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# How to Decrease the Amortization Bias: Experience vs. Rules

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# How to Decrease the Amortization Bias: Experience vs. Rules

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*Abstract:* We conduct an experimental study that tests the effectiveness of de-biasing a certain form of exponential growth bias found in household finance debt decisions, called the amortization bias. We provide 251 bachelor students at a German university with a short tutorial based on one of three learning methods: experiential learning, learning a simple "I Owe More" debt rule-of-thumb, as well as learning an extended, but more accurate version of the "I Owe More" debt rule. Immediately after completing these tutorials, we retest for the amortization bias and find a significant bias improvement in all three treatments. More importantly, after confronting the same participants with similar debt scenarios approximately three weeks later, we find that those who had previously received a debt tutorial maintain a significantly larger bias improvement over the control group. However, during this short period, most of the individuals who learned the simple and complex rules-of-thumb could no longer apply the rule and reverted back to their biased answers, while the experiential learning group best retained their improvement in bias. We find evidence in this experiment that experience-based learning may be better suited to produce long-lasting improvements for attenuating the amortization bias.

*Keywords*: Exponential growth bias, de-biasing strategies, amortization bias

*JEL classification*: D14

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## 1. Introduction

Exponential growth bias (EGB), the tendency to linearize exponential functions, has been well documented in academic research within the context of household finance, both in savings and debt decisions (Wagenaar and Sagaria, 1975; Wagenaar and Timmers, 1979; Eisenstein and Hoch, 2007; Stango and Zinman, 2009; McKenzie and Liersch, 2011; Almenberg, 2012; Soll, Keeney, and Larrick, 2013). Previous studies have also shown that understanding exponential effects can attenuate EGB and lead individuals to make better borrowing and savings decisions (Stango and Zinman, 2009; Song, 2012; Levy and Tasoff, 2015). Therefore, we believe it to be a worthwhile endeavor to investigate various ways of eliminating, or at least reducing EGB in such household savings and debt decisions.

In a recent experimental study, Foltice and Langer (2015) find results in favor of the effectiveness of formal formula learning and conclude that the long-term retention of the formal formula learning, even 18 to 20 months after the extensive learning, is indeed possible and may effectively de-bias individuals with simple savings questions using an available calculator. Additionally, Foltice and Langer (2015) summarize that, "knowledge of this formula may also aid in developing a more general and intuitive grasp of exponential effects, not only in the same domain, but in other exponentially-based domains".

However, we are unsure if this extensive formal formula learning is the one and only prescription to alleviating EGB in all household savings and debt decisions. For instance, the compound savings formula for a simple savings question might be easy enough for mathematically-minded business students to retain and effectively use over time. However, it might not be suitable for individuals who possess different learning preferences and mathematical capacities. At the same time, increasing the complexity of the question may lead to different conclusions regarding the effectiveness of learning, especially when it comes to the long-term retention of the equation. Perhaps most importantly, we are skeptical that extensive

and formal formula learning for each and every household savings and debt decision would be adequately retained over time by most individuals, nor would it be very cost effective to broadly implement this learning curriculum. Acknowledging these limitations, we seek to extend the initial findings of Foltice and Langer (2015) and evaluate the effectiveness of various learning methods in a more complex debt question, by completing a short tutorial designed to take approximately 10-minutes. If retained over time, these short tutorials would provide a more cost effective alternative to a time consuming extensive training curriculum for each possible savings and debt decision. If not, we would explore other alternatives, such as a "just-in-time" learning method, introduced by Fernandes, Lynch, and Netemeyer (2014), who propose learning about each savings and debt decision when they are presently applicable to an individual.

## 2. Background and Hypotheses

In order to address this research question, we employ fourth semester undergraduate business students at a German university. This specialized sample possesses a couple of unique characteristics. First, this group is very familiar with the compound savings equation; over 90% of the participants can consistently calculate savings questions correctly. On the other hand, we are confident that the individuals have not received any formal learning in the debt domain, such as calculating the amortization of a loan. Moreover, it is uncommon for German students to take out student loans or other types of debt, which could provide an experiential learning platform. These factors essentially place each participant on a common level, which gives us a uniform foundation to test the effectiveness of the learning. In Foltice and Langer (2015), this same group of participants displays strong evidence of an amortization bias, the tendency to linearly estimate the remaining balance on a loan at various points of a debt payoff schedule. In fact, some of the participants' "formulaic dependence" caused them to use a variation of the

compound savings equation, leading to an inordinate amount of invalid answers well above the initial balance of the loan.[1]

Understanding how quickly or, more importantly, how slowly a loan amortizes over time can influence borrowing decisions, whether it's within the context of buying a house or deciding to take out a personal loan. Increased bias has been shown empirically to lead to more negative financial decisions, such as increased borrowing (Stango and Zinman, 2009). Unfortunately, the steps required to learn and accurately calculate such an important decision are not as easy as the simple compound savings equation. In this task, the remaining balance $B$ on a loan with an initial amount $A$ after $n$ payments can be calculated as:

$$B = A \cdot \left[1 - \frac{(1+i)^n - 1}{(1+i)^N - 1}\right] \tag{1}$$

when the loan with an interest rate $i$ is to be fully paid back in $N$ equal installments.

From this equation, we can see that the calculation of the remaining balance is strongly driven by exponential components, although the application is much less obvious than in a simple savings scenario, where a present value $PV$ is just multiplied by an exponential factor $(1+i)^t$ to obtain the final value $FV$ of investing $t$ periods at an interest rate of $i$:

$$FV = PV \cdot (1+i)^t \tag{2}$$

Based on the importance of these slightly more complex debt questions, we believe it is worth testing appropriate learning methods aiming to de-bias or at least reduce bias for these decisions. In this paper, we test the effectiveness of various types of tutorials by running a multi-stage experiment. In this experiment, after answering a total of 16 questions (8 each in the savings and debt domains), a short tutorial designed to de-bias or reduce bias is randomly given

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[1] Formulaic dependence is defined as the tendency to solely rely on a formula to derive an answer, whether it makes sense intuitively or not.

to each participant in either the savings or debt domain. Previous simple and cost effective ways to de-bias consumers within household finance include: providing strong APR (annual percentage rate) disclosure (Truth in Lending) enforcement (Stango and Zinman, 2011), reminding customers of opportunity costs (Frederick, et al., 2009), displaying decision aids in the form of graphs and feedback devices, (Bhandari, Hassanein, and Deaves, 2009; Goda, Manchester, and Sojourner, 2014) and giving participants a brief tutorial teaching them about compound interest or the Rule of 72 (Eisenstein and Hoch, 2007; Song, 2012).

In general, we believe that the previous literature provides a good start in finding ways to de-bias consumers with their debt and savings decisions, though we are unconvinced that there is sufficient evidence of treatments providing any lasting effects. Therefore, in our experiment we not only measure the immediate effectiveness of each learning method, but we are also interested in evaluating the "stickiness" of the different types of training over time.

Each participant in the experiment received one of six different tutorials (intended to decrease bias in either the savings or debt domain). When setting up the experiment, we applied a symmetric 3 by 2 design for the tutorials (3 types of tutorials in each of the 2 domains) despite our prediction that there would be no evidence of exponential growth bias for our subjects in the savings domain. This was done to allow for symmetric analyses of the tutorial effects if such a bias existed. However, since no bias was found in the savings domain in 95% of the participants in this sample, we can treat those who received a savings tutorial as a control group when analyzing the tutorial effects in the debt domain.[2]

The tutorials used in this experiment are designed to utilize many of the components of the general de-biasing frameworks previously used by Fischhoff (1982) and Keren (1990). In summary, our learning framework seeks to:

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[2] Details of the savings results are presented in Foltice and Langer (2015).

1. Make participants aware of their bias (natural tendency) in their respective learning domain. Hence, each participant receives a "Bias Awareness Statement", which is accompanied by a chart/graph showing how a loan amortizes or how compound savings grows, depending on the domain of the tutorial.

2. Teach participants how to decrease the bias. In this experiment we provide three different types of tutorials (referred to as groups A, B, and C) for each of the two domains, savings and debt. Details of each debt tutorial are discussed in the next section.

3. Evaluate the effectiveness of each tutorial.

   a. First, we would like to observe the immediate bias improvement by giving each participant similar debt questions directly after completing the tutorial.

   b. More importantly, we measure the "stickiness" of the tutorial over time. Thereby, we test the retention of the participants' learning by bringing each individual back into the experimental lab approximately three weeks after the tutorial without a review of the material.

