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Ambiguity Aversion and Experiential Learning: Implications for Long-Term Savings Decisions

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Abstract

This paper evaluates potential methods for reducing ambiguity surrounding returns on equity to improve long-term savings decisions. We evaluate 221 undergraduate students in the U.S. and first assess the degree of ambiguity aversion exhibited by individuals in the sample population as they decide between a *risky* (known probability) option and *ambiguous* (unknown probability) option pertaining to their chances of winning $0 or $1 in a hypothetical lottery. Allowing participants to experience the underlying probability through sampling significantly influences behavior, as participants were more likely to select the ambiguous option after sampling. Similarly, we test whether sampling historical return data through learning modules influences long-term decision making regarding asset allocation within a retirement portfolio. Here, we find that participants who receive interactive learning modules—which require users to manually alter the asset allocation to produce a sample of historical return data based on the specific allocation entered in the model—increase their post-learning equity allocations by 10.1% more than individuals receiving static modules. Interestingly, we find no significant evidence of ambiguity aversion playing a role in the asset allocation decision.

Keywords: Ambiguity aversion, stock market participation, experiential learning, retirement planning

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1. Introduction

While making long-term savings decisions, early asset allocation missteps can be detrimental to the overall future amount of savings amassed over time. According to financial theory, young investors should allocate a large portion of liquid wealth to risky assets, such as stocks, because they already have a significant investment in human capital which is a "bond-like" asset (Peijnenburg, 2018). However, the observed findings do not align with this theory. Empirical evidence shows that allocations to stocks are particularly low, especially among younger individuals (Peijnenburg, 2018).

Previous studies have shown that ambiguity aversion leads to the adoption of a more conservative (i.e. less stocks) investment strategy (Branger, Larsen, & Munk, 2013; Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016) and lower stock market participation (Cao, Wang, & Zhang, 2005; Easley & O'Hara, 2009; Peijnenburg, 2018; Takashi, 2011; Constantinos, Richard, & Harris, 2013). Ambiguity refers to the uncertainty that a random event will occur when probabilities of possible outcomes are not provided (Peijnenburg, 2018). According to Epstein and Schneider (2010), uncertainty about specific events can be reduced by learning and quality signals. To reduce ambiguity aversion, individuals should be allowed to experience probability distributions (Güney & Newell, 2014). Using an interactive probability "distribution builder" can provide an effective aid by helping people to, "construct, as opposed to state", their risk preferences for retirement income (Goldstein et al., 2008). Stewart et al. (2006) present a theory of

decision by sampling (DbS), where the sample reflects both the immediate distribution of attribute values (e.g. expected returns) from the current decision's context and by the real-world distribution of attribute values (e.g. historical returns). Additionally, Güney & Newell (2014) find that sampling the probability distributions will lead to more accurate inferences by participants about the probability of winning, which could influence future preferences.

Regarding current financial markets, Barton and Wiseman (2014) argue that a disproportionate amount of focus is placed on short-term performance, implying that long-term data is also important to financial decision-making. Thereby, the duration of investment performance data reported by financial service providers could be considered a measure of quality that impacts the ease of consumption of the data, conceivably translating into varying degrees of ambiguity reduction regarding stock market participation.

In our survey-based study, we are particularly interested in finding ways to improve the asset allocation decision for younger individuals entering the workforce. Our survey results show that individuals, while predominantly ambiguity averse, are heavily influenced by the provided small samples. Interestingly, we find no link between ambiguity aversion and more conservative asset allocation. Finally, our results show that interactive/experiential learning based on sampling previous historical returns can significantly increase equity allocation compared to showing individuals static samples.

2. Literature Review

Research has shown that the U.S. stock market has, over the course of the last century, yielded an average annual return that is nearly 7.0% higher than Treasury bills (Mehra & Prescott, 2003). Based on the expected utility model for long-term investors, the

equity premium over the risk-free asset suggests that investors exhibiting reasonable risk aversion should still participate in the stock market to benefit from higher average returns (Constantinos, Richard, & Harris, 2013). However, the Survey of Consumer Finances conducted by the Federal Reserve Board in 2013 revealed only 48.8% of U.S. households directly or indirectly own public equity (Bricker et al., 2014).

Although many factors likely impact decision making in regard to long-term savings decisions, scholars surmise that financial literacy is significantly related to the quality of investment decisions (Lusardi & Mitchell, 2014) and investment returns (Clark, Lusardi, & Mitchell, 2016). However, previous studies have reported that financial education seminars were too general and needed to be better tailored to accommodate specific learning preferences (Moore, 2003) and should be personalized to particular subsets of the population (Lusardi & Mitchell, 2014). Further, Fernandes, Lynch, and Netemeyer (2014) found that interventions intended to improve financial literacy explain only 0.1% of the variance in the studied behaviors. They conclude by proposing an alternative "just-in-time" learning method, which emphasizes financial education immediately before an individual is about to make an important savings or debt decision (Fernandes, Lynch, and Netemeyer, 2014).

Due to the apparent lack of financial literacy throughout the population (Hilgert & Hogarth, 2002), some employers have implemented financial education programs in the workplace (Lusardi & Mitchell, 2014). Employer-sponsored learning modules have been studied to determine whether they can improve financial decision-making (Dolvin & Templeton, 2006). According to Clark, Lusardi, and Mitchell (2016), implementation of a learning module—which addressed retirement spending needs, Social Security, personal

savings, and employer-specific offerings—positively influenced participation, contribution, and allocation within the defined contribution plan. Moreover, of those who participated in the learning module, employees were less likely to discontinue contributions to the defined contribution plan (Clark, Lusardi, & Mitchell, 2016).

These specific observations support the assumption that learning modules can improve employees' financial behaviors. However, we believe that further studies of important drivers of financial behavioral changes as well as the timing of the financial educational interventions should be analyzed. One potentially interesting way to segment the population is by the degree of ambiguity aversion.

Ambiguity refers to the uncertainty that a random event will occur when probabilities of possible outcomes are not provided (Peijnenburg, 2018). As Portnoy, Han, Ferrer, Klein, and Clauser (2013) suggest, individuals can display varying levels of tolerance for uncertainty which can be operationalized in terms of ambiguity aversion. Thereby, individuals with low tolerance for uncertainty are considered highly ambiguity averse. Ambiguity aversion is displayed through an avoidance of decision making, or a generation of overly pessimistic estimations of risk, due to risk information that is inadequate, conflicting, (Portnoy, Han, Ferrer, Klein, & Clauser, 2013) or difficult to interpret (Epstein & Schneider, 2010). Because an ambiguous option involves inadequate information regarding risk (Han, Reeve, Moser, & Klein, 2009), options for which the information set is more complete, and comprehensible, are considered risky (Epstein & Schneider, 2010).

Individuals exhibiting a high degree of ambiguity aversion favor events for which probabilities of potential outcomes are known (risky event/known probability) over events

for which probabilities are unknown (ambiguous event/unknown probability) (Ellsberg, 1961; Güney & Newell, 2014). In relation to the stock market, ambiguity regarding the equity premium can arise when investors have a lack of statistical or theoretical evidence, or are unsophisticated in terms of investing. Therefore, the degree of tolerance for uncertainty can influence an investor's behavior. Previous studies have shown that ambiguity aversion leads to the adoption of a more conservative asset allocation strategy (Branger, Larsen, & Munk, 2013; Dimmock, Kouwenberg, Mitchell, & Peijnenburg, 2016) and stock market participation (Cao, Wang, & Zhang, 2005; Easley & O'Hara, 2009; Peijnenburg, 2018; Takashi, 2011; Constantinos, Richard, & Harris, 2013).

Peijnenburg (2018) shows that when investors learn about the equity premium, and perceive the premium to be less ambiguous, stock market participation increases. Unfortunately, this leads to behavior that contradicts financial theory in two respects: 1) the young are investing too conservatively, and 2) aging investors are becoming increasingly aggressive over time.

According to Epstein and Schneider (2010), uncertainty about specific events can be reduced by learning and quality signals. In an experiment similar to the two-color Ellsberg (1961) task, Güney and Newell (2014) include four adaptations of the original ambiguous box alongside one risky box and evaluate whether sampling reduces ambiguity regarding the underlying probability of winning. Güney and Newell (2014) found that the risky box, with the known probability, was more likely to be selected in subsequent rounds when the participant's average experience resulted in a loss. Conversely, the ambiguous box (unknown probability) was more likely to be chosen in subsequent rounds when the participant's average experience resulted in a win (Güney & Newell, 2014).

Results indicate that allowing decision makers to experience ambiguous probability distributions through sampling, instead of description, can cause reductions in ambiguity aversion (Güney & Newell, 2014). Moreover, ambiguity related to the stock return process can be dispelled through experience with realized returns (Campanale, 2011). Güney and Newell (2014) also argue that probability distributions related to ambiguous events can be intuitively expressed to facilitate their use, which can reduce ambiguity.

