



THE NOVA FINANCIAL LAB:

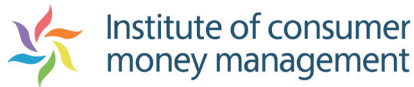
# A Behavioral Science Approach to Financial Literacy Games

## ABOUT US



**The Center for Advanced Hindsight** is an applied behavioral science laboratory at Duke University that creates and tests interventions to help individuals improve their financial, mental, and physical wellbeing.

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**The Institute of Consumer Money Management** conducts and provides funding for research and studies that promote positive spending behaviors and consumer asset building. ICMM is committed to promoting financial literacy in our community and across the United States.

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**NOVA Labs** is a digital platform from the producers of the popular PBS science series that engages middle and high schoolers in science games and interactives. Labs participants – more than 8 million to date – take part in real-world investigations by visualizing, analyzing, and playing with the same data that scientists use. Each Lab focuses on a different area of active research. But all of them illustrate key concepts with engaging multimedia content, guiding participants as they investigate scientific questions or design solutions to current problems.

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**Thought Café** is an award-winning animation, design, visual effects and vr/ar studio located in Toronto, Canada

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## EXECUTIVE SUMMARY

Despite facing momentous financial responsibilities with little room for error, many adolescents in the United States are inadequately prepared to make sound financial decisions. Whereas traditional forms of financial literacy education have shown modest results in preparing our youth for financial independence, they have largely ignored the behavioral barriers and biases that prevent adolescents from acting upon financial knowledge. The emerging field of game-based learning is uniquely situated to address such a gap by offering replayable, experience-based learning to train players to develop positive financial behaviors. Still, current financial games largely exclude behavioral science in their design and content. We begin by covering the current landscape of financial and behavioral games. Next, we introduce a financial behavior game we are helping to develop with the NOVA Labs team at GBH Boston. This game uses insights from the memory and behavioral science literatures to provide adolescents with an understanding of the cognitive and behavioral barriers that can make spending, budgeting, and managing debt difficult and empower adolescents by providing them with strategies and habits to overcome these barriers.

**KEYWORDS:** Behavioral science, behavior training, financial literacy, financial education, gamification, serious games, game-based learning




The transition from adolescence to adulthood brings newfound freedom and fresh responsibilities. Americans who turn 18 can move out of their parents' home, open a bank account, and sign a legally binding contract. They can apply for credit cards, go into debt, and play the lottery. Given this responsibility, it would make sense to assume these young adults have been well-prepared to take it on. However, personal finance statistics suggest otherwise. In 2019, 42 percent of 18–29 year-olds had no retirement savings and only 26 percent believed they were adequately prepared for retirement (Harrison, 2019). In 2020, more than 9% of credit card owners in this age range were at least 90 days late on their debt payment (Hayashi, 2020). If current trends persist, one in two will fail to create an emergency savings account (Harvey, 2019) and one in five will eventually default on their student loans (The Pew Charitable Trusts, 2020).

A lack of knowledge about financial topics (i.e., low financial literacy) is a commonly cited barrier to positive financial outcomes (Huston, 2010; Lusardi & Mitchell, 2011; Bhushan & Medury, 2013). Only an estimated one in three young adults possess basic knowledge of interest rates, inflation, and risk diversification (Lusardi et al., 2010). Concern about low financial knowledge is well-founded, as lower financial literacy is correlated with a range of unfavorable financial behaviors including late bill and credit card payments, failing to budget, few investments, failing to maintain emergency funds, and track expenses, as well as longer-term behaviors like poor debt management, little wealth accumulation, and a lack of retirement planning (Hilgert et al., 2003; Ameriks et al., 2003; Lusardi & Mitchell 2007; Stango & Zinman 2009; Hung et al., 2009; van Rooij et al., 2012).

Financial education has long been considered a powerful tool to mitigate adverse financial behavior by improving financial knowledge (Fox et al., 2005). A 2009 survey found that 84 percent of student respondents reported that they needed more financial management education (Sallie Mae, 2009). But whereas traditional forms of financial education, which focus on providing students with knowledge about financial concepts (conceptual literacy) and tools for applying those concepts (practical literacy), have shown modest results in preparing our youth for financial independence (Fernandes et al., 2014; Kaiser et al., 2020), there has been much less focus on how psychology interacts with the environment to make applying such concepts and tools in the real world difficult (e.g., behavioral

literacy). In other words, individuals who learn to make better financial decisions within the context of an intervention may not be able to act on (or even access) their newfound knowledge after the intervention.

### 3 Elements of Financial Literacy Games

TOPIC	CONCEPTUAL LITERACY	PRACTICAL LITERACY	BEHAVIORAL LITERACY
<b>Spending</b> 	Understanding how different monetary accounts work.	How to prepare a budget.	How we maintain mental accounts, when to break accounts, and what barriers prevent us from sticking to a budget.
<b>Credit</b> 	How credit and interest work.	How to manage a credit card.	How we can overuse credit by discounting the future and how credit reduces “pain of paying”.
<b>Saving</b> 	How compound interest works in long-term saving.	How to set up savings and retirement accounts.	The power of automatic transfers. How we put off saving for tomorrow and underestimate exponential growth of compounding interest.

The discrepancy between an individual's intention to change their behavior and their actual behavior is known as the intention-behavior gap (Sheeran & Webb, 2016). Information-rich interventions can overwhelm people with lots of forgettable detail while neglecting to emphasize bottom-line easily remembered principles (i.e., gist) that get at the core of what is being communicated (Reyna & Mills, 2014). Furthermore, financial decision-making is impaired by cognitive biases—the systematic tendencies in human thinking that can lead to myopic and inconsistent decision-making (Ariely & Kriesler, 2017; Ariely, Loewenstein, & Prelec, 2003; Tversky & Kahneman, 1981). Cognitive biases even interfere with seemingly intuitive choices like deciding how much money to spend on an iPod (Frederick et al., 2009), yet there are few financial literacy interventions that explicitly take these into

account (Kaiser & Menkhoff, 2017). Therefore, even with a wealth of financial knowledge, it is also important to have an understanding of how one's psychology can act as a roadblock to acting on that knowledge and provide habits to help one overcome them.

