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Integrating Financial Education and Sustainability through a Field-Based Project: Renewable energy and financial decision-making.

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ABSTRACT

Background: This study examines Financial Education from a Critical Mathematics Education perspective, using Scenarios for Investigation grounded in sustainability and incorporating themes such as decoloniality and Indigenous perspectives on the Anthropocene in Brazil. **Objectives:** It explores the role of Financial Education in students' decision-making processes related to consumption and financial practices, as well as its potential to foster more sustainable ways of living. **Setting and Participants:** The study involved undergraduate students in Environmental Sciences at the State University of Rio de Janeiro (UERJ), primarily from lower-middle-income backgrounds and with limited prior knowledge of finance. **Design:** The research is framed as an educational intervention based on Scenarios for Investigation within a Mathematical Modelling approach, informed by Critical Mathematics Education. **Data collection and analysis:** Data were generated through the development of an economic feasibility study and analyzed qualitatively, focusing on students' strategies and decision-making processes. **Results:** Students developed financing proposals that integrated Financial Education and sustainability, revealing shifts in their foregrounds and in their understanding of sustainable financial practices. **Conclusions:** Financial Education, when developed from a Critical Mathematics Education perspective through Mathematical Modelling, can contribute to expanding students' foregrounds and promoting more conscious and sustainable financial decision-making.

Keywords: Critical Mathematics Education; Financial Education; Scenarios for Investigation; Mathematical Modelling; Sustainability.

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A Educação Financeira e a Sustentabilidade desenvolvidas em um projeto único e sendo praticadas em conjunto, a partir do desenvolvimento de Pesquisa de Campo

RESUMO

Contexto: Este estudo examina a Educação Financeira a partir da perspectiva da Educação Matemática Crítica, utilizando Cenários para Investigação fundamentados na sustentabilidade e incorporando temas como decolonialidade e perspectivas indígenas sobre o Antropoceno no Brasil. **Objetivos:** Analisa o papel da Educação Financeira nos processos de tomada de decisão dos estudantes relacionados ao consumo e às práticas financeiras, bem como seu potencial para promover modos de vida mais sustentáveis. **Contexto e Participantes:** O estudo envolveu estudantes de graduação em Ciências Ambientais da Universidade do Estado do Rio de Janeiro (UERJ), majoritariamente de renda média-baixa e com conhecimento prévio limitado em finanças. **Desenho:** A pesquisa consiste em uma intervenção educacional baseada em Cenários para Investigação, dentro de uma abordagem de Modelagem Matemática, fundamentada na Educação Matemática Crítica. **Coleta e análise de dados:** Os dados foram produzidos por meio de um estudo de viabilidade econômica e analisados qualitativamente, com foco nas estratégias e nos processos de decisão dos estudantes. **Resultados:** Os estudantes desenvolveram propostas de financiamento que integraram Educação Financeira e sustentabilidade, evidenciando mudanças em seus foregrounds e na compreensão de práticas financeiras sustentáveis. **Conclusões:** A Educação Financeira, desenvolvida sob a perspectiva da Educação Matemática Crítica por meio da Modelagem Matemática, pode ampliar os foregrounds dos estudantes e promover decisões financeiras mais conscientes e sustentáveis.

Palavras-chave: Educação Matemática Crítica; Educação Financeira; Cenários para Investigação; Modelagem Matemática; Sustentabilidade.

INTRODUCTION

This study examines how knowledge of Financial Education (FE) can be constructed through a sustainability-focused project developed with undergraduate students in Environmental Science. It also explores how the integration of Financial Education and sustainability contributes to critical reflection and decision-making related to socio-environmental issues.

The relationship between FE and broader contemporary issues is also investigated, including decoloniality and the growing indebtedness of Brazilian families, interpreted through Bauman's (2008) concept of liquid modernity. In addition, historical dimensions are addressed, particularly the colonization of Brazil and Indigenous perspectives on environmental degradation.

This research aims to introduce foundational concepts of Financial Education that enable students to make informed decisions and to address the

challenges associated with excessive consumption. The guiding research question is whether Financial Education can contribute to preparing young people for financially stable and sustainable lives, free from unnecessary indebtedness.

The study is grounded in three main theoretical pillars: Critical Mathematics Education (Skovsmose, 2000, 2001, 2008, 2014), Bauman's concept of liquid modern consumer society (Bauman, 2008, 2011), and Mathematical Modelling (Barbosa, 2001, 2004).

It is also situated within the context of the Brazilian National Common Curricular Base (BNCC) and broader educational policy discussions, including Brazil's alignment with international organizations such as the OECD, reflecting increasing academic and institutional interest in the topic.

These themes are explored through a project involving a hypothetical middle-class household transitioning to a sustainable energy system. Students were challenged to identify the most appropriate strategy, whether through investment or financing, to raise the necessary capital. As the Scenario for Investigation was developed, following Skovsmose's (2000) framework, students constructed foundational financial knowledge while applying concepts from their field of study. The project's central focus was the relationship between Financial Education and sustainability.

