Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva / Italian Journal of Health Education, Sports and Inclusive Didactics - Anno 6 n. 4 - ISSN 2532-3296 ISBN 978-88-6022-456-9 - ottobre - dicembre 2022 - CC BY-NC-ND 3.0 IT-
https://doi.org/10.32043/gsd.v6i4.742

CHALLENGES OF TEACHING MENTAL ARITHMETIC AND SCHOOL PERFORMANCES IN A POST-COLONIAL CONTEXT: A CASE STUDY IN SENEGALESE PRIMARY SCHOOLS

SFIDE DELL'INSEGNAMENTO DELL'ARITMETICA MENTALE E DELLE PRESTAZIONI SCOLASTICHE IN UN CONTESTO POSTCOLONIALE: UN CASO DI STUDIO NELLE SCUOLE PRIMARIE SENEGALES

Manuel Garçon[1]
University of French West Indies
Manuel.garcon@inspe-martinique.fr

Abstract
Several studies show that negative social representations, if examined on the basis mathematics learning, have an impact on students' academic performance in this subject. These representations – as the product of a dominant culture – emerge within a learning ecosystem and are dependent on socio-economic factors. In some post-colonial territories, for example, they have been characterised by prejudices and stereotypes inherited from the colonial past. This article presents the results of a mathematics difficulty identification test conducted in the region of Thies, Senegal. The survey involves 2973 primary school pupils. The results indicate an average performance of these pupils in one single region. The study was completed by a sociological survey on the conceptions of mathematics in which 470 children participated: the analysis of the results, sometimes contradictory, allowed us to identify avenues of analysis that would allow us to imagine more contextualised and effective didactic strategies.

Diversi studi mostrano che le rappresentazioni sociali negative, se esaminate sulla base dell'apprendimento della matematica, hanno un impatto sul rendimento scolastico degli studenti in questa materia. Queste rappresentazioni, in quanto prodotto di una cultura dominante, emergono all'interno di un ecosistema di apprendimento e dipendono da fattori socio-economici. In alcuni territori postcoloniali, ad esempio, sono stati caratterizzati da pregiudizi e stereotipi ereditati dal passato coloniale. Questo articolo presenta i risultati di un test di identificazione delle difficoltà matematiche condotto nella regione di Thies, in Senegal. L'indagine coinvolge 2973 alunni delle scuole primarie. I risultati indicano una performance media di questi alunni in una singola regione. Lo studio è stato completato da un'indagine sociologica sulle concezioni della matematica a cui hanno partecipato 470 bambini: l'analisi dei risultati, a volte contraddittori, ha permesso di individuare percorsi di analisi che consentissero di immaginare strategie didattiche più contestualizzate ed efficaci.

Key-words
Mental calculation, Didactics of mathematics, Senegal, School difficulties, Performance.

Parole-chiave
Calcolo mentale, Didattica della matematica, Senegal, Difficoltà scolastiche, Performance.

Introduction

[1] Athor of DID YOU SAY MATHS? NOT EVEN SCARED! ASSESSMENT OF THE FIRST EXERCISE PERIOD OF THE MATH PLAN OF THE ACADEMY OF MARTINIQUE. *12th International Conference on Education and New Learning Technologies*, Jul 2020, Online Conference, France. pp.2669-2675

From the 1980s onwards, the emergence of studies in ethnomathematics helped demonstrate the role played by local cultures (more broadly the context) in the development of mathematical knowledge – textbook knowledge, computational skills and Exercices (Eglash, 2000; Selin, 2000). The pioneering works of Ubiratan D'Ambrosio (1979, 1980, 2016), later followed by Marcia and Robert Ascher (1986), have shown the usefulness of taking into account local approaches by integrating them into school curricula in order to offer a more contextualized and effective learning methods. This invitation is particularly justified in post-colonial territories such as Senegal where local practices (including those related to mathematical knowledge) have very often been replaced by those imposed by former colonizers. A number of sociological studies have confirmed that it is precisely in postcolonial contexts, particularly when they are associated with weak governance systems, low levels of economic development, and little recognition of local cultural Identities, that students' mathematical skills are also the lowest (Adelman, 2009; Halai et al., 2016; Chronaki et al., 2019).

Studies conducted in overseas France and in French-speaking Africa indicate a certain correlation between the low performance of students in the field of science, technology, engineering and mathematics (STEMs) and negative social representations, more precisely prejudices and stereotypes inherited from the colonial past (Traoré and Bednarz, 2009; Alì, 2020; Tiendrebeogo and Tamura, 2022). These factors shape the local learning context, contributing to the dissemination of educational conceptions among educators (at home and in the school context) that may depreciate certain disciplines (including mathematics) over others. In these countries and territories, mathematics was a victim of its own success: Alan Bishop's research (1990) has shown the role played by this discipline as an imperial tool par excellence (by virtue of its supposed universality). Mathematical skills could guarantee obtaining a position (and therefore privileges) within the colonial administration and, for the uneducated population, it constituted an almost magical domain, due to its alleged unintelligibility (Bosch, Chevallard and Gascón, 2006). These conceptions have survived the colonial era and still persist today, generating mental representations which result in negative perceptions of mathematics, as confirmed by many actors in the educational community (students, parents, teachers and educational staff).