As Epstein and Schneider (2010) suggest, the degree to which ambiguity is dissipated depends on the quality of the data provided. Regarding current financial markets, Barton and Wiseman (2014) argue that a disproportionate amount of focus is placed on short-term performance, implying that long-term data is also important to financial decision-making. Thereby, the duration of investment performance data reported could be considered a measure of quality that impacts the ease of consumption of the data, conceivably translating into varying degrees of ambiguity reduction regarding stock market participation.

The purpose of the study is to evaluate potential methods for developing educational tools that improve stock market participation among college graduates entering the workforce. We contribute to the literature by assessing whether experiential learning modules designed to reduce ambiguity can effectively improve financial decision-making as measured by an increase in the allocation to equity within the hypothetical retirement portfolio. This adds to the literature by supplying a link between studies that have assessed aspects of the issue in isolation: 1) the impact of ambiguity aversion on stock market participation, and 2) the effectiveness of learning modules and ease of data interpretation in improving financial decision-making. In this study, we examine whether experiential

learning modules can increase the asset allocation of young investors. Additionally, we evaluate whether the duration of return data provided (short-term vs. long-term data) influences decision making.

3. Experimental Design

In this study, we examine to what extent both the degree of ambiguity aversion and type of learning module impact financial decision-making related to retirement. We generated a survey consisting of two major components: a lottery designed to assess degree of ambiguity aversion and a learning module intended to improve financial decision-making pursuant to a hypothetical retirement portfolio. The experimental design involved a 4 x 4 analysis of manipulations to a 10-ball sample from the lottery and type of learning module. Manipulations for the independent variables were accomplished by varying the 10-ball sample administered to participants during the ambiguity aversion assessment and randomly assigning a learning module to each participant. Measurements of the effect of the number of winning balls present in the 10-ball sample were based on responses pertaining to these variables. Likewise, measurements of the impact of each type of learning module were based on responses to questions regarding asset allocation within the hypothetical retirement portfolio.

3.1 Subject and Procedure

We surveyed 221 undergraduate students enrolled across all majors at a mid-sized, private university in Indiana. Of the 221 participants that completed the survey, 65.6% identified as female and 34.4% identified as male, reflecting the composition of the overall student population. The ages of the participants ranged from 18-25 years old, with the average age of 20.36 years. Forty-eight percent of participants indicated that they had previously completed, or were currently enrolled in, a college-level finance course at the

time of participation in the study. This could have potentially skewed results as participants that had completed a finance course would have had preexisting exposure to return distributions. Fourteen percent of respondents specifically reported finance as their primary majors. Notably, over 50 unique majors were represented in the sample population, providing a more representative sample of the University.

Data collection was accomplished through an electronic questionnaire that was administered completely online. Initially, a brief assessment was conducted to determine the participant's inherent degree of tolerance for ambiguity which utilized a lottery with known (risky) and unknown (ambiguous) payout distributions. Participants were then instructed to construct a retirement portfolio consisting of stocks and bonds. Based on the condition to which the participant was assigned, each received one of four learning modules which contained graphic representations of historical return data on portfolios consisting of varying proportions of stocks and bonds. After completing the learning module, the participant could make changes to his desired asset allocation within the portfolio. Finally, a brief financial literacy test was conducted, and subjects were asked relevant demographic questions regarding educational background and debt. To incentivize completion of the survey, participants were given the option to voluntarily enter a random drawing to win one of 20 cash-equivalent gift cards worth $20 each.

3.2 Ambiguity Aversion Assessment and Lotteries

An assessment was conducted to isolate the point along the spectrum of ambiguity aversion on which each participant fell. In their studies, Dimmock, Kouwenberg, Mitchell, and Peijnenburg (2015); Portnoy, Han, Ferrer, Klein, and Clauser (2013) imply that individuals can display varying degrees of tolerance for ambiguity, which can be expressed

in terms of ambiguity aversion. Participants were initially given two options in regard to their odds of winning in the hypothetical lottery:

Option 1 (Risky)	**Option 2 (Ambiguous)**
50/50 chance of winning $0 or $1	Unknown probability of winning $0 or $1

It was explained that the unknown probability of winning (option 2) could be better or worse than the known, 50/50 chance presented in option 1. Selecting the known probability of winning over the unknown probability is a sign of avoidance or pessimism, which Portnoy, Han, Ferrer, Klein, and Clauser (2013) consider an indicator of ambiguity aversion.

After making the initial selection regarding odds of winning, participants were randomly assigned to one of four lottery conditions. The lottery was adapted from the experiment performed by Ellsberg (1961) and Güney and Newell (2014) in which participants were instructed to pick between several boxes containing specified and unspecified proportions of 100 colored balls as a means of assessing each subject's inherent degree of ambiguity aversion. In our experiment, participants were told that if a white ball was drawn, a prize of $0 was awarded. If a green ball was selected, a prize of $1 was awarded. Subjects assigned to the control group immediately moved on to the subsequent section of the survey, while those assigned to the remaining three conditions were shown a 10-ball sample drawn from the box containing all 100 balls. As Güney and Newell (2014) explain, sampling can dispel ambiguity by promoting more accurate inferences regarding the underlying probability of winning than generated through simple descriptions. The control group was used to determine whether viewing a sample from the lottery impacted financial decisions made in other sections of the survey. The content of the 10-ball sample

varied across the conditions: experiential negative sample contained four winning balls (N=53), experiential neutral sample contained five winning balls (N=58), and experiential positive sample contained six winning balls (N=59). See Appendix A for full visual details on this section of the experiment. A control group (N=51) did not view a sample and proceeded to the next section of the experiment.

In addition to functioning as a diagnostic tool, the ambiguity assessment allowed us to test whether participants' decisions were influenced by sampling. After viewing a sample, participants in the three experiential conditions were asked to estimate how many balls out of the total population of 100 balls were green (winning) to assess whether the subject was being attentive and determine if the sample influenced the participant's perception of the odds of winning $0 or $1 under the ambiguous scenario (option 2). Like Güney and Newell (2014), we presume that the participant's overall experience while sampling will impact behavior. We anticipate the sample in the experiential positive condition implies a higher underlying probability of winning if the ambiguous option is selected versus the 50/50 chance of winning under option 1. Conversely, we presume that the sample in the experiential negative condition implies a lower underlying probability of winning under the ambiguous option (2) as compared to the risky option (1). After viewing the sample, the degree of tolerance for ambiguity was further examined. Participants were given the opportunity to maintain or change their original selections regarding the probability of winning.

3.3 Hypothetical Retirement Portfolio

Following the ambiguity aversion assessment, participants were asked questions pertaining to saving for retirement as a baseline for evaluating pre- and post-learning

module behavior. All subjects were first presented with basic information about employer-sponsored 401(k) plans and an explanation of a company match. Next, participants were presented with basic descriptions of two major asset classes: stocks and bonds (see Appendix B). Descriptions of the assets and investment products were adapted from information offered to investors by the U.S. Securities and Exchange Commission's Office of Investor Education and Advocacy (n.d.). The information provided was intended to give a basic description of the important principles associated with retirement planning and saving without overwhelming the subjects. Participants were then asked to indicate the percentage of their hypothetical retirement portfolios they would allocate, in their first year of saving for retirement, to each investment type: stocks and bonds. We utilized the initial asset allocation to determine the subject's inherent bias toward, or against, equity which involves ambiguous returns (Cao, Wang, & Zhang, 2005; Easley & O'Hara, 2009; Takashi, 2011; Constantinos, Richard, & Harris, 2013). According to the literature, participants that exhibit an initially high degree of ambiguity aversion will have low allocations to equity within the portfolio. Data collected from the initial construction of the portfolio will provide a baseline to analyze changes in the post-learning equity allocation among learning conditions.

3.4 Learning Modules

After making the initial allocation decision for the hypothetical retirement portfolio, participants were randomly assigned to one of four learning module types outlined in Table 1:

Table 1. Group Breakdown of Participants, based on Learning Module

Overall Sample (N=221)	**Long-term Data (N=105)**	**Short-term Data (N=116)**
Static Chart (N=113)	(1) Long-term Data, Static Chart (N=54)	(2) Short-term Data, Static Chart (N=59)
Interactive Chart (N=108)	(3) Long-term Data, Interactive Chart (N=51)	(4) Short-term Data, Interactive Chart (N=57)

Note: We only evaluate completed surveys in our analysis, resulting in a similar, but not identical, number of participants in each group.

Manipulating the types of learning modules allows us to determine whether short-term or long-term data, in combination with the mode of learning (static or interactive charts) dispels ambiguity regarding equity returns and, thereby, improves willingness to participate in the stock market. Both learning modules that utilized long-term data presented average yearly returns for the S&P 500 and U.S. 10-year Treasury bonds from 1928-2016. Alternatively, learning modules that utilized short-term data only included annual return data from 2007-2016. Although Epstein and Schneider (2010) find that learning can reduce ambiguity, they argue that quality of the data and ease of interpretation is also important to dispelling ambiguity. In our study, we use the duration of the return data provided in the learning modules as a measure of quality. Presumably, other factors controlled, a more comprehensive set of historical data that covers a longer time period is of higher quality than a data set covering a narrowly defined period. We examine whether differences in the post-learning equity allocation emerge between those that received short-term data and those that viewed long-term data within the learning modules.

