Research Article

INTEGRATING FINANCIAL EDUCATION IN TEACHING EXPONENTIAL FUNCTIONS FOR GRADE 12TH STUDENTS

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ABSTRACT

 Financial Education is the new feature in the General Education Curriculum of Mathematics 2018 and is focused throughout the curriculum, from elementary to high school. This article would like to clarify the concepts related to financial education and provide pedagogical measures to integrate financial education into teaching Mathematics in high schools. An experiment in teaching exponential functions improved financial literacy for grade 12th students using credit cards shows the realizable and effectiveness of proposed measures. Thereby, students learned about credit cards (credit card statements, credit interest rates, closing balances, and annual fees), how credit cards work, how to calculate credit card debt, make a decision whether to pay via credit card or not, and explain why and how to use a credit card to be safe and avoid risks.

 Keywords: credit card; exponential function; financial education; integrate

1. Introduction

The General Education Curriculum of Mathematics 2018, in addition to the note about integrating teaching, also pays attention to financial education for students from an early age, reflected in the content and requirements to be achieved from grade 4th to grade 12th, especially in suggested experiential activities.

In Vietnam, many students lack financial knowledge, and parents are often afraid to share how to use money with their children. That makes them confused when they have related problems in their real life and quickly have mistakes in solving and choosing (for example, when buying, saving, or using credit cards, investing). Therefore, financial education for students in high schools is essential and brings many benefits for themselves and to educating them to become useful citizens for society.

In the current program, students are accessed to exponential knowledge through compound interest and growth. Textbooks focus on the tasks "calculate" more than applying

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exponential knowledge to solve practical problems such as making financial choices for individuals and understanding loan methods and credit cards. In the Math Program 2018, activities proposed to integrate financial education for students are diverse but still unclear for classroom implementation. Therefore, it causes difficulties for many teachers. In teaching exponential functions, the Math Program 2018 mentioned the contents and requirements related to financial education for students:

> Solve problems related to other subjects or real life associated with exponential and logarithmic functions (for example, interest rates and growth).

<div align="right">(Ministry of Education and Training, 2018, p.95)</div>

> - Identify some problems with interest rates and loans of credit institutions (such as banks and credit funds).
> - Calculate the interest on credit cards and fees (including transactions).
> - Be aware of the results of paying debts on time, including credit records and credit values.
> - Apply mathematical knowledge (such as knowledge of ratios, percentages, exponents, and logarithms) in solving some problems about interest rates and loans of credit institutions (such as banks and credit funds).

<div align="right">(Ministry of Education and Training, 2018, pp.113-114)</div>

Therefore, we will propose pedagogical measures to integrate financial education in teaching Mathematics and choose a method for experiential research in teaching exponential functions for grade 12th students to test the feasibility of that measure, contributing to improving financial literacy for students using credit cards.

2.   Research content

2.1.   Concept of financial education

According to Savard and Cavalcante (2021), financial education is the field of teaching and learning the financial dimension of the production and management of resources mediated by financial instruments (currency, models, concepts). Financial instruments can also assign a value to an action (service) or an object (good). According to them, financial literacy is understanding and knowing financial concepts and risks, skills, motivation, and confidence to apply them to make the right decisions across financial situations, thereby improving the financial well-being of individuals and society and facilitating economic life. Financial literacy can be seen as a result of financial education. Therefore, financial education in high schools 'improves students' financial literacy and promotes financial literacy for many people worldwide.

Integrating financial education in teaching mathematics is increasingly attractive in countries around the world. Mathematics knowledge is a helpful tool for solving financial problems in particular and practical problems in general. Thus, financial and mathematics education have a close relationship, contributing to each other while educating students to become citizens who reach the innovative requirements of the 21st century.

2.2.   Pedagogical measures to integrate financial education in teaching Mathematics

2.2.1. Measure 1 – Start the lesson with a financial problem to solve

At the beginning of the lesson, the activity "Determining the problem" should create opportunities for students to experience situations or problems related to finance. Then, teachers can build an activity or a system of questions to lead students to that situation or problem. The problem's closeness helps students be more interested in the following activities.

2.2.2. Measure 2 – Experience and solve financial problems to form new mathematics knowledge

After assessing the financial problem, teachers can hold activities or a system of guiding questions to help students experience, reflect, find a solution to solve the problem, and then form new mathematics knowledge.

2.2.3. Measure 3 – Apply mathematics to solve other financial problems

After learning mathematics, teachers provide situations with financial contexts, especially issues related to making financial decisions, so that students can apply mathematics to solve problems and improve their financial literacy.

To apply financial problems after learning maths, we propose the following process:

Step 1. Raise the problem

Teachers provide a real question or problem related to finance for students to experience and learn initially. Then, they lead students to the main problem to be solved.

Step 2. Solve the problem

Students propose measures and proceed to solve the problem with the guidance of teachers. First, students solve the problem individually or in groups depending on the goal of each activity. Then, students recognize new finance concepts and use mathematical and financial knowledge to solve problems.

Step 3. Institutionalize the knowledge

After solving the financial problem, teachers and students look at the problem together again, which is mathematical and financial knowledge students need to recognize. From there, students have a deeper look at the applications of mathematics in practice in general and finance in particular.

Step 4^t. Test, assess, and expand

Teachers test and assess the achievement of students through the lesson. Besides, expanding the problem is also necessary because it could help students easily recognize and apply it in similar situations.

2.3.   Integrating financial education in teaching exponential functions

2.3.1. Selection of pedagogy

As society develops, payment methods are also increasingly diverse. A credit card is a payment method that allows users to "spend first, pay later" and is helpful to many individuals. However, today there are many fraudulent credit institutions and hidden risks

when using this card without knowledge. Therefore, we choose measure 3rd and the process mentioned in section 2.2.3. build a case study to provide students knowledge about credit cards after completing the exponential functions, help them apply exponential functions to solve financial problems, and make the right financial choices in the future.

2.3.2. Experimental object

• Grade 12th students specializing in Chemistry at Ben Tre High School for the Gifted (the experiment was done after students had finished learning exponential functions).

• Experimental time: 10/10/2022 (3 periods).

• Students work in groups of 5.

2.3.3. Experimental content and results

Before the experiment, the teacher gave students a test of financial literacy about credit cards according to the following question system:

① How are credit cards used?

② How much is the interest rate of credit cards usually per year?

③ Should you buy large-value items via credit card in installments? Why?

④ In your opinion, what should be considered when using credit cards?

⑤ Mr. Binh spent 10,000,000 VND on his credit card in this month's statement. Assuming Mr. Binh does not use this credit card to pay anymore and does not pay the amount spent after three years, what is the outstanding balance on Mr. Binh's credit card? Know that the interest rate on that credit card is 24% per year.

⑥ In your opinion, which maths knowledge is applied in the problem of calculating the outstanding balance of a credit card?

⑦ Mr. Khoa has a savings account of 450 000 000 VND with an interest rate of 5.6% per year. If you do not withdraw money from the bank, the interest amount will be entered into the original capital (compound interest) every year. How much money will Mr. Khoa receive in both capital and interest after five years, assuming that during this time, he does not withdraw cash and the bank interest rate does not change? (Round to first decimal place)

⑧ Suppose a bank saver is "compound interest," A is the initial amount of capital, the interest rate of the deposit is r% per year, t (year) is the time of saving, and P(t) is the accumulated amount after t years. Assume that this person does not withdraw money, and the bank interest rate does not change for t years. What is the general formula to calculate the accumulated capital of this person after t years?

⑨ In your opinion, which mathematical knowledge is applied to the "compound interest" problem?

Results: Most students did not understand credit cards and used the "compound interest" formula for all questions to calculate the total accumulated amount when saving at a bank and calculating the outstanding balance on the credit card. Many students were

unaware of what Mathematics knowledge was applied here and gave many different answers. Only a few students gave exponential knowledge in their responses.

