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RESEARCH ARTICLE

STUDY OF INSTITUTIONAL COGNITIVE DYNAMICS RELATING TO THE TEACHING AND LEARNING OHM'S LAW IN BENIN

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ABSTRACT

This research analyzed the curricular dynamics relating to the teaching and learning of Ohm's law in Benin. It is useful for laying the foundations for understanding the role of the prescribed curriculum in the many problems highlighted with regard to the teaching and learning of Ohm's law. To this end, it analyzed the prescribed curriculum relating to Ohm's law in the light of Franklin Bobbitt's curriculum theory (Mœglin and Chaptal, 2016) and the methodological framework proposed by Barthès (2022) for analyzing curriculum systems. Research in physics education analyses content as it relates to teaching and learning in the school subject of physics. There is a wealth of research on physical concepts and laws, highlighting the problems associated with teaching and learning them, while attempting to propose solutions to mitigate these problems. Among these difficulties are institutional problems in the organization of teaching and learning of physical laws and concepts, as well as dysfunctions in the organizational implementation of the subject of physics. The question that arises is: to what extent does the prescribed curriculum contribute to the many problems identified in the teaching and learning of Ohm's law? The methodology consisted of a diachronic analysis of curricula and study guides from 1960 to 2020, focusing on axiological and epistemological dimensions. The results indicate that study programs relating to Ohm's law have evolved in a somewhat chaotic manner, both in terms of teaching paradigms, in terms of topics ranging from energetic to electrokinetic via electrostatic, in terms of the vague definitions of Ohm's law, and in terms of curriculum guidelines. This institutional curricular dynamic is likely to create instability in the implementation of Ohm's law in institutional subjects, which should be explored.

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INTRODUCTION

This research analyzed the prescribed curriculum for teaching and learning Ohm's law from a diachronic perspective, focusing on changes in the cognitive, ideological and paradigmatic content of programs at different school levels within the framework of a didactic programming. First, we present the conceptual and theoretical framework that served as the basis for the analyses. We then report on a few case studies of curriculum analyses, before posing the research question and describing the methodological approach of the study. Finally, we present the results.

Theoretical framework: The research is broadly in line with the curriculum theory approach developed by Franklin Bobbitt, as reported by Mœglin and Chaptal (2016). This theory provides a framework for reviewing and developing curriculum content along axiological and epistemological lines. Curriculum theory can be based primarily on the epistemological dimension, which constitutes the theoretical foundation that guides the selection of objectives, content and methods. The axiological dimension is based on a philosophical foundation in the choice of preferred values, a sociological foundation in the choice of social and individual needs, and a psychological or educational foundation in the choice of a theory of learning or teaching. The concept of curriculum includes the formal curriculum, which refers to the hierarchical set of content, tasks and procedures to be taught and learned, the observable actual curriculum, which refers to the subjects actually taught and practiced; the produced curriculum; the hidden curriculum, which represents what is concealed from the learner or by the teacher's involuntary actions based on their culture; and the possible curriculum, which "*remains virtual (in potential) until the conditions for its implementation are identified*" (Lange, 2014). The methodological framework for analysing curriculum systems proposed by Barthès (2022), based on the epistemologies of the sociology of curriculum developed by Forquin (2008), provides the basis for analysing curricula, which represent the ordered list of skills to be acquired by pupils and set national objectives to be achieved, in line with the expectations of the social and economic spheres.

LITERATURE REVIEW AND ISSUES

Previous studies have focused on curriculum analysis. Three such studies are presented, one for each of the categories listed above. Barthes, Alpe and Bader (2013) studied diachronic curriculum analyses of 17 professional bachelor's degrees in the field of the environment, whose curricula are evolving with the introduction of 'education for sustainable development' at university.

Methodologically, on the one hand, lexical occurrences in the degree programs were identified and categorized, as were the number of hours. On the other hand, modules were analyzed in detail according to categories that grouped together courses associated with corresponding teaching hours in 2001 and 2011. Variations in teaching hours between the two dates, whether positive or negative and exceeding 7 hours, were also extracted and analysed. The results show a reduction in the proportion of academic subjects and scholarly knowledge, the emergence of a new organizational and regulatory framework for specializations around sustainability, the establishment of a normative framework of values and experiences, and the development of project management and diagnostic skills. Barthes, Blanc-Maximin, and Dorier (2019) conducted comparative curriculum analyses from the perspective of the effects of curriculum guidelines on a produced curriculum.