"Serious games" (i.e., computer-based pedagogical games) are a strong candidate to provide such behavior training, using elements of video games such as interactivity, rules, goals, challenge, risk, and dynamic visuals to promote learning (Pivec et al., 2003). With a dynamic and salient format, serious games have the potential to engage players and simulate realistic scenarios better than traditional educational formats, allowing users to practice and learn from behaviors without real-world consequences (Jerčić et al., 2012). It is still too early to determine whether game-based learning is more effective than other styles of learning, but some experiments show promising results (Pivec et al., 2003). Since computers have become widely available for students, a small but growing number of financial games and behavioral change games have already been explored (see "Financial Literacy Games").



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In 2020, researchers at the Center for Advanced Hindsight of Duke University (CAH) signed on to advise GBH Boston's NOVA science series on PBS in the creation of a financial behavior game that bridges the gap between past research in financial literacy and behavioral training. This game is called NOVA's Financial Lab. Funded by the Institute of Consumer Money Management (ICMM), an organization committed to funding research that promotes positive spending behaviors and financial literacy, the Financial Lab is designed to empower adolescents by using behavioral science to instill healthier spending, budgeting, and debt-management habits. This game will be released online for free on the NOVA Labs platform in the winter of 2022. Based on user statistics of past games produced by

NOVA Labs, it is expected to reach hundreds of thousands of young people over time. After its launch, the Financial Lab will undergo testing and research by CAH, providing critical insights about the potential for serious games to promote behavioral change.

This paper offers a literature review of the research at the heart of the game. The first two sections of this paper explore the current landscape of financial games and behavioral change games. The final section introduces the behavior goals and design behind the Financial Lab, looking to past research as a guide. We discuss the three primary behavioral science topics which are tackled by three mini-games—opportunity cost neglect, mental accounting, and exponential growth bias, which represent behavioral barriers to short term spending, medium term budgeting, and long-term debt repayment and investment respectively. We demonstrate how each game provides players with feedback that captures memorable bottom-line messages (i.e., gist principles; Reyna & Panagiotopoulos, 2020; Reyna & Wilhelms, 2017), which are applicable to real-world decision making and gives players “just-in-time” opportunities to engage in behaviors that will provide immediate benefits to financial well-being.

# Financial Literacy Games

Financial literacy education programs so far have varied in content, audience, and methodology. The vast majority of programs are conducted through classroom teaching, self-study materials, informational websites, interactive games, and one-on-one counseling (Willis, 2008). In general, financial gamification is not a new concept. For example, an early version of Monopoly was patented back in 1903 with the goal of demonstrating “the present system of land-grabbing with all its usual outcomes and consequences” (Pilon, 2015). But the emergence of personal computers has only recently opened the door for digital financial education games, broadening gamification possibilities far beyond the constraints of physical board games. Free online financial literacy games have proliferated online (Page, 2020; Grossman, 2021), though few have been developed alongside researchers and undergone scientific scrutiny. Based on a search of the literature on Google Scholar using the key words “financial literacy game,” “financial education game,” “serious game in finance,” and “financial gamification,” we found unique personal finance video games in 8 different research papers, excluding papers with simple quiz games (this search also excludes a number of games designed for corporate finance in higher level education or job training) (see Harter & Harter, 2010; Iliev-Piselli et al., 2011; Liu et al 2011; Maynard et al., 2012; Warder et al., 2018; Nadolny et al., 2019; Erickson et al., 2019; Rasco et al., 2021). The first of these papers was published in 2010, suggesting that financial game design is still in its infancy.



One of the most commonly cited financial games is the Stock Market Game—an investment education program for students that allows users to invest \$100,000 of imaginary money into authentic stocks and watch the effects in real time. Although the game does not give players frequent or salient feedback or define clear behavioral goals, it does allow players to experiment freely and become comfortable with the practice of investing. [The game](#) has been incorporated into classroom financial lessons, reaching nearly 20 million students since its inception in 1977. In one randomized control trial of 730 students, researchers examined the effect of this game by pairing it with a seven-part lesson plan for high school teachers. Whereas teachers in the control group were simply instructed to “teach economic and financial concepts as they normally would” throughout the semester, test group teachers were trained in using the Stock Market Game and complementary “Learning From the Market” lessons for students. At the end of the study, the mean financial literacy test score of students in the control group rose from 44.79 to 49.56. On the other hand, the mean test score of students in the test group improved more drastically from 41.23 to 61.78 (Harter & Harter, 2010). Although this study did not prove that an investment game improved financial literacy on its own, it did show that a lesson plan built around such a game was more effective at improving literacy than a teacher’s traditional methods, affirming the potential for financial gamification.

Another financial game called Farm Blitz was developed by Doorway to Dreams to teach low-income adults about compound interest, debt, and savings by challenging them to make a profit while growing vegetables with borrowed money. Unlike the Stock Market Game, Farm Blitz is a short, replayable game designed to teach concepts without the assistance of supplemental material. According to a working paper on financial games, Farm Blitz was subject to a randomized control trial with 207 people. Participants either played the game for 45–60 minutes or read an online financial education pamphlet for 15–20 minutes. After the intervention, participants in both groups had higher financial confidence and knowledge, with the pamphlet offering slightly greater improvements. The game and pamphlet also had similar effects on intentions to engage in positive financial behaviors. There was no statistically significant difference between conditions; About 60 percent of participants opted to receive more information about saving for emergencies and 40 percent made a 3-month commitment to save in both groups. Still, the researchers argued that participant enjoyment, which was not measured, may be higher for the game than the pamphlet, which would make it a preferable method of financial education (Maynard et al., 2012).



**Behavioral science has demonstrated that humans tend to be present-biased, context-driven, forgetful creatures of habit living in a world that is largely built to take advantage of each of these tendencies.**

A third financial game that underwent scientific scrutiny was called Night of the Living Debt, an iPad application designed by University of Idaho Extension educators that challenges players to survive a zombie apocalypse parody in which zombies control expenses and collect debts. In order to win, players raise their credit score by budgeting their money between expenditures like education and home ownership and paying off their debts. Out of the ten financial games produced by the educators, they found Night of the Living Debt to be most successful at improving literacy. In a pre- and post-survey of about 1,500 participants, respondents showed higher financial knowledge of credit cards and loans after the game and were more likely to intend healthy behavior changes regarding credit card use and loans (Erickson et al., 2019). This study did not employ any standardized measures of financial literacy or behavior change, but it does highlight the potential for broad, behavior-based gamified learning that simplifies financial topics and uses metaphors to engage its users.