The article is organized into three main sections, followed by a conclusion. The first section discusses the theoretical framework underpinning the study, the second presents the field research, reporting the five sessions conducted with students and highlighting Mathematical Modelling (MM) as the guiding methodological approach, while the third presents the results and analyses. The article concludes with reflections on the importance of fostering ethical and financially literate citizens, thereby contributing to more sustainable social practices.

THEORETICAL BACKGROUND

The development of this study and its associated field research is supported by recent data from the PEIC (Consumer Indebtedness and Default Survey), conducted by the National Confederation of Trade in Goods, Services and Tourism (CNC), which indicated that 78.5% of Brazilian households were in debt in April 2024. This figure does not include installment payments or upcoming credit card bills; rather, it refers specifically to overdue payments, highlighting indebtedness as a persistent social issue that exerts continuous pressure on society.

However, this context does not appear to reduce consumption pressures, particularly among young people, who are often driven to consume at high levels in order to avoid social exclusion. This phenomenon can be interpreted through the work of Zygmunt Bauman, who characterizes contemporary society as "liquid modernity," a social structure defined by consumerism, the continuous replacement of goods, and the fragility of social relations.

In response to these dynamics, the project adopts the perspective of Critical Mathematics Education, as proposed by Skovsmose, in which mathematics is understood as a tool for informed decision-making. Within this framework, Financial Education is presented as a strategy to critically address excessive consumerism.

Bauman (2008) also discusses the impacts of globalization, particularly its role in shaping contemporary patterns of consumption. According to the author, globalization gives rise to what he terms the "industry of substitution and replacement," which contributes to the depletion of the planet's natural resources. In this context, sustainability emerges as a necessary dimension of the discussion and is therefore incorporated into the project design.

An alternative perspective on these issues is offered by Indigenous knowledge systems, which emphasize the interdependence between human life and the environment. From this viewpoint, the notion of an ethical society, composed of individuals capable of making financially sound decisions not only for personal benefit but also for collective well-being, becomes central to addressing current global challenges.

In this sense, the Anthropocene, as discussed by Krenak (2019), can be understood as the result of human actions that have led to significant environmental degradation.

Accordingly, Financial Education is positioned as a tool to support individuals both in their personal development and in their contributions to society as a whole.

At the individual level, the field research, characterized by the construction of a Scenario for Investigation, provided participants with fundamental financial knowledge. This process opened up new possibilities for the future by reshaping their perspectives and transforming their foregrounds.

At the collective level, the integration of Financial Education and sustainability expanded students' understanding of their roles within a more responsible and sustainable society.

Critical Mathematics Education

Skovsmose (2014) conceptualizes Critical Mathematics Education (CME) as a response to concerns within mathematics education, emphasizing that its primary aim is to humanize mathematics by positioning it as a tool for informed decision-making in everyday contexts.

> This perspective also includes a concern with the development of mathematics education as a support for democracy, suggesting that the micro-societies of mathematics classrooms should reflect democratic principles. It further emphasizes that mathematics is not merely a subject to be taught and learned, regardless of whether learning processes are organized according to a constructivist or sociocultural approach. Rather, mathematics itself constitutes a field that requires reflection (Skovsmose, 2000, p. 4).

Mathematics is widely recognized as a multidisciplinary language that plays a significant role across diverse fields. This view aligns with the notion of "mathematics in action," highlighting the social relevance of Critical Mathematics Education. Within this framework, teachers guide students in defining problems, collecting data, simplifying situations, and developing solutions, thereby fostering critical thinking.

The Liquid-Modern Society of Consumers

Bauman (2008) characterizes contemporary society through the concept of liquid modernity, in which accelerated consumption reflects the fluidity of social life, with each reinforcing the other. Excessive consumption is a defining feature of this society, where capitalist logics are embedded in everyday practices. Individuals are increasingly defined by the brands they consume or the technologies they possess, ultimately becoming commodities themselves. Those who are unable to consume are excluded from dominant consumption dynamics.

> The most prominent characteristic of consumer society is the transformation of consumers into commodities. "Being famous" means nothing more than appearing on the front pages of thousands of magazines and on millions of screens; being seen, noticed, commented on, and therefore presumably desired by many, much like shoes, skirts, or accessories displayed in glossy magazines and on television screens (Bauman, 2008, p. 4).

Throughout the centuries, society has been organized around production, characterized by labor, durable goods, and material accumulation, which represented wealth and future security. Contemporary society, however, is marked by a shift toward immediacy and rapid consumption, whose defining feature is the instant use of wealth and the continuous replacement of objects. Bauman (2008) suggests that individuals who fail to integrate into this system risk social invisibility, which is closely associated with social exclusion.

When this concept is applied to the Brazilian context, data from the Consumer Indebtedness and Default Survey (PEIC), conducted by the National Confederation of Trade in Goods, Services and Tourism (CNC), indicate that 78.5% of Brazilian households were in debt in April 2024. The Brazilian population in the twenty-first century therefore lives under a persistent condition of indebtedness.