The data analysed focused on sustainable development education projects contained in geography lessons for second and first-year secondary school students. Emancipatory and civic educational objectives were established, based on curriculum guidelines to be implemented. The approach consists of comparing the effects of a curriculum guideline implemented by a teacher and examining its influence on the work of 88 students, representing the effects of the curriculum produced according to the principle of counting lexical occurrences. Identifying the visible levels achieved in the curriculum guidelines (from 1 to 4) is an analytical approach that makes it possible to identify both the learning achieved in certain educational situations (teacher training, support, curriculum guidelines, etc.) and then to estimate the margin for progress that is still possible, which may prompt reflection on teaching methods or context. Barthes and Alpe (2016) carried out systemic curriculum analyses by examining the gaps between a reference framework and the curriculum produced in order to approach the hidden curriculum. Following the principle of lexical occurrence surveys, the measurement of gaps is applied between the prescriptive institutional reference frameworks for sustainable development considered legitimate and a produced curriculum.

The curriculum produced concerns the social representations of a group of Master's students who took a 45-hour module on sustainable development. The curriculum analyses made it possible to develop didactic recommendations and constituted a first step in the study of the hidden curriculum. The various studies are based on counting lexical occurrences to analyse the differences between the formal curriculum and the actual curriculum, or between the actual curriculum and the produced curriculum, either to measure the societal significance of curricular changes, highlight the effects of curriculum guidelines on a produced curriculum, or estimate the differences between a reference framework and a produced curriculum, with sustainable development as the subject of study. Few studies in didactics have focused on analysing the curriculum from the perspective of institutional cognitive dynamics (Chevallard, 1989). The particular contribution of this study is the diachronic analysis of the prescribed curriculum relating to the teaching and learning of Ohm's law in order to investigate the role of the institution responsible for implementing this law in secondary education in Benin in the numerous problems highlighted by recent research in science education concerning the teaching and learning of fundamental concepts of electrokinetics (Dognon, Magbondé and Oké, 2020; Dognon and Oké, 2025).

METHODOLOGICAL

This work involves conducting diachronic analyses of the prescribed curriculum relating to the teaching and learning of Ohm's law. The data corpus consists of curricula (prescribed curriculum) and study programme guides (curriculum guidelines) from the 1960s to the present day, divided as follows: 1960 to 1975, 1976 to 1981, 1981 to 1988, 1988 to 2005, and 2005 to 2020, the year of the last curriculum update. This time division is based on changes in teaching and learning paradigms, socio-political changes and changes in content in terms of the introduction of Ohm's law, whether through energetics, electrostatics or electrokinetics, as part of a teaching programme at the various levels of the curriculum concerned by the study of Ohm's law. For each of the periods identified, a qualitative descriptive analysis of the study of Ohm's law as prescribed in the curriculum is carried out.

Knowledge:
- The resistance of an ohmic conductor, characteristic U=RI. Graphical determination of R.

Objective:
- Recognize an ohmic conductor by its characteristic U=RI. - Graphically determine the resistance of an ohmic conductor. - Calculate the resistance of an ohmic conductor knowing the current flowing through it and the voltage across its terminals.
- Know how to measure resistance with an ohmmeter.

Knowledge:
- *The characteristics of the resistance of a cylindrical ohmic, relationship* $R=\rho\frac{l}{s}$. *Units.*

Related objectives
- Memorize the relationship $R=\rho\frac{l}{s}$
- Know that the resistance of an ohmic conductor is expressed in ohms.
- Show or indicate that the resistance of a cylindrical ohmic conductor is proportional to its length and inversely proportional to its cross-sectional area.

Knowledge
- *Series connection of two ohmic conductors, relationship R = R1 + R2. Application: voltage divider.*

Related objectives:
- Verify experimentally or indicate how to verify that R = R1 + R2.

Knowledge
- *Parallel connection of two ohmic conductors: relationship* $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$

Related objectives
- Knowing that in a circuit with a shunt: $i=i_1+i_2$
- Check that: $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}$
- Construct a voltage divider circuit.