## **BEHAVIORAL GAMES**

Behavioral science has demonstrated that humans tend to be present-biased (O'Donoghue & Rabin, 1999), context-driven (Thaler, 1999), forgetful (Milkman et al., 2021) creatures of habit (Neal et al., 2006) living in a world that is largely built to take advantage of each of these tendencies (Harris, 2015). Moreover, people perceive themselves as less biased as compared to their peers (Fedyk, 2018; Pronin et al., 2002; West et al., 2012), demonstrate overconfidence in their ability to resist bias (Pronin, 2007), and underestimate the extent to which behavioral interventions would help (Rogers & Milkman, 2016). A game meant to teach people to make better financial decisions must therefore also help people contend with the behavioral challenges that will inevitably occur once the individual finishes the game. This means providing them with an experience that helps them to see the biases play out while giving them strategies with which to overcome them.



A number of games have incorporated insights from psychology to achieve behavior change in fields of study such as energy (Orland et al., 2014), addiction (Boendermaker et al., 2015), and mental (Bul et al., 2015) and physical health (Thompson et al., 2010). For example, Basol, Roozenbeek and van der Linden (2020) developed a game that puts the player in the shoes of a disinformation spreader on social media whose goal is to attract followers using disinformation techniques. This game relies on pre-bunking—preemptively exposing people to disinformation techniques—in order to reduce players’ susceptibility to disinformation in the real world. Results showed improvement in the ability to detect disinformation even after 3 months had passed.



**A game meant to teach people to make better financial decisions must therefore also help people contend with the behavioral challenges that will inevitably occur once the individual finishes the game.**

Whereas the games referenced in the previous paragraph use behavioral science principles for behavior change in an unrelated field, other games solely train players in cognitive debiasing (see Mullinix et al., 2013; Dunbar et al., 2014; Clegg et al., 2014; Morewedge et al., 2015; Clegg et al., 2015; Martey et al., 2017). These games target all of or a subset of the following six biases: bias blind spot, confirmation bias, fundamental attribution error, the anchoring effect, the representativeness heuristic, and social projection. In each of these studies, the games were tested against informational debiasing videos, and all were generally found to be comparable or more successful than the video alternative at mitigating biases. Whereas the Financial Lab will address different biases from the ones tested in these games, the success of such experiments speak to the capabilities of debiasing training in influencing behavior. Dunbar et al. (2014) varied components of the game within different test groups to gauge the effectiveness of different design choices. They found that games with explicit explanations of cognitive biases demonstrated better outcomes than games that provided behavior training implicitly without mentioning the biases by name. They also found that their game showed better results when players received more exposure through repeated play. Motivated by these findings, the Financial Lab incorporates explicit video explanations of each behavioral bias and necessitates multiple playthroughs to complete the game.

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## The NOVA Financial Lab

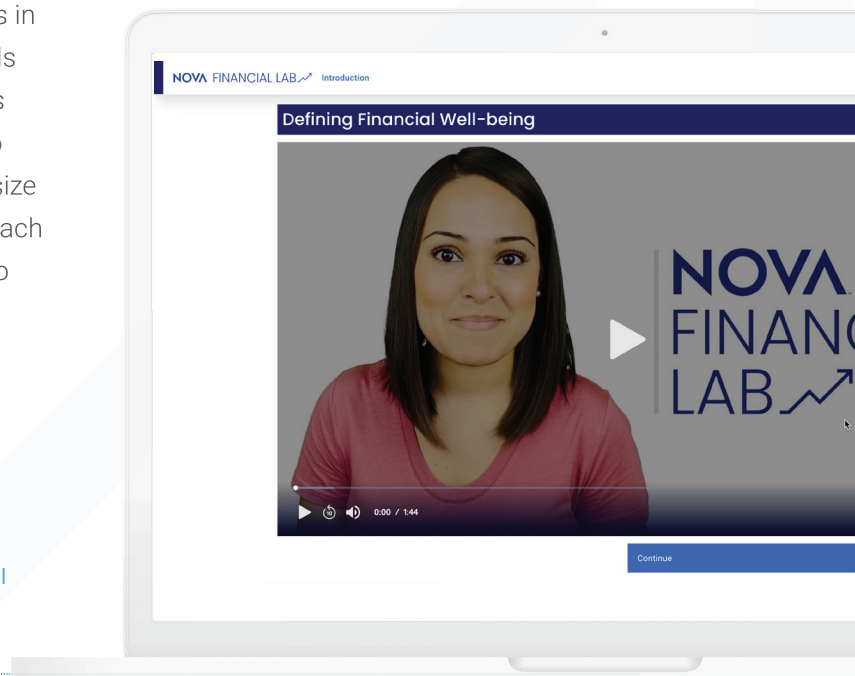
[www.pbs.org/wgbh/nova/labs/lab/financial](http://www.pbs.org/wgbh/nova/labs/lab/financial)

In the [NOVA Financial Lab](#), the player is responsible for taking care of their pet's financial needs and responsibilities. The pet acts as a playful metaphor for the player's financial needs in the real world—it has debts, needs for short-term and long-term savings, non-essential and essential expenses, and preferences. Furthermore, the pet is the player's only financial responsibility, meaning that all in-game income is solely to be used on the pet.

This game is composed of three mini-games—Shoppportunity Cost, Budget Buster, and Exponential Potential. Shoppportunity Cost focuses on instilling a habit of considering opportunity costs when making spending decisions. Budget Buster focuses on developing mental accounts (for essential, nonessential, and savings), and strategies for using them effectively. Exponential potential helps the player develop strategies for paying off debt and investing. We focused on these three topics due to their relevance to financial behavior. Each game will teach players about particular behavioral pitfalls in managing their money, but will also provide tools for managing their financial behaviors. Whereas the games will provide important information to increase financial literacy, they will also emphasize how to engage in healthy financial behaviors. Each game is designed to be played multiple times so that the player can reinforce desired behaviors.