Analysis: Students applied their real-life knowledge about ATM cards to answer questions related to credit cards, which led to inaccurate information. Besides, students are familiar with the problem of bank savings in the form of "compound interest" in current textbooks when learning about exponential functions, so when asked similar questions related to interest rates and interest, students applied them mechanically without giving a reasonable explanation. Initial results show that more than 90% of the students in the class have no understanding of credit cards, and the remaining 10% have knowledge but only know what credit cards are used for. On the other hand, 100% of students could answer the question of calculating the accumulated amount when saving in a bank in the form of "compound interest." In contrast, most students were confused about the problem of estimating credit card balances, and about 50% of students could not answer. The rest applied the "compound interest" formula.

Thus, in addition to the problem of "compound interest" they have learned in the current program, students have not had many opportunities to approach other financial problems related to exponential functions and still have many difficulties solving other financial problems. The new issue here is using a credit card and calculating the balance owed on it.

In the experimental process, teachers conduct teaching according to the process in section 2.2.3.

Step 1. Raise the problem

Students approach the opening problem related to installment payment via credit card. Then, make an initial guess on whether we should pay by credit card and give reasons.

"An wants to buy a laptop which costs 35 900 000 VND to support his studies. An has only saved 5 000 000 VND, and his monthly overtime income is 1 500 000 VND. The electronics supermarket suggested that he could buy a device in the form of installment payment via credit card with a term of 12 months with a 0% interest rate prepayment of 5 000 000 VND. In your opinion, should An buy goods in this form? Why?"

Results: Most students said they should not pay by credit card because they think An's income is too low compared to the amount he needs to spend. Many students who do not know such installments also believe they should not. A few students think An should pay by credit card but have not explained their answer.

We believe that it is because students do not know credit cards, so when they received the question "Should or should not we pay by credit card?", most students thought it should not. Some students seemed to find that the 0% interest rate when paying by credit card installments is favorable and preferable, but they were not confident in explaining. From here, students received the problem to be solved in the lesson about whether to pay via credit card and why. They are also motivated to go to the next problem-solving activity.

Step 2. Solve the problem

Before solving the problem, the teacher let students experience the following activities to help them have basic knowledge about interest rates and how credit cards work:

Activity 2.1. Learning about payment methods when we go shopping

The teacher, in turn, asked questions related to purchases, payment methods, ATM cards, and especially credit cards to check students' understanding.

Results: Many students were excited when asked about significant shopping events of the year on 9/9, 10/10, and 11/11. When the teacher asked about payment methods when making purchases, they were very confident in giving answers. However, when asked more specifically about ATM cards, almost 100% of students did not distinguish the operation of each card type.

We can see that shopping is now very popular with students, especially online shopping. Therefore, most were excited to integrate discount code-hunting events into the lesson. However, most students have not learned more about ATM card payment methods and have difficulty distinguishing different types of cards. So, the problem interested them and motivated students to continue learning about credit cards and how they work to find answers to the original problem.

Activity 2.2. Learning about credit card interest rates

Students worked in groups to find the actual credit card interest rates of three banks in Vietnam, compare them with lending and savings rates, and make comments.

Results: In group activities to learn about credit card interest rates, loan interest rates, and bank savings, groups were very active and enthusiastic in searching for information on the Internet, choosing the official website of the bank, and giving the appropriate answer. Since then, they could compare credit card interest rates with lending and savings interest rates and realized that credit card interest rates are much higher than the other two.

A dialogue between the teacher and a student:

Teacher: After learning about credit card interest rates, loan interest rates, and bank savings, what do you think about these interest rates?

Student: Credit card interest rates are much higher than the other two.

Teacher: With such disparity, should we use credit cards in consumption? What should we pay attention to when using it? How does calculating interest and balance on credit cards relate to mathematics? We will answer those questions in the following activities of the lesson.