The analysis and subsequent hypothesis testing concentrates solely on the debt domain results, as we have already noted that there is no bias that could be improved on within the savings domain. Before distinguishing between the different types of learnings (groups A, B, and C), we first derive two hypotheses on the general effectiveness of the short tutorials in the debt domain:

**H1 (Immediate effect of debt tutorial on debt questions): After receiving a short tutorial in the debt domain, all three learning groups will show a greater immediate improvement in bias for debt questions than those who received an alternative tutorial in the savings domain (control group).**

**H2 ("Stickiness" of debt tutorials on debt questions over time): After giving subjects similar questions on savings and debt scenarios after approximately three weeks, we**

**expect that all three debt groups will remain less biased than the control group who received a tutorial in the savings domain.**

In the second part of the analysis, we seek to disentangle the debt group tutorials in order to identify the most effective learning tool, both immediately after completing the tutorial and after three weeks. Thus, the final hypotheses are formulated:

**H3 (Comparison of different debt tutorials – immediate effect): In the debt domain, the participants who learned the rules of thumb will show greater immediate improvements in bias compared to those that received the experiential debt questions.**

**H4 (Comparison of different debt tutorials – "stickiness" over time): The experiential learning improvements will stick with the subjects better than those who learned a rule-of-thumb in the debt domain when tested approximately three weeks later.**

This is the first paper, to the best of our knowledge, to test the effectiveness of different "de-biasing" methods over time within the context of exponentially-based household finance decisions. Although we also test the immediate effectiveness on how well each tutorial attenuates the amortization bias, we place more of an emphasis on the "stickiness" of the training methods over time.

### 3. Experimental Setup

**Participants**

This experiment comprised 251 fourth-semester bachelor students (128 males and 123 females) who were enrolled in the mandatory Corporate Finance class for the Bachelor of Science Business program at the University of Muenster in Germany. The ages of the participants range from 19 to 27 with a median age of 23 years. The experiment was conducted in a computer lab

and was fully set up in English, although a German translation of the main questions was also provided.[3]

Rounds 1 and 2 for this experiment were completed in the first appointment in the experimental lab, while round 3 (the participants' second appointment) was conducted three weeks later. We did not tell the participants that they would be tested on the same questions during their second appointment. They were simply told that for the purposes of the experiment, it was very important that they attended both appointments. Table 1 provides a general overview of the experiment.

**Table 1. Experiment overview** - This figure outlines the overall experimental design, by appointment and round activity.

| Appointment 1 (90-120 minutes) | |
|---|---|
| **Round 1** | |
| 8 Savings Questions (4 Prospective/ 4 Retrospective) <br> 8 Debt Questions (4 Mid-Term/ 4 Long-Term) | Random Order |
| **Round 2** | |
| Tutorial | |
| 8 Savings Questions (4 Prospective/ 4 Retrospective)* <br> 8 Debt Questions (4 Mid-Term/ 4 Long-Term)* | Random Order |
| 5 Feedback Questions about the Tutorial | |
| **Appointment 2 (30-45 minutes)** | |
| **Round 3** | |
| 8 Savings Questions (4 Prospective/ 4 Retrospective) <br> 8 Debt Questions (4 Mid-Term/ 4 Long-Term) | Random Order |

* In round 2, all participants first received the eight questions from the domain of their respective tutorial.

**Incentives**

Each participant was given a 15.00€ (~$19.00) show-up fee for the first appointment, which was designed to last 90-120 minutes. Additional variable payouts of 20.00€, 40.00€, and 60.00€ were given to three randomly chosen participants in each session. Each session consisted of 20-

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[3] Since the Corporate Finance course is taught in English, we can safely assume that participants understood the English instructions.

25 participants, who all received the same training. These payouts were determined by the overall average accuracy (absolute error %) of all questions in round 1 and 2, compared to the other chosen participants in the session. Every participant was given an additional base amount of 8.00€ (~$10.00) for coming to the second appointment, which lasted approximately 30-45 minutes. Additional payouts of 15.00€, 25.00€, and 35.00€ were given to three randomly chosen participants in each session, with the payouts also determined by the overall average accuracy (absolute error %) of all questions in round 3, compared to the other chosen participants in the session. The average payout for both appointments was 32.20€ (20.07€ for rounds 1 and 2, 12.13€ for round 3).

**Procedure**

In each of the three rounds, every participant answered a total of sixteen questions, shown in Table 2, consisting of eight debt questions and eight savings questions (screenshots of the experiment and tutorial are shown in Supplement A). The eight debt questions consisted of four mid-term 10-year loans with an initial balance of $20,000, and four long-term 30-year loans with an initial balance of $200,000. A two-by-two matrix, shown in Table 2, was chosen for the mid-term and long-term loans (6% and 10% yearly interest rate with 50% and 75% time remaining on the loan).

For all rounds in this experiment, we allowed the use of non-programmable, scientific calculators (Olympia LCD-8110) in the experimental lab along with a pen and paper. This design decision allows us to separate the conceptual difficulties individuals have with understanding exponential growth from pure computational disabilities that could be overcome through the use of a calculator. We were also able to verify our initial expectation that none of the participants previously knew or could correctly calculate the actual formula for these debt questions.

**Table 2. Debt question vector.** Details of the eight debt questions given to each participant in all three rounds of the experiment.

| Debt Questions (8) | | |
|---|---|---|
| **Mid-Term (4)** | Annual Interest Rate | Time Remaining on Loan (%) |
| Initial 10-year loan of $20,000 | 6% | 75% |
| | 10% | 50% |
| **Long-Term (4)** | Annual Interest Rate | Time Remaining on Loan (%) |
| Initial 30-year loan of $200,000 | 6% | 75% |
| | 10% | 50% |

**Measuring Bias Size**

The question of how to measure bias size is challenging whenever tasks of different types and different parameterizations have to be compared and aggregated. Foltice and Langer (2015) suggest attaching the bias measurement directly to the exponential expression in each formula. They argue for an accumulation function $f_{i,t}(\theta)$ that is not only continuous and monotonic but also calibrated: it should produce the perfect exponential term: $(1+i)^t$ for $\theta = 0$ (no bias), and a linear term: $(1 + t * i)$, which fully neglects compound interest, for $\theta = 1$ (full bias). By fitting a $\theta$ to each given answer, one obtains a bias measure that canonically extends over different tasks and parameterizations. For analyses that combine debt and savings tasks as reflected in formulas (1) and (2), Foltice and Langer (2015) suggest to use the accumulation function $\check{f}_{i,t}(\theta) = (t \cdot i)^{(\theta)} \cdot ((1+i)^t - 1)^{(1-\theta)} + 1$ as it has various desirable properties.

In this paper, we follow this approach and generalize the amortization equation (1) to become

$$B = A \cdot \left[ 1 - \frac{\check{f}_{i,n}(\theta) - 1}{\check{f}_{i,N}(\theta) - 1} \right] \qquad (3)$$

We can write:

$$B = A \cdot \check{g}_{i,n,N}(\theta) \qquad (4)$$

with

$$\breve{g}_{i,n,N}(\theta) = 1 - \frac{\breve{f}_{i,n}(\theta) - 1}{\breve{f}_{i,N}(\theta) - 1} \tag{5}$$

The function $\breve{g}_{i,n,N}(\theta)$ is used to determine the bias size in the amortization scenario as $\theta = \breve{g}_{i,n,N}^{-1}\left(\frac{B}{A}\right)$. It has the same nice calibration properties as $\breve{f}_{i,t}(\theta)$ itself and assigns a bias of 0 to a perfect exponential estimate, i.e.

$$\breve{g}_{i,n,N}^{-1}\left(1 - \frac{(1+i)^n - 1}{(1+i)^N - 1}\right) = 0 \tag{6}$$

and a bias of 1 to a completely naïve debtor who assumes the remaining balance to decrease linearly in time:

$$\breve{g}_{i,n,N}^{-1}\left(1 - \frac{n}{N}\right) = 1 \tag{7}$$

Furthermore, this function $\breve{g}_{i,n,N}(\theta)$ is continuous and monotonic and can assign a bias size $\theta$ to any answer B<A in the debt domain.

**Tutorials**

At the beginning of round 2, each participant received one of six different treatments, outlined in Table 3. Upon completion of the tutorial, each participant answered the same eight debt and savings questions again that they received in round 1. At the end of round 2, each participant filled out a final five-question feedback form on the clarity of the questions and usefulness of the tutorials before concluding their session. Round 3, which was completed approximately three weeks after rounds 1 and 2, comprised the same eight debt and savings questions from the previous two rounds.

**Table 3. Tutorial overview.** Upon completion of round 1, each participant received a short tutorial. Six different tutorials (treatments) for this experiment are outlined below, using three different methods of learning for both the savings and debt domain. In each domain, one tutorial was designed to teach experiential learning, a simple formula, and a more complicated formula.

| Savings Groups | | Debt Groups |
|---|---|---|
| **Savings Group A**<br>8 practice questions with option for 8 additional practice questions | **Experiential Learning** | **Debt Group A**<br>8 practice questions with option for 8 additional practice questions |
| **Savings Group B**<br><br>Rule of 72 | **Simple Rule** | **Debt Group B**<br>Simple "I Owe More" debt balance rule |
| **Savings Group C**<br><br>Compound Savings Equation | **Complex Rule** | **Debt Group C**<br>Extended "I Owe More" debt balance rule |

As previously noted, all participants receiving a debt tutorial were shown an initial "Bias Awareness Statement", pictured below in Figure 1, before commencing their assigned group curriculum. Screenshots of all tutorials are also shown in Supplement A.

