Magna Scientia Advanced Research and Reviews

eISSN: 2582-9394

Cross Ref DOI: 10.30574/msarr

Journal homepage: https://magnascientiapub.com/journals/msarr/

(RESEARCH ARTICLE)

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The impact of practical physics laboratory work on student learning in public and private secondary schools in the city of N'Djamena

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Magna Scientia Advanced Research and Reviews, 2025, 13(01), 016-030

Publication history: Received on 22 November 2024; revised on 01 January 2025; accepted on 03 January 2025

Article DOI: https://doi.org/10.30574/msarr.2025.13.1.0011

Abstract

The present study revealed to us that there is an absence of practical work in physics in the laboratory in the 4th grade classes. To do this work, we prepared and distributed the questionnaires to students and teachers, distributed as follows:

- In high school-college A with 2 classes, we have 72 students;
- In high school-college B with 4 classes, we have 238 students;
- In high school-college C with 4 classes, we have 428 students;
- In high school-college D with 3 classes, we have 92 students.

After counting, we have.

- Out of 16 copies of questionnaires given to physical science teachers working in 4th grade in public and private establishments, 10 were recovered, or 62.5%.
- On the students' side, the 30 questionnaires and one hundred (100) copies of the series of exercises were fully returned, i.e. 100%.

Our work shows that 4 out of 10 teachers teach 80 to 100 students/class and 6 out of 10 teachers teach between 100 and more/4th grade class. It emerges that (60%) are responsible for "overcrowded" classes (100 and more than 120 students) and 40% intervene in classes with overcrowded numbers (80 to 100 students/class).

In the same sense, this form of practice in classes, lecture-based teaching leads students to simple temporary memorization, making it difficult to understand, assimilate and reproduce appropriate scientific concepts. On the one hand, teachers are overwhelmed with a number of classes and levels without the basic documents and adequate experimental equipment

Keywords: Physics practical work; Large classes; Lectures; Laboratory

1. Introduction

The teaching of physics is facing huge problems in secondary schools in Chad. Among these problems is the impact of teaching laboratory activities in physics on learning, which is currently paralyzed due to the plethora of students in classes and the lack of adequate working materials [1-4]. To popularize the concepts of laboratory activities in physics

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on student learning, its teaching must be inspired by local realities accompanied by appropriate teaching materials and carried out by a teaching staff working in acceptable conditions in order to obtain a desired overall performance [5-8].

In general secondary education, physics is an experimental science, a science that explores matter and energy, develops theories, analyzes the results of experiments using mathematical tools [8-10]. It is one of the parts of the physical sciences program, which can be based on laboratory activities on student learning. From this perspective, teaching physics to a student means "...forcing the mind to first observe the facts that surround it and to gradually develop its analytical capacities by expressing in it the true experimental method, the inductive method"[9] This bicyclic program, that is to say theory and practice, taught in Chad from the 6th to the final year of science, occupies an important place in the current context of globalization. Improving the teaching of physics in order to meet the size requirements of our constantly evolving societies has always been a concern of countries spread across our planet[10].

In the third millennium, the learning of students in physics in the laboratory is a luxury, because our establishments in cities and villages remain 99% without a physics laboratory, due to a lack of qualified human resources in sufficient numbers, financial and material resources allocated in this area like the area of appropriate infrastructure worthy of a laboratory. Faced with the cancer of third world countries like ours, the multidimensional under-equipment with its inhibiting corollaries, our concerns are growing: a more out-of-step tomorrow in the concert of nations of physics teaching in the laboratory. However, the goal of education is to help future offspring achieve the highest possible development for themselves and for the society to which they belong.

The teaching of physics is currently theoretical, because printed and non-printed teaching materials are sorely lacking. This is why Kouamé Krouma (Neldé Loudegué) stated: "theory without practice is empty, and practice without theory is blind" to this end, theory and practice must come together for modernization efforts in the interests of training young people [11].

How can we bring down the lead that is in the wing of physics teaching in laboratories in Chad to make it efficient and effective? Would it be possible to develop a physics teaching program in the laboratory that fits with our realities or even our societal projects that are in line with our progressive stage of development?

The teaching of physics in general and particularly laboratory activities for adequate learning was introduced in Chad by the colonizer at the 4th grade level in general education colleges (CEG) in 1956 [5] A few years later, the 1984 physical science program readjustment seminar extended the scope of the teaching of physics in the laboratory to learning, taking into account the country's real needs in this area. Given its importance in relation to the objectives set by the Ministry of National Education, internships, seminars and conferences have been organized here and there to make the teaching of physics in the laboratory more practical in colleges. [12] Moreover, in the face of this clear desire to create scientific establishments, we note that the reality on the ground is different. In most of the establishments where we conducted our survey, the difficulties identified on the ground are as follows: Insufficient qualified teachers in physical science (PS);

- Archaic reception structures;
- Absence of laboratory and experimental teaching materials;
- Insufficient textbooks;
- Plethora in the classrooms not allowing for good laboratory activity with the students;
- Out of step with new information and communication technologies.

The learners interviewed in the research field affirm that: "The fact of remaining 3 to 4 per table bench which can normally only contain two students can in no way allow adequate learning. No practice of physics in the laboratory because there is no follow-up from the managers of public and private establishments. The assessments are only summative." This statement wants to tell us that the State itself through the education delegates, the inspectors do not normally do their work that could lead to the creation of scientific high schools. Because without the laboratories, one cannot dream of creating scientific establishments. As for the practical work, they declare that "nothing is done; at least, they are given a diagram of the electrical circuit comprising the following elements: the conductive wire, the voltmeter, the ammeter, the generator, the switch, the bulbs etc. which are practically never seen by the learners. So they live in a cycle where all the lessons are abstract."

2. Materials and Survey Methodology

Our research methodology follows the logic of [5] and [13-19]

2.1. Study population and sample

The sample will focus on the number of students in two 4th grade classes in our four establishments.