Thus, most students began to have more awareness and confidence in understanding and solving the mentioned problems about the notes in using credit cards and the relationships in calculating credit card balances with mathematics.

**Activity 2.3. Learning about concepts related to credit cards**

Students watched a short video explaining the features of credit cards. By combining information searches on the Internet, teachers and students defined new concepts.

Results: Students participated in activities with excitement and seriousness, understood information quickly, and received new definitions related to credit cards: credit card statement, credit interest rate, balance at the end of the term, and annual fees.

Some typical assignments:
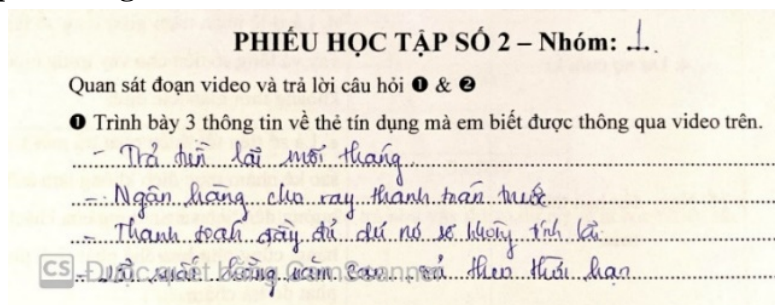
Picture 1. Group 1 assignment – Worksheet No. 2 sentence 1
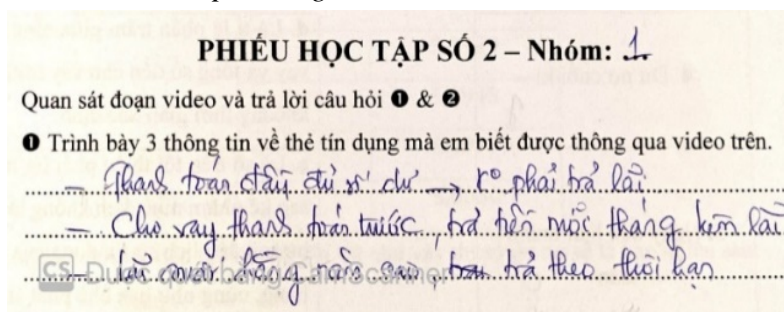
Picture 2. Group 2 assignment – Worksheet No. 2 sentence 1

We noted that students were enthusiastic about learning new concepts, contributing to improving students' understanding of credit cards. In addition, newly clarified concepts helped it more accessible for teachers and students to communicate in activities to learn more about calculating credit card balances and notes when using credit cards.

Activity 2.4. Calculating the debt balance of a credit card

Students learned the operation of calculating the credit card debt balance monthly in the case: **the cardholder does not pay any expenses at the end of the month** through a specific problem: Give a table showing the outstanding balance of a credit card month by month, knowing the cardholder does not pay any money at the end of each month. The interest rate is 22.99% per year.

| Month	Debt (million VND)
0	5,0000
1	5,0958
2	5,1934
3	5,2929
4	5,3943
5	5,4977
6	5,6030

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If he continues to not pay like this, what will the outstanding balance be as follows:

a) 7 months;   b) 1 year;   c) 5 years.

Results: Students were excited about finding the solution to the above problem. Initially, 100% of students thought that the monthly interest on credit cards is calculated as "compound interest," but they only explained it in a few specific cases.

When the teacher guided students to verify the answer using GeoGebra software, they were interested and focused on the teacher's actions in representing pairs of points (number of months; corresponding debt balance) on the coordinate plane. At first, students assumed that the points seemed to be in line. Then, when observing the operation of drawing a line passing through two points, they realized that the points do not lie on the same line. Moreover, therefore, students concluded that the "compound interest" option is appropriate. In this case, the groups adjusted their answers and formed a general formula for calculating the credit card balance. Also, from here, students realize that if they cannot afford to pay the outstanding balance each month, the amount of debt will increase very quickly.