**Figure 1. Bias awareness statement.** This introduction page was presented to all participants receiving a debt tutorial before commencing their assigned group curriculum.



**Bias Awareness Statement:**

When you pay off a loan each month, your early repayments are mostly interest with a small amount of principal. As you pay off your loan, this ratio gradually reverses.

The repayment structure for a loan looks like the graph below:

People, in general, fail to recognize this and tend to underestimate their outstanding balance at any given point during the loan.

When you are, for example, halfway through paying off a loan, you still will owe more than 50% of the original balance. How much more you owe depends on the yearly interest rate (APR) and the length of the loan.

After reading the "Bias Awareness Statement", debt group A received a tutorial based on experiential learning. This type of learning allows the participant to test their understanding and

"explore their developing ideas through interaction with their environment" (Kolb, 1984; Galligan, 1995; Gregory, 2002; Johnson and Sherraden, 2007). Each participant in this group was given the below instructions:

> *"Please take the next five minutes to complete the following 8 loan questions. Carefully read the question, type in your best estimate and click "submit."*
>
> *The correct answer will appear. You will also be able to see how much you under/overestimated.*
>
> *As you go through the questions, try to notice how much the interest rates and length of the loan affects the remaining amount of the initial loan balance.*
>
> *Upon completion, you will be given the option to either choose 8 more practice questions or to continue with the experiment."*

Debt group B received a short tutorial that "shows you a simple way to accurately estimate the remaining balance at any point (beginning, middle and end) of repaying a loan." This group learned what we call the simple "I Owe More" debt balance rule-of-thumb. This rule derives its estimate by starting from the naive linear estimate for the remaining balance $B = A \cdot \left[\frac{N-n}{N}\right]$ and adjusts the estimate upwards by adding the yearly interest rate to make it:

$$B = A \cdot \left[\frac{N-n}{N} + i\right] \tag{8}$$

For example, if you are paying a 12% yearly interest rate, this rule suggests that you will owe approximately 62% of the original balance when you are halfway through paying down a loan (50% + 12%).

Similar to the savings Rule of 72, which provides estimates within ±10% the correct answer up to a 32-year investment period and up to a 13% yearly interest rate, the simple "I Owe More"

rule estimates the correct answer within approximately ±10% (on a relative basis) for loans of 5 to 30 years with a yearly interest rate up to approximately 18% for a loan with 75% time remaining.[4] The accuracy is less dependable for loans with half of the balance remaining. Nevertheless, the rule can still generate an estimate within ±20% for loans up to 20 years with yearly interest rates up to 9%. See Appendix 1 for more accuracy details on this rule-of-thumb.

Finally, debt group C received a longer and more complicated, but more accurate, version of the prior equation learned by debt group B. This extended "I Owe More" rule adds an additional time factor (of 10 years or 120 months) to the simple equation learned by debt group B. This results in:

$$B = A \cdot \left[ \frac{N-n}{N} + \left(i \cdot \frac{N}{10}\right) \right] \qquad (9)$$

Using this equation, someone with a 20-year loan with a 12% yearly interest rate, will still owe approximately 74% of the initial balance when he is halfway through paying off the loan. The accuracy of this extended "I Owe More" rule, shown in detail in Appendix 2, is accurate within 10% of the correct answer for loans up to 30 years with interest rates up to 20% for any remaining balance percentage.

After a short explanation of the equation, each participant in debt group B and C completed two examples followed by two practice questions, which displayed the correct answer and the full calculations after each question was answered.[5] The full details of the tutorial question set up are provided in Appendix 3.

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[4] The Rule of 72 is a method used to estimate how long it takes for an investment to double, by taking "72" and dividing it by the interest rate (typically annual interest). For example, an investment earning 9% annually would double every 8 years.

[5] We used a slightly different matrix for the tutorial questions, which were 15 year, mid-term loans with an initial balance of $10,000, and 25-year loans long-term loans with an initial balance of $100,000. We used different interest rates (4% and 12%) and remaining times on the loan (20%, 40%, 60%, and 80%) in the tutorials in order to ensure participants were not seeing the exact same questions, and the subsequent answers, in the testing phase.

## 4. Round 1 (Pre-Tutorial) Results

Before examining the results of round 1, we must eliminate the answers that are out of the possible range for the remaining balance of a loan. Such answers, deemed as "invalid" or "insensible", include amounts greater than the initial balance of the loan or any amount less than $0. Participants are completely removed from the dataset for having three or less "valid" answers in any of the three debt rounds. This filter is applied in order to obtain valid individual improvements for all stages in this analysis. Unfortunately, many participants in this sample succumbed to using a variation of the compound savings formula in this domain in one or more of the rounds, yielding answers far greater than the initial balance. Thereby, a large number of participants (109) are eliminated from the sample, our analysis is restricted to about 57% (142 out of the 251) of all participants. We henceforth analyze the "valid" answers for the remaining participants in all stages.

**Table 4. Individual results summary, sorted by group.** Individual results are recorded as the median $\theta$ for all relevant answers for each participant. Each participant is required to provide at least three relevant answers in each of the three rounds to be counted in the data set. $\theta=1$ is equal to the naive (linear) bias and a $\theta>1$ underestimates the linear estimate.

| Group | N | Median $\theta$ | Min | Max | $\theta>0$ (%) | $\theta=1$ (%) | $\theta>1$ (%) |
|---|---|---|---|---|---|---|---|
| All Participants | 142 | 0.90*** | -1.51 | 2.15 | 81.0% | 21.1% | 23.9% |
| All Savings Groups | 64 | 0.88*** | -0.69 | 2.21 | 81.3% | 21.9% | 23.4% |
| All Debt Groups | 78 | 0.91*** | -1.51 | 2.13 | 80.8% | 20.5% | 24.4% |
| Debt Group A (Experiential) | 24 | 1.00*** | -0.48 | 2.05 | 91.7% | 29.2% | 33.3% |
| Debt Group B (Simple Rule) | 30 | 0.75*** | -1.51 | 2.13 | 73.3% | 16.7% | 20.0% |
| Debt Group C (Extended Rule) | 24 | 0.90*** | -1.34 | 2.10 | 79.2% | 16.7% | 20.8% |

At the individual level in round 1 before the tutorials, we calculate the median $\theta$ for all relevant answers provided by each participant and find results, as depicted in Table 4. Each learning group possesses a statistically significant amortization bias in round 1, with a median $\theta$ of 0.88 (0.91) for the savings (debt) groups.

**5. Debt Tutorial Feedback and Round 2 and 3 (Post-Tutorial) Results**

**Descriptive Statistics of the Debt Tutorials**

Before the round 2 and 3 results are presented, the descriptive statistics for each of the debt tutorials, shown in Table 5, are discussed. It appears that our intention to provide a 10-minute tutorial was generally successful, with the mean (median) completion time for each tutorial lasting approximately 10.39 (9.27) minutes.

**Table 5. Individual debt tutorial overview.** Descriptive statistics for the 78 debt tutorial participants included in the analyzed dataset.

| Group | N | Mean (Med.) Completion Time (in min.) | FQ3 Mean (Median) | FQ5 Mean (Median) |
|---|---|---|---|---|
| Debt Group A (Experiential) | 24 | 13.55 (11.30) | 3.42 (4.00) | 3.08 (3.00) |
| Debt Groups B & C (Rule) | 54 | 8.98 (8.50) | 4.35 (5.00) | 4.20 (4.00) |
| **Difference** | | | **0.94\*\*\*** | **1.12\*\*\*** |
| Debt Group B (Simple Rule) | 30 | 6.35 (6.05) | 4.67 (5.00) | 4.30 (5.00) |
| Debt Group C (Extended Rule) | 24 | 12.28 (11.58) | 3.96 (4.00) | 4.08 (4.00) |
| **All Debt Groups** | 78 | 10.39 (9.27) | 4.06 (4.00) | 3.86 (4.00) |

FQ3: Final Question #3 - The Tutorial was easy to understand
FQ5:  Final Question #5:  After the tutorial, the debt questions were easier to estimate.
Scale Used for Final Questions: 1. Strongly Disagree, 2. Disagree, 3. Neither Agree or Disagree, 4. Agree, 5. Strongly Agree

After the experiment, when we asked if "the tutorial was easy to understand," participants learning the simple rule of thumb in debt group B agreed the strongest, with an average reply of 4.67 out of 5 (median 5). Moreover, the debt group B participants strongly agreed that, "after the tutorial, the debt questions were easier to estimate" with an average answer of 4.30 (median 5). Conversely, the experiential learning debt group A was the least satisfied group in both questions, giving an average indifferent answer of 3.08 (median 3) on the question asking if the tutorial made the debt questions easier to answer.[6] Interestingly, when we compare the

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[6] We use a five-point scale for each of the final questions: 1. Strongly Disagree, 2. Disagree, 3. Neither Agree nor Disagree, 4. Agree, 5. Strongly Agree.

differences of the feedback responses between the experiential group and the two rule-of-thumb groups, the "rule" groups are significantly more satisfied in both questions.