To better understanding the issues raised by the various scholars, this article presents the results obtained within the framework of the second phase of the research project "Train to teach, to calculate mentally: a comparative approach between Senegal and Martinique and construction of teacher training program[2]". The main objective of the project was to examine mental processes and cultural artifacts related to this type of calculation in relation to the

[2] *Calcul Mental Africa2020* is a project led by the Institut National Supérieur du Professorat et de l'Éducation of Martinique (University of the French West Indies), an initiative of the French Institute in conjunction with the French Ministry of Culture, and the Ministry of Europe and Foreign Affairs.

sociocultural environment. It is therefore based on a comparative analysis of two post-colonial contexts which were in the past dependent on the same imperial power (France) even if they experienced a different decolonization process: Senegal (an autonomous country independent from France since 1960) and Martinique (an overseas territory and a department administratively attached to France since 1946). The secondary objective of the project was to develop and propose ways to improve students' performance in mental arithmetic – including building pedagogical tools adapted to local needs and cultures – based on participatory work involving French and Senegalese educators.

This article draws on the project in order to test the mental calculation skills of elementary school pupils in Thies, a Senegalese region, but also to understand their mental perception of the concept of number and its numerical representation. In November 2021, we tested 2973 students in 10 schools in the region of Thies of which 7 were public and 3 privates. We then interviewed 470 pupils to find out the perception they have as far as mathematics is concerned. The results obtained allowed us to measure these pupils' achievement levels in the field of mental calculation but also to better understand the role of the context in the perception of mathematics – here mental calculation.

1. The research process: research problem, methodology and study population

Senegal, like Martinique, is concerned with developing effective mental arithmetic teaching methods. This is evidenced by the introduction in 2016 of the Malaysian Universal Concept of Mental Arithmetic Systems program in a few Senegalese schools, targeting children aged 5 to 15. Several studies have focused on improving the quality of mathematics education, sometimes advocating for a decrease in school enrollment and sometimes for an increase in the number of hours of mathematics instruction at all levels. Others are interested in issues surrounding teaching resources and textbooks. In any case, the various initiatives have not systematically contributed to solving the problem of mathematics teaching, as the programs are not sufficiently adapted to the socio-economic and cultural context of Senegal (Vandewiele & D'Hondt, 1979; Sokhna, 2006).

Since the early 2000s, several studies have shown the importance of incorporating mathematical activities into every school level, starting from kindergarten. Indeed, the initiation to basic mathematical concepts such as mental calculation and counting starts in the elementary school level – from 3 to 10 years old (Von Aster, 2000; Butterworth, 2005). From this level, the teachings focus on developing key prerequisites among pupils and preparing them for the intermediary and advanced levels (Duncan et al., 2007; Aunio and Niemivirta, 2010; Mejias et al., 2019).

During the time of assessment, the instructions were stated orally. One point was awarded for each correct answer. To facilitate the study of correlations, the scores obtained by the participants were listed anonymously in an Excel spreadsheet according to the participants' school, grade and gender. The scores obtained through the large-scale use of the TRDM tool allowed us to identify not only the average performance of pupils based on certain variables but also the best performances, in order to finally quantify the rate of pupils who achieved the highest scores in each test.

The population of our study is made up of pupils enrolled in public and private primary schools located in the historical region of Thiès. At the start of the 2020-2021 school year – during which this research was conducted –, there were 1246 school structures for a total of 366,451 pupils (Inspection d'académie de Thiès, 2021). Our study tested the performance of a sample of this population: 2973 pupils from 11 schools (see Table 1).

Table 1. Study sample

School names	CP	CE1	CE2	CM1	CM2	Total
CPEE DANIEL BROTTIER	100	50	50	50	50	300
CPEE KEUR SAMBA	40	20	20	20	20	120
CPEE SAINTE BERNADETTE	97	50	48	50	50	295
EE CHEIKH SOULEYMANE DIOUF	90	45	45	45	45	270
EE EL HADJI AMADOU BARRO NDIEGUENE	101	50	49	50	50	300
EE EL HADJI BOUBACAR NDIAYE	120	60	60	50	50	340
EE EL HADJI IBRAHIMA SARR	99	50	50	50	50	299
EE MALICK KAÏRE DIAW	100	50	52	50	50	302
EE ROUTE DE MBOUR	100	50	50	50	50	300
EE SUD STADE	100	50	50	50	50	300
EE THIES NONES	47	25	25	25	25	147
Total	**994**	**500**	**499**	**490**	**490**	**2973**

-Private Catholic elementary schools are referred to as CPEE.
-Public elementary schools are referred to as EE.
-CP is the first year of primary schools (age range 5 to 6).
-CE1 is the second year of primary schools (age range 6 to 7)
-CE2 is the third year of primary schools (age range 7 to 8)
-CM1 is the fourth year of primary schools (age range 8 to 9)
-CM2 is the fifth and final year of primary schools (age range 9 to 10)

The gender distribution of pupils in our sample is consistent with that of the region (Inspection d'académie de Thiès, 2021). We thus have an equitable distribution between girls and boys (see Table 2).