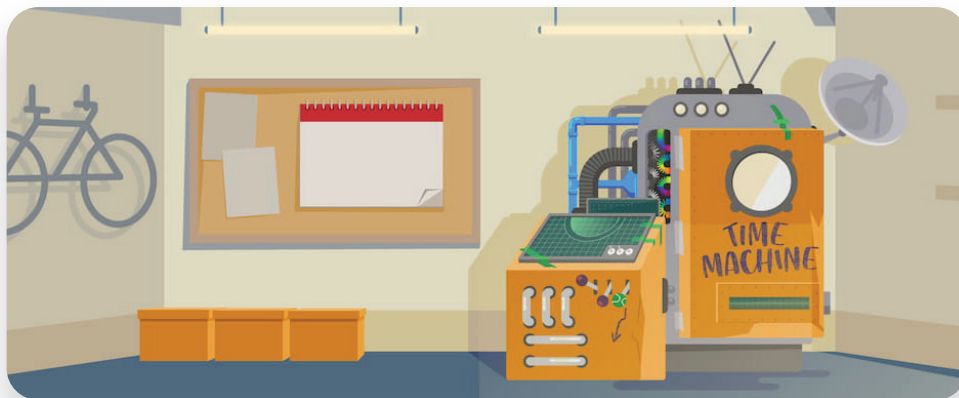
Videos are narrated by Yanelly Espinal, a financial literacy educator, and Director of Educational Outreach at Next Gen Personal Finance and is a member of CNBC's Financial Wellness Advisory Council.



In Shopportunity Cost, the player must maximize their pet's happiness with a limited budget by considering opportunity costs of present and future options. We chose opportunity costs as a focus of this game because of how fundamental they are to every-day spending decisions. In Budget Buster, the player is responsible for managing monthly spending on essential expenses and non-essential items, collecting savings, building credit, and handling emergencies and windfalls. This should give teens the tools to develop budgeting skills, learn the importance of saving for emergencies, and learn when budget accounts are helpful and when they should be ignored. In Exponential Potential, the player must strategize the best way to pay off their pet's long-term debts and invest in retirement savings.

**Shopportunity Cost is designed to focus players on immediate spending, Budget Buster on monthly budgeting, and Exponential Potential on long-term wealth management.** Aside from the importance of the behavioral biases reflected in each game, we wanted the three mini-games to help the player see the relationship between short, medium, and long-term financial decisions. Research by Hershfield, et al. (2011) found that young people decide to save more money when presented with a visual representation of their future selves. Bryan and Hershfield (2012) used messaging with themes of social responsibility to one's future self (as compared to themes of rational self-interest), and found that employees who received the social responsibility messaging and felt more connected

Bones the Dog



Cash the Cat



The player will choose either a cat or a dog as their avatar for each of the games. The first game (Shopportunity Cost) deals with immediate spending, the second (Budget Buster), medium-term budgeting, and the final one (Exponential Potential), long-term debts and investments. Prior to playing each game, the player will watch an instructional video that introduces relevant behavioral concepts and how to play. After each game, the player will watch another video that discusses how to overcome the behavioral biases that are featured in the game.

to their future self put more into their job-related savings accounts. By simulating short, medium, and long-term financial outcomes, we want to increase players' present-future continuity, helping them realize that they are acting on behalf of themselves, not some stranger whose future happiness doesn't really matter to them.



**By simulating short, medium, and long-term financial outcomes, we want to increase teenagers' present-future continuity, helping them realize that they are acting on behalf of themselves, not some stranger whose future happiness doesn't really matter to them.**

Each mini-game will also include behavioral science videos which will offer in-depth explanations and easily remembered gist principles that will help the player translate the lessons from the game to real-life, and opportunities to engage in healthy financial behaviors in-the-moment (see "Translating Lessons into Real-World Behaviors" for more on the last two points.) The behavioral goals within each mini-game are outlined on the following pages.



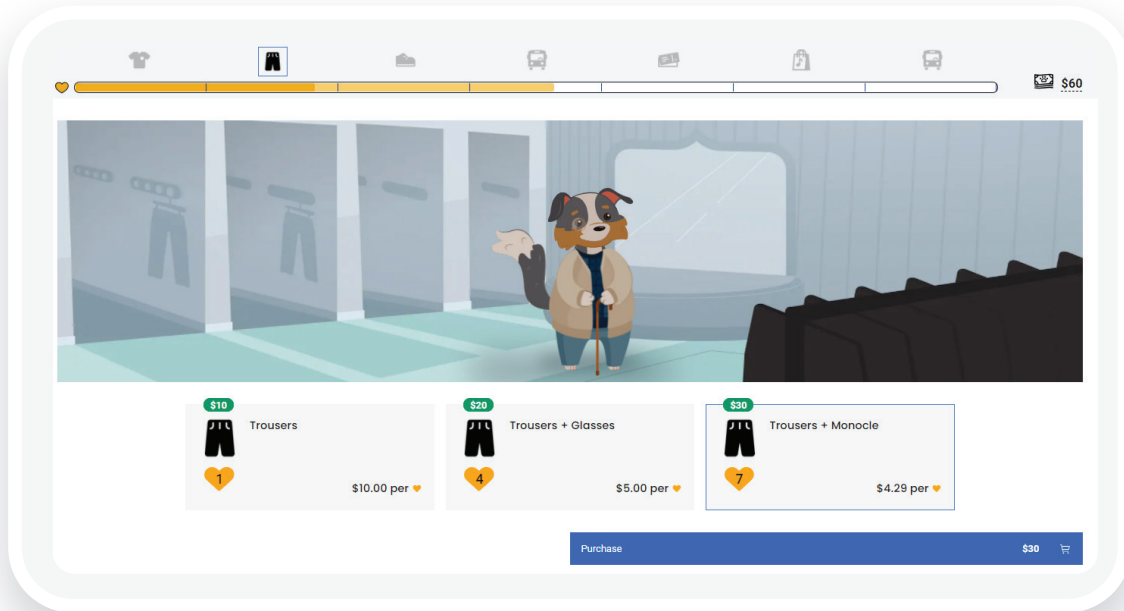
## Shoppportunity Cost

In this mini-game, the player must maximize their pet's happiness with a limited budget by considering opportunity costs of present and future options.