Figure 1. Part of the curriculum of physical sciences, 1988

Results of the analysis of the prescribed curriculum relating to the teaching Ohm's law

Ohm's law in Benin's school curricula from 1960 to 1975: From 1960 to the present day, Benin has undergone three reforms of its education system, two of which have fundamentally changed the teaching paradigm. As Hounkpè (2015, p.11) writes, when Benin gained independence in 1960, the public authorities retained the French colonial school curriculum, prioritizing the stability of socialization institutions. Independence did not put an end to school education; on the contrary. Until 1975, curricula were content-based. They consisted of a list of conceptual content that teachers were required to implement in the classroom, relying primarily on textbooks. Meanwhile, the 1970-1971 reform introduced by the then Minister of National Education with the assistance of Mr Grosette, a French civil servant, inspector of the Overseas Academy, representing the French governor in Dahomey, did nothing to change the situation. The physics curriculum is essentially the same as the French curriculum of the 1960s. The curriculum does not include the study of Ohm's law in the first cycle. It is in the first year of secondary school that Ohm's law is introduced in electricity under the heading 'electrostatics'. The programs highlight electrical forces (Coulomb forces) to introduce the work of electrical forces by linking them to the concept of potential difference and therefore to that of potential through the relationship $W= q (V_A-V_B)$. The program then prescribes two outcomes that lead to energy issues. One is related to electrical power (P = U.I), while the other leads to Joule's law. In both cases, resistance is defined mathematically. Under these conditions, it is not Ohm's law that is explicitly introduced.

Ohm's law in content-based curricula: 1975 to 1981: This period was one of profound political upheaval. The Marxist-Leninist government of the time wanted to reform the school system through its program known as the National Program for Building a New School. Ordinance 75-30 of 23 June 1975 on the national education policy enshrined in law the implementation of a new teaching method that broke with the colonial school system, as set out in the Policy Speech of 30 November 1972. It stipulates that the New School method should be essentially active and dynamic, supported by teaching methods that make judicious use of the study of the environment; that it should aim to socialize pupils while giving them the intellectual and practical means to transform themselves; and that it should also help them to acquire knowledge in a comprehensive manner, organized in a network rather than as a set of disjointed and inarticulate units. Despite this fine rhetoric, which sounds very contemporary, physics program continues to take the form of a list of content. Electricity and Ohm's law are still absent from secondary school program. It is still present in second-year Level II classes in the BG (Biology and Geology) and ST (Science and Technology) streams under the heading "Circuit Laws" in the entry "Electrokinetics", where the curriculum (Programme de l'Enseignement Moyen Général [PEMG], 1976, p. 134) provides a list of content :*Ohm's law for resistance; Generator-receiver (fém-fcém); Example of a chemical generator (batteries-accumulators); Generalized Ohm's laws; Generalized Pouillet's law. The programme as worded does not provide any comments to accompany its implementation. However, if we examine the textbooks currently in use (Cessac &Tréherne, 1966; Lamirand & Joyal, 1964 and Tréherne, 1972), we understand that Ohm's law for resistors corresponds to the expression U=R.I*; that Ohm's generalized law leads to the determination of the current in a circuit containing generators and receivers (motors, electrolysers, etc.), i.e. $I=\frac{\sum E_i-\sum E'_j}{\sum R}$and that Pouillet's generalized law expresses the intensity of the current, in the case of several generators in series concordance, excluding receivers with counter-electromotive force, in the form:$I=\frac{\sum E_i}{\sum R}$. In the appendix, the programme provides an indicative list of practical work, including Ohm's laws and EMF versus EMF. We conjecture that the experimental verifications of Ohm's laws (plural) relate to the laws as presented in textbooks at that time:

First law - Current intensity is proportional to potential difference. Second law - The intensity of the current is inversely proportional to the length of the wire.

Third law - The intensity of the current is proportional to the cross-sectional area of the wire. Fourth law - The intensity of the current depends on the nature of the wire.

Ohm's law in content-based curricula: 1981 to 1988: In September 1981, an initial assessment of the New School Building Programme was carried out. It highlighted a number of shortcomings. The curricula were revised because « …recognised as completely dense, because they consist of a collection of juxtaposed titles and content that is difficult for teachers to implement, especially since they are not accompanied by official instructions or specific objectives *». (Gomez &Huannou, 2009, p.41).* The programmes were revised and simplified at the start of the 1982–1983 school year with the introduction of electricity for the first time in the second year of Level I, in the third and fourth years of Level I, equivalent to the fifth, fourth and third years respectively. Ohm's law was explicitly included in the fourth-year programme and revisited in the third year. In the fourth year, the concept of resistance was introduced in its direct and exclusive relationship with the concepts of current intensity and electrical voltage. Electrokinetics sui generis was the order of the day. The curriculum included a list of content in paragraph three of the "Electricity" section, without any accompanying comments or instructions « *...construction of a current detector; greater or lesser deflection of its needle; current intensity, measurement, units; electrical voltage, measurement, units; relationship between voltage and intensity: experimental study of a resistor, Ohm's law »* (Physical Sciences Program, [PSP], 1982, p.8). Unlike previous programs, resistance is the central focus of study and is determined experimentally, and its relationship with energy concepts (power, work, Joule effect) does not appear.