Within our study, we also examine whether learning modules that contain static descriptions or allow for experiential sampling elicit different responses from participants. As Güney and Newell (2014) suggest, sampling data is more effective at reducing ambiguity than simply describing data. The static learning modules (1 and 2) contained five static charts that depicted the average historical returns to five unique portfolios

consisting of different allocations to stocks and bonds (see Appendices C and D): 1) 100% stocks, 2) 75% stocks and 25% bonds, 3) 50% stocks and 50% bonds, 4) 25% stocks and 75% bonds, and 5) 100% bonds. The charts indicated both the highest and lowest average return that occurred within the period. In addition, the average overall return on the portfolio during the entire period is denoted on the graphics.

Alternatively, subjects assigned to the conditions featuring interactive charts (3 and 4) were provided with an Excel file that contained one graph that could be manipulated by the participant (see Appendices E and F). Participants were instructed to input five unique values for the allocation to stocks within a hypothetical retirement portfolio composed entirely of stocks and bonds to mimic physically sampling the return data. The Excel model automatically determined the resultant allocation to bonds within the portfolio—once the equity allocation was input into the model—using the equation: (1 – % Allocated to Stocks) = % Allocated to Bonds. After specifying an allocation to equity, the graphic within Excel updated to reflect the historical yearly returns for a portfolio composed of the specific proportion of stocks and bonds designated by the participant. This process allowed the subject to experience underlying returns by sampling five unique portfolio compositions, and witness how altering the allocation to stocks and bonds would impact the risk and return characteristics of the portfolio, thereby reducing ambiguity. To ensure the participants that completed interactive learning modules sampled the exact same number of unique portfolios as subjects assigned to the static learning modules viewed, the individuals were required to report the five unique values selected for the equity allocation, and the corresponding average overall return for the resultant portfolio, within the electronic survey form.

The method differed from previous studies by allowing participants to experience returns to portfolios composed of varying allocations to stocks and bonds. Providing an opportunity to experience how adjustments to the asset allocation could impact the average return of the portfolio was a means of reducing the ambiguity associated with the behavior of stocks and bonds. Through an analysis of the responses, we were able to determine whether those that interacted with the more fluid, experiential model and experienced varying returns on the hypothetical retirement portfolio perceived the data as ambiguity reducing and increased stock market participation, measured by the allocation to stocks within the portfolio.

After reviewing the learning module materials, each participant was instructed to reconsider his initial asset allocation within the hypothetical retirement portfolio. Variances between the initial and revised asset allocation were analyzed to determine whether the type of learning module effectively reduced ambiguity regarding stock market participation as measured by an increase in the post-learning equity allocation. To supplement the analysis, we also examine whether the participant's exhibited degree of initial ambiguity aversion mediates the impact of the learning modules.

3.5 Financial Literacy and Retirement-Saving Savvy

Participants were asked to complete a series of demographic questions and a six-question financial literacy test (shown in Appendix G). Questions used in the financial literacy assessment were adapted from Lusardi and Mitchell (2007) and Clark, Lusardi, and Mitchell (2016).

3.6 Variable Descriptions

The variables used in the analysis are as follows:

Variable:	**Description:**
Dummy Variables	
Female	Sex of survey participant
Long-Term Data	Long-term average annual return data was provided
Experiential	Experiential (interactive) learning module was administered
Control Group	Group that did not receive an ambiguity intervention
Finance Course	Respondent had completed (or is currently enrolled in) a college-level finance course
Other Variables	
Financial Literacy	Percent of questions answered correctly on financial literacy test
Debt (in thousands)	Amount of debt (in thousands of dollars) the respondent anticipates by graduation

Note: The table describes the dummy variables and other variables utilized in the analysis. For all dummy variables, "0" indicates "no", and "1" indicates "yes". For example, *Long-Term Data* equals "1" signifies that the participant received a learning module that featured long-term annual average return data instead of short-term return data.

4. Hypotheses and Empirical Results

4.1 Degree of Ambiguity Aversion and Reaction to 10-Ball Sample

We sought to confirm findings from previous literature by testing whether the subjects of our research were inherently ambiguity averse. We find that, overall, 79.1% of respondents initially selected the known, 50/50 probability over the unknown probability. This is consistent with findings from previous research—in which Dimmock, Kouwenberg, Mitchell, and Peijnenburg (2015) find the majority of the sample population is ambiguity averse or ambiguity neutral—and serves as a basis for our condition-specific hypotheses. We anticipate that the composition of the samples corresponding with the various experimental conditions will elicit different responses from participants regarding selection of the risky (50/50 probability) or ambiguous (unknown probability) option. Formally we derive:

Hypothesis 1(a): Participants assigned to the experiential negative condition will be more likely to select the ambiguous option after viewing the 10-ball sample.

The hypothesis is grounded in the assumption that subjects will be influenced by the sample and will generalize the results from drawing the sample across the entire population. Of the 53 subjects assigned to the condition, there was a 5.7% reduction in the number of subjects who selected the risky option after sampling. This implies subjects perceived the situational ambiguity as less than prior to viewing the sample. We conduct a paired-samples t-test to compare the selection of the risky or ambiguous option made prior to, and following, sampling. Table 2 displays data from the paired samples t-test for each of the lottery conditions. For the experiential negative condition, we find the difference between the subjects' selections made prior to viewing the sample (M=0.75) and selections made after viewing the sample (M=0.70) is not significant; $t(53)=1.77$, $p = 0.08$. Therefore, we cannot reject the null hypothesis. It is not surprising that the reduction in ambiguity was not significant, as 84.9% of participants assigned to the experiential negative condition estimated the entire population of balls contained exactly 40 winning balls. Due to the design of our study, selecting the risky option (1) after sampling would be considered an indicator of ambiguity aversion. It is reasonable to assume that participants who believe the lottery only contains 40 winning balls would select option (1) after sampling to secure the guaranteed chance of winning that is superior to the perceived odds under the ambiguous option (2). Without testing the strength of the subjects' preference for one option over the other, we can surmise that the participants were indifferent to the ambiguous option as they had the opportunity to select the known, 50/50 probability, giving

them a guaranteed probability of winning that was superior to the odds most participants perceived they had if they were to pick the ambiguous option after sampling.

Conversely, we anticipate that subjects assigned to the experiential positive group will perceive the odds of winning to be higher than 50/50 after viewing six winning balls in the sample of 10, reducing ambiguity. Thereby, participants will be more inclined to select the ambiguous option after sampling. Formally, we derive:

Hypothesis 1(b): Participants assigned to the experiential positive condition will be more likely to select the ambiguous option after viewing the 10-ball sample.

We find a 35.6% reduction in the number of subjects that changed their selections from the risky option to the ambiguous option after seeing a sample containing six winning balls. For the experiential positive condition, we find a significant difference between the selection made prior to viewing the sample (M=0.78) and the selection made after viewing the sample (M=0.42); $t(59)=5.66$, $p = <0.0001$. Based on the findings, we conclude that the participants' assigned to the experimental positive condition perceived there to be a significant reduction in ambiguity after sampling.

Similarly, we hypothesized the group assigned to the experiential neutral condition, which saw a sample containing five winning balls out of 10, would behave in a way that reflects a reduction in ambiguity. Our intuition it that the sampling would dispel uncertainty regarding the underlying probability, creating the perception that the odds of winning option 2 were comparable to the 50/50 chance under option 1.

Hypothesis 1(c): Participants assigned to the experiential neutral condition will be more likely to select the ambiguous option after viewing the 10-ball sample.

Table 2 shows the experiential neutral group saw a 12.9% reduction in ambiguity even though most estimated that the population only contained 50 winning balls. It is possible that participants assigned to this condition were indifferent to the risky and ambiguous options, as they expected their odds to be 50/50 under the ambiguous option. Regardless, the reduction in ambiguity was significant at the $p < 0.01$ level. Subjects in all three conditions experienced a reduction in ambiguity aversion, which was significant in both the experiential neutral ($p < 0.01$) and experiential positive ($p < 0.001$) conditions.

Table 2. Paired Samples T-Test for Lottery Conditions

Pair	Mean	Std. Dev.	N	t	Sig. (2-tailed)
Ex. Negative Pre-Sample	0.7547	0.4344	53	1.7664	H1a.
Ex. Negative Post-Sample	0.6981	0.4635			0.0832
Ex. Neutral Pre-Sample	0.8793	0.3286	58	2.7971	H1c.
Ex. Neutral Post-Sample	0.7586	0.3548			0.0070**
Ex. Positive Pre-Sample	0.7797	0.4180	59	5.6615	H1b.
Ex. Positive Post-Sample	0.4237	0.4482			<0.0001***
Control Group Pre-Sample	0.7254	0.4507	51	NA	

Note: This table displays results of a paired samples t-test performed to determine whether the mean difference between the pre- and post-sample selections is zero.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

Our findings in Table 3 show that selection decisions were heavily influenced by the small sample of 10 balls. The majority of participants (80.6%) estimated the overall number of green (winning) balls out of 100 based on their experienced sample multiplied by a factor of 10. Because participants' decisions were greatly influenced by the sample, we sought to determine whether individuals forced to make long-term decisions, regarding the allocation of funds within a retirement portfolio, would be impacted in a similar way after viewing a sample of portfolio return data.