Financial Education (FE) can be understood as a strategy to address excessive consumption, contributing to the reduction of indebtedness through planning and by positioning mathematics as a tool for decision-making. It should be introduced early, and schools play a key role in this process by contributing to the formation of citizens. In this context, the role of teachers in fostering students' critical thinking has become increasingly important. Students are encouraged to critically examine the capitalist system of production and distribution of goods (Kistemann Jr. & Gomes da Silva, 2012).

Financial Education and the National Common Core Curriculum

Critical Mathematics Education (CME), through its focus on Financial Education (FE), offers an alternative approach to addressing indebtedness by fostering critical thinking and informed decision-making through financial planning. Within the school context, Financial Education has been incorporated into curricula as a transversal and interdisciplinary topic, while maintaining a strong connection to mathematics. In this sense, it aligns with CME by promoting approaches that move beyond consumerist logics.

Financial Education is identified as a priority by the Organisation for Economic Co-operation and Development (2005b, p. 5), which states: "Financial education should start at school. People should be educated about financial matters as early as possible in their lives." From a Critical Mathematics Education perspective, however, it is important to examine whether the agenda promoted by such organizations aims to foster critically aware citizens or to prepare individuals to integrate, uncritically, into the dynamics of the financial market.

Despite this tension, engaging children in financial decision-making processes can be considered pedagogically relevant, particularly when such engagement promotes reflection, autonomy, and critical awareness. Questions such as "How much of my allowance should I save each month in order to buy a new bicycle for my birthday?" illustrate how financial reasoning can be developed in meaningful contexts. In this regard, early access to financial literacy plays a key role in shaping individuals as citizens capable of informed and responsible participation in society.

The Brazilian government has strengthened the promotion of Financial Education through initiatives such as ENEF (2010), aimed at improving financial literacy and decision-making. The Ministry of Education (MEC) has also incorporated this theme into curricular discussions in the twenty-first century. As a result, the number of publications and research studies addressing Financial Education has increased significantly, many of which relate it to other disciplines and sectors of society, thereby highlighting its interdisciplinary nature.

With the introduction of the National Common Curricular Base (BNCC) in 2018, Financial Education gained greater visibility within the national curriculum. Financial Mathematics is now understood as one component within the broader scope of Financial Education.

Financial Education and Decoloniality

Coloniality can be understood as a legacy of colonial processes that persists in contemporary societies, shaping forms of cultural and social domination. It is associated with the production of racial and cultural hierarchies, as well as with the consolidation of economic systems that reinforce inequality. These dynamics also manifest in patterns of consumption and indebtedness, which contribute to ongoing processes of exclusion. In many cases, individuals are pushed outside the prevailing system, leading to marginalization, silencing, and increased financial vulnerability.

> Colonizing proposals emphasize a misleading notion of meritocracy and prosperity; that is, it is not sufficient to teach mathematical and financial content, train individuals in the use of spreadsheets, or employ simulators and applications if such knowledge does not take into account environmental balance, the population's quality of life, and all citizens' access to healthy living conditions (Kistemann Jr., 2024, p. 189).

Decoloniality can be understood as an effort to recognize marginalized voices and to challenge historically established forms of exclusion. Oliveira and Candau emphasize that an important step in the decolonial process involves strengthening the relationship between the recognition of cultural differences and education, not only in Brazil but throughout Latin America (Oliveira & Candau, 2010). For this process to be effective, the involvement of public authorities is essential, and Financial Education in schools can contribute by fostering critical awareness and informed decision-making.

> No one denies that South America is currently undergoing changes, innovations, and historical ruptures … those that point to and reveal new socio-political and epistemic formations, constructions, and articulations of State and Society, which are the result of and part of the strategies of action and struggle of ancestral movements and of their political-epistemic insurgency, which undoubtedly is opening the way to a possible new horizon, toward a turn of a decolonial character (Walsh, 2008, p. 4).

Financial Education can therefore play an important role in fostering citizenship and critical engagement with socio-economic structures associated with coloniality.

Decoloniality, Sustainability and Indigenous Worldviews

The Anthropocene refers to the current geological epoch characterized by significant human impact on the Earth's systems. From the perspective of Indigenous authors such as Ailton Krenak (2019), it is understood as a major socio-environmental crisis.

When examining the form of colonization imposed by Europeans from the sixteenth century onward, colonial discourses often positioned colonizers as "enlightened" in contrast to the populations they dominated, portraying them as bearers of wisdom and religiosity. In this context, the white way of life was regarded as the only legitimate one. Indigenous resistance was grounded in the rejection of the idea that all peoples are the same, becoming a central element of the decolonial process. From this perspective, social progress can be associated with the recognition and respect for cultural diversity.