2.1.1. Study population

The study population consists of 4th grade students in the four establishments with a total of 970 students. Thus, in 4th grade we have: In high school-college A with 2 classes, we have 72 students;

- In high school-college B with 4 classes, we have 238 students;
- In high school-college C with 4 classes, we have 428 students;
- In high school-college D with 3 classes, we have 92 students.

As for the teachers, starting from the 13 4th grade classes, we have a total of 8 teachers distributed as follows: one teacher in high school-college A, 2 teachers in high school-college B, 4 teachers in high school-college C and 2 teachers in high school-college C.

2.1.2. Sampling technique

We opted for probability sampling techniques in order to obtain a simple random sample by considering two 4th grade classes from each establishment.

- High school-college C, 214 students;
- High school-college D, 61 students;
- High school-college B, 120 students;
- High school-college A, 72 students.

This is presented in Table 1:

Table 1 Distribution and collection of questionnaires to students

School	Distribution	Recovery	% recovery
High school-college C	214	150	70, 09
High school-college D	61	61	100
High school-college B	120	100	83,33
High school-college A	72	70	97, 222
TOTAL	467	381	81,58

Source: Field survey

Reading the table above, we see that out of the 467 questionnaires distributed, we have recovered 381, i.e. a percentage of 81.58%. Among teachers, the questionnaires distributed are recovered in full.

2.2. Importance of teaching materials

Teaching materials can make teaching/learning very meaningful, but their shortage in our middle and high schools is an obstacle to the acquisition and perfection of knowledge.

Through our general hypothesis, the specific hypotheses arise, namely:

- HS1: the absence of a laboratory or the lack of teaching materials in electricity in the laboratories negatively impacts the learning of 4th grade students;
- HS2: The plethora of students in 4th grade classes does not promote the learning of electricity.

We have summarized the essentials in the following table:

Table 2 Summary table of the research hypothesis, variables, indicators and items

General hypothesis	Specific assumptions	variables	indicators
HG: The absence of a laboratory or the lack of teaching materials in the laboratory and the excessive number of students in 4th grade classes have a considerable impact on student learning.	HPS 1: The absence of a laboratory or the lack of teaching materials in the laboratory and the excessive number of students in 4th grade classes have a considerable impact on student learning.	VI : Lack of teaching materials	No lab; No light bulb; No voltmeter; No ammeter
		VD : Student learning	Handling of materials; Good grades; Good mastery;
	HPS 2 : The excessive number of students in the 4th grade does not promote student learning.	VI : the excessive number of students in 4th grade classes	60 to 80 students; 80 to 100 students; More than 100 students
		VD : student learning	Handling of materials; Good grades; Good mastery;

3. Result of the Methodological Framework and Processing of Survey Data

3.1. Presentation and analysis of collected data

The data collected relates to questionnaires sent to teachers and students. Here we proceed by presenting the data followed by commentary or analysis.

3.1.1. Presentation of questionnaire data intended for students.

It should be recalled that the questionnaire addressed to the students takes a total of eight items. Thus, the data are gathered in the tables below.

Table 3 Identification of students

School / Sex	Lycée-collège A	Lycée-collège C	Lycée-collège D	Lycée-collège B	TOTAL
Boy	45	111	41	67	264
Girl	25	39	20	33	117
TOTAL	70	150	61	100	381

Source: Field survey

The table shows us out of the 381 students surveyed, 264 students are boys and 117 girls. This shows that there are more boys in the four schools than girls.

After collecting the data in the field, we proceeded to the counting by manual counting.

- Out of 16 copies of questionnaires given to physical science teachers working in 4th grade in public and private schools, 10 were recovered, or 62.5%.
- On the students' side, the 30 questionnaires and one hundred (100) copies of the exercise series were fully returned, or 100%.

3.1.2. Analysis and interpretation of results

Teachers' point of view

- Question 1: How many 4th grade classes do you teach physical sciences in? Two, three, four, more?

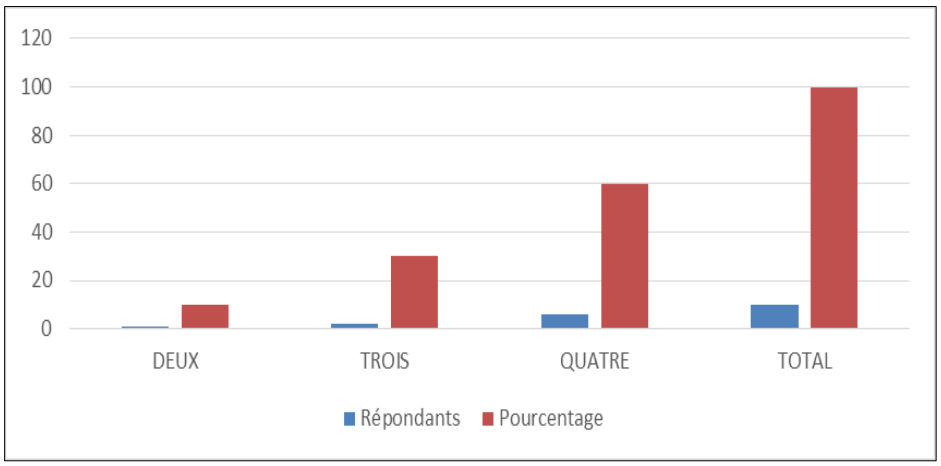

Figure 1 Result of teaching intervention in more than one 4th grade class

This histogram reveals that 6 out of 10 teachers have intervened in four 4th grade classes, 3 out of 10 are responsible for three classes and 1 out of 10 teachers in two 4th grade classes. It emerges from this figure that 60% of teachers have four classes of responsibility in physical sciences.

We note that a large number of teachers in this field intervene in 3 to 4 classes per level.

- Question 2: Do you teach other levels outside of 4th grade? Yes, No?