Table 2. Distribution of the sample by gender

Gender	Total number of pupils	Proportion in relation to the sample	Proportion in relation to the study population
Girls	1509	51%	52%
Boys	1464	49%	48%
Total	**2973**	**100%**	**100%**

The 11 schools within which the pupils who participated in this study are enrolled, are scattered throughout the region. We chose to divide our sample by respecting the same proportion of pupils by school type (public and private) in order to guarantee the statistical representativeness of our study: the regional school district has 988 public schools (approximately 79% of pupils) and 258 private schools (approximately 21% of pupils) (Inspection d'académie de Thiès, 2021. See table 3)

Table 3. Distribution of the sample based on school type

Schools types	Toal number of schools	Proportion in relation to the sample	Proportion in relation to study population
Public schools	2258	76%	79%
Private schools	715	24%	21%
Total	**2973**	**100%**	**100%**

While constructing this statistically representative sample, we also carried out a sociological survey by questionnaire with a small sample of our study population (470 pupils). The questionnaire consisted of six questions on mathematical activities in a local context (in order to identify the habits and tools used by families) and on attitudes towards mathematics and mental arithmetic (in order to detect children's mental representations). Although the sample we considered for this secondary survey was smaller, it maintained its statistical representativeness: the analysis of the children's answers thus helped us to interpret the results of our main study, in particular to explain certain statistical trends and inconsistencies. It also allowed us to better understand the healthy relationship that the pupils considered in our study have with mathematics in general and mental arithmetic in particular.

2. Pupils' performance

The TRDM method helped, above all, identify the average skills of the pupils interviewed in four fundamental areas:

- *Dictation* (so as to assess the pupils' ability to correctly associate a number with its numerical representation);
- *Comparison of quantities* (which assessed pupils' ability to identify two quantities, associate them with the corresponding numbers and correctly position these numbers on a scale of sizes);
- *The resolution of numerical complements* (which corresponds to the basic cognitive mechanism necessary for mental calculation);

- *Rapid calculation* (which requires both speed of execution and precision but also the ability to control the result).

The first three domains constitute the first part of the test, which is devoted to number construction, while the second part is limited to the speed test.

The TRDM was administered in classrooms during school hours in the presence of a teacher and one or more researchers associated with the project[3]. Each student was asked a series of questions adapted to his or her age and school level, following the instructions and procedures provided by the TRDM developers[4].

All areas combined, the average total score of the pupils who participated in our study ranged, depending on the level, from 50% (for CE2) to 58% (for CP) of correct answers. This is a first result that raised questions : indeed, the test designers suggested that scores between 25% and 74% are just average. At the general level, but also after an analysis by domain, we did not find significant differences between the performance of girls and boys.

The first part of the test shows rather consistent results. Indeed, apart from the CE2 graders which obtained 69% of correct answers, the four other levels presented similar results, between 73% and 74%. It would seem, in fact, that the rate of acquisition of skills in number construction is rather regular. We also found an unexpected trend concerning the comparison between "number dictation" and "number comparison". We can consider that dictation and knowledge of numbers is a prerequisite for comparison. However, for the CP (first graders), CE1 (second graders) and CE2 (third graders), the percentage of correct answers is higher in the « comparison » assignment than in « dictation ». This trend is does not appear in CM1 and CM2 levels, with improved performances in « dictation » in relation to « comparison », which we indeed expected. We also observed that CE2 pupils were more successful overall in the « number comparison » exercises than in the « number dictation » exercises, and that they obtained the lowest score for calculations of “complement to a number” (10, 100 and 1000). It is precisely in the latter area that the pupils who participated in our study obtained the lowest scores. The average score of CM1 (fourth graders) is 64% of correct answers and that of CM2 (fifth graders) 63%. This means that the average senegalese pupil (from a sociological point of view) leaves primary school and enters secondary school with an insufficient mastery of basic calculation skills.

Table 4. Results of the mental arithmetic test by level

	Averages				
	CP	**CE1**	**CE2**	**CM1**	**CM2**

[3] Some of the test-taking sessions were recorded by a team attached to the *Division de la Radio-Télévision Scolaire* (DRTS/Senegal), a public operator of the national Ministry of Education in charge of producing and publishing educational resources and a partner in our project. These recordings have been also used to develop study and teaching resources to be distributed in France and Senegal.

[4] We collaborated with the designers of the TRDM method to create a version of the test adapted to the territories of Martinique and Senegal. The starting point was to design an assessment that would cover the common parts of the official curricula of both territories. Optimisation work was carried out with *Mission Mathématiques 1er degré* in Martinique in order to find an adapted form of the test (organization of the questions, font size, inclusion of images, etc.) in relation to the national assessments.