🎯 **LEARNING GOAL:** Attend to opportunity costs in order to balance present and future well-being when making financial decisions

Every decision faces tradeoffs, but those tradeoffs are often ignored. When carrying out financial decisions, people tend to neglect future, alternative options that they are giving up (called opportunity costs). Opportunity cost neglect represents a failure to retrieve a relevant reasoning principle when it is needed (Corbin, Reyna, Weldon, & Brainerd, 2015)—which in the case of in-the-moment spending decisions, boils down to “money spent on something now is money that can’t be spent on something else later”. Research shows that merely mentioning the money that someone could save by abstaining from a purchase (or buying cheaper) changes decision-making. For example, a series of experiments demonstrated opportunity cost neglect by varying whether money saved was kept implicit or made explicit in the purchase of a CD. In the first experiment, willingness to purchase a \$14.99 CD fell from 75 percent to 55 percent when the “not buy” decision was changed to “keeping money for other purchases.” In another experiment where participants chose between a \$299 iPod, \$399 iPod, or neither, purchases of the cheaper iPod rose from 37 percent to 73 percent when subjects read the explicit opportunity cost that buying the cheaper iPod would mean “leaving you \$100 in cash.” The researchers also found that participants were more likely to imagine alternative items they could buy instead when opportunity costs were explicit, and they demonstrated these effects under incentive compatible conditions (i.e., when real money was at stake; Frederick et al., 2009). Variations of this opportunity cost neglect experiment have been replicated many times (Greenberg & Spiller 2016; Bartels & Urminsky 2015; Plantinga et al., 2018). One experiment showed that participants were far more likely to be affected by explicit opportunity costs if they felt more connected to their future selves, even when participants’ feelings of connectedness were artificially manipulated by administering a short reading to change how they felt about their future self (Bartels & Urminsky, 2015).

In this mini-game, the player is responsible for maximizing their pet's happiness on a trip to a music concert. They visit multiple "stores" in which they are able to make purchases for things that the pet will need for the trip. During the game, they make repeated purchasing decisions in which they need to trade off monetary and hedonic considerations. Each potential purchase gives the pet a certain amount of utility, or "happiness points," but the player only has a limited budget and cannot revisit stores. These happiness points determine the final score.



An example of one of the stores the player will see in the game. Each store is represented by the icons at the top. The happiness points are shown below with current points and potential gain (if the player makes the chosen purchase) in dark and light yellow respectively. The player is also shown their purchase options (selecting them will outfit the pet so that they can see what it will look like), along with the price, happiness points, and the ratio of price to happiness.








In between rounds, the player is shown an "Opportunity Cost Map", in which they are faced with their past decisions as well as their upcoming decisions. As they spend more, future decisions are crossed out, demonstrating how one's spending in the present can reduce one's future options. If the player runs out of money before they visit the last store, they lose the mini-game because they cannot pay for transportation home from the concert. Thus, the player must juggle the goals of making their pet happy and having the money to visit each store. The mini-game is designed such that (much like in real life), considering opportunity costs when making purchasing decisions leads to a better outcome at the

end of the game. Thus, the game is meant to prove the value of attending to future opportunity costs and instill a mental habit of considering these costs when players make decisions outside of the game, helping players to make less impulsive, and higher quality spending decisions.

Opportunity Cost Map

Thanks for purchasing Black Pants + Red Glasses!

It looks like you've lost the opportunity to buy item(s) in the future.

	—	—	<div>\$30</div>
	—	—	<div>\$30</div>
	<div>\$10</div>	<div>\$20</div>	<div>\$30</div>
	<div>\$10</div>	<div>\$20</div>	<div>\$30</div>
	<div>\$10</div>	<div>\$20</div>	<div>\$30</div>
	<div>\$10</div>	<div>\$20</div>	<div><del>\$30</del></div>
	<div>\$10</div>	<div><del>\$20</del></div>	<div><del>\$30</del></div>

You have \$50 left to spend for the rest of your evening.



After each decision, players are shown an “Opportunity Cost Map” that shows their past decisions, future potential decisions, as well as the opportunities they will miss out on due to their previous spending.



## Budget Buster

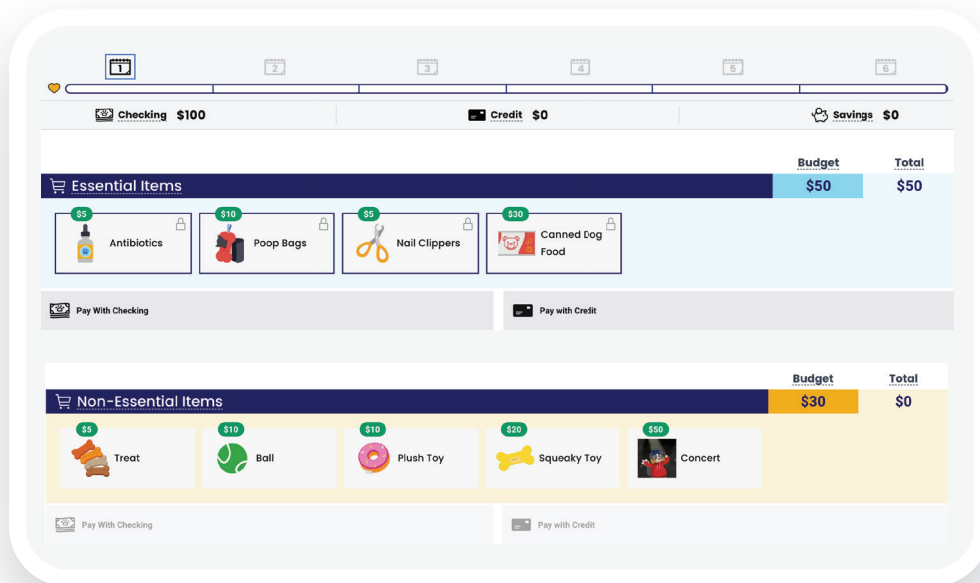
In this mini-game, the player is responsible for managing monthly spending on essential expenses and non-essential items, collecting savings, building credit, and handling expensive emergencies and windfalls.

🎯 **LEARNING GOAL 1:** Develop three broad mental accounts for essential expenses, non-essential expenses, and savings in order to assist with budgeting.

People tend to treat spending and earning inconsistently, separating and categorizing these decisions under separate mental “accounts.” This mode of thinking can lead to a range of behaviors considered irrational from a standard economics perspective, such as maintaining inflexible budgets (Thaler, 1999). For example, a family may allocate \$600 of their monthly income to groceries, \$100 for outings, \$80 for gas, etc., and prevent themselves from using money from one account to go toward the expense of another. Yet, budgeting can limit people from spending (Soman & Cheema, 2011), making it a potential remedy to the worryingly low amount of savings that many Americans—especially low-income Americans—set aside (Wilcox, 2008; Jeszeck et al., 2015). Still, budgeting with a large number of mental accounts has disadvantages. For example, researchers carried out an experiment testing how participants assessed imaginary spending decisions after they had already spent money on an expense in a hypothetical scenario. They found that participants tended to “adopt self-control strategies that are too strong,” exhibiting underconsumption of future goods in the same, narrow mental account such as “food” or “clothes” immediately afterward (Heath & Soll, 1996, p. 51). Furthermore, maintaining elaborate mental accounting budgets can make people give up on budgeting entirely (Ariely & Kriesler, 2017). To avoid these issues, Ariely and Kriesler (2017) recommend implementing a broad mental account for non-essential items in order to limit spending. This recommendation is consistent with a popular budgeting rule to use 50 percent of post-tax income on essential expenses, 30 percent on non-essential expenses, and 20 percent on savings (Whiteside, 2020).