Table 3. Descriptive Statistics of Participants' Estimates of Green (Winning) Balls out of 100.

			Estimate of Participant compared to their view sub-sample		
Group	*N*	*Mean*	*Less Than*	*Equal To*	*Greater Than*
Negative Sample (4 of 10)	53	37.91	(<40) 9.4%	(=40) 84.9%	(>40) 5.7%
Neutral Sample (5 of 10)	58	47.05	(<50) 8.6%	(=50) 87.9%	(>50) 3.5%
Positive Sample (6 of 10)	59	54.53	(<60) 30.51%	(=60) 64.5%	(>60) 0.0%
Overall Sample	170	48.80	16.5%	80.6%	2.9%

Note: This table displays results of the estimates of participants' of how many green (winning) balls out of 100 believed to be in the ambiguous sample after viewing a random 10-ball sub-sample. Sub categories are based on the individuals estimates compared to their view sub-sample multiplied by a factor of 10.

4.2 Ambiguity Aversion and Initial Stock Allocation

We next examine whether the exhibited degree of ambiguity aversion impacts the initial stock allocation within the hypothetical retirement portfolio. Based on previous literature, we anticipate a high degree of ambiguity aversion will be negatively associated with the initial equity allocation (Peijnenburg, 2018). Formally:

Hypothesis 2: Participants considered ambiguity averse will select lower initial equity allocations compared to participants that are considered ambiguity seeking.

Participants that initially selected the risky option (1) in the ambiguity aversion assessment were considered ambiguity averse, while those that selected the ambiguous option (2) were considered ambiguity seeking. As Table 4 shows, our findings are in conflict with the literature as we do not find a difference in the initial stock allocation between those that are ambiguity averse and participants that are ambiguity seeking.

Table 4. Two-Sample T-Test for Impact of Degree of Ambiguity Aversion on Initial Equity Allocation

Variable	**Ambiguity Averse** *Mean*	**Ambiguity Seeking** *Mean*	*Difference*
Initial Equity Allocation	53.90	54.62	0.71
N	174	47	

Note: This table displays results of a two-sample t-test performed to determine whether the mean difference between the ambiguity averse and ambiguity seeking participants' initial equity allocations within the hypothetical retirement portfolio is zero.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

We conducted a regression analysis to further examine the lack of difference between the initial equity allocation selected by the ambiguity averse and ambiguity seeking. As shown in Table 5, we analyze specific variables including the initial degree of ambiguity aversion (prior to sampling from the lottery), sex, financial literacy, completion of a finance course, and debt. Within the sample population, 39.5% indicated they had no personal debt. Of those that reported having debt, the anticipated amount of debt they would accumulate by graduation from the university was, on average, $30,605 (SD = $41,773; Min. = $0; Max = $180,000). We include financial literacy and previous experience with a finance course as variables in the regression (separately in Models 1 & 2 and together in Model 3) to determine if a preexisting exposure to financial education influenced the initial allocation decision. In Models 4 and 5, we add the control group as a dummy variable in order to assure that the first section of the experiment did not influence the initial equity decision in either direction.[1]

[1] We did not anticipate any influence or spillover effects from the previous section, but wanted to include it in the analysis in order to dispel any doubts or questions that the ambiguity treatments played a role in the overall results.

Overall, we find that financial literacy influences the initial allocation, but not significantly so. In Model 1, we find that those identifying as males allocate more to equity than females. The lack of difference between the initial asset allocation selected by the ambiguity averse and ambiguity seeking cannot be attributed to a participant's degree of ambiguity aversion, sex, or debt exposure. We ultimately find that completion of a finance course significantly increases the initial equity allocation by 10.60-10.94%, overriding any effect the participant's initial degree of ambiguity aversion would have on the allocation decision.

Table 5. Regression Model Results – Impact on Initial Equity Allocation

Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Ambiguity Averse	-0.54	-0.20	-0.67		-0.46
Male	6.53*	3.07	2.70	2.82	2.76
Financial Literacy	9.02		7.24	6.98	7.08
Finance Course		10.94***	10.67 ***	10.60***	10.60***
Debt (in thousands)	-0.02	-0.04	-0.00	-0.00	-0.00
Control Group				2.67	2.64
Constant	47.83***	47.94***	44.52***	43.57***	43.93***
N	221	221	221	221	221
Adjusted R-Squared	0.013	0.075	0.058	0.060	0.056

Note: This table displays the results of a regression analysis on the key variables listed to determine the various drivers of the initial equity allocation.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$

We recognize that the proportion of individuals in our sample that have completed finance coursework is artificially high, compared to the overall U.S. population, because the study solely involved undergraduate students.

4.3 Static and Interactive Learning Modules

Based on the statistical analysis of the lottery conditions in section 4.1, we determined that participants were heavily influenced by the samples of data provided. Next, we examine whether these findings translate to long-term financial decisions. Like the lottery conditions, participants were asked to allocate funds within a hypothetical

retirement portfolio between stocks and bonds. After selecting the initial equity allocation within the learning module, participants were shown a sample of historical return data that corresponded with specific portfolio allocations. We examine whether ambiguity was reduced after viewing the sample of return data, as measured by the post-sample equity allocation. Participants were assigned to either static or interactive learning modules. We anticipate that experiencing historical returns on portfolios composed of varying amounts of stocks and bonds will reduce the ambiguity associated with stock market participation. Further, we expect participants that are assigned to an interactive learning module will have a more robust experience and, thereby, will display a more profound reaction to the module (Kolb, 1984; Specht & Sandlin, 1991; Gosen & Washbush, 2004). Thus:

> *Hypothesis 3: Participants assigned to interactive learning modules will exhibit a greater increase to equity following completion of the learning module in comparison to those that receive static modules.*

In Table 6, we find evidence to support that interactive learning modules elicit a greater change in the allocation to equity than do static learning modules. We conduct a two-sample t-test to analyze the reactions to static and interactive learning modules due to the difference in the number of observations between participants assigned to static and interactive conditions. Five subjects did not comply with the instructions for inputting five unique allocations to equity and reporting the resultant average portfolio return while completing the interactive module. Additionally, one subject indicated that he would not participate in an employer-sponsored 401(k) if available. Therefore, we removed six sets of data from the sample. Participants assigned to interactive learning modules displayed a 13.56% increase in allocation to equity following completion of the module compared to

those that completed the static modules and displayed only a 2.96% increase in allocation to equity. As shown in Table 6, the results of the two-sample t-test indicate the difference in the increase in allocation to equity following completion of a static learning module compared to the increase in allocation to equity following completion of an interactive learning module is statistically significant at (t=3.92) p = <0.001. Participants that received interactive learning modules exhibited greater increases to their post-sampling equity allocations than did subjects who received static learning modules.

Table 6. Two-Sample T-Test for Static and Interactive Learning Modules

Samples	N	Before Stock %	After Stock %	Mean	Std. Deviation	t	Sig. (2-tailed)
Overall	221	54.05	62.20	8.14	.2337	3.72	0.002***
Static Learning Module	113	52.26	55.22	2.96	.2266	-0.98	0.3264
Interactive Learning Module	108	55.94	69.50	13.56	.2328	4.47	<0.001***
Within Group Difference (H3)				10.60		3.92	<0.001***

Note: This table displays results of a two-sample t-test performed to determine whether the mean difference between the change in equity allocation within the hypothetical retirement portfolio exhibited by those that completed a static or interactive learning module is zero.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

To further examine potential drivers of the significant difference in post-learning module equity allocation changes between those that received static or interactive learning modules, we utilized a two-sample t-test. In one test, we analyzed the impact of sex on the decision to alter the allocation to equity. Table 7 displays results of the analysis. We found that females exhibited a 4.26% higher increase in post-equity allocation compared to male participants, but the stock changes were not significantly different. This could be partially explained by the observation that 70.0% of finance majors in our sample are male. Therefore, a disproportionate number of male participants would, conceivably, exhibit a

smaller change to the post-learning equity allocation as they were likely familiar with concepts regarding asset allocation due to their finance coursework and were equipped to initially make an educated allocation decision.

Table 7. Two-Sample T-Test for Impact of Sex on Change in Equity Allocation

	Female	**Male**		
Variable	*Mean*	*Mean*	*Difference*	*Sig. (2-tailed)*
Stock Change	9.653	5.395	-4.258	0.149
Std. Deviation	21.442	19.366		
N	145	76		

Note: This table displays results of a two-sample t-test performed to determine whether the mean difference between females' (1) and males' (0) change to their post-learning equity allocations within the hypothetical retirement portfolio is zero.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

We analyzed whether taking a college-level finance course impacted participants' decisions to shift their equity allocations after completing the learning module. Table 8 shows that subjects who indicated they had not enrolled in a college-level finance course showed a 1.95% greater increase in equity allocation after completing a learning module, but this difference was not significant.