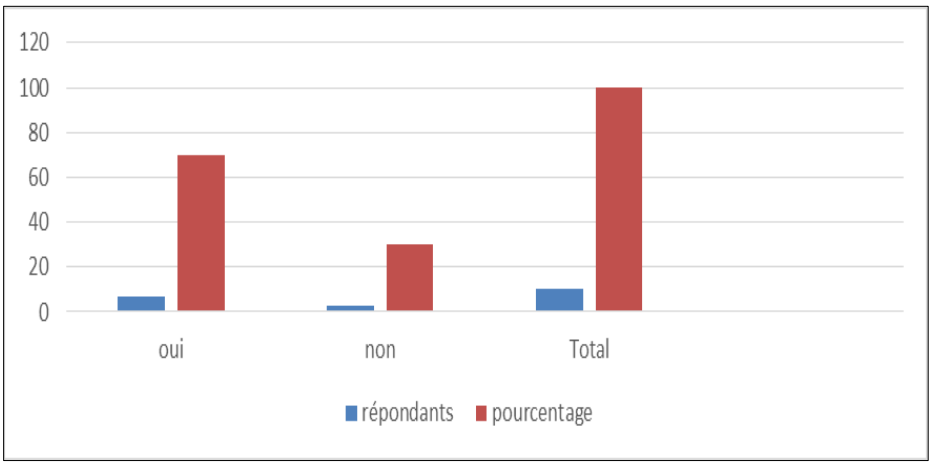

Figure 2 Result of teaching intervention in different classes

This figure shows that 7 out of 10 teachers intervene in physics and chemistry at other levels, except for 4th grade, and 3 out of 10 teachers teach only in 4th grade. It emerges from this data that 70% of teachers are more loaded. This overload does not promote quality teaching.

- Question 3: How many students do you have per class? 80 to 100; 100 to 120; more than 120?

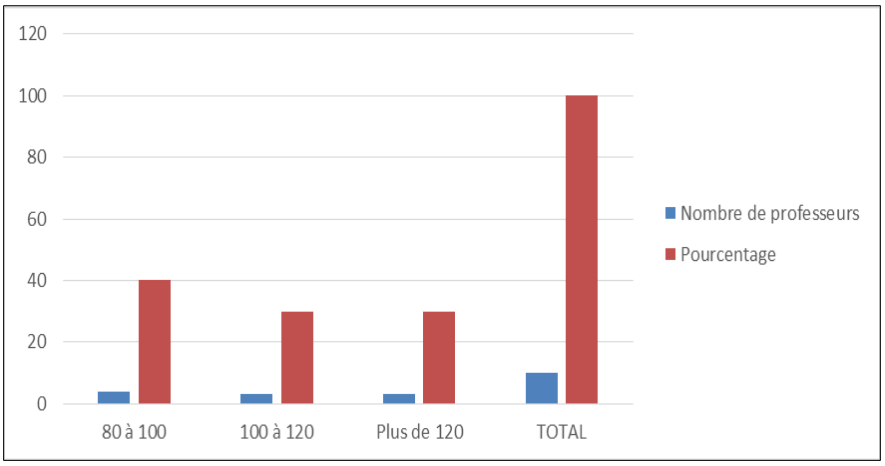

Figure 3 Survey results on the number of students taught per class

This figure shows that 4 out of 10 teachers teach 80 to 100 students/class and 6 out of 10 teachers teach between 100 and more learners/4th grade class. It is objectively clear that a large number of teachers (60%) are responsible for "overcrowded" classes (100 and more than 120 students) and 40% intervene in classes with overcrowded classes (80 to 100 students/class).

We note that 100% of physics and chemistry teachers intervene in classes where there are overcrowded students, because the number of students is between 80 and more than 120 per class.

- Question 4: In relation to the size of the class, what teaching method do you apply? Traditional, active, libertarian?

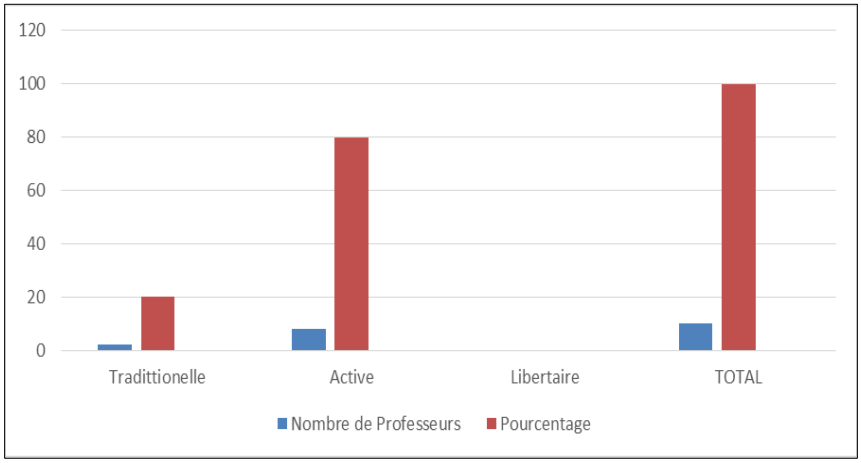

Figure 4 Result of teaching methodology used by teachers in relation to the class size

This figure indicates that in teaching practice, 8 out of 10 teachers, or 80% of the teachers surveyed use the active method and 02 out of 10, or 20% say they use the traditional or affirmative method.

The active method encourages participation in the course of a large number of students,

- Question 5: What are your teaching strategies? Theoretical course, practical work, both?