**Debt vs. Savings Group Results in Rounds 2 and 3**

For the hypothesis testing, we measure individual improvement as the difference in the absolute median θ for each participant in round 1 compared to their absolute median θ in round 2. Whereby, an individual with a median θ of 1.00 (naive biased) in round 1 and a median θ of -1.00 (reverse biased) in round 2 would not be recorded as an improvement of 2.00, but rather display no improvement (0.00) between rounds. In Table 6, we find individual θ improvements across all debt learning groups at the participant level (median of 0.57), while the control (savings) group showed no improvement from round 1 to round 2 (median of 0.00). For **H1**, we can reject the null hypothesis with a confidence level of 99% and conclude that the three groups receiving a debt tutorial showed a significantly greater immediate θ improvement (0.57 compared to 0.00) than the control group that received a tutorial in the savings domain.

While these results demonstrate the immediate effectiveness of the tutorials, bringing each participant back three weeks later to test the retention of their 10-minute tutorial renders slightly different conclusions. After this short time, we find that the median individual θ improvement for all debt groups from round 1 to 3 is 0.17, shown in Table 6. When we compare this improvement to the improvement of the savings group (0.00) over this three week period, we can again reject the null hypothesis for **H2** at the 90% confidence level. This significant difference in improvement provides some evidence that these 10-minute tutorials can provide some stickiness over time. However, we cannot ignore that after just three weeks, the initial θ improvement of these groups decreases by over 70%, from a median improvement of 0.57 down to 0.17.

**Table 6. Improvement summary by round and hypothesis testing at the individual level.** Median improvements in individual median θ, from round 1 to 2 and round 1 to 3. θ improvement indicates that a participants median estimate was closer to 0 (unbiased) in the evaluated stage than in round 1. For the hypothesis testing, a Wilcoxon Rank-sum test was used to analyze the differences in individual improvement for both the debt and control (savings) groups from round 1 to 2 (**H1**) and from round 1 to 3 (**H2**).

| Group | N | Median θ Improvement | Improvement > 0 (% of Participants) |
|---|---|---|---|
| **Round 2 from Round 1- Change** | | | |
| Savings Group | 64 | 0.00 | 39.7% |
| All Debt Groups | 78 | 0.57*** | 79.5% |
| **Difference - Hypothesis 1** | | **0.57*** | |
| **Round 3 from Round 1- Change** | | | |
| Savings Group | 64 | 0.00 | 50.0% |
| All Debt Groups | 78 | 0.17*** | 64.1% |
| **Difference - Hypothesis 2** | | **0.17*** | |

Statistical significance of Wilcoxon signed-rank test - * 90%; ** 95%; *** 99%
Statistical significance of differences using the Wilcoxon rank-sum test - * 90%; ** 95%; *** 99%

When we evaluate the retention of the formulas learned in the "rule" tutorials in Table 7, we find that these participants correctly answered, on average, 7.30 out of the 8 questions in round two, based on their respective tutorial learning.[7] This demonstrates that a majority of the subjects in these groups took the time to learn the material and were able to immediate apply their short learning.[8] However, after three weeks, the average number of correct answers is significantly reduced by more than half, down to 3.56 of 8 questions in round 3. These findings show how quickly a. individuals, even numerically-minded, forget a simple learning heuristic over a short period of time and b. an additional step in a simple rule heuristic (even if it's linear) can dramatically reduce its correct application over time. This also confirms our decision not to use the actual amortization formula (equation 1) in the tutorial design for debt group C, as

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[7] Similar results were seen when analyzing all participants, including those who were eliminated from the data set.
[8] We can't rule out that some of the participants may have jotted down the equation on their scrap paper during their tutorial. Writing down the equation wasn't explicitly prohibited in the experiment, though the experimenter in the computer lab didn't observe this as a common offense.

we believe that it would have been too complicated to be retained over time after only a 10-minute tutorial.

**Table 7. Debt tutorial rule retention overview, by round.**

| Group | Average # Correct Answers* (out of 8) | | | % Participants with 7 or more (of 8) Correct Answers | |
|---|---|---|---|---|---|
| | **Rd. 2** | **Rd. 3** | **Difference** | **Rd. 2** | **Rd. 3** |
| Debt Groups B&C (Rule) | 7.30 | 3.56 | 3.74*** | 87.0% | 35.2% |
| Debt Group B (Simple Rule) | 7.50 | 4.70 | 2.80*** | 93.3% | 50.0% |
| Debt Group C (Extended Rule) | 7.04 | 2.13 | 4.92*** | 79.2% | 16.7% |

\* Correct Answers meant the answers given in rounds 2 and 3 were consistent with their respective tutorial learning.
A two-pair t-test compares the differences of correct answers, by round. \* 90%; \*\* 95%; \*\*\* 99%

It is worth noting that if each of the eight debt questions were to be properly calculated using the learned formulas in debt groups B and C, the simple rule learned by group B delivers a median $\theta$ of 0.42, while the extended rule learned by group C, if calculated correctly provides a median $\theta$ of 0.08. Incidentally, these are the individual medians for each group in round 2. These imperfect $\theta$'s leave potential for larger improvements for these two groups, where a tutorial teaching a more accurate formula could increase improvements for these groups more than our results in the upcoming section indicate. However, based on the complexity of this decision, these were the most accurate rules-of-thumb that we could come up with.

**Rules vs. Experience Results in Rounds 2 and 3**

Here, we compare the differences of improvement between the experiential group and the two rules-of-thumb groups. In Table 8, both groups learning a debt rule (B and C) showed a smaller immediate $\theta$ improvement in round 2, 0.54, than the experiential group (0.60). Therefore, when we test **H3**, the difference of improvement of groups B and C against the experiential learning group A, using a Wilcoxon rank-sum test, we cannot reject the null hypothesis at any significance level.

**Table 8. Median θ improvement summary, by round at the individual level.** A Wilcoxon signed-rank test is used for the statistical significance of improvement for each learning group. For the hypothesis testing (H3 and H4), a Wilcoxon rank-sum test analyzes the differences in individual θ improvements between the experiential debt group (A) and the two debt groups learning a rule-of-thumb (groups B and C). The immediate learning improvement, rounds 1 to 2 test H3 and the "stickiness" of learning is tested in H4, from round 1 to 3. θ improvement indicates the individuals absolute θ improvement in the evaluated round compared to round 1. The "Perfect θ" shows the absolute θ improvement in bias when an unbiased θ of 0.00 is assigned for each correct calculation, per each individuals assigned tutorial.

**Difference/ Improvement for each group**

| Round 2 from Round 1- Change | N | abs Median θ | >0 (% of participants) | Perfect θ |
|---|---|---|---|---|
| Debt Group A | 24 | 0.60*** | 75.0% | 0.60*** |
| Rule Groups B+C | 54 | 0.54*** | 81.4% | 0.75*** |
| Debt Group B | 30 | 0.33*** | 80.0% | 0.72*** |
| Debt Group C | 24 | 0.83*** | 83.3% | 0.85*** |
| **Hypothesis 3** | | **0.06** | | **-0.15** |
| Both Debt Rule Groups vs. Experiential | | | | |

| Round 3 from Round 1 - Change | N | abs Median θ | >0 (% of participants) | Perfect θ |
|---|---|---|---|---|
| Debt Group A | 24 | 0.24*** | 83.3% | 0.24*** |
| Rule Groups B+C | 54 | 0.10* | 55.6% | 0.28*** |
| Debt Group B | 30 | 0.08 | 50.0% | 0.19** |
| Debt Group C | 24 | 0.12 | 62.5% | 0.29 |
| **Hypothesis 4** | | **0.14*** | | **-0.04** |
| Both Debt Rule Groups vs. Experiential | | | | |

Statistical significance of Wilcoxon signed-rank test - * 90%; ** 95%; *** 99%
Statistical significance of differences using the Wilcoxon rank-sum test - * 90%; ** 95%; *** 99%

Also depicted in Table 8, 83.3% participants in debt group A retain a positive θ improvement in round 3, although their group median improvement decreases 60% from 0.60 to 0.24 in three weeks. Furthermore, the formula groups B and C reduce their individual θ improvements down to a median of 0.10, giving back 81.5% of the improvement in only three weeks. Only 55.6% of the participants in these groups post an improvement after three weeks. When comparing the differences in median improvements round 1 to 3, debt group A exhibits a greater median θ improvement (0.14) over the two groups that learned a rule-of-thumb in their tutorial. We can reject the null hypothesis for **H4** at the 95% confidence level and find evidence that experiential learning held its stickiness over time better than the rule-of-thumb learning. Finally, as a

robustness check for the strength of the results, we assign a perfect, unbiased $\theta$ of 0.00 for each answer in rounds 2 and 3 that correctly applies the formula learned in a respective "rule" tutorial. Here, we find that the results do not significantly alter the results for the differences in immediate improvement (**H3**). However, after applying a perfect $\theta$, the differences of improvement between the experiential and rule learning groups over time become comparable, slightly in favor of the rule learning groups, but with no statistical significance.