PART 1 (construction of a nomber)	***Average number of correct answers***				
Number dictation	91%	72%	71%	84%	83%
Number comparison	82%	91%	88%	75%	77%
Complement to a number	60%	61%	53%	64%	63%
Sub-total part 1	**74%**	**74%**	**69%**	**73%**	**73%**
PARTIE 2 (speed calculation)[5]	***Average number of correct answers***				
Additions 1 minute	43,5%	60%	67%	62,5%	62,5%
Subtractions 1 minute	33,5%	50%	50%	50%	52,5%
Multiplications 1 minute		33,5%	43,5%	45%	55%
Divisions 1 minute			17%	25%	32,5%
Sub-total part 2	**38,5%**	**48%**	**44%**	**46%**	**51%**
Total array	58%	56%	50%	51%	55%

By contrast, the second part of the test, devoted to rapid calculations, was better performed by the CM2 graders (see Table 4), with an average score of 51% of operations correctly performed. Here we sum up the correct answers obtained for each of the four operations. As a reminder, they had 1 minute for each of the operations: addition, subtraction, multiplication and division. Table 3 shows the average number of correct answers obtained for each operation and the total for the whole (Subtotal part 2). As might be expected, addition was the most well mastered operation in all levels. On the other hand, the scores obtained in the operations that required the use of division were significantly lower, in all school levels (between 17% in CE2 and 32.5% in CM2). The trend observed is a progressive increase in rapid calculation skills between CP and CM2.

There were significant differences between the results obtained by students according to the type of school in which they were enrolled. Indeed, the first part of the test was better performed by private schools. There was a 10-point difference between the results in public and private schools. (See Table 5). Looking at each item, the percentage of correct answers is systematically higher in private than in public schools.

[5] First graders (CP) were only tested for « addition » and « subtraction » assignments. The CE1 pupils did « addition », « subtraction » and « multiplication ». The other 3 graders (CE2, CM1 and CM2) performed all 4 operations.

Table 5. Results of the "Construction of the number" per school type

Part 1 Construction of a number		
Exercise	Public	Privé
Number dictation	79%	91%
Comparison of numbers	80%	88%
Complement to a number	51%	61%
Sub-total part 1	**67%**	**77%**

This trend is confirmed in part 2 of the test (see Table 6). Indeed, it is again the private schools that obtained the best results (a difference of 8 points). We note that the results obtained by the pupils are identical as far as the « multiplication » assignment is concerned. This is an unexpected fact that would require further surveys, particularly at the didactic and pedagogical levels. For all other operations (addition, subtraction and division), the results are better in public schools.

Tableau 6. Résultats de la partie « Calculs rapides » par type d'établissement

Part 2 Speed calculations		
Assignments	Public schools	Private schools
Additions	54%	65%
Subtraction	35%	51%
Multiplications	44%	44%
Divisions	24%	27%
Sub-total part 2	**39%**	**47%**

The above-mentioned results helped confirm and clarify earlier analyses by other researchers who have studied a few primary schools in Senegal, mainly pointing out that the average performance of pupils in mathematics is rather disappointing and that the type of school (i.e., the school ecosystem or, more simply, the school context) has an impact on the development of certain skills (Dieng and Ibrahima, 2020), particularly in the construction of numbers (Diagne, Kafano and Ounteni, 2006) and mental calculation (Ndoye, 1999).

3. Pupils' overall attitudes

Among the pupils tested for their mental arithmetic skills, we selected 470 to be interviewed about their relationship with mathematics and arithmetic, but also about their home habits (in order to detect whether they carried out mathematical activities at home). To guarantee the homogeneity of the data, the sample was composed of approximately one hundred pupils per level (CP, CE1, CE2, CM1 and CM2). Data collection was carried out using a questionnaire with six gender-neutral questions focusing on students' interest in mathematics and mental arithmetic. The first four questions were closed, while the last two were open-ended, so that the student could let his or her experience run wild and fill in the questionnaire without being restricted. The responses we obtained seem to suggest that pupils in the region of Thies have a good bond with mathematics. Indeed, 97% of the respondents said they liked mathematics (a little, well, and a lot) while only 3% disliked it (see Table 7). This might have to do with

the teaching methods proposed by the teachers, but also by the diversity of the educational offer.

Table 7. Pupils and their relationship to mathematics

Do you like maths ?	***Number of pupils***	***Pourcentage***
I don't like Maths at all	4	1%
I don't like maths	11	2%
I like maths a bit	18	4%
I like maths	42	9%
I like maths very much	395	84%
Total	**470**	**100%**

If we consider the pupils' relationship with numbers and mental arithmetic, the results are identical to those found in the previous questions. This area of learning appears to be a very popular activity, with 97% of children giving positive feedbacks. Only 3% of the children answered that they did not really like numbers and mental arithmetic. This could be the result of a need to use mental arithmetic and numbers. Interviews with some of the pupils in this study confirm this hypothesis. Indeed, the mental manipulation of numbers is used on a daily basis when making local purchases (food, fuel). The relationship with mathematics is then appeased because it is of primary use.