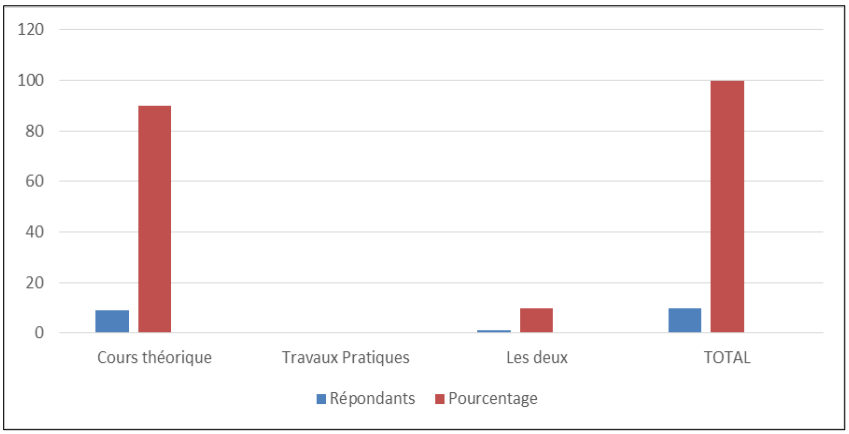

Figure 5 Results on teaching strategies by teachers

This figure shows that 9 out of 10 teachers, or 90%, find that the courses are probably theoretical and 1 out of 10, or 10% of teachers, on the other hand, say that they use practical and theoretical methods.

It reveals that practical work, which plays an essential role in teaching physics in general and laboratory work in particular, is non-existent in our public and private general education middle and high schools

- QUESTION 6: What are the material shortcomings?

Table 4 Distribution of teachers in relation to the lack or insufficiency of material

Answers	**Respondents**	**Percentage**
Lack of experimental materials	05	50%
Insufficient printed materials	01	10%
Lack of sophisticated equipment (computer, programmable calculators, etc.)	03	30%
No teaching materials	01	10%
TOTAL	10	100%

Out of 10 teachers surveyed, 5 lacked experimental materials to accompany their lessons and 3 lacked sophisticated materials. 1 in 10 teachers said that there was a lack of printed materials to support lessons and 1 in 10 said they did not use them at all.

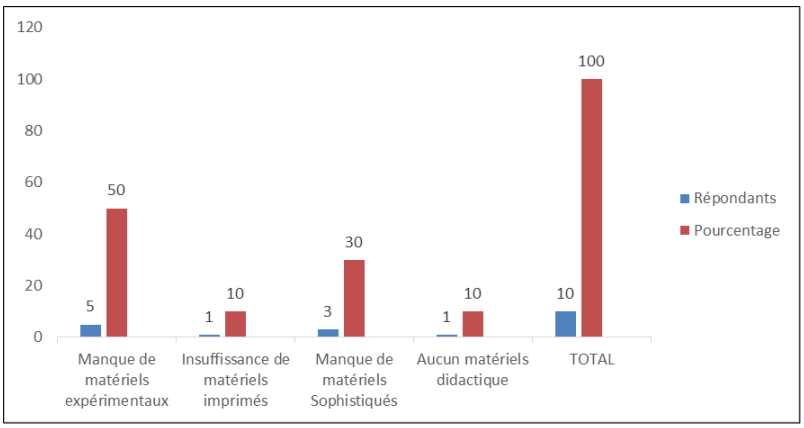

Figure 6 Distribution result due to lack or insufficient material given by the teachers surveyed

It emerges from this analysis that 50% of teachers do not have experimental teaching materials which are the pillars of a well-founded teaching, 30% are missing materials (extreme utility), 10% of teachers have not seen any teaching materials and 10% of teaching agents find it insufficient because they prepare their lessons with a single book. Finally, teaching is more theoretical than practical.

- QUESTION 7: What comments and suggestions do you make regarding the teaching of physics in the laboratory in 4th grade classes with a large number of students and without appropriate teaching materials?

Table 5 Suggestions and comments from physical science teachers regarding the teaching of physics in the laboratory in large classes and without appropriate teaching materials.

Answers	Number of teachers	Percentage
Provide institutions and teachers with laboratory equipment	03	30%
Increase the number of teachers in the field	03	30%
Increase the number of rooms and regulate the number of students	04	40%
TOTAL	10	100%

It emerges from this table that 30% of the teachers suggest that the State and the founders provide the establishments and the physics teachers with laboratory equipment; 30% propose the increase in the number of well-trained teachers and 40% estimate the regulation of the number of students and the multiplication of classrooms built.

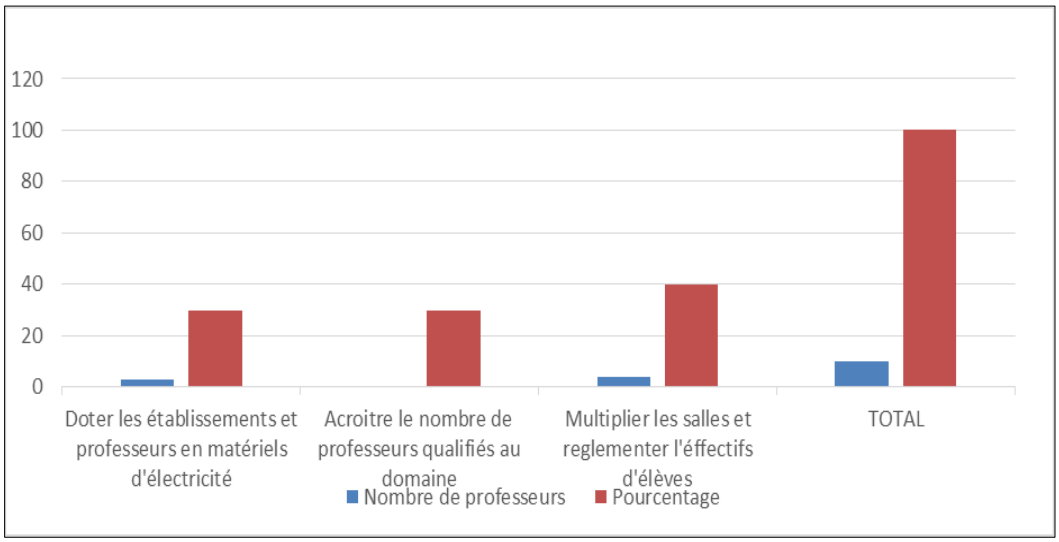

Figure 7 Survey results on the need for laboratory equipment and teaching materials

For the time being, taking into account the country's needs in scientific matters, it is important that politicians and technicians from the Ministry of National Education provide physical science teachers with acceptable working conditions.