## 6. Discussion and Conclusion

This paper tests the effectiveness of de-biasing the participants through the use of three various tutorials, based on three different types of learning: experiential learning (group A), learning a simple rule-of-thumb (group B), as well as learning a more complex, but more accurate, rule-of-thumb (group C). After receiving a short tutorial in the debt domain, we find that all debt tutorials are successful in significantly decreasing the amortization bias immediately following the learning. More importantly, when estimating similar debt scenarios approximately three weeks later, the three groups that received a debt tutorial maintain a significant improvement. These findings suggest that a short, 10-minute tutorial can "stick" over time. On the other hand, many participants in groups B and C that received a "rule-of-thumb" debt tutorial forgot their previously learned heuristic and reverted back to their biased answers. Individuals in these groups gave back 81.5% of their initial individual $\theta$ improvement in only three weeks. The experiential learning group A also decreased their initial improvement in this same time frame (by 60%), though 83.3% individuals maintained an improvement in bias. The effective application immediately following the tutorial and quick deterioration of the learning over only three weeks offers support to the idea of "just-in-time" learning, proposed by Fernandes, Lynch and Netemeyer (2014), where a short tutorial, regardless of the learning method, may be best suited for making more accurate financial decisions on an "as needed" basis.

When we compare the within-group "stickiness" of each learning method over this three week period, we find that the experiential learning debt group (A) maintains a significantly stronger bias improvement compared to the two groups (B and C) who learned a rule-of-thumb. This paper provides some evidence that experiential learning can provide an efficient, low-cost method that maintains its retention over time more effectively than learning a simple "rule-of-thumb" or a more formal equation. While we don't believe that a simpler and less biased heuristics exist in the debt-based question taught in the debt tutorials, we are cognizant that the results can be driven by the imperfect answers provided by the formulas. In our robustness check, the within-group differences vanish if the formulas could produce an unbiased estimate.

We believe that these results add complexity to the overall research question that addresses the appropriate ways to decrease the exponential growth bias in household finance savings and debt questions. Future research may need to differentiate between questions that are simple and potentially broad in application that could be accurately retained over time, such as the simple savings questions analyzed in Foltice and Langer (2015), and the more complex questions like the debt question evaluated in this paper. In future experiments, we would also like to test the effects of the "Bias Awareness Statement" in isolation, i.e. without any additional following information, in order to determine if simply being aware of the bias is enough to significantly reduce this bias over time.

Moreover, we only provided a 10-minute tutorial to each participant in this experiment. It's possible that a more rigorous and comprehensive learning would have yielded different results over time. However, we find it unrealistic to learn and memorize every possible household finance formula in hopes that it will be retained over a number of years, when it will be applicable to an individual's personal situation. We also believe that personal learning preferences play a role in determining the most effective method of learning for each individual. It is interesting to note that while the experiential debt group A maintained a larger

improvement compared to debt groups B and C, this group gave significantly worse feedback when asked at the end of the experiment if they felt that, "after the tutorial, the debt questions were easier to estimate." We do not know if this feedback was attributed to the general preferences of the participants in this experiment, or if individuals generally feel more confident learning more defined rules or equations, even if they don't yield perfect answers. Further examination that elicits personal learning preferences and measures learning improvement over a longer time period between the testing stages is required in order to provide stronger evidence of the long-term learning effects of the various training methods.

**Appendix 1. Accuracy of the simple "I Owe More" debt balance rule learned by debt group B.** We calculate the average error percentage of the rule compared to the actual answer for various loan lengths and interest rates. Formally, we use: Remaining loan balance = ((remaining payments/ total payments) + interest rate) * initial loan amount.
% error is calculated as: (estimated % remaining on loan generated by rule / actual % remaining on loan) -1
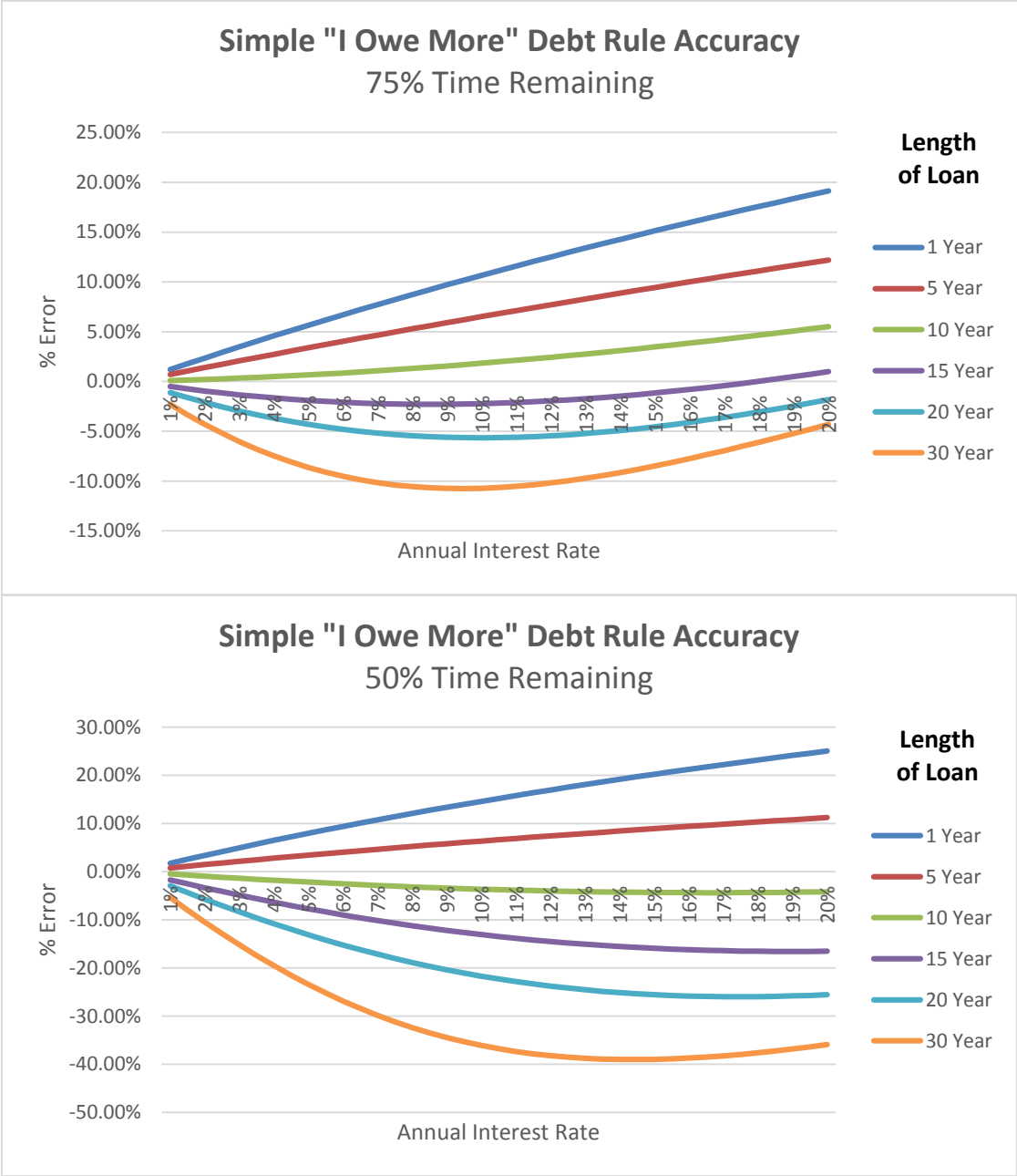
**Appendix 2. Accuracy of the extended "I Owe More" debt balance rule learned by debt group C.** We calculate the average error percentage of the rule compared to the actual answer for various loan lengths and interest rates. Formally, we use: Remaining loan balance = ((remaining payments/ total payments) + (interest rate * total payments / 120)) * initial loan amount