Table 8. Distribution of pupils according to their relationship to numbers and mental calculation

Do you like numbers and mental calculation	**Total of pupils**	**Pourcentage**

I don't like mental calculation at all	1	1%
I don't like mental calculation	11	2%
I like mental calculation a bit	19	4%
I like mental calculation	47	10%
I like mental calculation very much	392	83%
Total	**470**	**100%**

In Senegal, at least in the region of Thies, pupils are very clear about their intentions and uses of numbers and mental arithmetic. 95% of students attest to using mental arithmetic (see Table 9). 85% of them clearly target their use by testifying to a daily and practical use of the tool.

Table 9. Using numbers and calculation at home

Homeworks	**Total of pupils**	**Pourcentage**
No	25	5%
Yes	49	10%
Yes and I can give an example	396	85%
Total	**470**	**100%**

Thus, a categorisation of the results opens up analytical perspectives. We note that the senegalese pupils we considered in this survey apply mental arithmetic basics directly in their everyday life: uses often with a commercial aim in order to participate in family life, or to accompany their parents in their daily activities. Many of these young students referred to their use as such: going to the shopkeeper, helping in the family business, helping parents.

Sixty-five percent of young senegalese correspond to this pattern (see Table 10). On the other hand, 19% remained in a completely school-based pattern and related their use of the mathematical tool to the various learning activities seen in class. Only 16% gave no examples of their use of mental arithmetic outside the classroom. Contrary to what one might have expected from the results of the numeracy test, it appears that the attitude of Senegalese

pupils towards mathematics is largely positive. The importance of calculation automatisms in daily activity seems to us to be the most relevant hypothesis to explain this. Finally, the results obtained also seem to suggest that the discipline is more appreciated in its operational dimension (calculation) than in its conceptual dimension (mathematics as an abstraction).

Tableau 10. Examples of the use of numbers and calculation at home

Homework examples	**Total of pupils**	**Pourcentage**
Without answers	78	16%
Activities related to the use of maths	89	19%
Activities related to money handling	303	65%
Total	**470**	**100%**

We were interested in the role of mental arithmetic and numbers in games. The surprise here is that 72% of young Senegalese say that they do not play with mental arithmetic or numbers (see Table 11). Only 28% of them admitted to playing with the object of study, and thus appropriated it differently.

Many questions arise from these results, such as: "Why do senegalese pupils handle numbers and mental calculation so little in some game activities? Are games part of the learning process for mental arithmetic? The answers to these questions could help to improve some of the above-mentioned results obtained.

Table 11. Use of numbers and mental calculation in games

Do you play games that use numbers and mental calculation	**Number of pupils**	**Pourcentage**
No	338	72%
Yes	48	10%

Yes, I can provide an example	44	9%
Yes and I can provide at least 2 examples	40	9%
Total	**470**	**100%**

4. Interpretation of the results

This research, which is based on a sociological approach, helped measure the level of mathematical skills of primary schools' pupils in the academy of Thiès, using a reliable psychometric tool validated by the scientific community and based on a statistically representative sample. Above all, we confirm the relevance of the TRDM approach which could easily be deployed in other contexts to facilitate the assessment of pupils' performance in maths[6].

It is important to note that in our study we did not detect significant differences between the performance of girls and boys. This statistical consistency could be explained by considering that the gender gap[7] in STEM (probably already at work in childhood, as suggested by some authors including Makarova et al., 2019 and Miller et al., 2018), only becomes stronger and more visible from adolescence onwards. On the other hand, other sociological variables must be taken into account to explain certain differences in performance.

The results obtained confirm that the type of school (which generally reflects the socio-economic status of the students' families) partly determines the level of performance achieved by the students (as already observed by Mc Andrew et al., 2008) and that students from public schools have more difficulties in dealing with mathematics. In the future, it would be essential to look further into this aspect, by trying to determine more precisely the impact of certain variables such as the cultural capital of families (Bourdieu, 1979), the school effect (Cousin, 1993) or the teacher effect (Bressoux, 2001).

The various results also show that, in the elementary schools of the academy of Thiès, the rate of acquisition of skills in number construction remains stable. Indeed, the level of performance in this part changes little from one class to another (between 69% and 74%):

[6] In the framework of the Africa2020 Mental Calculation project, we conducted a comparable study, based on the same tool, with an equivalent sample of primary school pupils in Martinique.

[7] Gender inequality is generated in certain contexts by the effect of certain traditions, norms or socio-cultural values and that produces differences in treatment or performance between men and women.

pupils in the first year of primary schools obtain almost the same results as in CM2 (fifth graders). One would expect these results to increase from year to year.