3.2. Points of view of 4th grade students

- QUESTION 8: How often are you assigned by your physics teacher to answer a question orally or to go to the board to do an exercise or carry out an experiment?

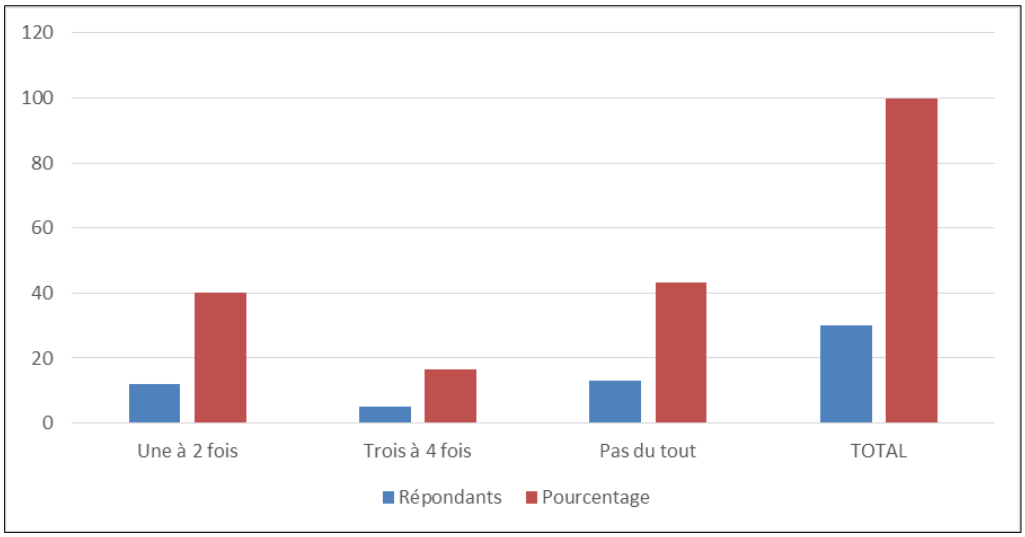

Figure 8 Result of the questionnaire on the processing of an exercise or the carrying out of an experiment

To this question, 40.01% of students say they were questioned only once or twice by their teachers; 16.66% were questioned 3 to 4 times and 43.33% say they were never questioned by their teachers during the school year.

- QUESTION 9: Are you satisfied with the course given by your teacher? Yes, No?

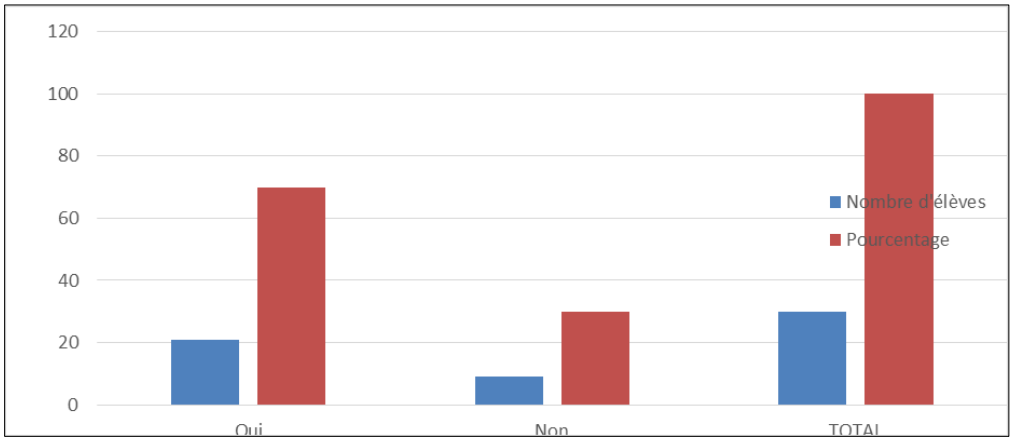

Figure 9 Distribution of satisfaction with the courses taught

This figure shows that 70% of students say they are satisfied with the courses and experiments given by their teachers. For these learners, the teacher is up to his task despite the difficult conditions in which the latter works.

On the other hand, 30% of students surveyed feel they are not satisfied with the courses and laboratory experiments for reasons such as the plethora, the agitation of students like the lack of learning materials.

- QUESTION 10: Have you ever had the opportunity to carry out experiments in the laboratory yourself? Yes, No?

Through this question, we noticed that out of the 100% of students surveyed, 86.67% say they have not carried out activities or practical work sessions in establishments with or without laboratories and only 13.33% agree that they have carried out laboratory activities whose relevance to our theme.

This analysis shows that the courses are mainly book-based. These students also say that they even lack certain local and commercial products.