% error is calculated as: (estimated % remaining on loan generated by rule / actual % remaining on loan) -1
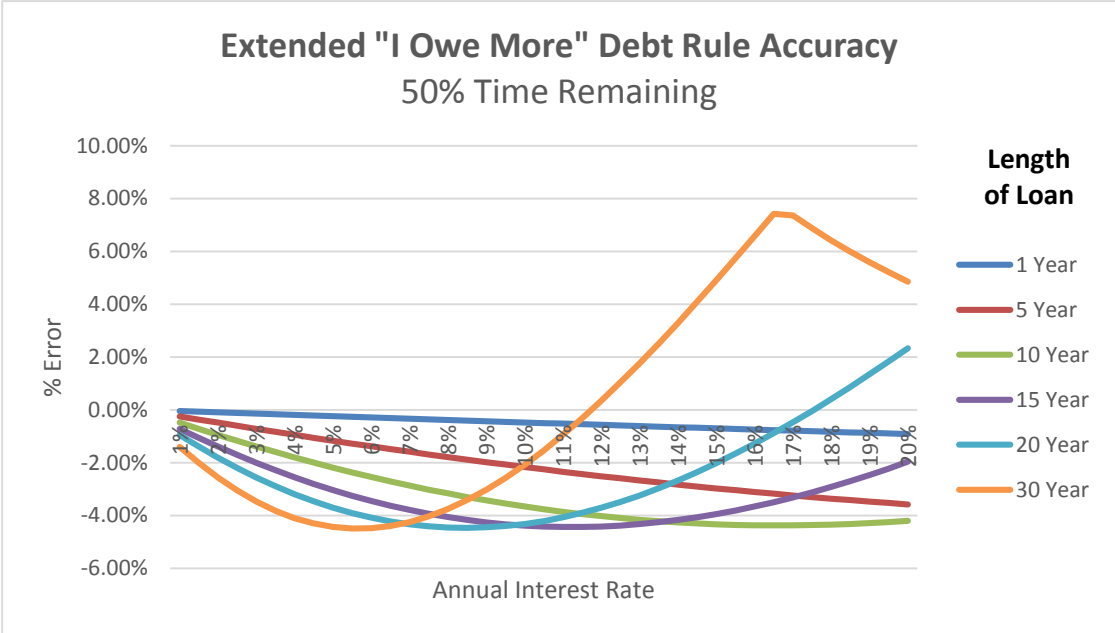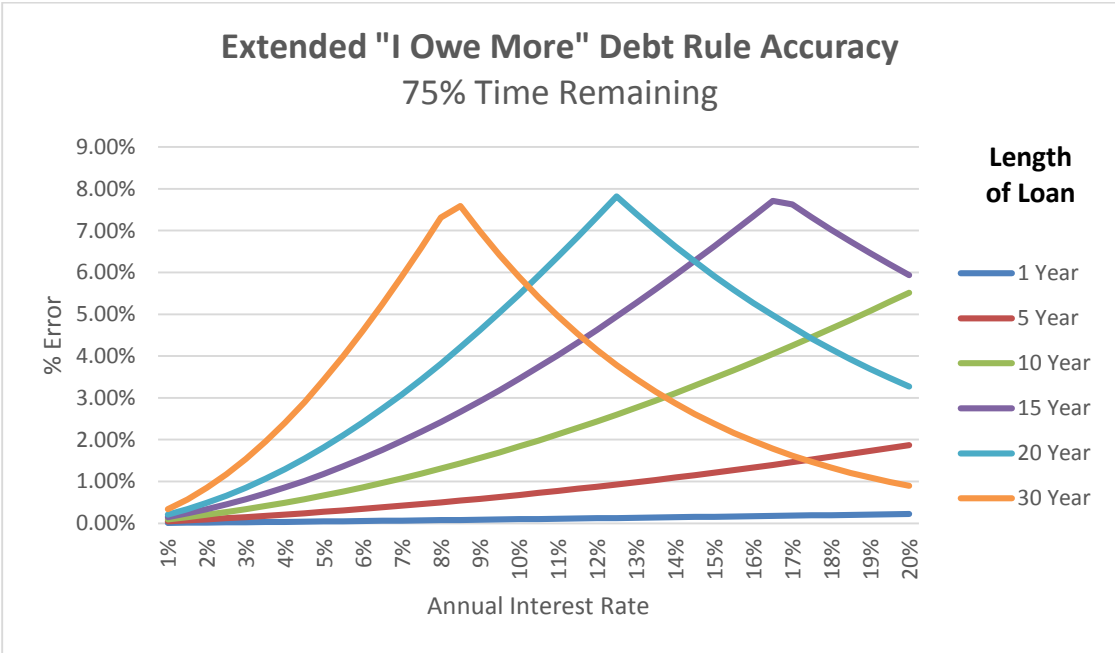
**Appendix 3. Debt Tutorial Details**

| Bias Awareness Statement (All Debt Tutorial Participants) |
|:---:|

| Debt Group A | | |
|:---:|:---:|:---:|
| **Mandatory Practice Questions (8)** | | |
| Mid Term (4) | Yearly Interest Rate | Time Remaining on Loan (%) |
| Initial 15 year loan of $10,000 | 4% | 80% |
| | 12% | 20% |
| Long Term (4) | Yearly Interest Rate | Time Remaining on Loan (%) |
| Initial 25 year loan of $100,000 | 4% | 60% |
| | 12% | 40% |
| **Optional Additional Practice Questions (8)** | | |
| Mid Term (4) | Yearly Interest Rate | Time Remaining on Loan (%) |
| Initial 15 year loan of $10,000 | 4% | 60% |
| | 12% | 40% |
| Long Term (4) | Yearly Interest Rate | Time Remaining on Loan (%) |
| Initial 25 year loan of $100,000 | 4% | 80% |
| | 12% | 20% |

| Debt Group B | | | |
|:---:|:---:|:---:|:---:|
| **Introduction to the Simple 'I Owe More' debt rule** | | | |
| **2 Examples with feedback** | | | |
| Loan (in years) | Initial Amount | Yearly Interest Rate | Time Remaining on Loan (%) |
| 15 | $10,000 | 12% | 80% |
| 25 | $100,000 | 4% | 40% |
| **2 Practice Questions with feedback** | | | |
| Loan (in years) | Initial Amount | Yearly Interest Rate | Time Remaining on Loan (%) |
| 15 | $10,000 | 4% | 20% |
| 25 | $100,000 | 12% | 60% |

| Debt Group C | | | |
|:---:|:---:|:---:|:---:|
| **Introduction to the Extended 'I Owe More' debt rule** | | | |
| **2 Examples with feedback** | | | |
| Loan (in years) | Initial Amount | Yearly Interest Rate | Time Remaining on Loan (%) |
| 15 | $10,000 | 12% | 80% |
| 25 | $100,000 | 4% | 40% |
| **2 Practice Questions with feedback** | | | |
| Loan (in years) | Initial Amount | Yearly Interest Rate | Time Remaining on Loan (%) |
| 15 | $10,000 | 4% | 20% |
| 25 | $100,000 | 12% | 60% |

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# Supplement A. Full Experiment Information

## Experiment Introduction and Instructions

# Experiment Introduction and Instructions (continued)

**Experiment - Stages 1 & 2**

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**Incentives**

Today, each participant will be given a base amount of €15 for completing Stages 1 and 2.

An additional variable amount will be paid out to 3 randomly chosen participants from each session (i.e. the people sitting in this room) with payouts consisting of €20.00, €40.00 and €60.00. The variable payout will depend on the overall average accuracy of your answers/estimates in both stages, if chosen, compared to other chosen participants in this session.

The overall payout range today will be €15 to €75, with an average approximate €20 payout for each participant.

For your second Appointment (Stage 3), you will be given an additional base fee as well as possible additional variable payouts for completing the final Stage.

For the purposes of this experiment, it is essential that you show up for your second appointment.

Back          Continue

---

**Experiment - Stages 1 & 2**

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---

Please follow the provided instructions and give your best estimate when necessary.

You may answer each question in whole numbers, for example $51000, or in 2 decimal points, for example $51000.34. You are not required to use a decimal point in your answers, but if you do, please use a '.' Instead of a ','

You may use a calculator, pencil/pen, and paper, which will be provided by the experimenter.

Please note: There is no 'back' button for this experiment. When you click 'continue', you can't go back.

Continue

**Introduction/Incentives and Instructions (text)**

*Introduction – Stages One and Two*

Welcome to Stages 1 and 2 of this experiment.

This experiment consists of 3 Stages. Stages 1 and 2 will be completed today and Stage 3 will be completed at a later date. It will take approximately 2 hours to complete Stages 1 and 2, about an hour for each Stage. Stage 3 will take approximately 45 minutes to complete.

Please follow the provided instructions and give your best estimate/guess when necessary.

You may use a calculator, pencil/pen, and paper, which will be provided by the experimenter.

Thank you for participating in this experiment. Your assistance is greatly appreciated.


*Incentives - Stages one and two*

Today, each participant will be given a base amount of €15 for completing Stages 1 and 2.

An additional variable amount will be paid out to 3 randomly chosen participants from each session (i.e. the people sitting in this room) with payouts consisting of €20.00, €40.00 and €60.00. The variable payout will depend on the overall average accuracy of your answers/estimates in both stages, if chosen, compared to other chosen participants in this session.

The overall payout range today will be €15 to €75, with an average approximate €20 payout for each participant.

For your second Appointment (Stage 3), you will be given an additional base fee as well as possible additional variable payouts for completing the final Stage.

For the purposes of this experiment, it is essential that you show up for your second appointment.


*Introduction – Stage Three*

Welcome to Stage 3 of this experiment.

This stage consists of 20 decisions and 5 financial questions and will take approximately 45 minutes to complete.

Thank you for participating in this experiment.

*Incentives – Stage Three*

Today, each participant will be given a base amount of €8 for completing Stage 3.

An additional variable amount will be paid out to 3 randomly chosen participants from each session (i.e. the people sitting in this room) with payouts consisting of €15.00, €25.00 and €35.00. The variable payout will depend on the overall average accuracy of your answers/estimates in this stage, if chosen, compared to other chosen participants in the session.