> Suspending the sky is to expand our horizon, not a prospective horizon, but an existential one. It is to enrich our subjectivities, which are the very matter that the time we live in seeks to consume. If there is a desire to consume nature, there is also a

> desire to consume subjectivities, our subjectivities. Therefore, let us live them with the freedom we are able to invent, not to place them on the market. The fact that we are traveling together does not mean that we are all the same (Krenak, 2019, p. 18).

Zygmunt Bauman (2000) argues that processes of globalization and increasing consumption may reshape understanding of citizenship. Krenak (2019) further raises critical questions about the relationship between citizenship and consumption, asking why one should be a citizen if one can instead be a consumer and reflecting on the implications of living primarily as a holder of commodities.

Within this context, Financial Education can be understood as part of broader debates on consumption, citizenship, and social organization. It may also be interpreted as resonating with certain Indigenous perspectives on sustainability and collective well-being. In this sense, Financial Education can play an important role in supporting the development of citizenship and more sustainable socio-economic practices.

Financial Education, Ethics, and Sustainability

Lapyda (as cited in Kistemann Jr., 2024, p. 9) uses the term "financialization" to describe situations in which financial logic dominates economic activities and decision-making processes, consistently benefiting financial actors, particularly those within the financial elite, who gain disproportionately in relation to the broader population.

With the advent of industrial development, societies were reorganized into a model characterized by expanding patterns of mass consumption and the exclusion of individuals lacking sufficient financial resources to participate in this process. Zygmunt Bauman (2008) argues that individuals increasingly come to be treated as commodities within consumer society. Unrestrained consumption has led to the production of non-durable goods with rapid replacement cycles, increasing profits for the consumer goods industry while simultaneously accelerating the depletion of the planet's resources and generating large volumes of waste, often toxic.

Uncontrolled and reckless profit-seeking has thus become an ethical concern. In this context, Financial Education is proposed as a relevant educational approach when critically integrated into school curricula, with the aim of fostering reflective and responsible decision-makers who are capable of

managing their own lives and making financially informed choices that also take into account ethical and sustainability considerations.

Teacher Professional Development

According to Skovsmose (2000), Critical Mathematics Education (CME) can be developed through situations that foster students' critical thinking, particularly through the construction of projects and Scenarios for Investigation. He also introduced the concept of mathemacy, which encompasses both mathematical skills and the ability to interpret and act within socially structured contexts. This concept is closely related to literacy, as defined by Paulo Freire (1996), who argues that literacy involves more than decoding text; it includes the ability to interpret the social context in which texts are embedded.

With regard to teacher education in CME, Kistemann Jr. (2022) proposes what he terms the critical pedagogical triad, supported by the construction of investigative scenarios that require teachers to move beyond their comfort zones and engage with uncertainty, thereby encouraging students to participate in inquiry-based learning. This triad is grounded in the concepts of literacy, mathemacy, and technoracy—that is, the ability to integrate technology into projects while adopting a critical approach.

Skovsmose (2000) argues that shifting from the exercise paradigm to the Scenario for Investigation may weaken the "traditional classroom" model and guide students toward inquiry and new forms of learning.

> A Scenario for Investigation is planned to provide meaning to what students are producing in the activity. Students are invited to explore hypotheses and make discoveries. The teacher cannot anticipate what students will discover, which implies a high degree of unpredictability. The goal is not to obtain definitive results, but rather for students to make their own discoveries (Skovsmose, 2011, p. 5, as cited in Milani, 2020).

In this perspective, the teacher is positioned as a researcher, and the continuous pursuit of new knowledge contributes to the co-construction of knowledge with students. In this sense, the classroom can be understood as a space for investigation, incorporating games, mathematical modelling, and other pedagogical processes.

Research Methodology – Mathematical Modelling

Barbosa (2004) argues that Mathematical Modelling (MM) involves problematization and inquiry-based processes, in which the formulation of questions and the search for answers constitute interrelated activities. He presents MM as an approach capable of translating situations drawn from social contexts, emphasizing that its use in purely fictitious scenarios, devoid of real-life applicability, has limited educational value.

According to Barbosa (2004), the modelling process comprises the following stages: problem formulation, problem simplification, data collection, and problem solving.

In some cases, the research problem may be proposed by the students themselves. However, as demonstrated in this study, the problem was defined by the teacher-researcher, and students agreed to participate in the investigation. They were responsible for the stages of problem simplification, data collection, and problem solving, under the guidance of the researcher. The field research, conducted in an external setting, brought the project closer to everyday life by situating the activity within real-world contexts.

METHODOLOGY AND FIELD RESEARCH

A qualitative research approach was adopted. As noted earlier, the study was conducted in an undergraduate Environmental Sciences class at the State University of Rio de Janeiro (UERJ). This group was selected because its characteristics aligned with the objectives of the study: students predominantly from lower- and middle-income backgrounds, with aspirations for social mobility through education, a reasonable level of maturity, and limited prior exposure to financial concepts.