Some typical assignments:
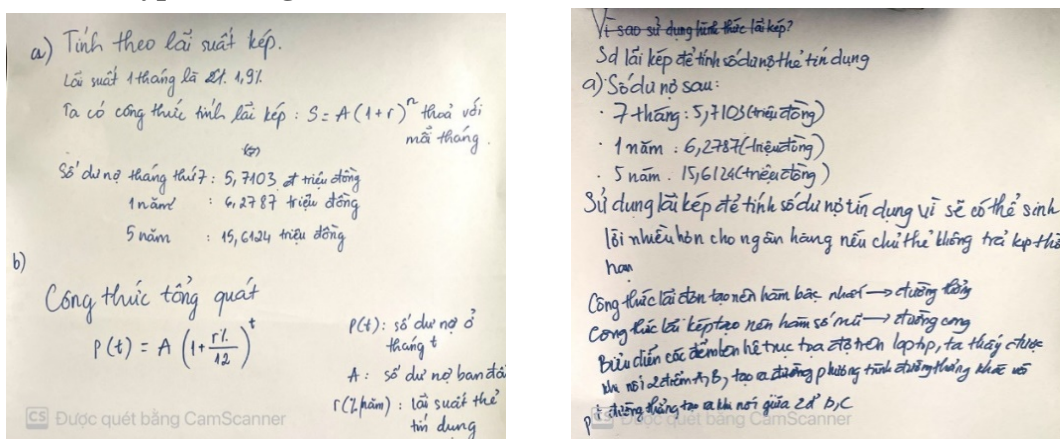
Picture 3. Assignment of group 2 and group – Worksheet No. 2

Like the pre-experiment test, students of the groups applied the known "compound interest" formula to the case of credit cards. However, giving explanations made it difficult for groups. After observing the verification with GeoGebra software, the groups recognized and adjusted the answers accordingly, improving their understanding of using exponential functions in the problem of calculating credit card balances. From there, students formed a general formula and set up an exponential function in calculating credit card debt balance in a specific case. At this point, students had understood how it works and how to calculate the basic balance in credit cards, realized another application of exponential functions in the financial field and knew the "compound interest" formula also used in credit card balance calculation.

Activity 2.5. Solving financial problems related to credit card

Back to the opening problem, students could answer,, make appropriate decisions, and present notes when using credit cards.

Results: Students calculated and made an assessment of should or should not pay by credit card. They were excited because they could verify and give a suitable explanation for the original prediction: An should not pay by credit card in this case. After all, his current income is insufficient to pay the outstanding balance each month. Besides that, students could state reminders for those who use credit cards to ensure their safety and avoid risks.

Dialogues between the teacher and students:

When choosing the opening problem:

Teacher: Going back to the opening problem, do you think An should pay by credit card in installments or not?

Student: I think he shouldn't.

Teacher: Why do you think so?

Student: Because according to the calculation, every month, An has to pay:

$(35,990,000 - 5,000,000): 12 = 2\,582\,500 > 1,500,000$

An does not have enough money to pay each month, which can cause debt and increase debt quickly.

Teacher: So, could you give me some other choices for An?

Student 1: Finding a more suitable model or learning more about other sources of income, considering installment policies to pay accordingly.

Student 2: I'm asking for money from my parents.

Student 3: Increasing the payment period to reduce the monthly payment amount.

When answering the first question:

Teacher: From the knowledge learned today, do you think using credit cards is always a good choice in consumption?

Student 1: Yes, we can still use it if we can pay the debt every month on time.

Student 2: Yes, it's not always good because interest rates are high, and balances can increase rapidly.

Teacher: So, when using credit cards, what do you think we should pay attention to?

Student 1: Please note interest rates, fees and payment due time.

Student 2: Please note that you can use it within the payment limit.

Student 3: Please note the interest-free period.

