Athens Journal of Technology and Engineering - Volume 13, Issue 3, September 2026 – Pages 171-194

Teaching Financial Literacy with a STEAM Approach

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In Japan, children have traditionally had limited exposure to financial literacy education. However, recent societal changes—such as low interest rates, wider internet access, and the lowering of the legal age of adulthood—have increased the need for financial education, which was introduced to high schools in 2022. In line with Society 5.0, which emphasizes problem-solving and interdisciplinary thinking, Kurume KOSEN has incorporated STEAM education into its "Liberal Arts Special Lecture" since 2019. This course promotes collaboration among students from various departments and fosters deep learning. As part of this initiative, we developed STEAM-based financial education materials on simple and compound interest, integrating economics and mathematics. These materials were used in an open course for elementary and junior high school students and their parents, with KOSEN students serving as teaching assistants. The course was divided into two parts: the first explored future financial needs and money growth using arithmetic and geometric sequences; the second explained the differences between simple and compound interest through simulations, also addressing the risks of debt. The program was well received, offering valuable social engagement opportunities. Although still in the early stages, the initiative shows promise and calls for further refinement of teaching methods.

Keywords: *financial education, simple interest and compound interest, isometric sequence and geometric sequence, economics, mathematics*

Introduction

According to Van Rooij, Lusardi, and Alessie (2011, 2012), financial literacy encompasses not only understanding interest rates but also inflation, time value of money, and money illusion. Their standard questionnaire has been widely used internationally, allowing for cross-country comparisons. Incorporating these elements into our STEAM-based financial education could enhance its comprehensiveness and relevance.

STEAM education, introduced by Yakman (2008), is a learning approach that utilizes science, technology, engineering, the arts, and mathematics as entry points to promote inquiry, dialogue, and critical thinking in solving real-world problems.

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https://doi.org/10.30958/ajte.13-3-2 doi=10.30958/ajte.13-3-2

While a wide range of teaching materials related to STEAM education exists, those incorporating the "A"—the liberal arts—are relatively limited, as STEAM evolved from STEM education. In Japan, 51 technical colleges (KOSEN), including our institution, serve as regional hubs for STEAM education and provide support to junior high school students.

Since 2019, our college has implemented STEAM education as part of a specialized liberal arts course for fourth-year students. In this course, faculty members from various disciplines, including mathematics, debate, and economics, design unique themes based on their expertise, and students from five different departments select and attend lectures that align with their interests. Through collaborative learning among students from diverse academic backgrounds, we aim to foster deep learning that integrates knowledge and creativity. However, opportunities for students to apply and share their learning with society—particularly through teaching others—remain limited.

Meanwhile, the need for financial education in Japan has increased significantly. Factors such as prolonged low interest rates, diversified employment patterns, and changes in the pension system have made it increasingly necessary for individuals to manage their own financial assets. In addition, the lowering of the legal age of adulthood in 2022 has required younger people to make financial decisions and enter into contracts, contributing to the rise in financial troubles among youth. Under these circumstances, the development of financial literacy from an early age has become a pressing issue. Nevertheless, many people in Japan have had few opportunities to receive financial education either at school or at home, and international surveys have revealed that financial knowledge in Japan lags that of other countries.

In response to these challenges, financial education initiatives began in Japan in 2005. With the 2022 revision of the national curriculum guidelines, financial education was officially incorporated into high school home economics and civics classes. The curriculum covers four major areas: "life planning and household budgeting," "financial and economic systems," "consumer protection and prevention of financial problems," and "career education." These areas are designed to help students develop problem-solving skills by learning how to engage with financial matters in their personal lives and in relation to society. However, due to the lack of standardized teaching methods, differences in teachers' knowledge, limited instructional time, and the complexity of the content, financial education still faces numerous challenges.

Against this backdrop, the purpose of this study is to develop and implement financial education materials that integrate perspectives from economics (liberal arts) and mathematics, and to support STEAM education for junior high school students through an open lecture format. The goal is not only to stimulate students' interest in economics and mathematics but also to encourage multifaceted thinking. In addition, we involved students who had previously taken the liberal arts seminar as teaching assistants (TAs), aiming to improve their instructional skills and deepen their understanding of the material.

This initiative was realized in the form of an open lecture for junior high school students in 2024. The course began with the socially relevant and relatable topic of Japan's "20 million yen (approximately 118,000 euros) retirement issue," and included explanations on life planning and money management. This was followed by a smooth transition to mathematical content, introducing the concepts of simple and compound interest as methods of growing money, and demonstrating how to calculate the Rule of 72 as an application of compound interest. Survey results indicated that the materials effectively enhanced students' interest in both economics and mathematics. Furthermore, comments from TAs suggested that their participation improved their teaching skills and motivation to learn.

As a prior case, in 2022, we (Sakai et al., 2023) developed and implemented STEAM teaching materials on "financial economics" for a public lecture open to both junior high school students and the general public. Female students from the liberal arts seminar participated as instructors, applying their knowledge of economics and mathematical skills in a socially engaged context. Given the broad scope of financial economics, this lecture focused on "interest rates" as a central theme, integrating economics (A) and mathematics (M) in the instructional design. In the mathematics section, a female student from the author's mathematics class explained the differences between simple and compound interest, saving and repayment methods, and the long-term impact of compound interest. Exercises using calculators and financial simulators were incorporated to facilitate hands-on understanding, reflecting the simulation approach used in the economics section.

This paper is organized as follows. First, we introduce the background of our initiative, including the "20 million yen retirement issue" in Japan. Second, we outline the content of our practice and review the scenes from the open lecture, including photographs, questionnaire results, and participant feedback. Finally, we present our conclusions and discuss directions for future research.