Table 8. Two-Sample T-Test for Impact of Finance Course on Change in Equity Allocation

	Finance Course	**No Finance Course**		*Sig. (2-*
Variable	*Mean*	*Mean*	*Difference*	*tailed)*
Stock Change	7.162	9.113	1.951	0.488
N	105	116		

Note: This table displays results of a two-sample t-test performed to determine whether the mean difference in changes to the post-learning equity allocation between those that had taken a finance course (1) and had not enrolled in a finance course (0) is zero.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

In order to obtain a more robust measure of the population's financial literacy, we also examined participants' scores on the financial literacy assessment. Results of the assessment are presented in Table 9. The average score on the assessment was 65.4%. This score is consistent with responses obtained in a financial literacy assessment, conducted by

Hilgert and Hogarth (2002), in which participants could correctly answer only two-thirds of the questions.

Table 9. Results of Financial Literacy Assessment

# of Correct Answers	0	1	2	3	4	5	6
Count of Participants	2	14	29	36	47	59	34
Percent of Total (N=221)	0.90%	6.33%	13.12%	16.29%	21.27%	26.70%	15.38%

Note: This table displays the results of the six-question financial literacy assessment administered to study participants. For example, two participants correctly answered zero of the six questions, and 12 participants correctly answered one of the six questions.

Two competing factors likely contributed to the difference in post-learning module equity allocations observed between the subgroups that had, and had not, completed a finance course. For those that had completed a finance course, the learning modules could have served as a refresher of financial principles. Perhaps the financially literate participants could more easily consume the data provided in the learning modules, contributing to a greater increase in post-equity allocation than those that did not as easily understand the modules. Alternatively, the financially literate participants may have anchored to their pre-sample equity allocations, as they were prepared to initially make an educated allocation decision. Thereby, this subgroup's decisions may have been less influenced by the learning modules, explaining the lower post-learning equity allocation change as compared to the change exhibited by the group that had not taken a finance course.

We further examine potential drivers of the significant difference in post-sample equity allocations reported by those that received static or interactive learning modules by performing a regression analysis. As shown in Table 10, we analyze specific variables,

including sex, financial literacy, ambiguity aversion, and debt to identify contributing factors to the significant difference in the change to post-learning module equity allocations between static and interactive conditions. We include financial literacy and experience taking a finance course as additional variables in the regression. In Model 3, we include the control group from the first part of the experiment that didn't receive an ambiguity reduction treatment.

Table 10. Regression Model Results – Impact on Change in Equity Allocation

Variable	*Model 1*	*Model 2*	*Model 3*
Female	4.457	4.359	4.389
Financial Literacy	9.808	9.596	9.676
Ambiguity Aversion		-0.887	-1.025
Experiential	10.135***	10.023***	10.120***
Finance Course	-2.518	-2.717	-2.690
Debt (in thousands)	-0.011	-0.014	-0.012
Control Group			-1.763
Constant	-0.210	0.766	1.130
N	221	221	221
Adjusted R-Squared	0.074	0.067	0.064

Note: This table displays the results of a regression analysis on the key variables listed to determine the various drivers of the post-learning module equity change decision.
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$

Ultimately, we found that the significant difference in changes made to equity allocations following the learning module cannot be attributed to participants' sex, debt, or financial literacy. We conclude that completion of an experiential learning module significantly increases post-learning module equity allocations by 10.02-10.14% more than the static learning module.

4.4 Long-Term and Short-Term Return Data

We further examine whether differences emerge between reactions to long-term and short-term data by studying the decisions regarding portfolio allocation following completion of the learning modules. To do so, we analyze whether participants that viewed

long-term return data exhibited a greater change to their initial portfolio allocations than those shown short-term return data.

We conduct a two-sample t-test to analyze the reactions to long-term and short-term data due to the difference in the number of observations between participants assigned to long-term and short-term conditions. On average, those that viewed long-term data increased the initial equity allocation within the hypothetical retirement portfolio by 10.03% while those that viewed short-term data only increased the allocation to equity by 6.06% after completing the learning module. As illustrated by Table 11, the results of the t-test indicate the difference in the increase to equity following completion of the learning module between those that viewed long-term data and participants that received short-term data is not statistically significant at t=1.43; p = 0.156.

Table 11. Two-Sample T-Test for Long-Term and Short-Term Return Data

Samples	Mean	N	t	Sig. (2-tailed)
All Long-Term Data	10.03	116	5.20	<0.001***
All Short-Term Data	6.06	105	3.01	0.003**
Difference	3.98		1.43	0.156
Short-Term Static	1.28	54	0.53	0.595
Long-Term Static	4.51	59	1.93	0.058
Short-Term Interactive	11.12	51	3.52	<0.001***
Long-Term Interactive	15.75	57	5.38	<0.001***

Note: This table displays results of a two-sample t-test performed to determine whether the mean difference between the equity allocation change exhibited by those that saw long-term or short-term data is zero.
* significant at p < 0.05; ** significant at p < 0.01; *** significant at p < 0.001.

4.5 Effect of Learning Modules and Degree of Ambiguity Aversion

In our analysis, we have found that the completion of an experiential learning module elicits a greater change in the post-learning equity allocation than completion of a static learning module. To further explain this difference, we test whether ambiguity aversion mediates the relationship between the type of learning module and post-learning equity allocation change. As Snow (2010) suggests, data that dispels ambiguity is of

increasingly greater value to decision makers that exhibit a greater degree of ambiguity aversion. Formally, we hypothesize:

> *Hypothesis 4: Participants that display an initial ambiguity aversion will exhibit a greater post-learning equity allocation change after completing an experiential learning module than those classified as ambiguity seeking.*

We analyze whether the effectiveness of the type of learning module depends on the participant's inherent degree of ambiguity aversion, as determined by responses to the ambiguity assessment. Results of the two-tailed t-test are presented in Table 12:

Table 12. Two-Sample T-Test for Degree of Ambiguity Aversion (A.A.) and Impact of Learning Modules

		All Modules	**Static Module**	**Experiential Module**	
Degree of A.A.	*Variable*	*Mean*	*Mean*	*Mean*	*Difference*
Ambiguity Seeking	Stock Change	7.49	1.00	14.86	13.86**
	DF	47	25	22	
Ambiguity Averse					
	Stock Change	8.32	3.40	13.23	9.71**
	N	174	88	86	
	Difference	-0.83	-2.52	1.63	
	t	-0.24	-0.63	0.30	

Note: This table displays results of a two-sample t-test performed to determine the mean difference in post-learning stock change between subgroups that received static and experiential learning modules is zero. We compare the observed mean difference among individuals that displayed a low degree of ambiguity aversion ("Ambiguity Seeking") and high degree of ambiguity aversion ("Ambiguity Averse").
* significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

Our analysis shows that, overall, those who were initial ambiguity averse increased their equity allocation by 0.83% more than those who were ambiguity seeking, though not statistically significantly so. Ambiguity aversion does not appear to play a significantly role in the increase of stock allocation, while the experiential module continues to significantly drive the increase in equity allocation.

5. Discussion and Limitations

Through our analysis, we find that participants were strongly influenced by sampling data both during completion of the ambiguity assessment and construction of the asset allocation in their retirement portfolio. Consistent with findings from previous studies, experiencing underlying probabilities through sampling effectively reduced ambiguity regarding the odds of drawing a winning ball from a lottery and the probability of earning a positive return on an investment portfolio which influenced decision making. However, we do not find a difference in the initial equity allocation between individuals that are ambiguity averse and those that are not, which conflicts with previous literature. Participants that completed an experiential learning module exhibited statistically significant increases to post-learning equity allocations compared to those that viewed static charts. The fluid nature of the interactive modules allowed participants to engage with the portfolio return data and modify inputs based on their curiosities. Requiring participants to manually report the five unique stock allocations input into the module, along with the module's outputs for overall average portfolio returns, likely made subjects more aware of the correlation between the proportion of equity within the portfolio and corresponding average portfolio returns. In the future, developers of financial education tools could incorporate interactive elements that allow participants to sample portfolio returns which, we show, can effectively reduce ambiguity. Our study supports Campanale (2011) and Güney and Newell (2014) that sampling data by altering the portfolio allocation and viewing historical returns reduces the ambiguity associated with stock returns, thereby increasing stock market participation. These results remain robust when short-term (10 years) and long-term historical returns are provided. Peijnenburg (2018) argues, and we observe, that allocations to equity are especially low among young adults. Results from our

study suggest that improving educational tools by incorporating interactive elements that allow users to experience stock returns can improve financial decision-making and equity allocations. Ultimately, improving long-term savings decisions at a relatively young age will provide a stronger foundation for a healthy financial future. Based on our findings, increasing the equity allocation by 10.1% at age 22 would result in a 5.1% increase in monthly income in retirement[2] (Vanguard, 2017).