Thirdly, Ohm's law is not explicitly included in the curriculum. The curriculum recommends doing « *… Reminders on: current and voltage, their measurements, the relationship between current and voltage; heat dissipation in a resistor, Joule's law, advantages and disadvantages of heat dissipation in a resistor. ... » (Ibid, p.11).* It is well understood that in Year 9, Ohm's law serves as a springboard for introducing its energy aspect, namely Joule's law ($P = R.I^2$), and resistance is determined mathematically. In the first year of BG and ST classes, Ohm's law is taught, but fundamentally nothing has changed since the period 1975-1981.

Ohm's law in objective-based curricula: 1988 to 2005: The redesigned École Nouvelle program was criticized for simply listing content without commentary. It was under these circumstances that new programs, known as Intermediate Programs, were launched. These programs included content accompanied by educational objectives. Comments provided teachers with guidance on how to achieve these objectives. The electricity program was completely overhauled. Electrokinetics was included in the curriculum at all levels in the first cycle. The second-year science class, which until then had only covered mechanics and optics in physics, now included electrokinetics in its physics curriculum in the second cycle. In these programs, Ohm's law is taught only in Year 9 and Year 10 C and D, even though it appears to be used in Year 11 to calculate energy balances and in Year 13 in the context of oscillating electromagnetic circuits.

In Year 9: The chapter on electricity comprises two sections: one is entitled « Resistance »without any explicit mention of Ohm's law; the other is entitled electrical energy. The study of resistances includes a list of content with associated objectives and comments as shown in PSP (1988, pp. 63, 75). It is clear that, for the first time, the study of the resistance of an ohmic conductor is central to electricity with the explicit introduction of the characteristics of an ohmic conductor. As recommended in the comments, this will involve setting up an ohmic conductor test rig and taking a series of measurements of the voltage U and current I flowing through the conductor. The comments then prescribe two ways of using the measurement results: one consists of entering the values of I and U in a table; calculating the ratio $\frac{U}{I}$then show that it is constant and consider this constant as the value of the resistance of the ohmic conductor. Another way of using the measurement results is to plot the corresponding values of U and I on a rectangular coordinate system and construct a graph of the function U= f(I). The program leaves it up to the teacher to indicate the procedure for determining resistance, i.e. the slope of the line obtained. As presented, the study of Ohm's law therefore involves two fundamental mathematical concepts: proportionality in numerical calculation theory and the affine application of linear algebra. The value R of the resistance of an ohmic conductor is therefore determined by reading its relationship with the voltage U and the intensity I of the current flowing through it. This reading is based on the observation of the regularity of a certain singularity between U and I in order to extract a universal relationship through induction (Figure 1).

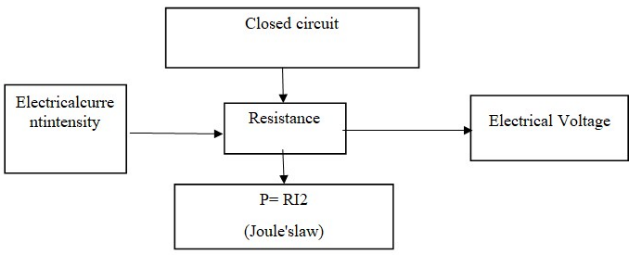

Figure 2. Schématisation de l'étude de la loi d'Ohm dans les programmes d'études en 3ème de 1989 à 2005

Even though the program does not explicitly refer to the result of the process in terms of Ohm's law, it is clear from the title 'resistance' that it is indeed about the rediscovery of Ohm's law. In this vein, the program focuses on the mathematical relationship between voltage, current and resistance. ($R = \frac{U}{I}$)and does not concern itself with stating Ohm's law. With regard to these two methods of data processing (use of proportionality and the equation of a straight line), the comments specify that :

For physicists, these are two common data processing procedures in many fields. The aim is therefore to begin teaching pupils these two procedures. They draw on mathematical skills that have been acquired or are yet to be acquired. Teachers should therefore not hesitate to consult their mathematics colleagues to determine the best approach to ensure that learning takes place with as few difficulties as possible. (PSP, 1988, p.76)

They clearly highlight the programme authors' concern about the mathematical difficulties involved in this experimental-inductive approach to the mathematization of the physical phenomenon in question. We therefore see two representations of Ohm's law: an algebraic representation (U=R.I) and a graphical representation. These comments therefore suggest the interdisciplinary mathematical-physical work inherent in learning physical concepts. They raise the question of the didactic programming of the concepts being studied in mathematics for and in relation to those relating to physics concepts for a given class. In further exploration of the concept of electrical resistance, the comments call for the introduction of « a simplified model of a metallic conductor where atoms are represented by spheres between which free electrons, represented by dots, can move more or less easily » (Ibid). This approach highlights two points of view: the first tends to explain the movement of electricity, and the second expresses the microscopic point of view of Ohm's law. The study of electrical resistance in Year 9 also covers the characteristics of a cylindrical and homogeneous conductor. The aim is to convey the relationship$R=\rho\frac{l}{s}$. This relationship highlights that the resistance of a conductor depends on its geometry (cross-section and length) but also on its nature. These two dependencies highlight Ohm's law in its macroscopic form (geometric dependency) and its microscopic form (dependency on the nature of the material). With regard to ohmic conductor combinations, the program recommends an experimental study to determine the equivalent resistance to a series combination of ohmic conductors (R= R1 +R2) without explaining the procedure. The prescribed program to do « *a very important application: the voltage divider* ». This is indeed an application of Ohm's law, although the program and comments do not specify this clearly. The case of two ohmic conductors connected in parallel seems more problematic to us. Indeed, the program requires verification that the relationship $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$by assigning as an additional objective the establishment of the law of derivative currents i=i1+i2. This is where Bruhat's question (1931) « *How can we arrive at the formula giving the equivalent resistance of two shunt branches without using Ohm's law?* » takes on its full meaning.

Studying Ohm's law in competency-based programs: In 1991, at the beginning of the democratic revival, an educational policy framework document was created and, following the passing of the framework law, led to the implementation of the New Study Programmes (NPE) based on the Competency-Based Approach (APC). The active phase began in the sixth form of secondary school at the start of the 2005-2006 academic year and was rolled out across all primary and secondary schools at the start of the 2011-2012 academic year. In these curricula, electricity remains part of the syllabus in the fifth form of primary school and from the sixth form to the final year of secondary school.

Ohm's law in the first cycle of general secondary education: In the first cycle, Ohm's law was included in the third-year curriculum in the two previous curricula and the current curricula. In the new curricula currently in force, Ohm's law no longer appears as a subject of study, serving only to study the Joule effect. Ohm's law is brought back into the fourth year as a subject of study in its own right under the title: « *Use of measuring devices for certain electrical quantities. Verification of Ohm's law* ». The conceptual content to be covered is as follows (Curriculum, 4th [P.E], 2007, p.3): Measuring the intensity of direct current; Measuring electrical voltage; Resistance of an ohmic conductor (characteristic of an ohmic conductor: U=R.I; graphical representation and association of ohmic conductors. With regard to the subject of study, verification of Ohm's law, the curriculum guide (GPE 4th, 2007) prescribes, on a list of knowledge and techniques to be acquired, the verification of Ohm's law at the terminals of an ohmic conductor and the graphical determination of the resistance of an ohmic conductor. The program therefore prescribes the verification of Ohm's law rather than the establishment of Ohm's law. Establishing Ohm's law would consist of an inductive demonstration of the existence of this law for a particular class of dipoles called ohmic conductors, which would require using a series of voltage and current measurements and searching for a functional relationship of proportionality between them. One might wonder how it is possible to verify Ohm's law when it is not yet known. In this case, since Year 7, this is the first time that pupils have encountered Ohm's law. The only learning objective related to verifying Ohm's law concerns the measurement of voltage, current and resistance. This is why the comments include a statement of Ohm's law. Ohm's law: the voltage between the ends of an ohmic conductor is equal to the product of the resistance of the ohmic conductor and the current flowing through it. It is expressed as U = R.I. (GPE 4è, 2007, p.17). Verification of Ohm's law therefore consists, in line with the purely technological approach of using electrical measurement devices, of correctly measuring the voltage U across the terminals of an ohmic conductor and the intensity I of the current flowing through it, and measuring the resistance of this ohmic conductor after removing it from the circuit.

The resistance value obtained must then be multiplied by the current intensity I and the result of this product must be checked to ensure that it is equal to the voltage value. One might question the scientific value of learning this verification method if the commentary had not clearly stated that the aim of this verification is to explore the technological aspects of using an electrical measuring device. Under these conditions, how can the resistance of an ohmic conductor be determined graphically? The program, the program guide and the comments remained silent on this point. The very statement of Ohm's law, as given in the programs, seems to us to be questionable. Indeed, as worded, it is merely a verbalisation of the mathematical relationship U=R.I, which expresses Ohm's law. It is clear that the wording given in the syllabuses equates the relationship U=R.I with the statement of Ohm's law. The programs seem to overlook the proportional relationship between voltage and current in an ohmic conductor. However, this concept of proportionality is central to Ohm's law. For us, this failure to highlight a homomorphism between the concept of proportionality in mathematics and Ohm's law in physics removes any opportunity to learn not only about the basis of Ohm's law, but also other future knowledge such as spring calibration, kinetic energy (proportionality with the square of velocity), the weight of a body and the intensity of gravity, and much more knowledge to be learned in later classes.

The conceptual content of the program (4th Year Study Program [P.E], 2015, p.86), which suggested that voltage and current measurement data for an ohmic conductor would be dealt with graphically, was no longer mentioned anywhere in the comments in the program guide. On the contrary, the program clearly specifies (GPE Year 4, 2015, p.20) « *to measure the intensity of a direct current and the voltage across an ohmic conductor placed in an electrical circuit and the resistance of an ohmic conductor* ». The study program and guide prescribe the graphical determination of the resistance of an ohmic conductor. This graphical determination requires plotting the characteristic line of the ohmic conductor and determining its slope coefficient, which provides the value of the resistance. But for the programs, this process is self-evident. Indeed, they do not mention the technical or technological dimensions underlying this determination. If we consider that the educational planning for the Year 8 program provides for this course to be taught at the beginning of the school year in Year 8 and that in mathematics, the concepts of the mean line or linear application will only be taught and learned in Year 9, we can easily understand that the construction, in class, of the technique for graphically determining resistance, at the initiative of the teacher, would be problematic. Le schéma ci-dessus (Figure 3) nous permet de résumer l'étude de la loi d'Ohm telle prescrite par les programmes d'études en classe de quatrième. It is easy to note an entry exclusively through electrokinetics without any contribution from energetics or reference to a mechanical analogy. This gives pride of place to electronics. Moreover, the Study Programs clearly specify the field as "Electricity and Electronics" (P.E 4ème, 2015, p.86).

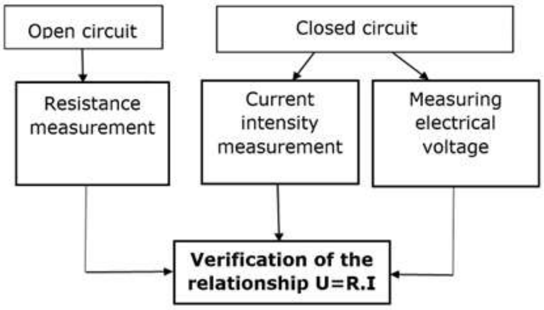

Figure 3. Schematic representation of the study of Ohm's law in Year 9 curricula from 2015

In third grade: Electricity is introduced in the Year 10 curriculum through the topic of energy, and there is no mention of Ohm's law. However, it presents the ohmic conductor as conceptual content, specifying the demonstration of the Joule effect with this ohmic conductor. In this configuration, resistance is calculated mathematically and, using the relationship that expresses Ohm's law, allows calculation using the formula P= R.I2, which is characteristic of the Joule effect.

Ohm's law in the second cycle of general secondary education: In Year 11, The electricity program in Year 10 is based on electrokinetics without reference to any other field of physics. Electric current in electrical components is central to learning. The concepts of electric current, electric voltage, resistance and the characteristics of electric dipoles are introduced experimentally and independently. The study of Ohm's law concerns ohmic conductors and active dipoles. With regard to ohmic conductors, the knowledge and techniques to be mobilized relate to the tracing of the characteristics of an ohmic conductor, Ohm's law for a conductor, the operating limits of an ohmic conductor and the determination of resistance by exploiting the characteristics. The program content is modelled on that of the intermediate programs for the third year of secondary school (1988-2006), with the notable difference being the introduction of the operating limits of an ohmic conductor and, above all, the use of Ohm's law to establish the various rules relating to the combination of ohmic conductors in series (R=R1+R2) and in parallel ($\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$).The extension of the study of Ohm's law concerns the DC voltage generator. The knowledge and techniques to be developed are based on an experimental approach and relate to plotting the characteristics of a generator with internal resistance, Ohm's law for such a generator, and the graphical determination of the internal resistance and electromotive force of this generator. The concept of a circuit's operating point is clearly presented in the syllabus. The comments request that the operating point be determined either graphically from the u=f(i) characteristic curves of a generator and a conductor in the same coordinate system, or by calculation using Ohm's law for the ohmic conductor and for the generator (Figure 4).

In Year 11 classes C and D, Ohm's law is included in the curriculum through an introduction to energy. Ohm's law is studied in the context of a circuit's energy balance. The study of Ohm's law in the first year focuses on electrical receivers and generators. In the first case, the receivers in question are defined as dipoles in which part of the electrical energy is converted into a form of energy other than thermal energy. This is the case with an electric motor, which converts part of the electrical energy into mechanical energy, and with an electrolyser, which converts part of the electrical energy into chemical energy. Initially, the program will study the Joule effect in an ohmic conductor ($P= RI^2$) and then, based on the U= f(i) characteristics of generators and receivers, extract Ohm's law for receivers (U= E'+r'I; where E' is the counter-electromotive force of the receiver and r' is its internal resistance) and Ohm's law for generators (U=E-rI).

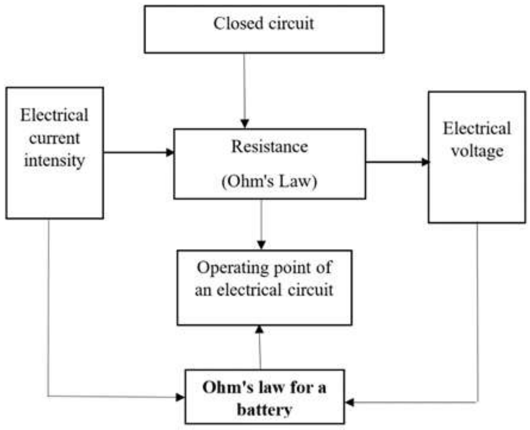

Figure 4. Schematic representation of the study of Ohm's law in Year 12 C and D programs from 2009

The power balance (power received by the receiver (P_r = U.I) = useful power supplied by the receiver (P_u= E'.I) + power dissipated in the receiver by the Joule effect (P_j= r'.I^2)) also allows Ohm's law to be established for a receiver.As in the program for the years 1975 to 1980, the new program requires an energy balance to be calculated for the entire circuit (generators, receivers, ohmic conductors) in order to derive Pouillet's law. Pouillet'slaw :($I = \frac{\sum E_i - \sum E'_j}{\sum R}$)is presented here as a generalization of Ohm's law. As shown in the table below summarizing the status of Ohm's law, the curriculum relating to Ohm's law has evolved in a somewhat chaotic manner. By refocusing on the requirements of Ohm's law for Year 9, it appears that this law was introduced at this level between 1981 and 1988 through electrokinetic, then disappeared as a teaching subject and learning in favour of Year 9 through an introduction to energetics, only to reappear in Year 8 in 2005 without any justification for these sudden changes.

Table 1. Temporal and programmatic evolution of Ohm's law from 1960 to 2020 according to the teaching approach

Period	Entrance via	Year				Educationalapproach
		8	9	10	11	
1960-1975	Electrostatic				X	Programme by content
	Electrokinetic					
	Energetic					
1976-1981	Electrostatic					Programme by content
	Electrokinetic				X	
	Energetic					
1981-1988	Electrostatics					Programme by content
	Electrokinetics	X			X	
	Energetic		X			
1988-2005	Electrostatics					Programme by objectives (intermediate programmes)
	Electrokinetics		X	X		
	Energetic				X	
2005-2020	Electrostatics					Competency-basedapproach
	Electrokinetics	X		X		
	Energetic					

CONCLUSION

This research analyzed the cognitive dynamics of teaching and learning Ohm's law in Benin using a diachronic approach. The results highlight a chaotic curricular evolution that is likely to have adverse effects on institutional subjects (teachers and students) in the construction of this law. Indeed, for the same generation of teachers responsible for implementing this knowledge in the classroom, there have been no fewer than three changes in teaching approaches and many more changes in the requirements of Ohm's law. It is highlighted that, for the same level, there are two representations of Ohm's law: an algebraic representation (U=R.I) and a graphical representation that requires interdisciplinary mathematics-physics work in the classroom, which in practice is never implemented. Sometimes these changes occur from one school year to the next. The same is true for introductions to the law through energetics, electrostatics or electrokinetics, which are poorly explained. Overall, the study highlighted a curricular dynamic that is likely to destabilize teachers' practical epistemology and compromise the conceptualization of Ohm's law.

REFERENCES

Barthes, A., (2022). *Methodologies for analysing curriculum systems, Treatise on research methodology in education and training sciences.* hal-03679681.

