Systems Engineering and Embodied AI for Financial Literacy Social Robots

(Technical Paper)

Financial Literacy as the Future and its Socioeconomic Inequalities

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

With consumerism increasing and the financial environment changing with technological advances, financial literacy has become popular and necessary. The definition of financial literacy has many interpretations such as the understanding of household economics or the knowledge of money management skills such as budgeting, borrowing, saving, etc. (Hogarth, 2002). The root of this newfound importance for finances could be attributed to the increased range of options in bank loans, saving plans, online trading accounts, etc. In addition, major decisions such as retirement plans have been shifted away from employers and the government and towards the individual (OECD, 2006). The responsibility for major financial decisions has become greater at the individual level, making lack of financial awareness detrimental. Thus, financial education is critical and has become ingrained in school education systems. Continuous improvement in the field is occurring with research on best practices and teaching methods. Unfortunately, equitable access to this education is hard to find and a problem that needs to be addressed. This inequality is rooted in many demographic and socioeconomic differences found within students and their households. For my capstone, my team was tasked with creating an AI robot to help teach students financial literacy. The purpose of this paper is to highlight how robots can be utilized to help bridge the financial illiteracy gap but to also shine a light on the greater issues of inequitable access to resources and experience when it comes to financial literacy and how this could be targeted as well.

Technical Discussion

According to a 2022 report, the current average federal student loan debt balance is approximately $40,000 (Hansen, 2022). