

COMPOUND INTEREST AND EPISTEMOLOGICAL OBSTACLES: ANALYSIS OF THE IDEAS OF STUDENTS IN THE 3RD YEAR OF HIGH SCHOOL

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ABSTRACT

The teaching of Financial Mathematics (MF) and Financial Education (PE) are important in Basic Education, as they enable students to develop skills to critically analyze the financial situations experienced in their daily lives. This study, which results from a monographic work carried out to obtain the certificate of Specialist in Mathematics Teaching, aims to identify whether in the understanding of the answers to the five situations proposed for 10 students of the 3rd year of High School on Compound Interest (JC), in terms of conscious consumption within the scope of PE, there are epistemological obstacles as recommended by Bachelard. The qualitative approach proved to be more appropriate and the interest in interpreting the understanding of these students to understand the limits between the phenomenon and the context led to the option for action research. Thus, it was identified that the understandings presented about JC can be characterized as verbal obstacle and pragmatic knowledge and that therefore they hinder the making of decisions about managing their finances such as choosing the most advantageous way to make payments, make purchases, or other situations that involve money throughout their lives.

Keywords: High School. Financial Education. Epistemological Obstacles. Compound Interest.

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INTRODUCTION

In Brazil, family indebtedness has grown to the point of arousing social, political and economic concerns. This misfortune, which compromises the well-being of these families, could be circumvented with a basic education that would provide Financial Education that actually contributes to the formation of the citizen.

According to the National Confederation of Commerce (CNC), through the Consumer Indebtedness and Default Survey (PEIC), published in July 2020, 69% of families that receive up to 10 minimum wages have increased their debts. This increase was registered as a record, because compared to the month of June, which was 68.2%, and July of the previous year, which was 65.4%, there was a significant increase.

On average, 30.3% of the income of these families is consumed by these indebtedness, which are: post-dated check, credit card, overdraft, store card, personal loan, car installment and home ownership. Also in this survey, it is evident that three out of four respondents report that "the most common debt among Brazilians is credit cards", totaling 76.2% of the population. (LISBON, 2020).

The credit card appears as the main responsible for the indebtedness of the Brazilian population. This attribute that is associated with its misuse reveals a precarious management of finances by the Brazilian population, therefore, it actually explains the lack of Financial Education – PE in Brazilian families and schools.

This assumption goes beyond the educational sphere, as it arouses the interest of institutions such as the Organization for Economic Cooperation and Development (OECD). The OECD, which brings together 36 developed countries with high GDP and HDI indexes, recommends that its key partners include PE in their national education strategies, defines it as:

[...] the process by which financial consumers/investors improve their understanding of financial concepts and products and, through objective information, instruction and/or advice, develop the skills and confidence to become aware of financial risks and opportunities, to make informed choices, to know where to seek help and to take other effective measures to improve their financial protection and well-being (OECD, 2005b, p. 26).

In addition, he suggests that "Financial education should start at school. People should be educated about financial matters as early as possible in their lives." (OECD, 2005b, p. 6). Thus, since 2009 there have been a series of discussions by the National

Congress regarding the inclusion of Financial Education in Basic Education. (VIEIRA *et al.*, 2019).

In 2010, aiming to promote PE actions throughout the country, the Federal Government created the National Strategy for Financial Education (ENEF), in 2017, the focus was integrated with the proposals of the National Common Curricular Base (BNCC) (BRASIL, 2017). But why teach PE in schools? For Mundy (2008, p. 70): "[...] There is a consensus that the purpose of financial education is to help students manage their money as well as their lives".

After bringing the Brazilian family indebtedness highlighting the credit card according to Lisbon (2020), we chose to adopt as a presupposition in our study this purpose of PE pointed out by Mundy (2008). And the option for Compound Interest (JC) as a curricular component, Financial Mathematics (MF), Cambraia and Ribeiro (2011), show that a large part of financial transactions are explicitly or implicitly associated with this mathematical object, in addition, compound capitalization systems offer greater financial return.

Still on indebtedness, in 2017 it was published on the InfoMoney website of the National Association of Finance, Administration and Accounting Executives – ANEFAC that 99.4% of Brazilians are unaware of the concept of JC. This publication elects the misuse of credit cards as one of the villains of the finances of the Brazilian population and recalls that for many paying the minimum/partial amount has been difficult and concludes, not knowing JC, in addition to compromising finances, can also influence the financial behavior of the population. (BORTOLOTTI, 2017).