Senegal being a multilingual country (Dreyfus and Juillard, 2005), we can consider here the linguistic obstacle (Daff and Dramé, 2016). Indeed, a few researchers have hypothesised that the mastery of the language, but also the specificities of the latter (notably in the field of semantics and nomenclature associated with mathematics) can have an impact on the learning of numbering, and then of calculation (Jarlégan, Fayol and Barouillet, 1996). Mélissa Arneton, in her doctoral thesis (2010), explored the West Indian context on the basis of this hypothesis, although in her study she finally concluded that "whatever the school level considered, the linguistic dimension has no link with school performance in either French or mathematics. Bilingual students do not perform worse than monolingual students' (Arneton, 2010: 339). However, her work did not take into account the very particular linguistic construction of cardinal numbers - the natural integers - that is specific to the Wolof language (Eglash, 1997). The transition of the logic of number construction from Wolof to French requires specific work that could explain the initial difficulties of pupils who construct numbers from this language, especially in the first years of schooling. This issue should also be studied from a didactic point of view (including observation of classroom practices) in order to put forward relevant hypotheses.

Finally, with regard to our secondary survey, which served as a corollary to the TRDM, we suggest that the relatively positive relationship to mathematics and more specifically to mental arithmetic in Thiès could be explained for at least three reasons:

- In primary schools within the district of Thies, the teaching of mathematics is often associated (either teachers or school textbooks) with a cultural approach to the discipline. Mental arithmetic is used in everyday life for the manipulation of numbers when shopping.

- There is a political will to improve the level of students in Mathematics. The evolution of the place of Mathematics in the official programmes testifies to this. Significant efforts have been made in the framework of the various mechanisms put in place by Senegal in general and the academy of Thiès in particular to improve mathematics teaching practices. The Project to Strengthen the Teaching of Mathematics, Science and Technology (PREMST) is one such example. From 2007 to 2011, the pilot regions of Fatick, Louga and Thiès benefited from in-service training modules that have given full satisfaction. From 2011 to 2015, these modules were improved and rolled out nationwide. There is also the Project for the Improvement of Learning in Mathematics at Elementary Level (PAAME) implemented by JICA (Japan International Cooperation Agency). It aims to share "good practices" in the teaching of mathematics based on collaboration between schools and surrounding

communities. These initiatives focus on didactic and pedagogical reinforcement in the teaching of Mathematics. We will subsequently see an improvement in student achievement.

- The fact that pupils appreciate the operational dimension (calculation) rather than the conceptual one (mathematics as an abstraction) has been confirmed by other studies (Papp and Theresa, 2017; Swacha, 2021). It invites us to imagine innovative didactic strategies that take advantage of the opportunities offered by gamification and the use of serious games, escape games and other similar activities could facilitate the learning of computational automatisms.

- The prospects for collaboration between Senegal and Martinique, which began with the Africa2020 Mental Calculation project, will lead to exchanges of pedagogical practices that will improve the level of competence of primary school pupils in both territories in mental calculation and, we hope, in Mathematics in general.

Conclusions

This research shows an updated and statistically representative panorama of social representations towards mathematics and the performance of primary schools' pupils in the academy of Thiès, Senegal, in the field of number construction and mental calculation. We hope that other similar studies will be carried out in the future: the large-scale deployment of the TRDM combined with a sociological survey would provide the education authorities with a more complete overview that would facilitate the detection of territorial inequalities.

The follow-up of the Africa2020 project as implemented in Martinique and Senegal is to compare the data collected in both Senegal and Martinique. In this way, we hope to better situate the role played by post-colonial dynamics in different contexts. Finally, we hope that this research will contribute to ongoing debates on the development of the senegalese education system in terms of mathematics and science teachings.

References

Adelman, C. (2009). International comparisons: What your fourth-grade math can reveal. International Higher Education, (55), 21-23.

Alì, M. (2020). The Education System in the French Departments of America: French Guiana, Martinique and Guadeloupe. Dans J. Sieglinde et M. Parreira do Amaral, (dir.) The Education Systems of the Americas (pp. 583-606). Bale, Suisse: Springer Nature,. https://doi.org/10.1007/978-3-319-93443-3_9-1.

Arneton, M. (2010). Bilinguisme et apprentissage des mathématiques : études à la Martinique. Thèse de doctorat à l'Université Nancy 2.

Ascher, M. et Ascher, R. (1986). Ethnomathematics. History of science, 24(2), 125-144.

Aunio, P. et Niemivirta, M. (2010). Predicting children's mathematical performance in grade one by early numeracy. Learning and Individual Differences, 20(5), 427-435. https://doi.org/10.1016/j.lindif.2010.06.003

Bishop, A. J. (1990). Western mathematics: The secret weapon of cultural imperialism. Race & Class, 32(2), 51-65.

Bosch, M., Chevallard, Y. et Gascón, J. (2006). Science or magic? The use of models and theories in didactics of mathematics. Dans Proceedings of the fourth congress of the European Society for research in mathematics education (pp. 1254-1263). Barcelona: Fundemi IQS–Universitat.

Bourdieu, P. (1979). Les trois états du capital culturel. Actes de la recherche en sciences sociales, 30(n.s. L'institution scolaire), 3-6. https://doi.org/10.3406/arss.1979.2654.

Bressoux, P. (2001). Réflexions sur l'effet-maître et l'étude des pratiques enseignantes. Les dossiers des sciences de l'éducation, 5(1), 35-52. https://doi.org/10.3406/dsedu.2001.949.

Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. Developmental psychology, 22(6), 723.

Bronfenbrenner, U. (2005). Making human beings human: Bioecological perspectives on human development. Londres: SAGE.

Butterworth, B. (2005). The development of arithmetical abilities. Journal of Child Psychology and Psychiatry, and Allied Disciplines, 46(1), 3-18. https://doi.org/10.1111/j.1469-7610.2004.00374.x

Chronaki, A., Adams, G., Andrade, M., Bruno, G., Demissie, F., Marcone, R., Para, A., Povey, H., Swanson, D., Valero, P. et Yolcu, A. (2019). Unfolding global/local policies, practices and/or hybrids in mathematics education worldwide: utopias, pleasures, pressures and conflicts. Dans Proceedings of the Tenth International Mathematics Education and Society Conference. MES10, Janvier 10. http://shura.shu.ac.uk/24289/.

Cousin, O. (1993). L'effet établissement : construction d'une problématique. Revue française de sociologie, 34(3), 395-419. https://doi.org/10.2307/3321974.

D'Ambrosio, U. (1979). A Course, an Invitation and a Project: History of Ibero‐American Mathematics. European Journal of Science Education, 1(4), 452-453.

D'Ambrosio, U. (1980). Matemática e Sociedade: Considerações Histórico-Pedagógicas. Ciência e filosofia, (2), 81-88.

D'Ambrosio, U. (2016). An overview of the history of ethnomathematics. Dans M. Rosa, U. D'Ambrosio, D. Clark Orey, L. Shirley, W. V. Alangui, P. Palhares et M E. Gavarrete (dir.), Current and future perspectives of ethnomathematics as a program (p. 5-10). https://doi.org/10.1007/978-3-319-30120-4_2.

Daff, M., & Dramé, M. (2016). Dakar, Métropole et capitale de la stabilisation du plurilinguisme dominant au Sénégal. Le Français dans le monde, (30), 151-161.

Diagne, A., Kafando, I., & Ounteni, M. H. (2006). Déterminants des apprentissages dans l'éducation primaire au Sénégal. Les Cahiers du SISERA, 7. https://invenio.unidep.org/invenio/record/9722/files/determinants%20.pdf

DIENG, A. M., & Ibrahima, S. Y. (2020). Les performances de l'éducation en Afrique francophone: une analyse multiniveaux. Revue de Recherches en Economie et en Management Africain, 8(8). https://revues.imist.ma/index.php/CREMA/article/view/22815

Dreyfus, M., & Juillard, C. (2005). Le plurilinguisme au Sénégal: Langues et identités en devenir. Paris: Karthala.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K. et Japel, C. (2007). School readiness and later achievement. Developmental Psychology, 43(6), 1428-1446. https://doi.org/10.1037/0012-1649.43.6.1428

Eglash, R. (1997). When math worlds collide: Intention and invention in ethnomathematics. Science, technology, & human values, 22(1), 79-97.

Eglash, R. (2000). Anthropological Perspectives on Ethnomathematics. Dans Selin, H. (dir.) Mathematics Across Cultures. Science Across Cultures: The History of Non-Western Science (pp. 13-22). Dordrecht: Springer. https://doi.org/10.1007/978-94-011-4301-1_2

Garcon, M. (2021). Les maths ? Même pas peur ! Bilan de la première période d'exercice du Plan Math de l'Académie de Martinique. Communication présentée aux Journées de la Recherche en Éducation (JRE2021) de l'Université de la Polynésie française. Faa'a, Tahiti, Polynésie française, 28-29 avril.

GARÇON, Manuel (2022), "Corpus de recherche. Résultats du projet Calcul Mental Africa2020 (volet 4 : Perception des élèves concernant les mathématiques et le calcul mental au Sénégal)", Mendeley Data, V1, doi: 10.17632/58xrjmfzgt.1

GARÇON, Manuel (2022), "Corpus de recherche. Résultats du projet Calcul Mental Africa2020 (volet 2 : test de calcul mental au Sénégal)", Mendeley Data, V1, doi: 10.17632/7vm4x2b7hw.1

Georges, C., Cornu, V. et Schiltz, C. (2021). The importance of visuospatial abilities for verbal number skills in preschool: Adding spatial language to the equation. Journal of Experimental Child Psychology, 201: 104971. https://doi.org/10.1016/j.jecp.2020.104971.

Ghazali, M., Mohamed, R. et Mustafa, Z. (2021). A Systematic Review on the Definition of Children's Number Sense in the Primary School Years. EURASIA Journal of Mathematics, Science and Technology Education, 17(6): em1968. https://doi.org/10.29333/ejmste/10871.

Halai, A., Muzaffar, I. et Valero, P. (2016). Research rationalities and the construction of the deficient multilingual mathematics learner. Dans R. Barwell, P. Clarckson, A. Halai, M. Kazima, J. Moshkovich, N. Planas, M. Setati-Phakeng, P. Valero et M. Villavicencio Ubillus. (dir.), Mathematics education and language diversity (p. 279-295). Springer - International Commission on Mathematical Instruction.

Inspection d'académie de Thiès. (2021, avril). Rapport revue régionale 2020. Ministère de l'éducation nationale.

Jarlegan, A., Fayol, M. et Barrouillet, P. (1996). De soixante douze à 72, et inversement: Une étude du transcodage chez les enfants de 7 ans. Revue de Psychologie de l'Education, 1, 109-131.

Leyens, J.P. (1983) [2006]. Sommes-nous tous des psychologues : approche psychosociale des théories implicite de la personnalité. Sprimont : Mardaga.

Makarova, E., Aeschlimann, B., & Herzog, W. (2019, July). The gender gap in STEM fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. In Frontiers in Education (Vol. 4, p. 60). Frontiers Media SA.

Martini, S. F., Schiltz, C., Fischbach, A. et Ugen, S. (2021). Identifying math and reading difficulties of multilingual children: Effects of different cut-offs and reference groups. Dans A. Fritz, E. Gürsoy, M. Herzog (dir.) Diversity Dimensions in Mathematics and Language Learning. Perspectives on culture, education, and multilingualism (pp. 200-228). Berlin, Boston: De Gruyter.

Mc Andrew, M., Garnett, B., Ledent, J., Ungerleider, C., Adumati-Trache, M. et Ait-Said, R. (2008). La réussite scolaire des élèves issus de l'immigration: une question de classe sociale, de langue ou de culture ?. Éducation et francophonie, 36(1), 177-196.

Mejias, S., Muller, C. et Schiltz, C. (2019). Assessing Mathematical School Readiness. Frontiers in Psychology, 10, 1173. https://doi.org/10.3389/fpsyg.2019.01173

Miller, D. I., Nolla, K. M., Eagly, A. H., & Uttal, D. H. (2018). The development of children's gender-science stereotypes: A meta-analysis of 5 decades of US Draw-a-Scientist studies. Child development, 89(6), 1943-1955.

Ndoye, A. K. (1999). Auto-perception des difficultés des filles dans l'apprentissage des sciences, des mathématiques et de la technologie (SMT) au Sénégal. IAPETUS, 3, 45-62.

Papp, T. A. et Theresa, A. (2017). Gamification effects on motivation and learning: Application to primary and college students. International Journal for Cross-Disciplinary Subjects in Education, 8(3), 3193-3201.

Piaget, J. (1935). La naissance de l'intelligence chez l'enfant. Neuchâtel-Paris: Delachaux et Niestlé.

Selin, H. (dir.) (2000). Mathematics Across Cultures. Science Across Cultures: The History of Non-Western Science. Dordrecht : Springer.

Sokhna, M. (2006) Formation continue des professeurs de mathématiques au Sénégal : analyse de la transmutation d'un dispositif de formation. In Université de Sherbrooke (ed.), L'enseignement des mathématiques face aux défis de l'école et des communautés. Québec : actes du colloque international Espace Mathématique Francophone, Sherbrooke.

Stoet, G. et Geary, D. C. (2013). Sex differences in mathematics and reading achievement are inversely related: Within- and across-nation assessment of 10 years of PISA data. PLoS One, 8(3), e57988. https://doi.org/10.1371/journal.pone.0057988.

Super, C. M. et Harkness, S. (1986). The developmental niche: A conceptualization at the interface of child and culture. International journal of behavioral development, 9(4), 545-569.

Swacha, J. (2021). State of research on gamification in education: A bibliometric survey. Education Sciences, 11(2), 69.

Tiendrebeogo, E. S. et Tamura, K. (2022). Quality of Mathematics Education in Burkina Faso Junior High School: Prescriptions, Practices, and Issues. NUE Journal of International Educational Cooperation, 15, 41-49.

Traoré, K. et Bednarz, N. (2009). Mathématiques de la vie quotidienne au Burkina Faso: une analyse de la pratique sociale de comptage et de vente de mangues. Educational Studies in Mathematics, 72(3), 359-378.

Vandewiele, M. and W. D'Hondt, W. (1979). La perception de quelques difficultés en mathématiques par les professeurs en classe de troisième dans l'enseignement secondaire au Sénégal. Educational Studies in Mathematics, Vol. 10 (2), 199-225.

Von Aster, M. (2000). Developmental cognitive neuropsychology of number processing and calculation: Varieties of developmental dyscalculia. European Child & Adolescent Psychiatry, 9(II) : 41-57. https://doi.org/10.1007/s007870070008

Vygotski, L. (1934) [1997]. Pensée et langage. Paris : La Dispute.

Weitekamp, M. A. (2017). The image of scientists in The Big Bang Theory. Physics Today. 70(1): 40–48. https://doi.org/10.1063/PT.3.3427.

.