The overall payout range will be €8 to €43, with an average of an approximate €12 payout for each participant.

*Final Instructions* – *All Stages (1-3)*

Please follow the provided instructions and give your best estimate when necessary.
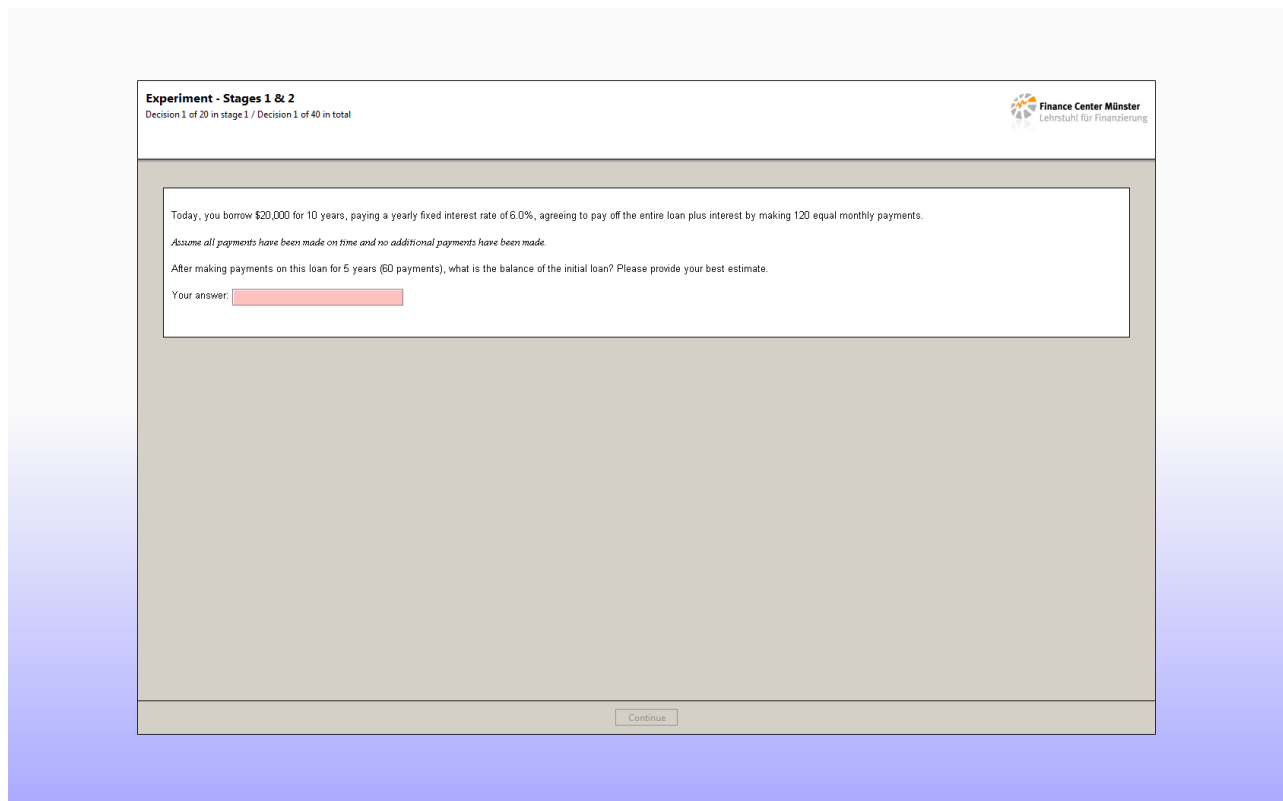
You may answer each question in whole numbers, for example $51000, or in 2 decimal points, for example $51000.34. You are not required to use a decimal point in your answers, but if you do, please use a '.' Instead of a ','

You may use a calculator, pencil/pen, and paper, which will be provided by the experimenter.

Please note: There is no 'back' button for this experiment. When you click 'continue', you can't go back.

Click 'continue' to begin the next/final stage.

## Experiment Debt Question Format

Today, you borrow $20,000 for 10 years, paying a yearly fixed interest rate of 6.0%, agreeing to pay off the entire loan plus interest by making 120 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 5 years (60 payments), what is the balance of the initial loan? Please provide your best estimate.

Your answer:

Continue

## Text

Today, you borrow $_____$ for $\_\_\_\_$ years, paying a yearly fixed interest rate of $\_\_\_\_\_$%, agreeing to pay off the entire loan plus interest by making $\_\_\_\_\_$ equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

**After making payments on this loan for $_____$ years ($\_\_\_$ payments), what is the remaining balance of the initial loan? Please provide your best estimate.**

**Savings Question Format (Prospective)**

You currently have a balance of $10,000 in your account. You leave this money in your savings account for 36 years at a constant annual interest rate of 12%.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.

Based on the above information, estimate your total account balance after 36 years. Please provide your best estimate.

Your answer:

Continue

You currently have a balance of $10,000 in your account. You leave this money in your savings account for __ years at a constant annual interest rate of _**%**.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.

*Based on the above information, estimate your total account balance after __ years. Please provide your best estimate.*

## Savings Question Format (Retrospective)

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Your goal is to have $100,000 in your savings account 36 years from today. Today, you will invest an initial amount of money in your savings account for 36 years at a constant interest rate of 12% per year.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.

How much do you need to invest today in order to reach your savings goal in 36 years?

Your answer:

Continue

> Your goal is to have $100,000 in your savings account __ years from today. Today, you will invest an initial amount of money in your savings account for __ years at a constant interest rate of **_%** per year.

Assume no additional deposits or withdrawals. Interest is compounded annually and reinvested into the account.

*How much do you need to invest today in order to reach your savings goal in* __ **years***? Please provide your best estimate.*

# Information and Conclusion

# Information and Conclusion (continued)

# Tutorial – Debt Group A (Experiential Learning)



Text:

## Learning Phase:

Please take the next five minutes to complete the following 8 loan questions.  Carefully read the question, type in your best estimate and click 'submit.'

The correct answer will appear.  You will also be able to see how much you under/overestimated.

As you go through the questions, try to notice how much the interest rates and length of the loan affects the remaining amount of the initial loan balance.

Upon completion, you will be given the option to either choose 8 more practice questions or to continue with the experiment.

# Tutorial – Debt Group A (Experiential Learning) - continued

**Experiment - Stages 1 & 2**
Stage 2 Training - Practice Question 5 of 8

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Today, you borrow $100,000 for 25 years, paying a yearly fixed interest rate of 4.0%, agreeing to pay off the entire loan plus interest by making 300 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 5 years (60 payments), what is the balance of the initial loan? Please provide your best estimate.

Your answer: 80000

Continue

---

**Experiment - Stages 1 & 2**

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Today, you borrow $100,000 for 25 years, paying a yearly fixed interest rate of 4.0%, agreeing to pay off the entire loan plus interest by making 300 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 5 years (60 payments), what is the balance of the initial loan? Please provide your best estimate.

 **Result:**

Your answer: $80,000.00

The correct answer is $87,104.62.

You underestimated by $7,104.62 or 8.16%.

Continue

# Tutorial – Debt Group A (Experiential Learning) - continued

**Experiment - Stages 1 & 2**

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You now have the choice to either attempt 8 more practice questions or continue with the experiment.

○ I want more training
○ Continue with experiment

Continue

# Tutorial  Completion – All Groups

**Experiment - Stages 1 & 2**

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Your training is complete. You will now be directed to make your best estimate on the same 14 savings and debt questions you received in Stage 1.

Good Luck.

Click on 'Continue' when you are ready.

Back          Continue

## Tutorial – Debt Group B (Simple Rule Learning)



## Learning the 'I Owe More' – Debt Balance Rule:

This short tutorial will show you a simple way to accurately estimate the remaining balance at any point (beginning, middle and end) of repaying a loan.

- The 'I Owe More' Debt Balance Rule adds the yearly interest rate on the loan to appropriately adjust the remaining balance estimate upward. For example, if you are paying a 12% yearly interest rate, you will owe approximately 62% of the original balance when you are halfway through paying down a loan (50% + 12%).

Regardless of how much time remains on the loan, you can accurately estimate the remaining balance by adding the yearly interest rate to the percentage of time remaining on the loan.

Let's say, if you have 3 years/36 months remaining on a 15 year/180 month, $10,000 loan (20% remaining) with a 12% interest rate, you will have approximately 32% of the original balance (20% + 12% = 32%) as your remaining balance on the loan.

Finally, you take the remaining balance, in our example 32%, and multiply it by the initial loan amount ($10,000) to get your estimate of $3,200.

The equation for the 'I Owe More' Debt Balance Rule looks like:

Remaining Loan Balance = ((remaining payments / total payments) + interest rate) * Initial Loan Amount

Step 1 – Calculate Time Remaining (as a %) of overall loan

Step 2– Add the Yearly Interest Rate to Step 1 Result

Step 3 – Multiply Step 2 result * Initial Loan Amount

Let's look at a couple of examples to see how this equation works.