In Budget Buster, players are tasked with taking care of their pet's monthly expenses. They will learn to distinguish essential from non-essential goods and manage their budget while ensuring that their pet remains happy (with non-essential purchases), can handle any sudden emergencies, and can pay off any credit card debt. This game is designed to help players break free from habits of either budgeting with overly narrow mental accounts or failing to budget at all. Players are meant to adopt three broad mental accounts for non-essential spending, essential spending, and savings. To encourage this habit, all decisions are framed by these three distinct accounts and players are scored on their ability to assign monthly expenses to the correct account.



Players must buy all essential items each month. They must also decide which nonessentials to buy to keep their pet happy. All purchases can be made with cash or credit.

🎯 **LEARNING GOAL 2:** Treat money as fungible by adjusting mental account budgets if necessary and attending to absolute rather than relative savings and costs.

Because money is fungible, dollars are mutually interchangeable and should theoretically be treated with equal value. Mental accounting can violate the principle of fungibility (i.e., the value of money is the same regardless of where it comes from or what it is being spent on) by evaluating financial activities under separate accounts with inconsistent preferences. This leads to a number of irrational behaviors,

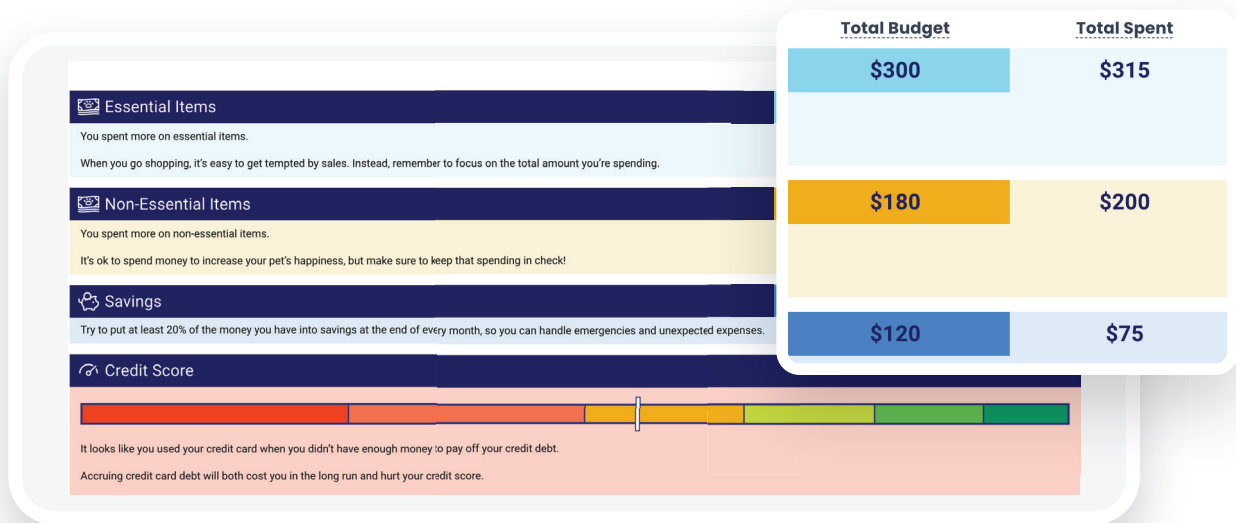
including the underconsumption of goods within a mental account, as described above. However, many negative behaviors associated with mental accounting are not directly caused by spending budgets. One behavior Thaler (1999) notes is that people tend to treat money differently depending upon the way it is acquired, whether through work, gifts, or otherwise. As further proof, one study found that when people received windfall money, they tended to spend that money on an expense they rated similarly on a scale that ranges from “serious” to “frivolous.” Tax returns were more often spent on paying bills, while winnings of an office football pool were more often used for eating out (O’Curry, 1997). People also tend to treat money differently depending upon the method of payment. Most notably, people spend more when they use a credit card than when they use cash (unlike cash, credit cards charge users in one large sum after the purchase, separating payment from spending and reducing the salience of overspending; Thaler, 1999).

Additionally, people tend to treat savings in relative rather than absolute terms. It is theorized that individuals gain transaction utility based on the perceived value of a “deal,” with larger transactional utilities for larger deals (Thaler, 1999). For example, Tversky and Kahneman (1981) presented participants with the following scenario:

“Imagine that you are about to purchase a jacket for (\$125) [\$15], and a calculator for (\$15) [\$125]. The calculator salesman informs you that the calculator you wish to buy is on sale for (\$10) [\$120] at the other branch of the store, located 20 minutes drive away. Would you make the trip to the other store?”

While only 29% of respondents said they would complete the drive to save \$5 on a calculator they were going to buy for \$125, 68% of respondents would perform the same drive to save \$5 on a calculator they were going to buy for \$15 because the deal represented a larger relative discount. Furthermore, marketing research shows that consumers are more likely to make a purchase when the gap between the discounted price and the original reference price is larger (Compeau & Grewal, 1998). While one could hypothesize that consumers use the original price to gauge the quality of a product, the transactional utility effect persisted even when experiments separated an “irrelevant” original price from a separate measure of product quality (Huang, 2019). These discrepancies highlight clear inconsistencies in the way individuals treat money and violate the principle of fungibility.

Whereas mental accounting budgets are encouraged in this game, it also uses a number of strategies to penalize players for violating fungibility. Players will receive windfalls and emergencies that force them to be flexible with their budgets in changing circumstances and to treat all forms of earnings (income, windfalls) equally. If they fail to use windfalls to balance out unanticipated spending in other months and instead treat it as “fun” money, they may end up overspending on non-essential items. If they refuse to use money from one account to go toward another and instead treat credit card debt as “future” spending, they may go into credit card debt. Both errors would hurt their final score, as players



Players are shown how much they spent as compared to what they would have spent if they followed the 50-30-20 rule and are shown their credit score. They are given feedback for their spending and credit card habits below each category.

are graded on their credit score. Finally, players must assess “deals” at the beginning of each round to practice ignoring transactional utility. In each deal, they are shown two distinct discounted non-essential items and must buy both items but can only use one discount. In order to score points, they must choose the discount with the higher absolute savings for their essentials account overall (e.g., 25% off of \$100) rather than the relative savings (e.g., 50% off of \$40).