In the research by Abar, Branco and Araújo (2018) there are 27 studies on the theme of PE obtained from the CAPES Dissertations and Theses Portal in the period from 2014 to 2016. Among these researches from the titles that explicitly bring Elementary School and EM, we detected a numerical balance of 5 studies that address Elementary School and another 5 EM.

We also turned to the Tangram magazine, because despite being recently created, it has disseminated two publications on the theme of PE – v. 1, n. 4 (2018) and v. 2, n. 1 (2019), each one has 7 articles, while in n. 4 there are 5 articles that address Elementary Education in n. 1 there are 3, in the case of the MS approach there are none in n. 4 and only 1 in n. 1. In view of this situation, we can affirm that there is a need for more research on PE within the scope of EM. Thus, regarding the conceptual domain, we are based on the idea of Epistemological Obstacles, idealized by Gaston Bachelard, in the twentieth century

in his work: *The Formation of the Scientific Spirit*. For Pesa and Greca (2000), the epistemological obstacles appear in the act

of knowing, and can be defined as "resistances of thought to thought" (p.9).

A general classification of epistemological obstacles, Bachelard (1996) categorizes them as obstacles of first experience, premature generalization, verbal obstacle and unique and pragmatic knowledge. However, we will delve into the verbal obstacles and the unique and pragmatic knowledge, due to the prevalence of these in the research carried out.

By *verbal obstacle*, Bachelard (1996, p. 91) says that it is: "[...]a verbal explanation with reference to a noun loaded with adjectives [...]". On the other hand, the unique and Pragmatic Knowledge, according to Andrade, Zylbersztajn and Ferrari (2002, p. 5) "translates into the search for the utilitarian character of a phenomenon as a principle of explanation."

The focus on indebtedness brought about by the misuse of credit cards does not refer to the interest of identifying or justifying its causes. The purpose of this is to reveal obstacles to the understanding of JC in order to be properly explored in the bias of conscious consumption in order to help students manage their financial activities.

METHODOLOGY

We adopted the qualitative approach that, according to Bicudo (2012, p. 17), involves:

A way of proceeding that allows the subject of the process to be highlighted, not looking in isolation, but socially and culturally contextualized; more than that and mainly, to work by conceiving it as always being together with the world and, therefore, with the others and the respective utensils arranged in the existential surroundings, constituting the other and the world in its historicity.

The aim of identifying the main epistemological obstacles to the learning of Compound Interest in a group of high school students led to the option for case studies. This approach serves the purpose of revealing their possible existence and nature as we perceive them, as Yin (2005) points out, appropriation involves the fact of dealing with the investigation of contemporary phenomena of reality, aiming to clarify limits on the analyzed context.

The JC content is part of the school curriculum, is experienced in the 1st year classes of High School (EM) and in addition to internal evaluations it is also included in external evaluations such as SAEP, SAEBE, ENEM. The invitation to join the study, carried out from

May to June 2020, was extended to the four classes of the 3rd year of the EM of a public school in the neighborhood of Ponte dos Carvalhos, located in the city of Cabo de Santo Agostinho, in the state of Pernambuco. In these classes, the first author of this study acted as an effective teacher of the

MS there were 133 students in the age group of 16 to 18 years old and we experienced Remote Teaching. The research took place during the pandemic of the new coronavirus (SARS-CoV-2) and brought many unforeseen events, in particular, the lack of access to the Internet by students who, many times, had to access it through third-party electronic devices.

As for the primary data to diagnose difficulties about JC, they come from the questionnaire constructed. Thus, they meet the assumption of translating the investigative intents of specific issues as Gil (2008) points out, so we resort to the following questions:

1. In your view, what are JC?
2. Describe a day-to-day situation that you have used JC.
3. In your opinion, what is the difference between Simple Interest (JS) and JC?
4. If you owned a bank and a customer borrowed money from your bank, (a) would you choose to receive this money back to JS or JC (knowing that the fee (i) charged would be the same in both modalities)? Why? (b) And if you were the customer, which of the forms of capitalization would you choose? Why?
5. John applies R\$ 3,000.00 at a rate $i = 3\%$ p.m. for two months, what amount will John have at the end of this investment? (LIMA, 2020, p. 48-49)

These questions were made available to students and answered by them through the *Google classroom* platform. The analyses of these responses were guided by the epistemological obstacles characterized by Bachelard (1996) and as for the ideas of MF and PE, these were brought from the literature review of Fontes e Fontes (2020) and Paias (2019).