20 million yen Retirement Issue

This issue gained widespread attention following a 2019 report by the Market Working Group of the Financial Services Agency. The report estimated that, in a model household consisting of a retired couple—specifically, a husband aged 65 or older and a wife aged 60 or older—a monthly shortfall of approximately 55,000 yen in living expenses would lead to a cumulative deficit of about 13 million yen over 20 years, and approximately 20 million yen over 30 years. Although this estimate was based on a specific model case and does not necessarily apply to all individuals, the figure was extensively reported in the media and triggered significant public concern. The issue highlighted the lack of financial preparedness for retirement and emphasized the need to enhance financial literacy among the Japanese population.

Construction of the Open Course

The course included 16 junior high school students and their parents. Participants were self-selected, and the questionnaire was designed to assess six STEAM competencies. Reliability was ensured through internal consistency checks, and statistical analysis (paired t-tests) was conducted to evaluate pre- and post-course changes.

In this class, we designed a financial literacy program as a theme for STEAM education, integrating perspectives from economics (liberal arts) and mathematics. Through activities in which participants consider future financial needs and planning—with guidance from instructors and teaching assistants (TAs)—the course aimed to: (1) help TAs improve their teaching skills and deepen their understanding, (2) stimulate participants' interest in economics and mathematics, and (3) provide students with insights for developing multifaceted thinking. For the TAs, this initiative also served as an opportunity to give back to society by applying their acquired knowledge of economics and mathematics in a real-world educational setting.

The remainder of this paper is structured as follows. First, as an introduction to financial education, we present the "20 million yen retirement issue" and its historical background. Next, we explain the three basic steps of financial planning—reviewing expenses, reducing expenditures, and increasing income—through a series of exercises. In particular, the section on increasing income uses a worksheet to help visualize money growth, accompanied by explanations of arithmetic and geometric sequences, including how to calculate their sums.

Finally, the course concludes with practical exercises that deepen understanding of wealth-building methods, such as simple and compound interest, the Rule of 72, and the effects of long-term saving with compound interest.

To evaluate the effectiveness of the course, pre- and post-class questionnaires were administered to examine changes in participants' awareness and understanding.

The structure of the class was as follows:

(Pre-class questionnaire)
(1) 20 million yen retirement issue
(2) A financial plan
(3) Problem exercises
(4) Methods to increase wealth
(5) Problem exercises
(Post-class questionnaire)

Content of the Practice

In this class, financial education was implemented using a STEAM-based approach for junior high school students and their parents. The program also provided an opportunity for our students—who had studied economics and mathematics through regular courses and liberal arts seminars—to serve as teaching assistants (TAs). The goal was not only to spark participants' interest in finance but also to encourage the development of multiple perspectives. At the same time, the TAs were given a chance to give back to society by applying their academic knowledge in a practical teaching context.

The class was structured as follows:

(a) Learning Content
Financial literacy from the perspectives of economics and mathematics
(b) Structure

- Participants: 16 junior high school students and their parents
- Facilitators: Three female students (TAs) and two instructors
- Duration: 120 minutes (60 minutes for economics, 60 minutes for mathematics)

The class began with a pre-class questionnaire. In this study, we defined six key competencies to be fostered through STEAM education and developed corresponding questionnaire items for each competency:

(1) Problem-Solving Skills
- When you didn't understand something, did you try to look it up yourself?
- When you faced a problem, did you try to solve it on your own?

(2) Critical Thinking
- When you encountered something you didn't understand or found strange, did you think, "Why is that?"
- When listening to your friends or teachers, did you ever think, "Why do they think that way?"

(3) Creativity
- Do you enjoy coming up with fun ideas or thinking of something new?
- When doing something, did you try to add your own creative twist or personal touch?

(4) Flexibility
- When plans or situations changed suddenly, were you able to stay calm and respond appropriately?
- When things didn't go as expected, did you try different approaches to solve the problem?

(5) Perspective-Taking
- When a problem occurred, did you try to consider the cause and solution from a broader point of view?

(6) Execution Ability
- Did you follow through with the plans you made?
- Even when things didn't go well, did you make efforts to complete the task?

-

Introduction to the Course

In this section, we present scenes from the open course along with photographs. Slides were displayed on the screen (Figure 1), and key points regarding the "20 million yen retirement issue" were explained. Using a newspaper article as a reference, we discussed how the amount of money required for retirement has changed over time. We also emphasized that this amount can vary significantly depending on individual living conditions and lifestyle choices. Through this discussion, participants were encouraged to recognize the importance of developing financial literacy that enables them to make informed decisions without being influenced by external information.

Participants took notes on their answer sheets before attempting the exercises, while TAs circulated the room and provided assistance (Figure 2). Through these interactions, the female students serving as TAs developed their ability to teach and support others.