# Tutorial – Debt Group B (Simple Rule Learning)- continued

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Today, you borrow $10,000 for 10 years, paying a yearly fixed interest rate of 4.0%, agreeing to pay off the entire loan plus interest by making 120 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 8 years (96 payments), what is the balance of the initial loan? Please provide your best estimate.

**Result:**

Your answer: $2,400.00. Correct!

Correct answer: $2,400.00.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (120-96) /120 = 20.0%

**Step 2 - Add the Yearly Interest Rate to Step 1**

Step 1 Result (20%) + yearly interest rate (4%) = 24%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

Multiply percentage by Initial Loan Balance; $10,000 * 24% = $2,400.00

Continue

---

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Today, you borrow $100,000 for 20 years, paying a yearly fixed interest rate of 12.0%, agreeing to pay off the entire loan plus interest by making 240 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 8 years (96 payments), what is the balance of the initial loan? Please provide your best estimate.

**Result:**

Your answer: $72,000.00. Correct!

Correct answer: $72,000.00.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (240-96) /240 = 60.0%

**Step 2 - Add the Yearly Interest Rate to Step 1**

Step 1 Result (60%) + yearly interest rate (12%) = 72%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

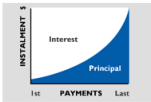Multiply percentage by Initial Loan Balance; $100,000 * 72% = $72,000.00

Continue

# Tutorial – Debt Group C (Extended Rule Learning)

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**Bias Awareness Statement:**

When you pay off a loan each month, your early repayments are mostly interest with a small amount of principal. As you pay off your loan, this ratio gradually reverses. The repayment structure for a loan looks like the graph below:



People, in general, fail to recognize this and tend to underestimate their outstanding balance at any given point during the loan. When you are, for example, halfway through paying off a loan, you still will owe more than 50% of the original balance. How much more you owe depends on the yearly interest rate (APR) and the length of the loan.

**Learning the "I Owe More" - Debt Balance Rule:**

This short tutorial will show you a simple way to accurately estimate the remaining balance at any point (beginning, middle and end) of repaying a loan.

The "I Owe More" Debt Balance Rule adds the yearly interest rate on the loan multiplied by a time factor to appropriately adjust the remaining balance estimate upward. The "I Owe More" time factor is simply the overall length of the loan (in years) divided by 10.

For example, if you are halfway through paying a 20 year loan with a 12% yearly interest rate, you will still owe approximately 74% of the original balance when you are halfway through paying off a loan. The calculation would look like, 50% remaining time + (12% interest rate* 2 time factor) = 74%.

Regardless of how much time remains on the loan, you can accurately estimate the remaining balance by adding the (yearly interest rate * the time factor) to the percentage of time remaining on the loan.

Let's say, if you have 1 year (12 months) remaining on a 5 year (60 month), $10,000 loan (20% time remaining) with a 12% interest rate, you will have approximately 27.6% of the original balance; (12% * .6) + 20% = 27.6%; as your remaining balance on the loan.

Finally, you take the remaining balance, in our example 27.6%, and multiply it by the initial loan amount ($10,000) to get your estimate of $2,760.

Continue

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The equation for the "I Owe More" Debt Balance Rule looks like:
Remaining Loan Balance = (remaining payments / total payments) + (interest rate*(# years of overall loan/10) * Initial Loan Amount

This equation is broken down into 3 easy steps.
Step 1 - Calculate Time Remaining (as a %) of overall loan
Step 2 - Multiply the interest rate by the time factor and add the result to Step 1
Step 3 - Multiply the Step 2 result * Initial Loan Amount

Let's look at a couple of examples to see how this equation works.

Continue

**Text**

## Learning the 'I Owe More' – Debt Balance Rule:

This short tutorial will show you a simple way to accurately estimate the remaining balance at any point (beginning, middle and end) of repaying a loan.

– The 'I Owe More' Debt Balance Rule adds the yearly interest rate on the loan multiplied by a time factor to appropriately adjust the remaining balance estimate upward. The 'I Owe More' time factor is simply the overall length of the loan (in years) divided by 10.

For example, if you are halfway through paying a 20 year loan with a 12% yearly interest rate, you will still owe approximately 74% of the original balance when you are halfway through paying off a loan. The calculation would look like, 50% remaining time + (12% interest rate* 2 time factor) = 74%.

Regardless of how much time remains on the loan, you can accurately estimate the remaining balance by adding the (yearly interest rate * the time factor) to the percentage of time remaining on the loan.

Let's say, if you have 3 years (36 months) remaining on a 15 year (60 month), $10,000 loan (20% time remaining) with a 12% interest rate, you will still have approximately 38% of the original balance, (12% * 1.5) + 20% = 38%, as your remaining balance on the loan.

Finally, you take the remaining balance, in our example 38%, and multiply it by the initial loan amount ($10,000) to get your estimate of $3,800.


The equation for the 'I Owe More' Debt Balance Rule looks like:

Remaining Loan Balance =

(remaining payments / total payments) + (interest rate*(# years of overall loan/10) * Initial Loan Amount

**This equation is broken down into 3 easy steps.**

Step 1 – Calculate Time Remaining (as a %) of overall loan

Step 2- Multiply the interest rate by the time factor and add the result to Step 1

Step 3 – Multiply the Step 2 result * Initial Loan Amount


Let's look at a couple of examples to see how this equation works.

# Tutorial – Debt Group C (Extended Rule Learning)- continued

**Experiment - Stages 1 & 2**

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**Example 1:**

Today, you borrow $10,000 for 10 years, paying a yearly fixed interest rate of 12%, agreeing to pay off the entire loan plus interest by making 120 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 2 years (24 payments), what is the remaining balance of the initial loan? Please provide your best estimate.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (120-24)/120 = 80%

**Step 2 - Multiply the interest rate by the time factor and add the result to Step 1**

Time factor = Number of years on loan /10; = 1
Yearly Interest Rate * Time factor = 12% * 1 = 12% and add step 1 result, 80% = 92%
80%+ (12%*1) = 92%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

Multiply percentage by Initial Loan Balance; $10,000*92% = $9,200

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**Experiment - Stages 1 & 2**

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**Example 2:**

Today, you borrow $100,000 for 20 years, paying a yearly fixed interest rate of 4%, agreeing to pay off the entire loan plus interest by making 240 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 12 years (144 payments), what is the remaining balance of the initial loan? Please provide your best estimate.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (240-144) / 240 = 40%

**Step 2 - Multiply the interest rate by the time factor and add the result to Step 1**

Time factor = Number of years on loan /10; = 2
Yearly Interest Rate * Time factor = 4% * 2 = 8% and add step 1 result, 40% = 48%
40% + (4%*2) = 48%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

Multiply percentage by Initial Loan Balance; $100,000*48% = $48,000

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# Tutorial – Debt Group C (Extended Rule Learning)- continued

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**Experiment - Stages 1 & 2**

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Today, you borrow $10,000 for 10 years, paying a yearly fixed interest rate of 4.0%, agreeing to pay off the entire loan plus interest by making 120 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 8 years (96 payments), what is the balance of the initial loan? Please provide your best estimate.

**Result:**

Your answer: $2,000.00. Incorrect, please check your calculations!

Correct answer: $2,400.00.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (120-96) /120 = 20.0%

**Step 2 - Multiply the interest rate by the time factor and add the result to Step 1**

Time factor = Number of years on loan / 10 = 1
Yearly Interest Rate * Time factor = 4.0% * 1 = 4.0% and add step 1 result (20.0%)= 24%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

Multiply percentage by Initial Loan Balance; $10,000 * 24% = $2,400.00

Continue

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**Experiment - Stages 1 & 2**

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Today, you borrow $100,000 for 20 years, paying a yearly fixed interest rate of 12.0%, agreeing to pay off the entire loan plus interest by making 240 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 8 years (96 payments), what is the balance of the initial loan? Please provide your best estimate.

**Result:**

Your answer: $84,000.00. Correct!

Correct answer: $84,000.00.

**Step 1 - Calculate Time Remaining (as a %) of overall loan**

Remaining Percentage = (Total Payments - Payments Made) / Total Payments; (240-96) /240 = 60.0%

**Step 2 - Multiply the interest rate by the time factor and add the result to Step 1**

Time factor = Number of years on loan / 10 = 2
Yearly Interest Rate * Time factor = 12.0% * 2 = 24.0% and add step 1 result (60.0%)= 84%

**Step 3 - Multiply Step 2 Result * Initial Loan Amount**

Multiply percentage by Initial Loan Balance; $100,000 * 84% = $84,000.00

Continue

# Tutorial – Debt Group C (Extended Rule Learning)- continued

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Today, you borrow $10,000 for 15 years, paying a yearly fixed interest rate of 4.0%, agreeing to pay off the entire loan plus interest by making 180 equal monthly payments.

*Assume all payments have been made on time and no additional payments have been made.*

After making payments on this loan for 3 years (36 payments), what is the balance of the initial loan? Please provide your best estimate.

**Result:**

Your answer: $8,000.00

The correct answer is $8,448.47.

You underestimated by $448.47 or 5.31%.

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