In total, the mini-game is designed to teach players the advantages of flexible mental accounting budgets in mediating self-control and increasing savings while also training them to recognize violations of fungibility in order to improve spending decision quality.



## Exponential Potential

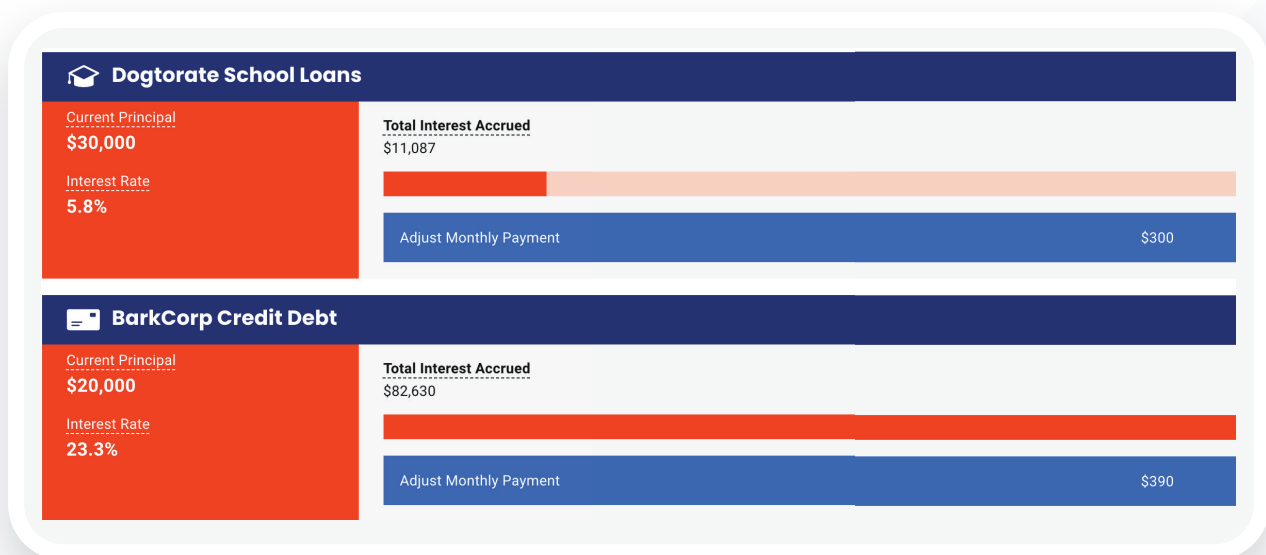
In this mini-game, the player must strategize the best way to pay off their pet's long-term debts and invest retirement savings.

🎯 **LEARNING GOAL 1:** Overcome exponential growth bias by grasping the powerful, non-linear effect of interest rates over time to develop a debt payment and investment strategy based on interest rates.

People tend to underestimate both the returns on long-term investments and the losses accrued by debt. Both of these miscalculations stem from exponential-growth bias, the tendency to anticipate linear growth when an exponential interest rate is given. The bias is more pronounced for longer time-horizons. One correlational study found that exponential growth bias is strongly correlated with higher rates of borrowing, less saving, lower net worth, and portfolios with more short-term assets and short-term installment debt, even when accounting for demographics, life-style factors, available resources, preferences, and expectations (Stango & Zinman, 2009). Levy and Tasoff (2016) found similar results in a U.S. representative sample, also finding that the bias was uncorrelated with age and education, suggesting that it did not diminish with life experience. As noted in the research paper, past exponential growth-bias interventions, most of which center around investment and debt, have had mixed, somewhat conflicting results in increasing savings (MacKinnon & Wearing, 1991; Eisenstein & Hoch, 2007; McKenzie & Liersch, 2011; Soll et al., 2013; Goda et al., 2014; Levy & Tasoff, 2016; Song, 2020). For example, one intervention found that displaying projected retirement income increased annual contributions by only \$85, equivalent to a 3.6 percent increase in average contribution level or 0.15 percent of average salary (Goda et al., 2014). On the other hand, a field experimenter in China found that just explaining the concept of compound interest to participants increased their pension contributions by an astounding 40 percent (Song, 2020). Another experiment found that the vast majority of college student participants underestimated exponential growth or expected it to be linear, which led them to under-estimate the cost of waiting to save. Those researchers also found that highlighting exponential-growth savings motivated undergraduates and employees to save more (McKenzie & Liersch, 2011).

Incomplete understanding of interest leads to harmful investing and debt payment strategies that keep people from building wealth. In theory, the optimal strategy is to put all funds toward the debt or investment with the highest interest rate, thereby minimizing interest payments or maximizing savings growth. However, Amar et al. (2011) found instead that people tend to pay off their smallest debts first and distribute investment money evenly across all accounts they have access to, regardless of interest rates. In a subsequent experiment by the researchers that asked participants to allocate money to a number of debts with varying interest rates, people performed somewhat closer to the optimal strategy when given extra information that highlighted the actual dollar amount of debt accumulating from interest.

In this mini-game, the player is responsible for their pet's long term debt and investment payments. Given a constant portion of fixed monthly income over 30 years, the player must decide how this money should be distributed to maximize net worth at the end of the time horizon. After the player sets the allocation for each account, they finalize their decision and watch their pet's accounts change over time on a dynamic graph before being scored on the pet's final net worth.



Example of 2 of the 4 accounts a player is paying towards. The accounts are: credit card (high interest/high principal), student loan (low interest/high principal), car loan (moderate interest/low principal), and a retirement (moderate interest/begins at \$0 principal). Players move sliders to determine how much they will pay into each account each month (all debts do have a minimum payment.)



After each round, players are shown a graph comparing their performance paying off debt and investing to an “optimal” playthrough, which represents the monetary outcomes if the player chooses the strategy that maximizes their net worth. The buttons underneath the graph allow the player to look at debts and investments together or individually (the graph above depicts a player comparing their debt to the optimal debt.)