With regard to the methodological framework, and in line with the concept of Scenarios for Investigation, Mathematical Modelling (MM) was adopted as the guiding approach. The instructional workshop was organized into five sessions. With the exception of the first meeting, all subsequent sessions involved research activities and the collection of preliminary data conducted by the student groups. The class was divided into three groups, each consisting of three students. The following sections describe each meeting in detail, highlighting the knowledge developed throughout the process.

First Meeting

At the first meeting with the Environmental Sciences class, the primary objective was to build students' trust and obtain their consent to participate in

the study. To this end, the Scenarios for Investigation were introduced, the chosen methodology, namely Mathematical Modelling (MM), was outlined, and the research objectives and guiding problem were presented.

Once the students had agreed to participate as researchers in the proposed project, key concepts, such as budgeting, were introduced. Each group created an imaginary family closely resembling the participants' own family backgrounds. The groups estimated household income as well as fixed monthly expenses, with particular emphasis on energy costs. The budget was required to include a surplus, and each group determined how much their family would be willing to invest monthly in a project aimed at transitioning the household energy matrix to clean energy.

The groups then conducted a brief internet search to identify the interest rates offered by banks for investing the budget surplus over a one-year period rather than consuming it immediately. This activity prompted discussion among students about the rapid pace of excessive consumption and how money changes in value over time. Using domino tiles, the teacher-researcher designed a simulation in which a student would take out a bank loan, enabling discussion of simple and compound interest and identifying which is more commonly applied in everyday financial practices.

In this way, students developed foundational financial concepts and began constructing the Scenario for Investigation in alignment with the project's objectives.

Second Meeting

At this stage, the groups shared their findings. They presented their research on sustainable energy and discussed the advantages of adopting a clean energy matrix in residential settings. Each group described the characteristics of the imagined household and determined the monthly amount to be invested in the project, in accordance with budget constraints and the specific features of each family.

For example, Group II proposed the following Scenario for Investigation: the project cost was BRL 29,000.00, with a monthly budget surplus of BRL 1,400.00 and a monthly investment contribution of BRL 1,000.00. The family consisted of four members (two children and two guardians). This household can be characterized as a consumer-oriented family that pays monthly mortgage installments for their home.

Third Meeting

Each family was expected to make a monthly contribution in the form of a bank investment until the amount required to implement the project was reached. The groups then conducted field research, contacting financial institutions to determine the interest rates associated with investments such as savings accounts and Certificates of Deposit (CDBs), in the latter case taking into account income tax deductions.

The groups identified that savings account returns are linked to the Special System for Settlement and Custody (Selic), which records transactions involving most securities issued by the Brazilian National Treasury. The Selic rate is managed by the Central Bank of Brazil (BCB). When the Selic rate is less than or equal to 8.5% per year, savings accounts yield 70% of the Selic rate plus the Reference Rate (TR). When the Selic rate exceeds 8.5% per year, savings accounts yield 0.5% per month plus the TR. The TR is a reference rate calculated daily by the Central Bank and is used to adjust savings accounts, the FGTS, and certain real estate funds.

On the date of the third meeting, April 16, the Selic rate was 14.25% per year. Consequently, the groups concluded that savings accounts yielded 0.5% per month plus the TR, with no income tax applied to this type of investment.

With regard to CDBs, the groups found that their returns are linked to the Interbank Deposit Certificate (CDI), a short-term credit instrument used by banks to borrow and lend funds among themselves. On April 16, the CDI rate was 14.15% per year, and in the classroom example, a post-fixed CDB yielding 100% of the CDI was considered. The groups applied the concept of rate equivalence, given by:

$$(1 + i_{a.a.}) = (1 + i_{a.m.})^{12}$$

where $i_{a.a.}$ represents the annual interest rate and $i_{a.m.}$ is the monthly interest rate.

The example presented by the researcher in the classroom introduced the concept of a uniform series of investments, with monthly contributions of BRL 2,000.00 applied to both savings accounts and CDBs. The aim was to reach an amount exceeding BRL 60,000.00 and to compare the number of months required to achieve this target under each investment option.

The groups learned to perform calculations using the future value factor for uniform series, given by $FV = PMT \cdot \frac{(1+i)^n - 1}{i}$

Where **FV** represents the future value, **PMT** the monthly investment amount, **i** the monthly rate of return, and **n** the investment period. The problem was also solved using a financial calculator as a complementary approach.

After completing the calculations, it became evident that, even after income tax deductions, the CDB remained a more advantageous investment option than savings accounts. Accordingly, the groups chose to apply the CDB-based calculations to their own projects. To illustrate the procedures adopted, the results obtained by Group II are presented below.

Fourth Meeting

At this stage, the groups realized that investing to accumulate the capital required for the project would take time. This approach aligned with the profile of Group I's family, which was uncomfortable with debt; however, it was less suitable for the families in Groups II and III, who preferred to access the benefits of the asset immediately.