While our study has important implications for long-term savings decisions, the applicability of our findings should be considered. Study participants were asked to answer questions pertaining to a hypothetical retirement portfolio. Responses elicited from subjects may differ from behavior exhibited when investing real money in a retirement portfolio. Because the study was conducted at a private university, the sample surveyed is not entirely representative of the U.S. population in regard to demographics such as income, sex, and education. Therefore, the results should not necessarily be generalized across the entire population. However, the results could conceivably be used to inform the development and implementation of long-term savings and retirement planning education for recent college graduates entering the workforce.

A possible limitation of the current study is our assumption that a high allocation to equity is better than a low allocation to equity for all young investors. During the survey,

[2] We utilize the Vanguard Retirement Income Calculator and assume the individual is currently 22 years of age, makes $50,000 a year, saves 6% of his salary annually for retirement, has $0 already saved for retirement, needs to replace 80% of his income, and plans to retire at age 65. Initially, we assume a portfolio composed of 50% stocks and 50% bonds which, based on the historical, long-term average annual return data included in our Excel model, would earn an average annual return of 7.78%. We then increase the equity allocation by 10.1%, resulting in a portfolio composed of 55% stocks and 45% bonds, which we expect to earn an average annual return of 8.01%. These expected annual return values were entered in the Vanguard calculator to estimate the individual's expected monthly income in retirement. We then calculate the percent change on the two, expected monthly income values output by the Vanguard model which results in a 5.1% increase in monthly retirement income.

participants were not asked questions regarding tolerance for risk which could have impacted the participant's optimal portfolio allocation. However, in developing a generalized standard against which we could compare participants' behavior regarding portfolio allocation, we considered a couple of factors. First, we restricted the study population to undergraduate students attending a mid-sized university. Overall, 94.0% of participants reported they were 18-22 years old. At a young age, a high equity allocation within the retirement portfolio is generally considered good. Second, we examined the portfolio allocations within target date funds at Fidelity Investments (called Freedom Funds) expiring in 2040 (FFFFX), 2050 (FFFHX), and 2060 (FDKVX) (Fidelity, 2017). The average allocation to equity (including domestic and international equity funds) across all three lifecycle funds is 93.3%. These observations suggest it is appropriate for the participants in our study to devote the greatest proportion of their retirement funds to equity.

6. Conclusion

This paper evaluates potential methods for reducing ambiguity surrounding returns on equity to improve long-term savings decisions. We find that decision-making related to ambiguous and risky options can be substantially influenced by experiential learning. Allowing participants to experience the underlying probability through sampling significantly influences behavior, as participants were more likely to select the ambiguous option after sampling. Similarly, we test whether sampling historical return data through learning modules influences long-term decision making regarding asset allocation within a retirement portfolio. Sampling underlying probability distributions provides easy-to-interpret signals which can lead to the formation of more accurate estimations regarding

the risk and return characteristics of equity, reducing ambiguity. Our study supplements previous literature, providing a link between research on the effect of ambiguity on stock market participation and implementation of educational programs to improve the asset allocation decision for young adults. We find that participants who receive interactive learning modules—which require users to manually alter the asset allocation to produce a sample of historical return data based on the specific allocation entered in the model—increase their post-learning equity allocations by 10.1% more than individuals receiving static modules. We hope that the results of our analysis could prompt financial service providers and employers to utilize financial education tools, which incorporate experiential learning, to promote long-term savings decisions that improve the asset allocation of young adults entering the workforce.

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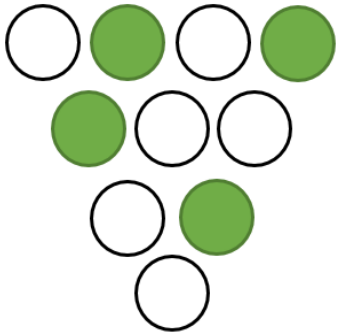
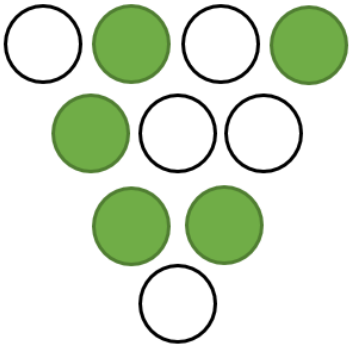
Appendix A

10-Ball Samples from Lottery

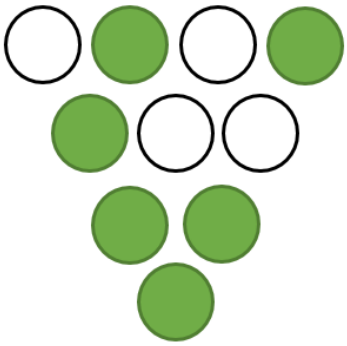
1) Experiential Negative Sample



2) Experiential Neutral Sample



3) Experiential Positive Sample



Appendix B

Descriptions of Stocks and Bonds

Please read the following descriptions of two major asset classes: stocks and bonds.

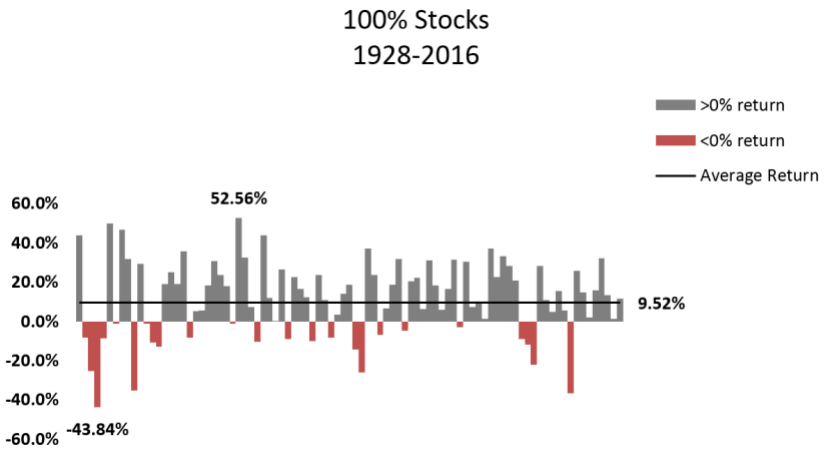
STOCK: “Stocks are a type of security that gives stockholders a share of ownership in a company. Stocks are also called “equities”. Stock prices move down as well as up. There is no guarantee that the company whose stock you hold will grow and do well, so you can lose money you invest in stocks.”

BOND: “A bond is a debt security. Borrowers issue bonds to raise money from investors willing to lend them money for a certain amount of time. When you buy a bond, you are lending to the issuer, which may be a government, municipality, or corporation. In return, the issuer promises to pay you a specified rate of interest during the life of the bond and to repay the principal when it ‘matures’, or comes due after a set period of time. Investors buy bonds because they provide a predictable income stream. Bonds carry certain risks which include the issuer failing to make payments and defaulting on its bonds.”

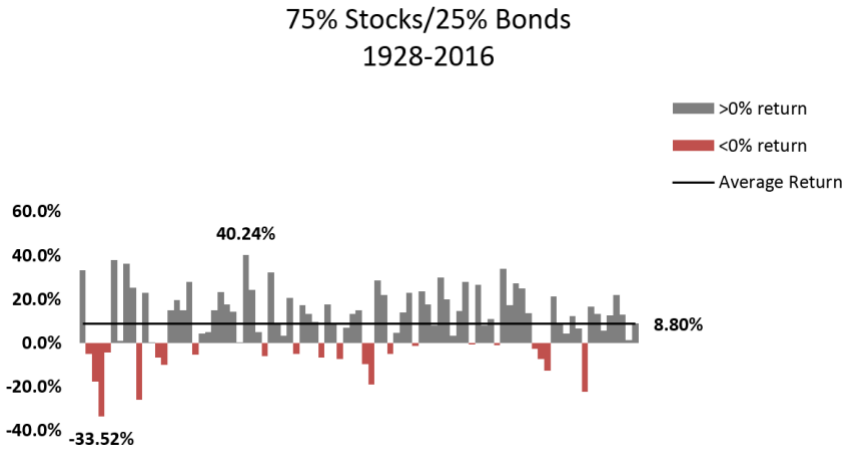
Appendix C

Learning Condition: Long-term Data, Static Charts

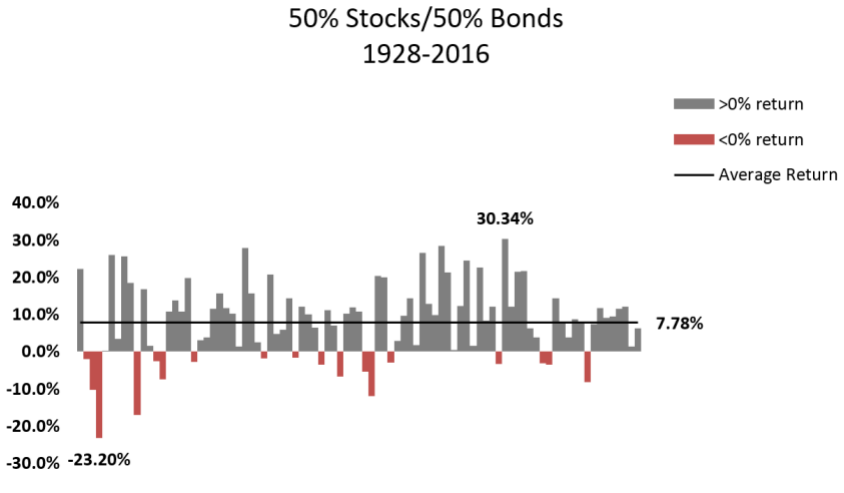
1)