The secondary data of this study originated from a literature review (thesis, dissertations, monographs, books, journals and articles) on the following approaches: Epistemological Obstacles, Financial Mathematics in Basic Education and Compound Interest in High School. After the analyses, the findings were presented to the students of the four classes already mentioned, with the intention of expanding their understanding of JC and PE.

PRESENTATION AND DISCUSSION OF THE RESULTS

In this part, we present the analysis of the errors found in the five proposed questions based on the difficulties of students' misunderstanding of their resolutions through the classification made by Bachelard (1996) about the epistemological obstacles.

ANALYSIS OF QUESTION 1

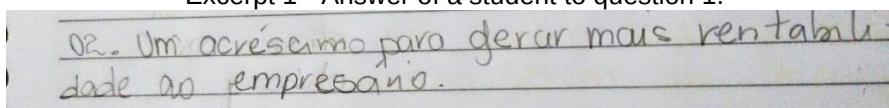
Table 1 - Results of Question 1.

Criteria	Errors Found					Total (TI)
	E1	E2	E3	E4	E5	
Total (PI)	1	1	2	2	1	7

Legend: E1: Error in understanding Compound Interest as a profitability generator; E2: Error in defining Compound Interest as Simple Interest; E3: Error in defining Compound Interest as "Interest on Interest"; E4: Error in associating Compound Interest to only some banking operations or debts; E5: Other errors; PI: Per item; TI: Total items./Source 1 - Author, 2020.

The error E1 on *compound interest* as an object of financial mathematics committed by A1, highlighted in excerpt 1, as a positive factor of this idealization, it is observed that it 'understands to generate profitability for the investor', but does not see the negative factor of the possibility of generating debt. This deficit of recognition in a way justifies the misuse by Brazilians of credit cards, overdrafts, the diversity of loans, etc.

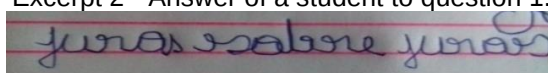
Excerpt 1 - Answer of a student to question 1.



Source 2 - Response from a student, (2020).

Regarding error E3, we found prevalence in the answers of 2 students. In this error, students define compound interest simply as "Interest on Interest", this conception being mistakenly used in the media, some teachers and even in some books. However, this gives the impression that compound interest is levied only on interest, leaving aside the incidence of this type of capitalization also on the initial capital (C0). We observe in excerpt 3, this "definition" of compound interest.

Excerpt 2 - Answer of a student to question 1.



Source 3 - Response from a student, (2020).

In the excerpt above, we find the prevalence of the *verbal obstacle*, because, as pointed out in Bachelard (1996), that is, the student explains what compound interest is by analogy to the term: "interest on interest" which is a term widely used by educators, books and subjects in order to facilitate the understanding of this capitalization system.

Regarding error E4, it was observed in 2 students. We found that students have a very limited view of the incidence of compound interest in daily life, defining it only as that levied on debts in general, as evidenced in excerpt 3.

Excerpt 3 - Answer of a student to question 1.

Aquilo que eu devo

Source 4 - Response from a student, (2020).

In excerpt 3, according to these discussions, there is a prevalence of the epistemological obstacle, *pragmatic knowledge*, in accordance with Andrade, Zylbersztajn and Ferrari (2002).

ANALYSIS OF QUESTION 2

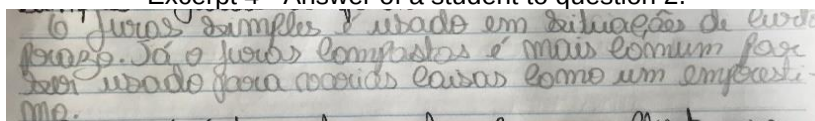
Table 2 - Results of Question 2.

Criteria	Errors Found					Total (TI)
	E1	E2	E3	E4	E5	
Total (PI)	3	2	1	1	2	9

Legend: E1: Associate Simple Interest to the short term and Compound Interest to the long term; E2: Associate the difference between the forms of capitalization to just collection or profit; E3: Point out simple interest as being calculated in the total amount (amount) and compound interest as this total plus an amount of interest; E4: Define simple interest as something static, that is, that regardless of the time the amount to be paid will be the same and compound interest as varying over time, that is, the longer a financial operation lasts, the greater its profitability; E5: Other errors; PI: Per item; TI: Total items./Source 5 - Author, 2020.