A new stage of field research was then initiated, aimed at identifying the interest rates offered by financial institutions for financing projects of this nature. The groups identified a public financial institution linked to the Federal Government that subsidizes sustainability projects for individuals at a competitive rate of 1.18% per month.

This rate was considered the most suitable option for their projects. Consequently, the next step involved understanding how financing models operate, specifically the Price Table (French Amortization System) and the SAC model (Constant Amortization System), in which amortization refers to the portion of each installment allocated to reducing the principal.

The analysis indicated that, under the Price Table system, installment amounts are fixed, which benefits borrowers who are unable to afford higher payments at the beginning of the financing period. However, this model results in higher total interest payments over longer financing periods.

In contrast, under the SAC model, installment amounts are higher at the beginning but decrease over time as the interest component of each payment is reduced, while the amortization amount remains constant. This model is commonly used for long-term financing.

To illustrate the results obtained by the groups, the data for Group II are presented below.

Under the Price Table system, the first step was to calculate the installment amount, as payments are fixed in this model. An approximation based on a uniform payment series was adopted, considering the present value (PV) as the financed amount, BRL 29,000.00. The interest rate applied was that offered by the financial institution, namely 1.18% per month, and the financing period was set at thirty-six months.

The results indicate that the installment amount was consistent with the family's planned monthly contribution, that is, below BRL 1,000.00. Over the thirty-six-month financing period using the Price Table, total interest amounted to BRL 6,762.60, resulting in a total disbursement of BRL 35,762.60.

Group II perceived the fixed installment as a strategic advantage, as it enabled more effective monthly financial planning. Therefore, they opted for the Price Table system.

Table 1

Analysis of Group II Financing Using the Price Amortization System

Period	Installment	Interest	Amortization	Outstanding Balance
0	0	0	0	29000
1	993	342	651	28349
2	993	335	659	27690
3	993	327	667	27023
...	...	...	...	...
34	993	34	959	1952
35	993	23	970	982
36	993	12	982	0
Total	35763	6763	29000	

The next step was to perform the same calculations using the SAC system and to compare the two alternatives. Initially, the amortization amount was determined, as it remains constant on a monthly basis. The financed amount, BRL 29,000.00, was divided by the total number of installments, in this case thirty-six, resulting in a monthly amortization of BRL 806.00.

The interest rate offered by the financial institution, 1.18% per month, was then applied.

Table 2

Financing Analysis of GROUP II Using the SAC Model

Period	Installment	Interest	Amortization	Outstanding Balance
0	0	0	0	29000
1	1148	342	806	28194
2	1138	333	806	27389
3	1129	323	806	26583
...	...	...	...	...
34	834	29	806	1611
35	825	19	806	805
36	815	10	806	0
Total	35331	6331	29000	

The calculations showed that, over 36 months, using the SAC system, the total disbursement would be BRL 35,331.00, of which BRL 6,331.00 corresponded to interest, representing a difference of BRL 432.00 in favor of the SAC system compared to the Price Table.

However, until the sixteenth installment, the family would need to commit to monthly payments exceeding BRL 1,000.00, as initially planned. Although this option would result in lower interest payments, it would require a greater financial commitment at the beginning of the financing period.

For these reasons, Group II opted for the Price Table system. It is important to note, however, that this decision was based on the family's specific characteristics, for whom adhering to the initial plan was essential, even if it involved slightly higher interest payments.

Regardless of whether the SAC or Price model was adopted, the group recognized that financing would allow immediate access to the asset while also reducing part of the expenses previously allocated to electricity. This led to the understanding that, in certain situations, financial leverage and the assumption of debt may be advantageous under specific conditions.

Fifth Meeting: "Living in Financial Balance"

At this stage, the groups completed the final phase of the Mathematical Modelling (MM) process, namely the problem-solving phase. Each group

presented its solution, followed by a collective discussion in which one of the main conclusions was that there was no single solution; rather, the most appropriate option depended on the characteristics of each family.

Another key outcome was the recognition of the importance of decision-making, as the choices related to the project would directly influence the family's future quality of life.

During this final meeting, an individual questionnaire was administered. Students responded anonymously, indicating only their group affiliation, and provided their perspectives on the workshop, the methodology employed, and the knowledge developed in relation to the proposed theme. The questionnaire administered to the students is presented in Appendix I of this article.

RESULTS AND ANALYSES

The questionnaire proved to be a valuable instrument for understanding students' responses, as it enabled an analysis of how their ways of thinking evolved as a result of their participation in the Financial Education Workshop. Furthermore, it made it possible to identify perceived changes in financial reasoning and attitudes.

Following the workshop, Financial Education was perceived by participants as an important tool for managing personal life, enabling individuals to plan and manage their finances more effectively. Participants also emphasized the role of the school in this process and acknowledged the thematic diversity involved, noting that each group constructed a distinct Scenario for Investigation, which resulted in the development of substantially different projects.

This section presents an analysis based on students' responses to the ten questions included in the questionnaire provided in Appendix I. It is important to note that the responses were anonymous; respondents were identified only by their group number. All participants completed the questionnaire on May 28, 2025.