Figure 1. *Lecture*

Figure 2. *Question answering by TAs*

Three Steps for creating a Financial Plan

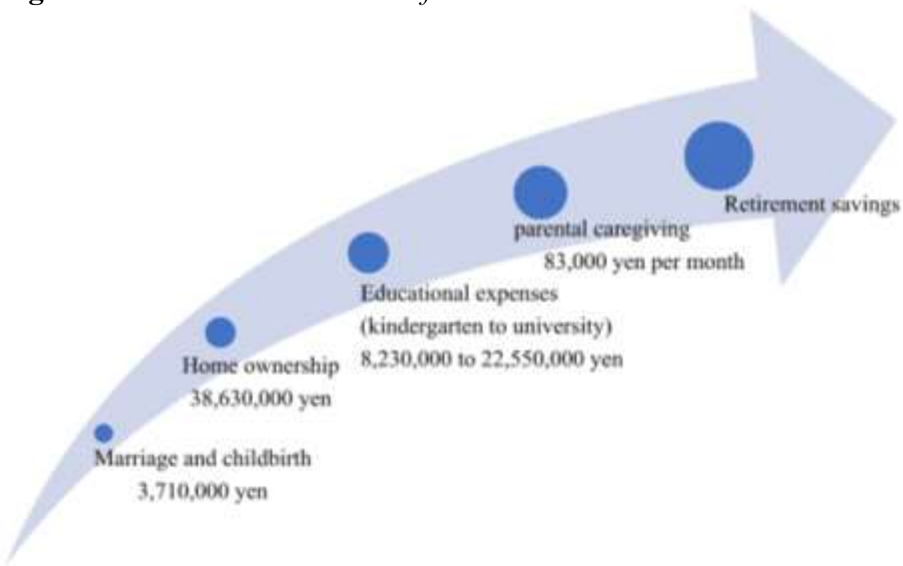
In the next part of the class, we introduced the three steps for creating a financial plan using presentation slides.

- Step 1 involves assessing future expenses by estimating the financial requirements for various life events and essential needs.
- Step 2 focuses on reducing expenditures by identifying opportunities to save through careful spending management and the elimination of unnecessary costs.
- Step 3 entails increasing income by developing strategies to accumulate the remaining required funds—such as through additional earnings, savings, or investment options.

Figure 3. *Three Steps for creating a Financial Plan*

In Step 1, we presented examples of major life events along with their estimated costs (Figure 4).

Figure 4. *Costs associated with Life Events*



Participants were then guided to complete a life planning worksheet to calculate the total amount of money needed through retirement (Table 1). Additionally, by estimating their annual income and expenditures during retirement, participants could project the total financial resources necessary to sustain post-retirement life (Figure 5).

Table 1. *A Sample of Life planning Sheet*

	Family members' ages				Life events, dreams, and goals	Budget
A.D.	Husband	Wife	First child	Second child		
2024	54	44				
2025	55	45			European trip	400,000 yen
2026	56	46			Buying a house (down payment)	4,500,000 yen
2027	57	47				
2028	58	48			Buying a massage chair	500,000 yen
2029	59	49				
2030	60	50				
2031	61	51			Asian trip	300,000 yen
2032	62	52				
2033	63	53				
2034	64	54			World trip	6,000,000 yen
2035	65	55				
2036	66	56			To get a dog	300,000 yen
2037	67	57				
2038	68	58				
					Total budget	12,000,000 yen

Figure 5. *Calculation of Retirement Funds*

Yearly retirement income	Yearly retirement expenses	Yearly deficit
① yen	② yen	③=①-② yen

Yearly deficit	Number of years after age 65	Nursing care costs	Retirement funds
③ yen	④ years	⑤ 8,000,000 yen	⑥=③×④+⑤ yen

In Step 2, participants used a structured worksheet to calculate the amount of savings required to meet their future needs (Figure 6). This was done by subtracting their current assets from the projected expenses identified in Step 1, helping them clarify the financial gap to be filled. After identifying the target savings amount, participants calculated their current monthly income and expenditures using another worksheet (Figure 7). This activity enabled them to better understand their potential monthly savings and evaluate the feasibility of achieving their financial goals. The worksheet also included recommended spending ratios for each expense category, allowing participants to compare these benchmarks with their own expenditures and visually identify areas for adjustment based on their priorities.

Figure 6. *Target savings Confirmation Sheet*

Projected financial needs	①	yen

Current assets	
Cash	yen
Savings	yen
Stocks, bonds, and mutual funds	yen
Investment property	yen
cash surrender value	yen
Jewelry	yen
Others	yen
Required savings	
③=①-②	yen

Figure 7. *Household spending Ratio*

Income	
Item	Amount
Monthly income	yen

Expenses			
Items	Amount	Proportion income	Ideal Spending Ratio
Rent	yen	%	20～30%
Insurance premium	yen	%	3～5%
Communication expenses, utilities	yen	%	7～9%
Food expenses	yen	%	10～15%
Social expenses	yen	%	7～10%
Clothing expenses	yen	%	5～7%
Education expenses	yen	%	10%
Miscellaneous expenses	yen	%	3～5%
Savings	yen	%	15～20%
Total expenses	yen	100%	

In Step 3, we introduced various strategies for accumulating additional funds to address potential shortfalls. These included:

- Increasing income through employment (e.g., side jobs or post-retirement work)
- Enhancing pension benefits (e.g., deferring pension claims or using private pension plans)
- Utilizing tax-exempt accounts (e.g., defined contribution plans or NISA)
- Growing wealth through investments (e.g., bonds, stocks, real estate, mutual funds, gold, and foreign exchange)

To help participants understand how money can grow over time, two hands-on exercises using structured worksheets were conducted, as described in what follows:

Exercise 1. Let's stick five colors of round stickers on the board according to the following rules.

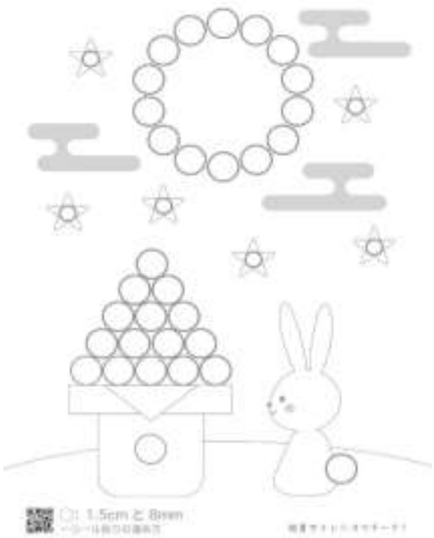
Figure 8. *Christmas. From Chiikumura, 2024 (https://chiiku-baby.jp/maru-sticker/)*

【Rules】
① Use one sticker of the first color.
② Use two more stickers than in ① for the second color.
③ Use two more stickers than in ② for the third color.
④ Use two more stickers than in ③ for the fourth color.
⑤ Use two more stickers than in ④ for the fifth color.

Question 1.
(1) How many stickers were used in total?
(2) If you continue the same rule and use a sixth color, how many stickers would you have in total?

Exercise 2. Let's stick five colors of stickers on the board according to the following rules.

Figure 9. *Otsukimiusagi. From Chiikumura, 2024 (https://chiiku-baby.jp/maru-sticker/)*



【Rules】
① Use one sticker of the first color.

② Use twice as many stickers of the second color as in ①.
③ Use twice as many stickers of the second color as in ②.
④ Use twice as many stickers of the second color as in ③.
⑤ Use twice as many stickers of the second color as in ④.

Question 2.

(1) How many stickers were used in total?
(2) If you continue the same rule and use a sixth color, how many stickers would you have in total?

From a mathematical perspective, the number of stickers in Question 1 follows an arithmetic sequence with a first term of 1 and a common difference of 2 (i.e., 1, 3, 5, 7, 9, …). Part (1) asks for the sum of the first five terms, and part (2) asks for the sum of the first six terms.

In Question 2, the number of stickers forms a geometric sequence with a first term of 1 and a common ratio of 2 (i.e., 1, 2, 4, 8, 16, …). Part (1) asks for the sum of the first five terms, and part (2) asks for the sum of the first six terms.

These two questions use the familiar activity of placing stickers to help participants understand the difference between "adding 2" and "multiplying by 2" in terms of how quantities grow. This visual and hands-on approach supports the conceptual understanding of the fundamental distinction between arithmetic and geometric growth. Furthermore, the process of solving these problems naturally leads to the derivation of the formulas for the sums of arithmetic and geometric sequences (Figures 10 and 11).

Figure 10. *Solution to Problem 1*

(1)

Sticker	First Color	Second Color	Third Color	Fourth Color	Fifth Color
Number of Stickers	1	3	5	7	9

(2) Let's calculate 1 + 3 + 5 + 7 + 9 + 11. Let this sum be denoted as x.
Then, $x = 1 + 3 + 5 + 7 + 9 + 11$. Since adding in reverse order doesn't change the result, we also have $x = 11 + 9 + 7 + 5 + 3 + 1$.

$$\begin{array}{rl} x = & \boxed{1} + \boxed{3} + \boxed{5} + \boxed{7} + \boxed{9} + \boxed{11} \\ +)\ x = & \boxed{11} + \boxed{9} + \boxed{7} + \boxed{5} + \boxed{3} + \boxed{1} \\ \hline \end{array}$$

Adding these two equations together gives:
$2x = 12 + 12 + 12 + 12 + 12 + 12 = 72$.
Dividing both sides by 2, we get $x = 36$.

Figure 11. *Solution to Problem 2*

(1)

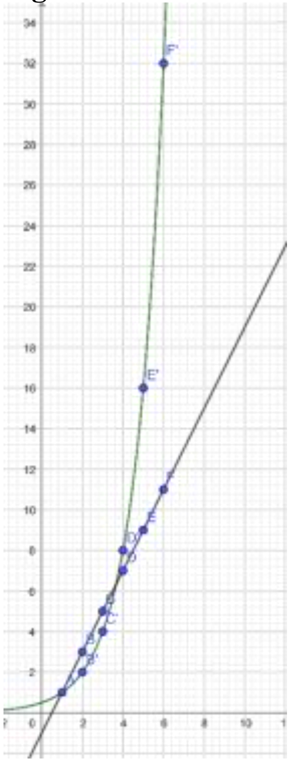
Sticker	First Color	Second Color	Third Color	Fourth Color	Fifth Color
Number of Stickers	1	2	4	8	16

(2) Let $x = 1 + 2 + 4 + 8 + 16 + 32$. If we multiply both sides by 2, we get: $2x = 2 + 4 + 8 + 16 + 32 + 64$. If we calculate $2x - x$, we have $x = 64 - 1 = 63$ (see the following calculation).

$$\begin{array}{rl} 2x = & \quad\;\; 2 + 4 + 8 + 16 + 32 + 64 \\ -)\;\; x = & 1 + 2 + 4 + 8 + 16 + 32 \\ \hline x = & 64 - 1 = 63 \end{array}$$

Furthermore, GeoGebra was used to display graphs of the functions represented in Problems 1 and 2, thereby enhancing participants' visual understanding of the differences in the rate of increase in the number of stickers. In this context, the black graph represents the linear function $y = 2x - 1$ corresponding to Problem 1, while the green graph illustrates the exponential function $y = 2^{x-1}$ associated with Problem 2 (Figure 12).

Figure 12. *Functions corresponding to Problem 1 and 2*



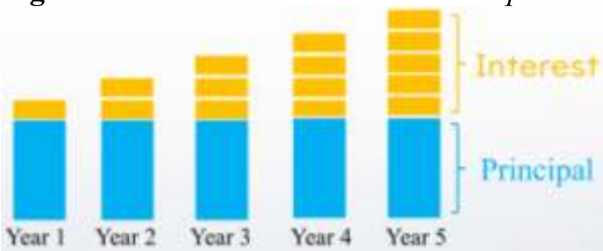
In this part of the class, we also explained the concepts of simple and compound interest, the Rule of 72 as a practical application of compound interest, the power of long-term accumulation, and basic methods for repaying borrowed money. These topics were presented to deepen participants' understanding of how money grows over time and the financial implications of interest in real-life scenarios.

Simple Interest and Compound Interest

In addition to simple and compound interest, financial literacy includes understanding inflation, time value of money, and money illusion. These concepts are essential for making informed financial decisions and should be considered in future curriculum development. In this section, we defined simple interest and compound interest, and provided practical examples to illustrate their applications.

Definition 1. Simple interest is defined as interest calculated solely on the initial principal, without incorporating the accrued interest into the principal.

Figure 13. *Investment Growth under Simple Interest*



Example 1. Suppose an initial investment of 1,000,000 yen is made at an annual simple interest rate of 3%. Since interest is calculated only on the principal, the amount increases linearly:

- After 1 year: 100 + 3 = 103 (ten thousand yen)
- After 2 years: 100 + 3 + 3 = 106 (ten thousand yen)
- After 3 years: 100 + 3 × 3 = 109 (ten thousand yen)

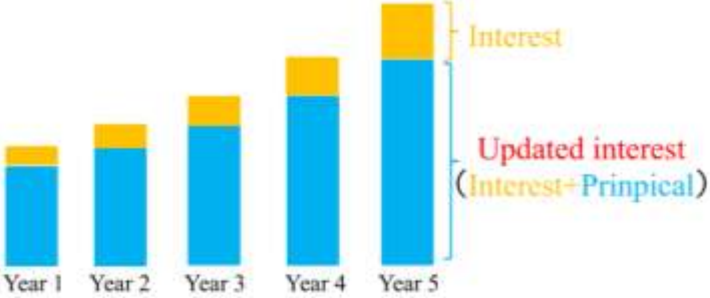
More generally, after n years, the total amount is given by:

$$A = a(1 + nr)$$

where a is the initial principal, r is the annual interest rate (as a decimal), and n is the number of years.

Definition 2. *Compound interest* is interest calculated on both the initial principal and the accumulated interest from previous periods.

Figure 14. *Investment Growth under Compound Interest*



Example 2. Suppose the same 1,000,000 yen is invested at an annual compound interest rate of 3%. The amount grows exponentially:

- After 1 year:
  $100 + 100 \times (3/100) = 100 \times (1 + 0.03) = 100 \times 1.03^1$ (ten thousand yen)
- After 2 years:
  $(100 \times 1.03^1) \times 1.03 = 100 \times 1.03^2$ (ten thousand yen)
- After 3 years:
  $(100 \times 1.03^2) \times 1.03 = 100 \times 1.03^3$ (ten thousand yen)

More generally, after *n* years, the total amount is given by:

$$A = a(1 + r)^n.$$

where *a* is the initial principal, *r* is the annual interest rate (as a decimal), and *n* is the number of years.

The differences between simple and compound interest, as well as their calculation methods, were explained. Participants then used calculators to solve an exercise designed to reinforce their understanding by comparing the outcomes of both interest calculations (Figures 15 and 16).

Exercise 3. Calculate the simple and compound interest for an investment of 1,000,000 yen at an annual interest rate of 3% using a calculator.

Figure 15. *Simple and Compound Interest Calculation Sheet*

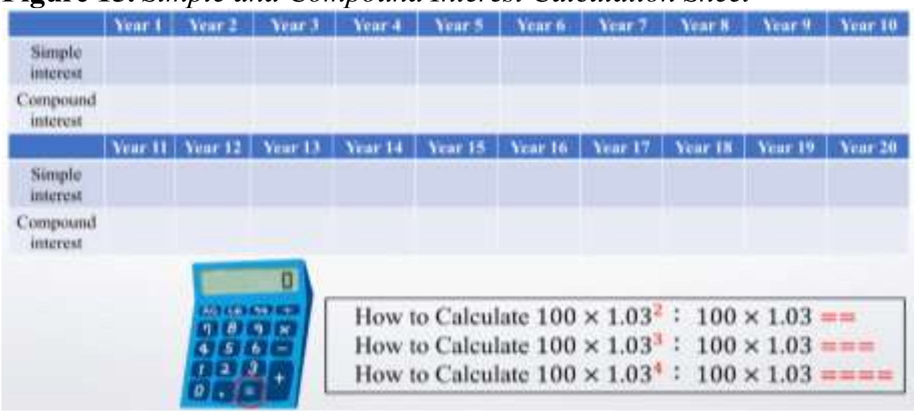
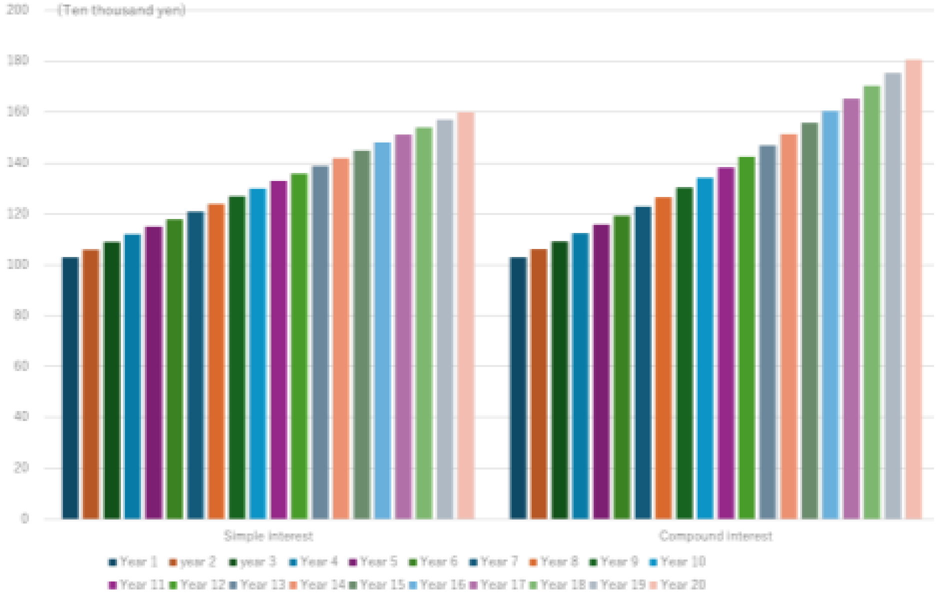


Figure 16. *Comparison between Simple and Compound Interest*



Rule of 72

Next, to illustrate the Rule of 72, the following question was presented to the participants:

Question 1: Under compound interest at an annual rate of 3%, how many years will it take for the principal to double?

As demonstrated in Example 2, we explained that the task was to find the smallest natural number n that satisfies the inequality $100 \times (1.03)^n \geqq 200$. After this explanation, participants were encouraged to use calculators to compute powers of 1.03 (such as $1.03^2, 1.03^3$, etc.) to determine the value of n.

After participants had estimated the value of n, we explained that, from a mathematical perspective, the exact value of n can be obtained using common (base-10) logarithms to solve the inequality: $100 \times (1.03)^n \geqq 200$. Dividing both sides by 100 gives: $(1.03)^n \geqq 2$. Taking the common logarithm of both sides results in: $\log_{10}(1.03)^n \geqq \log_{10} 2$.

Applying the logarithmic identity $\log_{10} a^p = p \log_{10} a$, we have:

$n \log_{10} 1.03 \geqq \log_{10} 2$. Solving for n, $n \geqq \frac{\log_{10} 2}{\log_{10} 1.03} \approx \frac{0.3010}{0.0128} \approx 23.5$.
Therefore, the smallest natural number satisfying the inequality is $n = 24$.

We then introduced the Rule of 72, an approximation method that estimates the doubling time under compound interest by dividing 72 by the interest rate: $n \approx \frac{72}{r}$. For an interest rate of 3%, this yields: $n \approx \frac{72}{3} = 24$. This illustrates that the Rule of 72 provides a close approximation to the exact logarithmic calculation (Table 2).

Table 2. *Calculation Examples using the Rule of 72*

(1) Interest rate (%)	(2) Doubling time under compound interest	Product of (1) and (2)
2	36	72
3	24	72
4	18	72
6	9	72

Long-term saving

To help participants understand the power of long-term saving through compound interest, the following problem was presented, followed by a detailed explanation:

Question 2: If you deposit 100,000 yen annually at an interest rate of 2% compounded annually, what will be the total amount at the end of the 5th year?

Answer to Question 2:
The total amount accumulated by depositing 100,000 yen annually at a compound interest rate of 2% per year, with deposits made at the end of each year, is calculated step-by-step as follows. (Amounts are expressed in units of 10,000 yen.)

- Year 1:
  $10\times1.02 = 10.20$
- Year 2:
  $(10\times1.02+10)\times1.02=20.604$
- Year 3:
  $\{[(10\times1.02+10)\times1.02]+10\}\times1.02=31.216$
- Year 5 (after continuing the same process):
  $((((10\times1.02+10)\times1.02+10)\times1.02+10)\times1.02+10)\times1.02=53.0812$

Therefore, the total amount at the end of the 5th year is approximately 530,812 yen.

Remark 1. In general, the total amount accumulated after n years of annual deposits of a yen at a compound interest rate r is $\frac{a(1+r)\{(1+r)^n-1\}}{r}$.
In Question 2, the parameters are: the annual deposit is $a = 10$ (in ten thousand yen), the annual interest rate is $r = 2\%$, and the duration is $n = 5$ years.

To further support participants' understanding of how compound interest affects long-term savings—and to visualize how changes in interest rate and savings period influence the outcome—a savings simulator was used. Participants calculated the accumulated amounts under various conditions (Table 3 and Figure 17).

Exercise 4. Using the savings simulator, complete the following table.

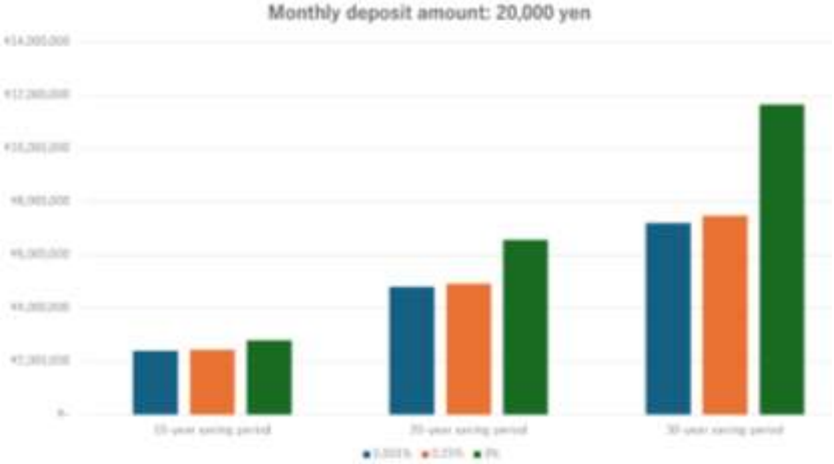
Table 3. *Calculation examples using the Rule of 72*

Monthly deposit amount	Interest rate	10-year saving period	20-year saving period	30-year saving period
20,000 yen	0.001%			
	0.25%			
	3%			

Figure 17. *Savings Simulator. From FSA Japan, 2024 (https://www.fsa.go.jp/policy/nisa2/moneyplan_sim/index.html)*

Subsequently, a graph was presented to help participants visually understand the powerful effects of compound interest and long-term saving (Figure 18).