Thus, after studying activity 2.4., students realized that outstanding loans would increase rapidly if they did not pay in full each month. They also realized the importance of paying off credit card balances on time. They could make an appropriate financial decision in the opening problem and give some notes when using credit cards in economic life, avoiding risks when encountering fraudulent credit institutions.

Step 3. Institutionalize the knowledge

The teacher took the step of institutionalizing knowledge so that students could review the mathematical knowledge applied in the lesson.

Results: 100% of students stated that exponential knowledge had been applied and recognized one more application of exponential functions in the financial field besides saving bank accounts. From explaining the difference between "simple interest" and "compound interest" in learning how to calculate credit card balance, students were reminded about exponential functions.

Step 4. Test, assess, and expand

Before the end of the lesson, the teacher guided students to summarize and evaluate the level of their qualities and abilities achieved through this lesson.

Results: Most students mentioned new knowledge about applying exponential functions in using credit cards learned through this lesson. Most of them self-assessed the level of achievement of their qualities and abilities from good to very good; some self-assessed need to try harder in detecting and solving problems.

Self-assessment at the end of class helped students increase their ability to summarize what they have learned, and self-recognize their achieved levels of competence and quality, thereby knowing what they have learned and need to try harder.

Picture 4. Assignment of student – Worksheet No. 3

After the experiment, the teacher checked the students' financial literacy with the same questions as the pre-experiment test to assess the effectiveness of the lesson.

Results: Most students had the correct answer when asked about how credit cards work and interest rates, applying the formula to calculate credit card debt balance and using knowledge of exponential functions quickly.

Analysis: Through the lesson that integrated financial education for students on using credit cards in consumption, more than 90% of students have basic knowledge about credit cards, improve financial literacy and be able to choose how to use credit cards in daily consumption rationally, avoiding risks.

Thus, the experiment has verified the feasibility of the proposed measure.

3.   Conclusion

Through research, the integration of financial education in teaching exponential functions for grade 12th students not only helps students improve their ability to apply mathematical knowledge but also popularizes students' new knowledge about using credit cards in life, helping them make appropriate financial choices in the future. At the same time, organizing activities in class helps create excitement and motivation for students to form and apply knowledge. Therefore, the integration of financial education in teaching the topic of exponential functions in particular, and teaching in mathematics, in general, is essential because of its practical benefits and contributes to educating students into successful careers and valuable citizens in the future.

❖ *Conflict of Interest: Authors have no conflict of interest to declare.*

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TÍCH HỢP GIÁO DỤC TÀI CHÍNH TRONG DẠY HỌC HÀM SỐ MŨ Ở LỚP 12

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TÓM TẮT

Giáo tục tài chính là một điểm mới được đưa vào chương trình giáo dục phổ thông môn Toán 2018 và được chú trọng xuyên suốt từ cấp tiểu học cho đến trung học phổ thông. Bài báo sẽ làm rõ các khái niệm liên quan đến giáo dục tài chính, đồng thời đưa ra các biện pháp sư phạm nhằm tích hợp giáo dục tài chính trong dạy học Toán ở trường phổ thông. Một nghiên cứu thực nghiệm liên quan đến dạy học hàm số mũ nhằm góp phần nâng cao hiểu biết tài chính cho học sinh lớp 12 trong việc sử dụng thẻ tín dụng cho thấy tính khả thi và hiệu quả của biện pháp mà chúng tôi đã đề ra. Qua đó, học sinh được tìm hiểu về thẻ tín dụng (bảng sao kê thẻ tín dụng, lãi suất tín dụng, dư nợ cuối kì, phí thường niên…), cách thức hoạt động của thẻ tín dụng, tính được số dư nợ trong thẻ tín dụng, đưa ra quyết định có nên chi trả qua thẻ tín dụng hay không và giải thích được lí do, cách sử dụng thẻ tín dụng để đảm bảo an toàn và tránh rủi ro.

Từ khóa: thẻ tín dụng; hàm số mũ; giáo dục tài chính; tích hợp