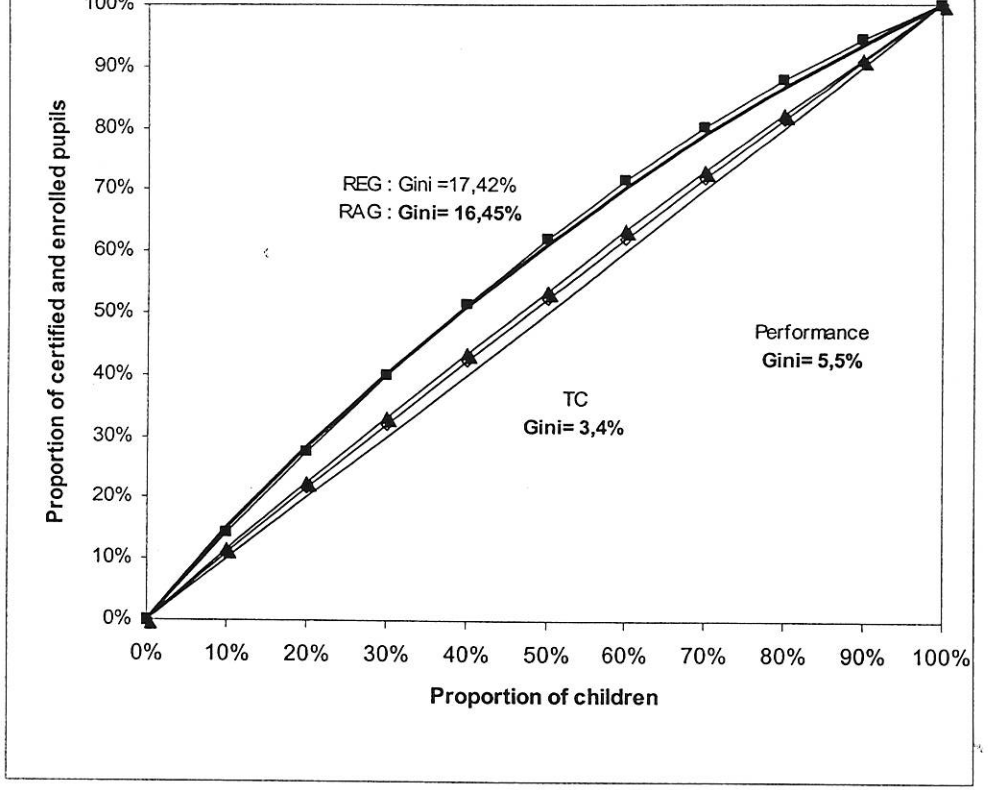


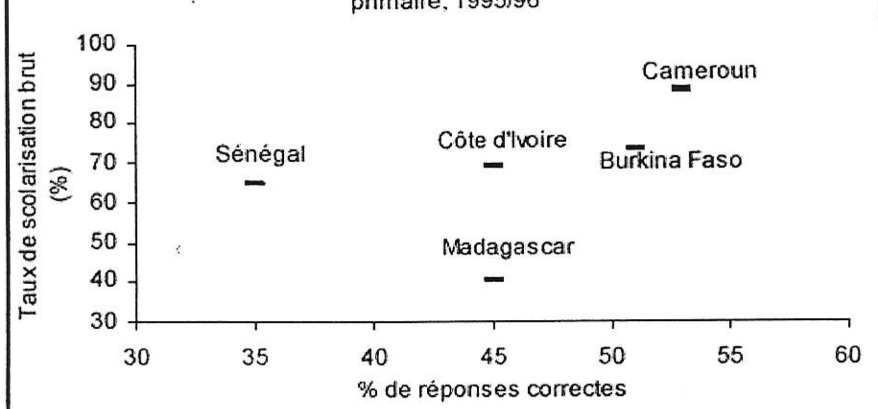
Measure of regional education inequality

One can say that the mediocrity of the performances is well shared. The level of disproportion is 5.5%. That is, the performance, measured by the capacity of the establishment to bring a pupil to the certificate at the end of the six school year, differentiates only slightly the establishments. They tend all to complete the training in 7 years. When, well even, the regions better equipped in classrooms, increase, a little bit, their advantages and produce proportionally more certificates. So, we can say that, it is the rate of education which differentiates strongly the regions. 17.42% reveals a very large disparity. But, the less lucky children, with regard to the access to the school, are not more unlucky for the certificate. Hence, we can say that it is the distribution of the school places that is uneven. With an equal number of places, the access to the certificate is slightly disparate.