The following section presents selected responses from each group, highlighting key patterns in students' perceptions.

Group 1

Responses emphasized the importance of making appropriate decisions in the presence of interest rates and of considering the specific characteristics

of each family. Students perceived the workshop as an opportunity to learn how to manage capital in large-scale investments.

Regarding the methodology, participants highlighted the effectiveness of the Scenario for Investigation in supporting knowledge construction in Financial Education. While some expressed a preference for traditional teaching models, others emphasized the value of Mathematical Modelling, particularly in demonstrating that mathematics extends beyond the classroom.

Participants also noted that adjustments to the Scenario for Investigation were made with the support of the researcher, which was considered important given their limited prior knowledge of financial concepts and their stronger familiarity with the sustainability aspects of the project.

Following the workshop, students reported having acquired knowledge related to the proposed theme. The responses suggest that the experience contributed to the development of a more critical perspective on different financial possibilities, expanding their understanding of investment and financing strategies.

Students associated liquid modern society with the fragility of social relationships, highlighting a lack of planning and the prevalence of unnecessary expenditures. Some explicitly stated that they did not consider themselves to be consumerist. Although they acknowledged that financial leverage may be useful in certain situations, they generally viewed indebtedness negatively.

The coherence of this group's responses is particularly noteworthy, as their self-identification as non-consumerist aligned with the profile assigned to the hypothetical family they constructed, which prioritized avoiding debt.

Group II

Responses emphasized the importance of the workshop stages in supporting knowledge construction on a topic with which students initially had little familiarity. Questionnaire responses indicated that, after each meeting, students engaged in extensive discussions among themselves, addressing both Financial Education concepts and sustainability-related issues, such as the installation of solar panels.

All group members reported an intention to become more organized and to develop more structured financial plans for their personal lives.

Participants highlighted that the Scenario for Investigation they developed was highly beneficial and that the researcher's interventions

contributed significantly to their understanding of the project. They also emphasized the dynamic nature of learning through Mathematical Modelling, in which discussion and problem formulation played a central role. Whereas Financial Education had previously been perceived merely as expense control, it came to be understood as a tool for managing personal finances and, more broadly, one's way of life. Participants also acknowledged that families may become indebted due to necessity, unreflective consumption, or a lack of planning.

An analysis of the responses suggests a degree of inconsistency within this group. The strategic role of financial leverage was not mentioned in the questionnaire, and indebtedness was discussed primarily from a negative perspective. However, because the family constructed by the group sought immediate access to a particular asset, the solution proposed during the workshop involved financial leverage through the contracting of a loan.

Group III

Responses emphasized the importance of acquiring knowledge on a topic with which students had no prior familiarity. All participants agreed that the Scenario for Investigation they developed was highly effective.

According to the questionnaire responses, the aspect that most attracted the group's attention was the wide range of investment possibilities. This finding is particularly noteworthy, as their proposed solution involved long-term financing rather than investment to obtain the necessary capital. However, it is important to highlight that this was the only group in which all participants stated that not all forms of indebtedness are negative, provided that effective repayment mechanisms are in place.

Students also identified themselves as consumerist, while acknowledging the need to seek sound financial alternatives and recognizing that consumption for its own sake constitutes a habit without tangible benefit.

In concluding this stage of analysis, the results indicate high levels of student engagement, as well as the quality of the research conducted by participants, both within their field of study (sustainability) and across broader themes, including budgeting, interest rates, investment, financing, and the time value of money. These findings suggest that an important component of the curriculum established by the BNCC was successfully addressed.

These findings also reinforce the role of Financial Education in promoting critical and contextualized learning, as proposed within the framework of Critical Mathematics Education.

CONCLUSIONS

This study examined how Financial Education, developed through a sustainability-oriented project grounded in Critical Mathematics Education, can contribute to students' decision-making processes and to the development of more sustainable ways of living.

The findings indicate that integrating Financial Education and sustainability, structured through Scenarios for Investigation and supported by Mathematical Modelling, enabled students to develop greater awareness of their financial decisions. In particular, participants demonstrated an enhanced understanding of the implications of consumption, indebtedness, and long-term financial planning.

The study aligns with competencies established in the BNCC, which recognize Financial Education as a transversal and multidisciplinary theme. Throughout the planning and implementation of the workshop, specific competencies and skills were intentionally selected, and a structured pathway was designed to support their development.

From the perspective of Critical Mathematics Education, the results reinforce the role of Financial Education as a tool for fostering citizens capable of making informed, responsible, and context-sensitive decisions, thereby contributing to more sustainable and socially just ways of living.

Finally, the field research provided relevant insights by contributing to shifts in students' perceived foregrounds. In addition, the educational product developed within the study offers possibilities for supporting teaching practices and may serve as a reference for educators interested in integrating Financial Education and sustainability into their pedagogical work.