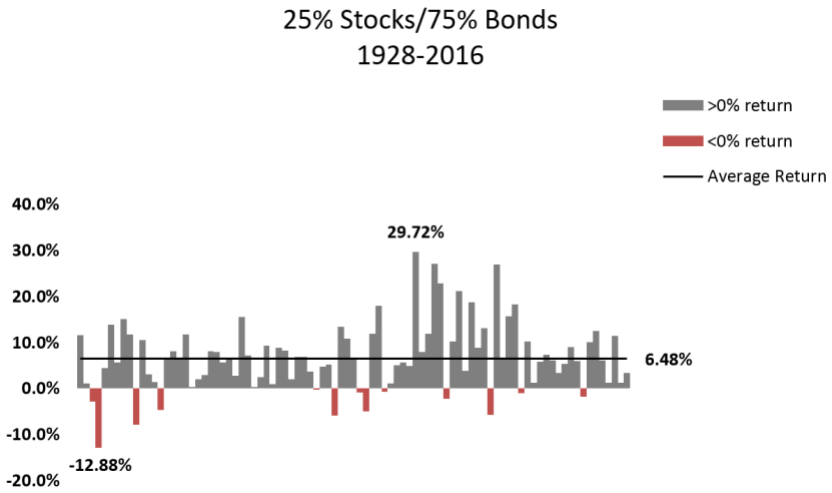
2)



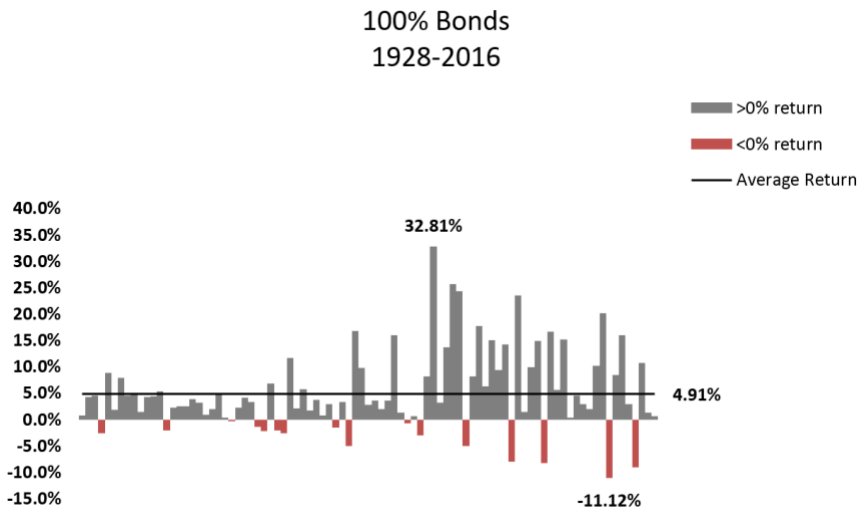
3)



4)


25% Stocks/75% Bonds
1928-2016
>0% return
<0% return
Average Return
40.0%
30.0%
20.0%
10.0%
0.0%
-10.0%
-20.0%
29.72%
6.48%
-12.88%

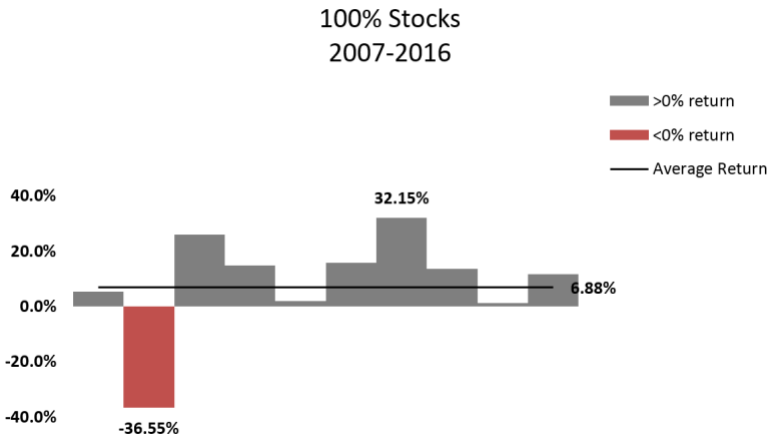
5)


100% Bonds
1928-2016
>0% return
<0% return
Average Return
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
-5.0%
-10.0%
-15.0%
32.81%
4.91%
-11.12%

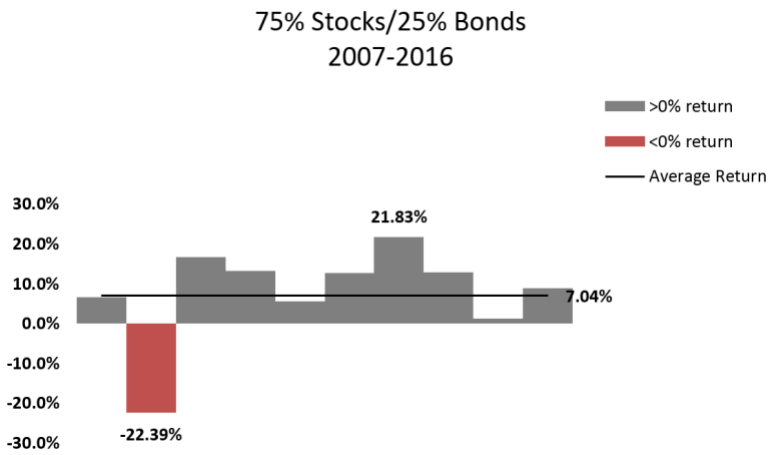
Appendix D

Learning Condition: Short-term Data, Static Charts

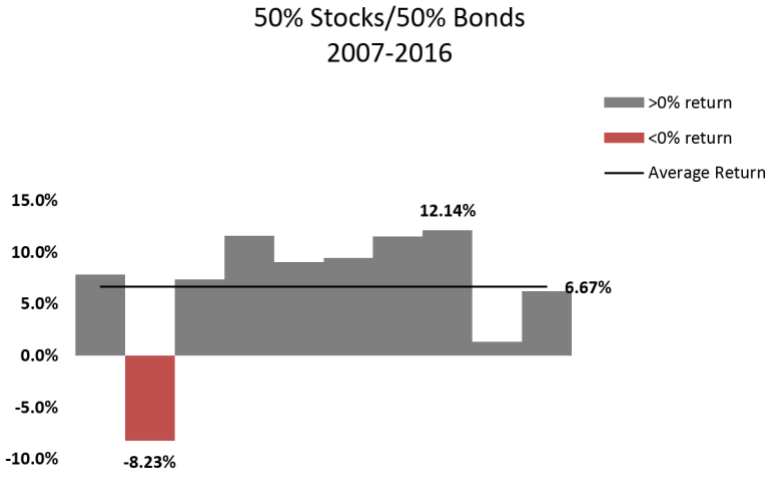
1)



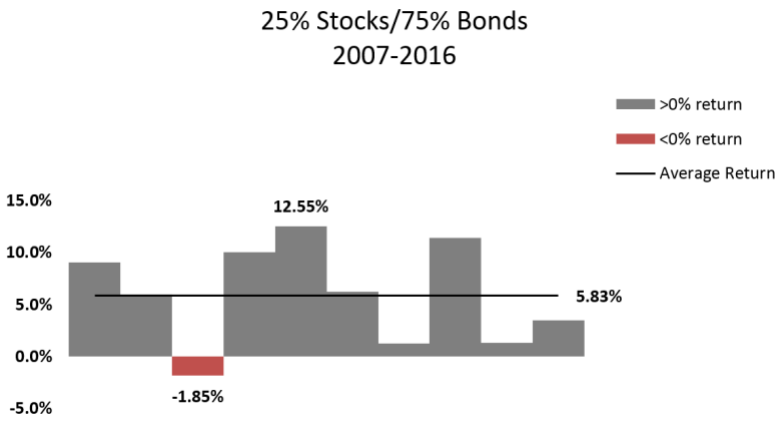
2)