If a debt is paid off before 50 years have passed, the mini-game pauses and allows the player to re-allocate that monthly portion to another account. One playthrough of this mini-game has two rounds to allow the player to learn from past performance and develop better strategies.

Because past graphical interventions that aim to improve accurate exponential growth predictions have shown varied results, we decided to avoid emulating such a goal. Instead, this game is designed to instill an intuition about the power of interest rates and time horizons on debts and investment growth. Scoring based on strategy for the highest net worth, rather than prediction of the final net worth, is meant to emphasize this behavioral goal. Furthermore, the player is not primed with any strategies before playing the mini-game, providing them with the chance to test out theories and learn the optimal payment strategy (maximise deposits in the account with the highest interest rate) through practice. However, players are shown a comparison between their performance and “optimal” performance as they play, allowing them to gain immediate feedback on how their strategies are playing out and make in-game adjustments. After the mini-game is completed, a short video explains various debt and investment payment methods with their benefits and costs, concluding with the optimal strategy.

🎯 **LEARNING GOAL 2:** Make investment allocation and debt payment decisions independent from the default and minimum payment options.

A great deal of research has shown that people are biased toward preserving their current state of affairs by choosing not to take action in a decision, even if it is against their best self-interest (Fosgaard, 2013; Samuelson & Zeckhauser, 1988; Johnson et al., 1993; Madrian & Shea, 2001; Johnson & Goldstein, 2003; Thaler & Benartzi, 2004). The first study to comprehensively document this phenomenon found that fewer than half of those invested in a CREF (stock) and TIAA (fixed income) plan in 1987 had ever changed their initial asset allocation, even though it is recommended that people close to retirement should have an allocation with lower risk. A series of randomized control experiments by the researchers bolstered evidence of the bias, including one in which participants were asked to invest an imaginary inheritance to a portfolio of their choice. Some participants were told that the inheritance was currently invested in one of the portfolios. The researchers found that participants were more likely to choose the portfolio currently invested in than those who were given a different default portfolio or no default at all (Samuelson & Zeckhauser, 1988).

In order to provoke status quo bias, this game has built-in defaults for each debt and investment option that are far from the optimal choice (similar to the minimum payment option provided by credit card companies.) If the player declines to change their pet's monthly allocations, the pet will make minimum payments on all debts and put the rest of their money into a low yield savings account. Furthermore, if a debt is paid off before 30 years have passed, the player can decline to re-allocate the money to another investment or debt and allow it to accrue in their pet's savings account. To increase their score, the player must overcome status quo bias within the game in order to allocate money to the highest interest option.

## TRANSLATING LESSONS INTO REAL-WORLD BEHAVIORS

One challenge for any educational intervention is ensuring that participants walk away with strong and stable memories of what they learned after the intervention is complete. According to a theory of memory and cognition called fuzzy-trace theory, humans encode two types of memory representations: verbatim and gist. Verbatim representations are short-lived memories that capture the fine-grained details of experience, whereas gist representations are long-lasting memories that capture overall meaning (Reyna, Rahimi-Golkhandan, & Helm, 2018). Educational interventions that emphasize rote memorization of facts risk teaching information through verbatim representations that are quickly forgotten (much like a student cramming for a test the night before). Therefore, the key to long-lasting learning is to ensure that participants are encoding the intended bottom-line meaning (e.g., gist) of the lessons. Prior work using fuzzy-trace theory has shown that adolescents who agree with “gist principles” such as “no risk is better than some risk” are less likely to report engaging in behaviors that violate those gist principles (Reyna & Wilhelms, 2017), suggesting that emphasizing such gist representations will make them more available in memory, and thus more likely to be retrieved when making decisions. Evidence supporting this comes from an adolescent health intervention on reducing sexual risk-taking which found that pairing traditional knowledge-based materials alongside messages emphasizing underlying gist principles led to larger improvements in behavior, attitudes and intentions than a traditional educational approach (Reyna & Mills, 2014).



**Narrative structures are useful for conveying gist, improving long-term retention of the lessons learned in the game.**

The Financial Lab uses two methods to aid participants in encoding the appropriate gist representations. First, each mini-game contains messages that summarize the content into simple, gist principles that relate to real-world behaviors. For example, Shopportunity Cost displays messages such as “Don’t forget—spending now means sacrificing later!” to instill the bottom-line gist of attending to opportunity costs. Second, the goals in each mini-game are integral to the overall narrative of the Financial Lab; the player is constantly reminded of their objectives as it relates to the pet’s in-game



needs. Narrative structures are useful for conveying gist (Reyna, Corbin, Weldon, & Brainerd, 2016), improving long-term retention of the lessons learned in the game.

After each mini-game, we also offer players the chance to translate insights from the game into real-world behaviors. For example, one post-game pop-up in Budget Buster provides players with an actionable step they can immediately take to overcome an early barrier to long-term saving habits:

### Budget Buster



Make a commitment to put at least 20% of the money you have into savings at the end of every month! Add a reminder to your phone now!

Aim for a goal of having at least \$500 in savings for emergencies!

Developing concrete plans to implement a new behavior increases the likelihood that this new habit of mind will stick (Duckworth et al., 2018). Furthermore, providing such suggestions immediately after the mini-game increases the chance of follow-through by acting as a “just-in-time” intervention.

# Conclusion

NOVA's Financial Lab is a financial game that puts psychology and behavior at the forefront of its design. Like other serious games, it provides players with the opportunity to learn through repeated experience with relevant financial situations. Unlike previous financial literacy games, the lab focuses on behavioral principles related to spending and saving. Whereas it includes standard conceptual elements common to financial literacy courses, as having knowledge about financial topics is important to understanding how to play the game, it seeks to go one step further and provide context for how to apply that knowledge with healthy financial behaviors. NOVA's Financial Lab uses a narrative structure beginning with a focus on the behaviors relevant to immediate spending, then budgeting for the near future, and finally, handling debt and long-term investments. Within each game, the player is provided with bottom-line principles that are meant to reinforce memory representations that can lead to better decision-making in the real world and given immediately actionable opportunities to engage in behaviors that will facilitate positive financial behaviors in the future. The NOVA Financial Lab will be available online to anyone who wants to access it (though it is targeted at adolescents), providing them with a rewarding, replayable experience that will improve both their understanding of financial topics, and their approach to the behavioral aspects of spending and saving money.

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