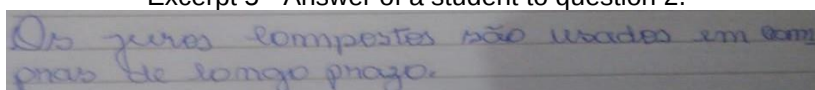
Regarding error E1, we noticed prevalence in the answers of 3 students, some of whom pointed to Simple Interest as being levied on short-term operations, as shown in excerpt 4. In relation to this same error, we found that in relation to another student, the prevalence found was the association of compound interest with long-term operations, as evidenced in excerpt 5.

Excerpt 4 - Answer of a student to question 2.



Source 6 - Response from a student, (2020).

Excerpt 5 - Answer of a student to question 2.

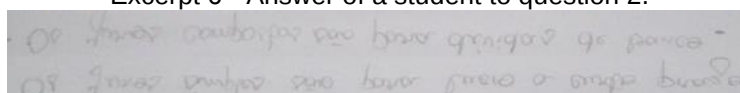


Source 7 - Response from a student, (2020).

In excerpts 4 and 5, the idea of an epistemological obstacle of the *pragmatic knowledge type prevails*, where students use a phenomenon to explain the difference between JS and JC.

Error E2 was identified in the answers of two students. His explanations associate the difference between JS and JC only to debts/profits as shown in excerpt 6 below.

Excerpt 6 - Answer of a student to question 2.



Source 8- Response from a student, (2020).

ANALYSIS OF QUESTION 3

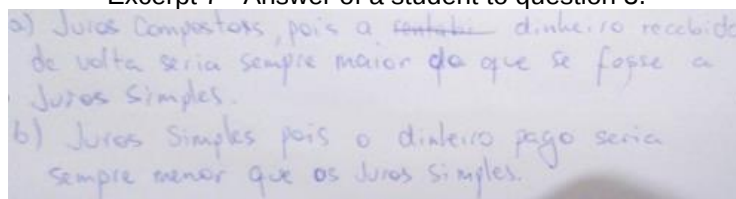
Table 3 - Results of Question 3.

Criteria	Errors Found					Total (TI)
	E1	E2	E3	E4	E5	
Total (PI)	1	1	1	1	2	6

Legend: E1: Error in believing that the interest charged in the simple capitalization system is always lower than that charged in the compound capitalization system; E2: Point out the form of capitalization, but do not know how to explain the reason for the choice; E3: Believe that Simple Interest is the best option in both questions; E4: Believe that in the long run Simple Interest yields more than Compound Interest; E5: Other errors; PI: Per item; TI: Total items./Source 9 - Author, 2020.

In relation to error E1, we found its prevalence in the analysis of an answer, the student mistakenly believes that simple interest is always lower than compound interest even considering that the rate and the time to which it was submitted are the same for both capitalization systems. This prevalence is found in excerpt 7.

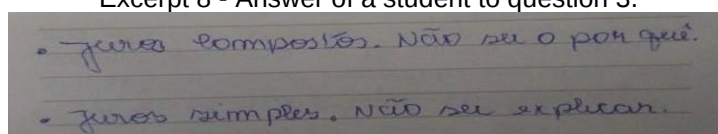
Excerpt 7 - Answer of a student to question 3.



Source 10 - Response from a student, (2020).

Regarding error E2, the student answers the questions, but does not know how to explain the reason for the choice. We observe this answer cataloged in excerpt 8 below.

Excerpt 8 - Answer of a student to question 3.



Source 11 - Response from a student, (2020).

CONCLUSION

In this initial part, we highlight findings such as verbal *epistemological obstacles* and unique *and pragmatic knowledge* that interfere in the quality of the teaching and learning process of the JC. Thus, the use of situations experienced by students outside of school, such as those existing in textbooks, does not guarantee the acquisition of concepts such as JC.

The nature of these two obstacles encountered, in part, may come from the way mathematical objects have been experienced in the classroom, in this case with emphasis on FM. We believe that incorporating aspects of PE that have been neglected for too long into basic education curricula can help reverse these misinterpretations.

The diagnosis allows us to say that if the adherence of students were much greater than ten, the category of epistemological obstacles would not be just two. On the other hand, the lack of studies on PE in MS noted in the bibliographic survey, given its importance both for understanding objects of PE and for the formation of citizens, requires the development of more studies.

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