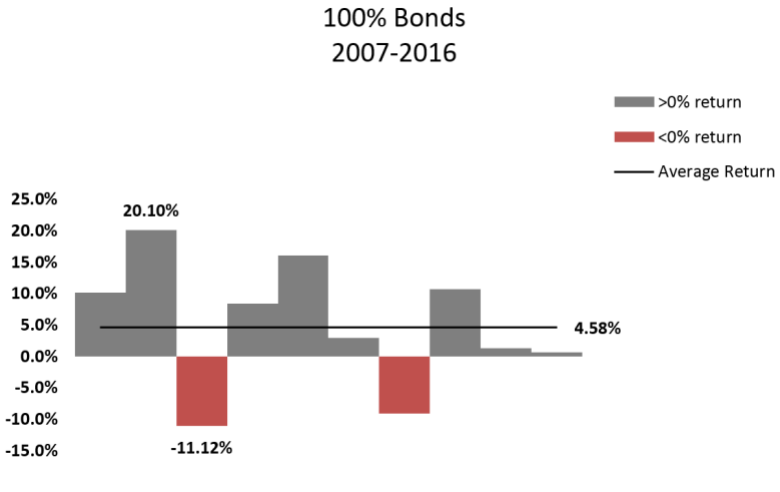
3)



4)


25% Stocks/75% Bonds
2007-2016
>0% return
<0% return
Average Return
15.0%
10.0%
5.0%
0.0%
-5.0%
12.55%
-1.85%
5.83%

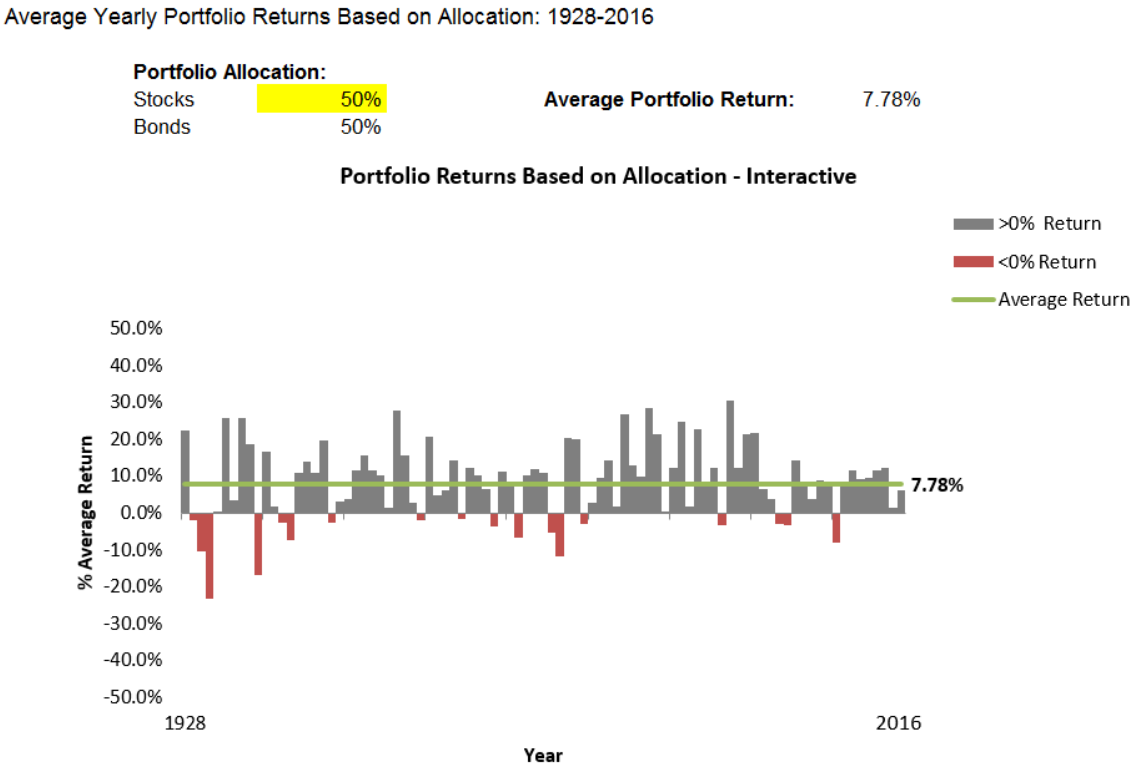
5)


100% Bonds
2007-2016
>0% return
<0% return
Average Return
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
-5.0%
-10.0%
-15.0%
20.10%
-11.12%
4.58%

Appendix E

Learning Condition: Long-term Data, Interactive Chart

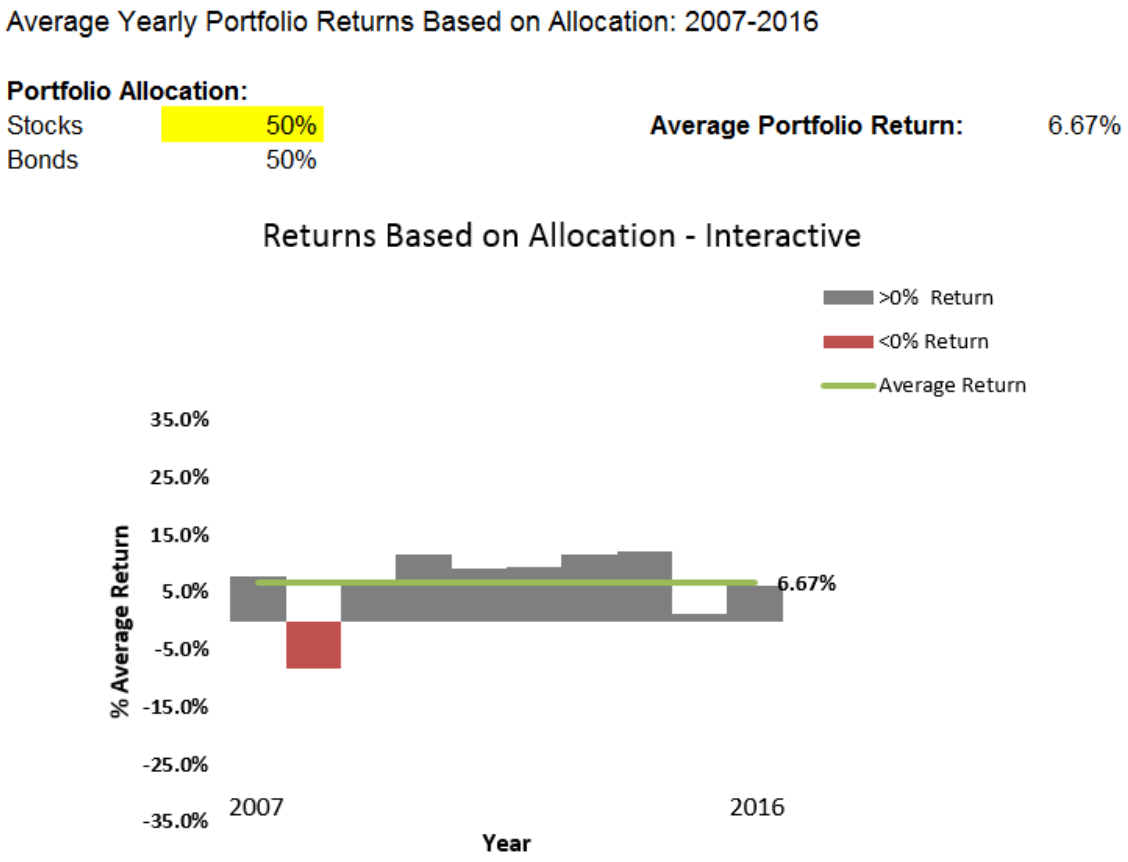
Participants assigned to the long-term data, interactive chart condition were shown one chart. The participants were instructed to enter five unique values for the stock allocation in the yellow box. The chart data updated to reflect the average, annual return data for the portfolio composition specified by the participant.



Appendix F

Learning Condition: Short-term Data, Interactive Chart

Participants assigned to the short-term data, interactive chart condition were shown one chart. The participants were instructed to enter five unique values for the stock allocation in the yellow box. The chart data updated to reflect the average, annual return data for the portfolio composition specified by the participant.



Appendix G:

Financial literacy test questions, adapted from Lusardi and Mitchell (2007) and Clark, Lusardi, and Mitchell (2016). The questions are presented below, and the correct answers are denoted in bold:

1. True/**False** – Mutual funds pay a guaranteed rate of return. (Lusardi & Mitchell, 2007)
2. **True**/false – Over the long term, stocks have the highest rate of return compared to other investment vehicles (i.e. bonds, etc.). (Lusardi & Mitchell, 2007)
3. If you had $200 in a savings account and the account earns 10% interest each year, how much money would be in the account at the end of two years? (Adapted from Lusardi & Mitchel, 2007)
    a. Less than $240
    b. $240
    c. More than $240
4. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, how much would you be able to buy with the money in this account? (Clark, Lusardi, & Mitchell, 2016)
    a. More than today
    b. Exactly the same
    c. Less than today
5. Assume that an employer matched employee contributions dollar for dollar. If the employee contributed $100 to the 401(k) plan, his account balance in the plan including his contribution would (Clark, Lusardi, & Mitchell, 2016):
    a. Increase by $50
    b. Increase by $100
    c. Increase by $200
    d. Remain the same
6. Having $100,000 in a retirement account at the age of 65 is enough to live comfortably throughout retirement.
    a. Completely Disagree
    b. Somewhat Disagree
    c. Neutral
    d. Somewhat Agree
    e. Somewhat Disagree