It is necessary to clarify that the dissertation on which the article submitted to the journal is based was not reviewed by an ethics committee due to the fact that the names of the students participating in the research remained anonymous throughout the study, and all participants were adults and signed an Informed Consent Form (ICF). Furthermore, the families they created during the project are fictional. Therefore, there is no reference to the real lives of the research participants throughout the study. In this way, the authors consider that

Acta Scientiae is exempt from any ethical question related to the aforementioned article.

AUTHORS' CONTRIBUTIONS STATEMENTS

HTJ conceived the study, developed the theoretical framework, designed the methodology, conducted the investigation, collected and analyzed the data, and interpreted the results. LMG contributed to revising and editing the manuscript, improving its academic language, clarity, organization, structure, and compliance with the journal guidelines. GFB supervised the research process, contributed to the methodological and theoretical discussions, and critically reviewed the manuscript. All authors discussed the results and approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are not publicly available due to ethical considerations but are available from the corresponding author upon reasonable request.

REFERENCES

Barbosa, J. C. (2001). Modelling in mathematics education: Contributions to the theoretical debate. In *Proceedings of the 24th Annual Meeting of ANPED*. ANPED.

Barbosa, J. C. (2004). Mathematical modelling: What is it? Why? How? *Veritati*, (4), 73–80.

Bauman, Z. (2000) *Globalization: The Human Consequences*. Cambridge: Polity Press.

Bauman, Z. (2008). *Life for consumption: The transformation of people into commodities*. Zahar.

Bauman, Z. (2011). *Is ethics possible in a world of consumers?* Zahar.

Brazil. (2018). *National Common Curricular Base.* Ministry of Education.

Confederação Nacional do Comércio de Bens, Serviços e Turismo. (2024). *Consumer indebtedness and default survey (PEIC)*. CNC.

Freire, P. (1996). *Pedagogy of the oppressed*. Paz e Terra.

Kistemann Jr., M. A. (2012). On the production of meanings and decision-making by consumer-individuals. In *Proceedings of the III EIEMAT – Winter School of Mathematics Education & 1st National PIBID-Mathematics Meeting*.

Kistemann Jr., M. A., & Gomes da Silva, G. H. (2012). The mathematics teacher and classroom investigation, frame by frame. *GEPEM Bulletin*, (60), 93–107.

Kistemann Jr., M. A. (2024). Perspectives on financial education: Looking to the future without forgetting lessons from the past. In M. A. Kistemann Jr. (Ed.), *Cycles of financial education in Brazil: Perspectives of mathematics educators (1990–2024)* (pp. 186–192). Editora Akademy.

Kistemann Jr., M. A. (2022). 21 years of investigation scenarios: Experiences of a mathematics educator in continuing education. In P. A. G. Civiero, R. Milani, A. S. Lima, & F. O. Miranda (Eds.), *Taking flight with critical mathematics education: Discussions on teacher education in mathematics* (pp. 86–103). IFC.

Krenak, A. (2019). *Ideas to postpone the end of the world*. Companhia das Letras.

Oliveira, L. F., & Candau, V. M. (2010). Decolonial pedagogy and antiracist and intercultural education in Brazil. *Educação em Revista*, 26(1), 15–40. https://doi.org/10.1590/S0102-46982010000100002

Skovsmose, O. (2000). Investigation scenarios. *BOLEMA – Mathematics Education Bulletin*, 14, 66–91.

Skovsmose, O. (2001). *Critical mathematics education: The question of democracy*. Papirus.

Skovsmose, O. (2008). *Challenges of reflection in critical mathematics education*. Papirus.

Skovsmose, O. (2014). *An invitation to critical mathematics education*. Papirus.

Walsh, C. (2008). Interculturality, plurinationality, and decoloniality: The political-epistemic insurgencies of refounding the state. *Tabula Rasa*, (9), 131–152. https://doi.org/10.25058/20112742.343

APPENDIX A - FINAL QUESTIONNAIRE

The following questions comprised the questionnaire completed by participants in the field research and, consequently, in the Financial Education workshop:

1) How do you evaluate the five stages of the workshop proposed by the researcher–professor? Were they effective in fostering your understanding of Financial Education?
2) In your view, were the student groups able to work effectively in developing the Scenario for Investigation?
3) Were the interventions of the researcher–professor important in guiding the groups within the Scenario for Investigation?
4) Do you consider knowledge construction through Mathematical Modelling workshops to be more stimulating than traditional classes?
5) What was your understanding of Financial Education prior to participating in these activities?
6) What has changed in your understanding of Financial Education after participating in this workshop?
7) What do you understand by liquid modern society? Do you consider yourself to be consumerist? Which factors may lead a family into debt?
8) Is all indebtedness necessarily negative? Is there such a thing as conscious indebtedness? Can indebtedness serve as leverage for achieving a personal goal?
9) Do you believe that you developed knowledge throughout the activities carried out? Do you intend to modify your habits and your way of managing money?
10) Do you feel more confident in assisting your family with financial planning and future decision-making?