Barthes, A. and Alpe Y., (2016). *Using social representations in education*, L'Harmattan.

Barthes, A., Alpe, Y. and Bader, B., (2013). Questions and positions on education for sustainable development at university in France: example of short professional cycles? *Environmental Education Research*, Volume 19(3), p.269-281.

Barthes, A., Blanc-Maximin, S. and Dorier-April, E., (2019). What are the curriculum guidelines for education in sustainable territorial foresight? Values of emancipation and the aims of young people's political involvement in case studies in geography, *Education and socialization*. CERFEE notebook, n°51.

Bruhat, G., (1931). *About Ohm's law*, Bulletin of the Union of Physicists. May–June 1931

Cessac, J. and Treherne, G. (1966), *Physics Course for First Year Secondary School Students*. Nathan Publishing.

Chevallard, Y. (1989). *The concept of relationship to knowledge. Personal relationship, institutional relationship, official relationship. Seminar on mathematics and computer science teaching*, Joseph Fournier University, Grenoble 1, June 1989, Internal document no. 108.

Curriculum (2007). *Physical Sciences*, *Chemistry and Technology, Year 9,* Directorate of Educational Inspection, Porto-Novo.

Curriculum (2015). Physics, Chemistry and Technology, Year 9, revised and proofread version, National Institute of Engineering, Training and Capacity Building for Trainers. Cotonou.

Curriculum. (2008). Physics, Chemistry and Technology, Year 8, revised version, Directorate of Educational Inspection, Porto-Novo.

Dognon, A. Z. M. and Oke, E. (2025). Didactic analysis of physical education: situation of specific determinants specific to teaching in Benin, *Pluraxe/Monde*, Volume 3, issue 12, DOI: 10.5281/zenodo.17810389

Dognon, A. Z. M., Oke, S. E. and Magbonde, K. C. (2020). Teaching and learning Ohm's law in Year 9: exploratory study in Benin, *Proceedings of the 2nd ADiMA* Colloquium, Institute of Mathematics and Physical Sciences, Dangbo, Benin, pp. 106–117.

Forquin J-C (1990). *Sociology of education, ten years of research*, INRP/L'Harmattan.

Forquin J-C (2008). *Sociology of the curriculum*, PUR, 197 p

General Secondary Education Curriculum [PEMG] (1976,). *Physical Sciences*, Ministry of General Secondary Education, Cotonou.

General Secondary Education Curriculum [PEMG]. (1976). *Physical Sciences*, Ministry of General Secondary Education, Cotonou.

Gomez M-R. et Huannou, A. (2009). *Education for Development*, Benin Private Investors Council, CAAREC, coll. Studies.

Hounkpe, A. D. G. (2015). Curriculum reforms in Benin: identifying structural shortcomings for greater efficiency, *Pluralistic thinking*, n° 38, pp.143-161 ; URL : https://www.cairn.info/revue-pensee-plurielle-2015-1-page-143.htmDOI: 10.3917/p p.038.0143

Lange, J-M. (2014). Possible curriculum for Education for Sustainable Development: between participatory actions and multi-referential investigations of issues, *Environmental Education*, Volume 11.

Mœglin, P. and Chaptal, A. (2016, *Chapitre 1. John Franklin Bobbitt. Pierre Mœglin. Industrialising education: Annotated anthology (1913–2012)*, Presses Universitaires de Vincennes (PUV), pp. 77–88. 'Media' collection, 978-2-84292-547-5. hal-01391778.

Physical Sciences Program [PSP] (1982). *Physical Sciences*. Ministry of General Secondary Education, Cotonou

Physical Sciences Program [PSP] (1988). *Physical Sciences*. Ministry of General Secondary Education, Cotonou.

Program Guide, (2009). *Physical Sciences, Chemistry and Technology, Year 10, C and D*, Directorate of Educational Inspection, Porto-Novo.

Skills-Based Curriculum (2011). *Physical Sciences, Chemistry and Technology, Terminale D class, revised version*. Directorate of Educational Inspection, Porto-Novo.

Skills-Based Curriculum (2011). *Physical Sciences, Chemistry and Technology, Terminale C&E class, revised version*, Directorate of Educational Inspection, Porto-Novo

Study Program Guide (2007). *Physics-Chemistry-Technology, Year 8, revised version*, Directorate of Educational Inspection. Porto-Novo.

Study Program Guide (2015). *Physics, Chemistry and Technology, Year 9, revised and proofread version*, National Institute of Engineering, Training and Capacity Building for Trainers. Cotonou.

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