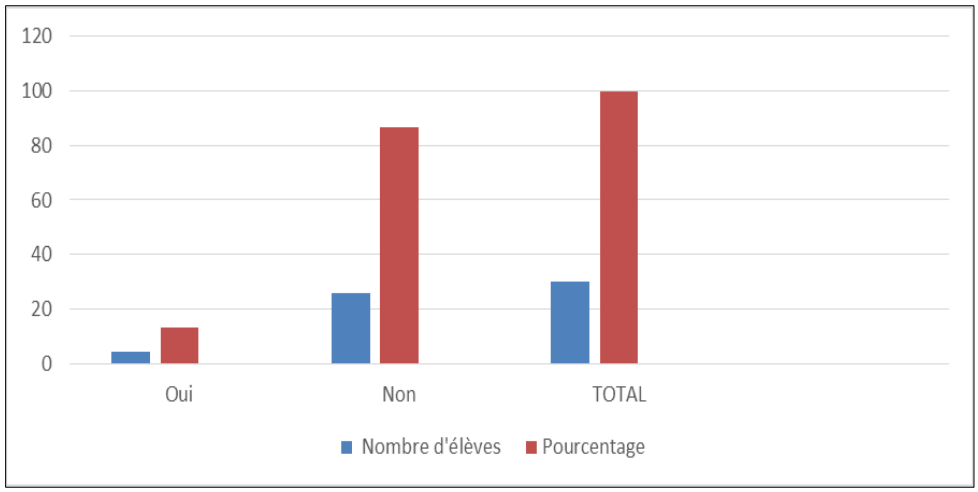

Figure 10 Students' performance of laboratory experiments

- QUESTION 11 WHY?

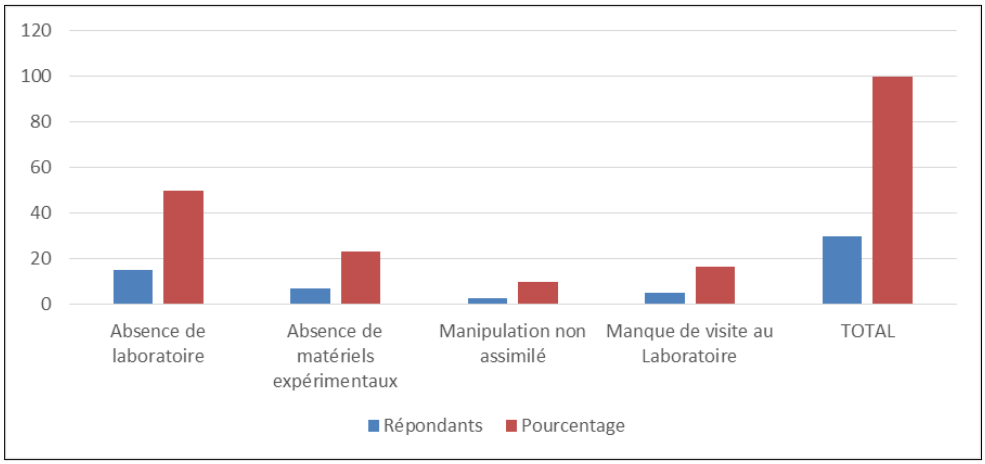

Figure 11 Survey results on the absence of laboratories and teaching materials for practical work

50% of students say that their respective schools do not have a laboratory, 23.33% say that there is a lack of experimental materials, 10% of learners agree that they have carried out non-assimilated handling activities and 16.67% of students say that they do have laboratories in their schools but their doors are always closed, the materials piled up and covered in dust. There are even expired products. The other concern is that some teachers have not received training that predestines them to carry out handling activities with students.

- QUESTION 12: What are your needs for learning in the laboratory?

Based on this table, 11 out of 30 students, or 36.66%, need a laboratory and experimental teaching materials, 10 out of 30, or 30% want the State to build them libraries in the establishments well-stocked with materials, including those of electricity, 7 out of 30, or 26.68% of learners need qualified teachers, laboratory technicians and librarians and 2 out of 30, or 6.66% say that the State must build them vocational training schools in this field of laboratory.

Table 6 Distribution of students according to their needs in the laboratory

Needs	Number of learners	Percentage
Laboratory and experimental materials	**11**	36.66%
Construction and equipment of libraries	**10**	30%
Training of qualified teachers, laboratory technicians and librarians	**07**	26.68%
Creation of laboratory training schools	**02**	6.66%
TOTAL	**30**	100%

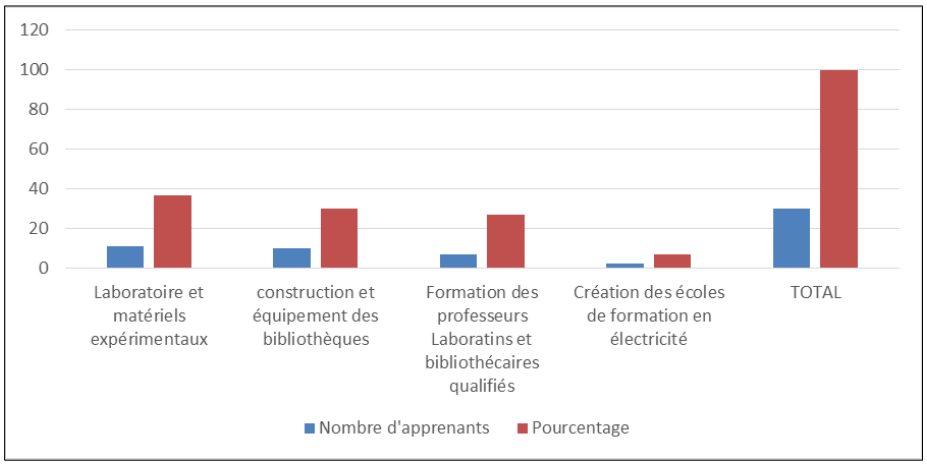

Figure 12 Result of the needs expressed for practical work

It emerges from this analysis that the needs of learners are immense. Thus, this Chadian youth demands the improvement of learning conditions for a certain tomorrow, an evolved society.

3.2.1. Survey result on student effectiveness

We assessed the skills of our learners through the efficiency test. At each targeted establishment, twenty (20) students took the test and the success threshold is set at 20 out of 40 points.