Figure 18. *Comparison of amounts by interest rate and saving period*



At the end of this section, methods of loan repayment were introduced. Specific loan amounts and interest rates were used to pose a realistic question and prompt participants to consider how different repayment methods affect total repayment amounts.

Question 3. I borrowed 1 million yen at an annual interest rate of 5%.

(1) If I repay 100,000 yen at the end of each year, how many years will it take to fully repay the loan?

(2) If I want to repay the loan in 10 years, how much should I repay at the end of each year?

To help participants solve this question, we first explained the concept of the present value of an annuity, using the following step-by-step analysis.

(1) Fixed Payment of 100,000 Yen Each Year
To calculate the present value of a payment of 100,000 yen to be made one year from now at an annual interest rate of 5%, we let x denote the present value. Then:
$1.05x = 100{,}000 \Rightarrow x = \frac{100{,}000}{1.05} \fallingdotseq 95{,}238.$
Similarly, the present value of a payment of 100,000 yen two years from now is:
$(1.05)^2x = 100{,}000 \Rightarrow x = \frac{100{,}000}{(1.05)^2} \fallingdotseq 90{,}702.$
For a payment made three years from now:
$(1.05)^3x = 100{,}000 \Rightarrow x = \frac{100{,}000}{(1.05)^3} \fallingdotseq 86{,}383.$
In general, the present value of 100,000 yen to be paid n years from now is:
$x = \frac{100{,}000}{(1.05)^n}.$
(2) Fixed Repayment Over 10 Years
Suppose a fixed payment of x yen is made at the end of each year for 10 years. The total present value of these payments must equal 1,000,000 yen.

The present value of these payments is given by the sum:

$$\frac{x}{1.05} + \frac{x}{(1.05)^2} + \frac{x}{(1.05)^3} + \cdots + \frac{x}{(1.05)^{10}} = 1{,}000{,}000$$

Factoring out x, we get:

$$x\left\{\frac{1}{1.05} + \frac{1}{(1.05)^2} + \frac{1}{(1.05)^3} + \cdots + \frac{1}{(1.05)^{10}}\right\} = 1{,}000{,}000$$

Let this sum of the geometric series be denoted by S, where

$$\mathrm{S} = \frac{1}{1.05} + \frac{1}{(1.05)^2} + \frac{1}{(1.05)^3} + \cdots + \frac{1}{(1.05)^{10}}.$$

This is a finite geometric series, and its sum can be calculated using the standard formula: $S = \frac{\frac{1}{1.05}\left\{1 - \frac{1}{(1.05)^{10}}\right\}}{1 - \frac{1}{1.05}} = \frac{1 - \frac{1}{(1.05)^{10}}}{1.05 - 1} = \frac{1 - \frac{1}{(1.05)^{10}}}{0.05}$. Thus, the fixed annual payment x can be obtained by solving: $x = \frac{1{,}000{,}000}{S}$

This approach helps participants understand how interest rates, loan durations, and repayment schedules influence the total cost of borrowing.

Exercise 5. (1) Using the savings simulator, complete the table below and calculate the total present value of the loan repayments.

Table 4. *Calculation of Present Value*

	$\frac{100{,}000}{1.05}$	$\frac{100{,}000}{(1.05)^2}$	$\frac{100{,}000}{(1.05)^3}$	$\frac{100{,}000}{(1.05)^4}$	$\frac{100{,}000}{(1.05)^5}$	$\frac{100{,}000}{(1.05)^6}$	$\frac{100{,}000}{(1.05)^7}$	$\frac{100{,}000}{(1.05)^8}$	$\frac{100{,}000}{(1.05)^9}$	$\frac{100{,}000}{(1.05)^{10}}$
Present Value	95,238	90,703	86,384	82,270	78,352	74,621	71,067	67,683	64,460	61,390

	$\frac{100{,}000}{(1.05)^{11}}$	$\frac{100{,}000}{(1.05)^{12}}$	$\frac{100{,}000}{(1.05)^{13}}$	$\frac{100{,}000}{(1.05)^{14}}$	$\frac{100{,}000}{(1.05)^{15}}$
Present Value					

(2) Using the savings simulator, determine the values of S (the sum of the geometric series) and x (the fixed annual repayment amount), respectively.

Remark 2. The present value $\boldsymbol{PV}$ of an ordinary annuity, in which a fixed payment A is made at the end of each period over n periods with a constant interest rate r, is given by the following formula:

$$PV = A \times \frac{1-(1+r)^{-n}}{r}.$$

In Question 3(1), the present value PV is 1,000,000 yen, the annual payment A is 100,000 yen, and the interest rate r is 0.05. In Question 3(2), the present value PV is 1,000,000 yen, the annual payment A is 100,000 yen, and the number of periods n is 10.

Considerations Based on Questionnaire Results

To assess the extent to which the goals of this practice were achieved, we analyzed the percentage of correct responses on in-class exercises and the results of pre- and post-class questionnaires.

For the questionnaire analysis, each response item was scored on a 4-point Likert scale: "Agree" = 4 points, "Somewhat agree" = 3 points, "Somewhat disagree" = 2 points, and "Disagree" = 1 point. Table 1 presents the mean scores for each competency area, comparing responses before and after the class.