Conclusion

In this work, one has tried to show that there are good and better school indicators of effectiveness. It appeared that, the rates of certification and that of education allow, more than the rates of completion or success to the examinations, to see better the level of education of a population. For a rigorous national planning, it is better to use this type of indicators rather than to others. Indeed, one should not lose sight of the fact that the project of education for all, preached by UNESCO, goes further than the complete school cover. It aims indeed a real successful education for all the children, which corresponds to the objectives that one finds in certain developed countries. In the United States, since 2002, on proposal of the Government of George W Bush, the objective to be reached in 2012 is (No Child behind left: NCBL). That is, no pupil below the minimum threshold of knowledge in reading and mathematics. In France, it is entitled: "For the success of all the pupils". The development of education should take


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Proportion of certified and enrolled pupils
REG : Gini =17,42%
RAG : Gini= 16,45%
Performance
Gini= 5,5%
TC
Gini= 3,4%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Proportion of children



Source : Katharina Michaelowa (2000)

Table III: Admission Capacity and certification

Region	net Admission Rate	Generational Admission Rate	Gross Admission Rate	RC/ cohort	Rate of education by Generation	CFEE In 6 years	CFEE7 in 7 years	CFEE8 in 8 yearss
Dakar	69,51%	90,86%	92,00%	42,08%	38,24%	15,08%	22,35%	4,65%
Diourbel	34,47%	41,00%	44,45%	39,54%	16,21%	13,35%	21,10%	5,09%
Fatick	77,55%	93,95%	94,26%	46,08%	43,29%	17,42%	24,15%	4,52%
Kaolack	55,87%	65,58%	67,55%	44,69%	29,31%	14,33%	23,10%	7,26%
Kolda	87,80%	102,88%	99,22%	45,82%	47,14%	16,01%	23,92%	5,88%
Louga	59,60%	66,90%	64,80%	43,94%	29,39%	14,48%	22,93%	6,53%
St-Louis	36,07%	43,39%	43,18%	42,22%	18,32%	13,83%	22,19%	6,20%
Tamba	64,62%	72,15%	68,78%	49,95%	36,04%	18,18%	25,70%	6,06%
Thiès	65,36%	83,35%	85,02%	46,53%	38,78%	15,13%	23,87%	7,52%
Ziguinchor	81,26%	98,61%	102,18%	44,85%	44,23%	16,50%	23,60%	4,75%
Senegal	63,51%	77,07%	77,20%	40,40%	31,13%	13,78%	21,45%	5,17%

Table IV : Certification Capacity

Region	RGE	Growth Rhythm for 50% in 2015	Growth of certified	Growth Rhythm for 100% en 2015	Growth of certified
Dakar	38,24%	2,26%	4,91%	8,34%	10,99%
Diourbel	16,21%	9,84%	14,39%	16,37%	20,92%
Fatick	43,29%	1,21%	2,06%	7,23%	8,08%
Kaolack	29,31%	4,55%	7,62%	10,77%	13,83%
Kolda	47,14%	0,49%	3,79%	6,47%	9,77%
Louga	29,39%	4,53%	7,93%	10,74%	14,14%
St-Louis	18,32%	8,73%	14,15%	15,19%	20,61%
Tamba	36,04%	[illegible]	[illegible]	[illegible]	[illegible]

Cohort	Enrolment	Number of pupils reaching the average	promoted proposed by the classroom council	promoted retained definitively
CE1_Ba	42	18	31	31
CE1_Bb	43	21	37	37
CP_Aa	42	26	38	40
CP_Ab	43	29	41	41
CI_Ba	47	21	42	42
CI_Aa	55	21	41	43
CI_Bb	50	24	45	45
CP_Ba	52	25	43	47
CI_Ab	60	30	40	48
CP_Bb	54	36	48	48
CM1_A	49	38	43	48
CE1_Aa	56	6	36	50
CE1_Ab	56	6	29	51
CE2_A	61	35	52	55
CE2_B	62	34	51	56
CM1_B	65	6	50	58

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