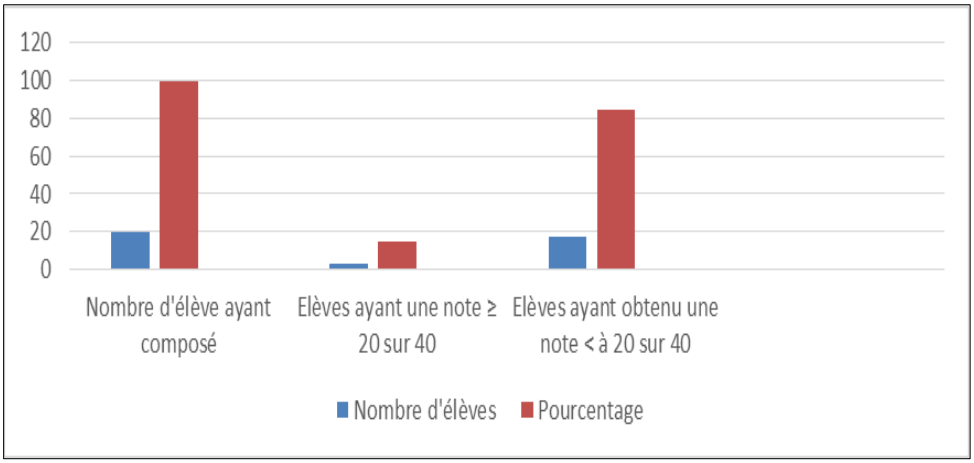

Figure 13 Assessment result carried out at Lycée-College C

This table reveals that out of 100% of students who participated in the assessment, 15% reach the efficiency threshold, while 85% of learners are below average.

It emerges from this table that laboratory teaching at Lycée-College C, 4th level is ineffective.

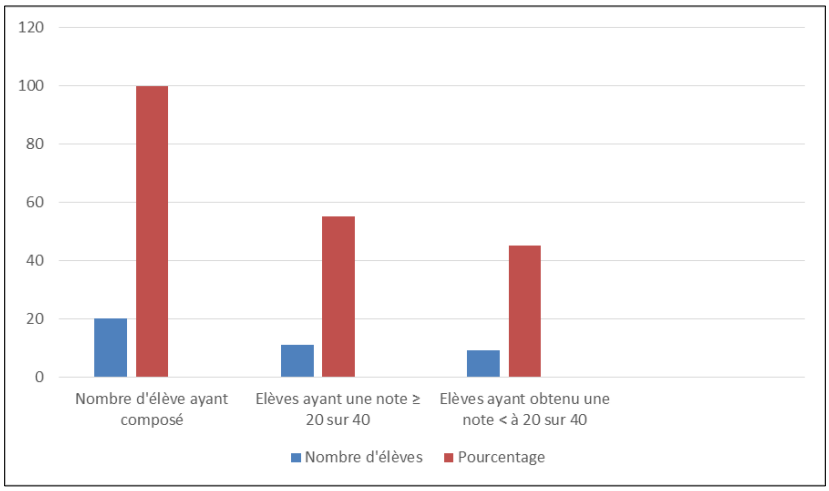

Figure 14 Assessment results carried out at Lycée-Collège A

This table shows that 55% of students obtained a score greater than or equal to 20 out of 40 points and 45% never reached the efficiency threshold. Unlike Lycée-Collège C, Lycée-Collège A (80 to 100 students/room) is clearly efficient. This largely justifies that the students of this establishment work efficiently in this area.

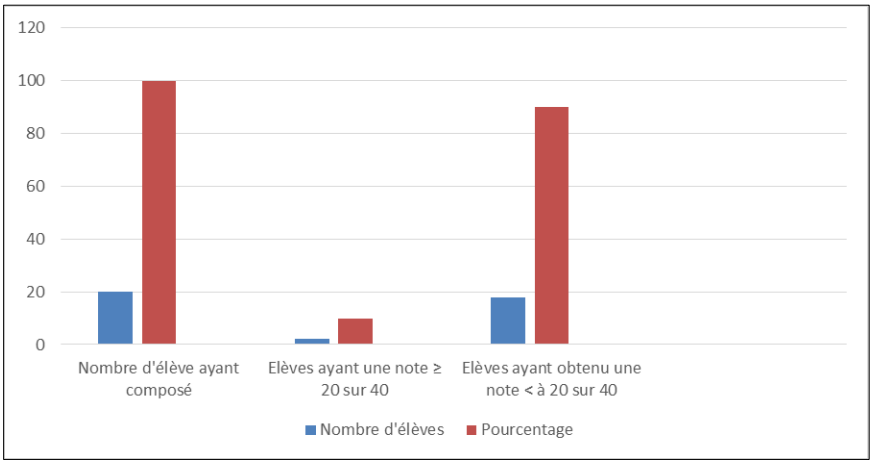

Figure 15 Assessment result carried out at high school-college D

This figure proves that 02 students out of 20, or 10%, obtained a grade greater than or equal to 20 out of 40 points awarded and 18 learners out of 20 missed the average.

It emerges from this observation that laboratory teaching in this establishment in 4th grade is catastrophic.