Table 5. *Average Score for Question Item Choices*

Competency	Question items	Before	After	Increase
Problem-Solving Skills	When you didn't understand something, did you try to look it up by yourself?	3.25	3.29	0.04
	When you faced a problem, did you try to solve it on your own?	3.19	3.24	0.05
Critical Thinking	When you encountered something you didn’t understand or found strange, did you think, "Why is that?"	3.31	3.47	0.16
	When listening to your friends or teachers, did you ever think, "Why do they think that way?"	3.50	3.65	0.15
Creativity	Do you enjoy coming up with fun ideas or thinking of something new?	3.31	3.65	0.33
	When doing something, did you try to add your own creative twist or personal touch?	3.25	3.24	(0.01)
Flexibility	When plans or situations changed suddenly, were you able to stay calm and respond appropriately?	3.13	2.88	(0.24)
	When things didn’t go as expected, did you try various approaches to solve the problem?	3.06	3.47	0.41
Perspective-Taking	When a problem occurred, did you try to consider the cause and solution from a broad point of view?	2.94	3.24	0.30
Execution Ability	Did you follow through with the plans you made?	3.19	3.24	0.05
	Even when things didn’t go well, did you make efforts to complete the task to the end?	3.31	3.53	0.22

To evaluate the effectiveness of the financial literacy course, a paired t-test was conducted using the pre- and post-class questionnaire scores. The test compared the mean scores across six STEAM-related competencies: problem-solving, critical thinking, creativity, flexibility, perspective-taking, and execution ability. The analysis yielded a t-statistic of **−2.3679** and a p-value of **0.0394**. Because the p-value is below the conventional threshold of 0.05, the difference between the pre- and post- class scores before and after the course is statistically significant. These results suggests that the course had a meaningful impact on participants' development of STEAM competencies, particularly in areas such as critical thinking and perspective-taking. The results for each of the six competencies are summarized as follows:

1. Problem-Solving Skills

The results showed a slight improvement. Students already exhibited a moderately strong inclination toward solving problems independently, and the program modestly reinforced this tendency without significantly altering their overall behavior.

2. Critical Thinking

A clear improvement was observed. The program appears to have strengthened students' curiosity and their ability to critically reflect on their own and others' viewpoints. Activities involving discussion and inquiry likely contributed to this development.

3. Creativity

A notable increase was observed in students' enjoyment of generating new ideas, indicating heightened interest in creative thinking. However, there was little change in their ability to translate these ideas into practical improvements. This suggests that while students felt more creative, they did not necessarily take more creative action.

4. Flexibility

The results revealed contrasting tendencies. Students became more willing to try different approaches when encountering difficulties, indicating improved adaptive thinking. However, their confidence in staying calm during unexpected changes decreased slightly. This suggests that while their experimental mindset grew, their emotional resilience may require further support.

5. Perspective-Taking

This competency demonstrated one of the most substantial improvements, especially given its relatively low baseline. The program appears to have helped students broaden their outlook and integrate multiple viewpoints—an essential objective of interdisciplinary STEAM education.

6. Execution ability

A marked improvement was observed in students' perseverance and their capacity to follow through with tasks despite obstacles. The structure of the program, which emphasized project-based and goal-oriented activities, likely played a key role in fostering this competency.

Table 6. *Overall Summary*

Competency	Key Changes	Evaluation
Problem-Solving	Slight improvement	Stable
Critical Thinking	Consistent improvement	Positive
Creativity	Increased idea generation, but flat in execution	Partially effective
Flexibility	Increased problem-solving flexibility, decreased composure	Mixed results
Perspective-Taking	Major improvement	Highly effective
Execution Skills	Improvement in perseverance	Steady growth

The program effectively supported the development of several key STEAM-related competencies, particularly in critical thinking, creative ideation, perspective-taking, and resilience in execution. However, certain areas—such as emotional flexibility and the practical application of creative ideas—may benefit from more targeted instructional strategies in future implementations.

Overall, the results indicate a positive developmental impact, while also highlighting areas for further refinement and growth.

We also received the following comments from participants regarding the course theme and instructional materials:

- "In the economics part, I wanted more concrete examples. In the mathematics section, working with actual numbers helped me realize how significantly interest rates affect outcomes. Overall, I'm glad I attended the course."
- "The female students' explanations were calm and easy to follow."
- "The content was interesting, but I was disappointed that there were so few participants."
- "I plan to try the simulation at home. The course was very informative. I wish more people had the chance to hear it."

Limitations of this study include a small sample size and potential biases such as self-selection and social desirability. Additionally, the applicability of this model to other educational contexts may be constrained by differences in resources and curricula.

Conclusion and Future Directions

Future research should include longitudinal studies to assess the retention of financial concepts and compare outcomes with control groups. The STEAM approach could also be adapted to other domains such as physics and chemistry. We received the following comments from female teaching assistants regarding the course theme and instructional materials:

- "I was nervous, but it was a valuable experience."
- "I found the simulations useful and could easily understand the outcomes of long-term savings."
- "I should have practiced the simulation a bit more. I'm glad I learned about interest rates through this course. I hope to apply this knowledge when borrowing money in the future."

The results of the questionnaire indicate that the course was effective for learners and demonstrated promise as a STEAM education tool.

Looking ahead, we propose the development of two new teaching tools for future implementation:

1. Knot Theory
   Knot theory can be introduced to beginners without requiring prior background knowledge, making it highly accessible. It is supported by a range of visual teaching materials and is linked to various disciplines such as quantum field theory in physics, molecular design in chemistry, and DNA structure in biology. In future work, we aim to create STEAM teaching materials that connect mathematics with physics and chemistry.

2. Graph Theory
   Graph theory is another promising subject area. Like knot theory, it is accessible to beginners and does not require deep prior knowledge. It has broad interdisciplinary applications across fields such as physics, chemistry, computer science, linguistics, and the social sciences. We plan to explore its potential for integration into STEAM education through the development of engaging and visually intuitive materials.

Acknowledgments

The authors would like to express their sincere gratitude to the teaching assistants — Kokoro Kawaida, Funa Miyake, and Mizuki Yoshida — for their outstanding contributions and dedicated support throughout the project.

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