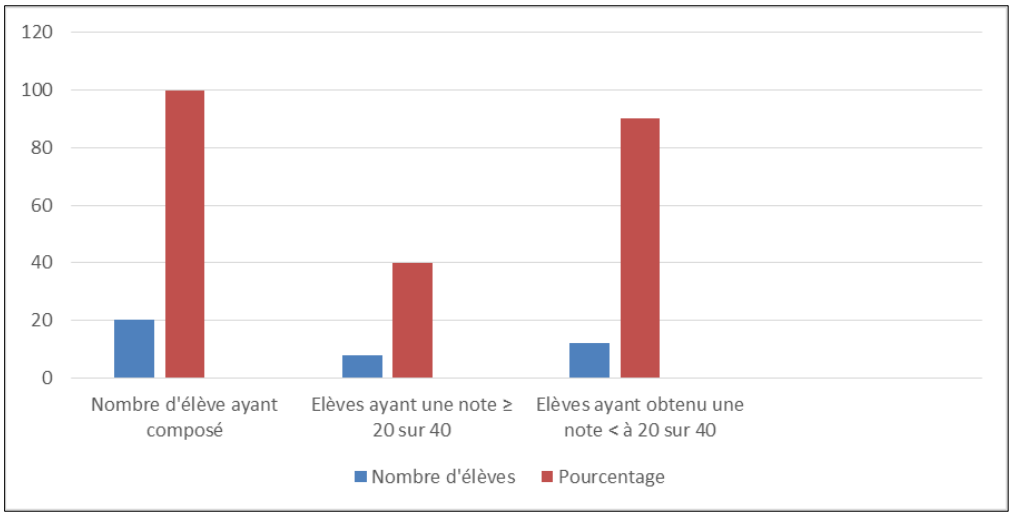

Figure 16 Assessment result carried out at high school-college B

This figure of high school-college B stipulates that 40% have reached the success threshold and 60% are ineffective.

The summary of the results of four (4) establishments is given in the following figure

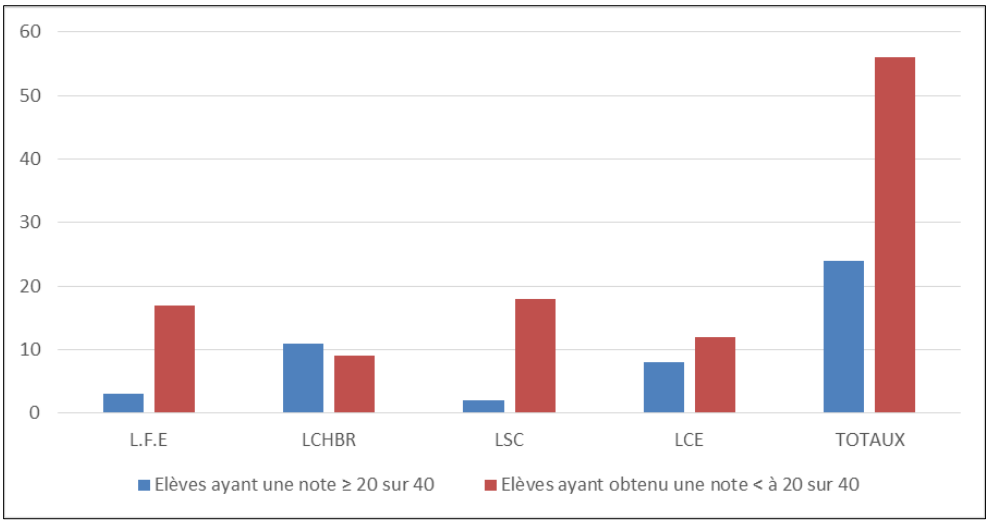

Figure 17 Summary result of four (4) establishments

According to this figure, we affirm a priori that high school-college A is more efficient (11 out of 20) than high school-college B which turns out to be not very efficient (8 out of 20). They are followed by high school-college C and high school-college D (2 out of 20). The last two establishments mentioned above (LFE and LSC) are the seats of exponential disorder, cause of student inefficiency.

Overall, these four (4) establishments have 24 competent students and 56 incompetent students in the laboratory.

Compared to this result,, it is appropriate to say that formative assessment in these classes with large numbers of students poses enough problems for teachers who are unable to control the level of knowledge of most of their students.

4. Conclusion

While waiting for the best teaching/learning conditions to be created, physical science teachers and their students must accommodate the unfavorable situation they are in by using their initiative and imagination to achieve high performance: "methodological resourcefulness".

Are we not called upon at different levels of responsibility to make laboratory teaching effective in 4th grade classes?

It emerged from the analysis of our survey that the plethora of a class and the lack of teaching materials and laboratory rooms have negative effects on the quality of teaching/learning of physical sciences in general and particularly laboratory science in public and private secondary schools in the city of Ndjamena, particularly 4th grade classes.

Indeed, the plethora of students in a class does not allow the teacher to organize and correct homework within a reasonable time. According to the statistical tables below:

 60% of teachers intervene in classes with a size of between 100 and 120 students and even more, teach classes in four (4) 4th grade classes per establishment and 70% say they intervene in other levels; also 56.66% of students say they stay 4 to 6 per table bench and 13.34% litter the floor;

Despite the active method applied by 80% of teachers to arouse the spirit of creativity and awakening of students, in our opinion, the plethora does not allow us to objectively measure student performance. We believe that in teaching practice, three (3) grades are required per quarter and the judgment and decision stages must be within a reasonable time of three (3) days. We say that in reality, after correcting the assignment, very few students have their average, 24 out of 80.

As for teaching materials, 90% of the teachers surveyed say that the courses are theoretical; 50% have increasing needs for experimental materials, 10% for printed materials and 10% others say that they have not received any teaching materials.

In the same vein, 86.66% of students admit to never carrying out laboratory experiments in their establishments.

From the point of view of the search for knowledge and formative assessment, 43.33% of students say that they have not been designated by their trainers to respond orally or go to the blackboard to solve an exercise during the school year and 40.01% are designated only once or twice. However, this form of assessment allows the teacher to check during his course whether the educational objectives set are achieved. Thus, 100% of students affirm variously the improvement of teaching/learning conditions in the laboratory.

Taking into account our survey, it must be clearly emphasized that the use of teaching materials (printed, experimental, etc.) in laboratory teaching not only facilitates students' understanding of the course, but also prevents the teacher from making long abstract speeches without real impact on learning and summative assessment. However, some establishments have laboratories (Felix Eboué high school and Sacre Cœur high school) that are not functional for various reasons (political, personal, technical, administrative, etc.)[20][21][22].

Compliance with ethical standards

Acknowledgments

At the end of this work I would like to thank the African Laboratory for Sustainable Development Research (AfricLab).

Disclosure of conflict of interest

The authors declare no conflicts of interest.

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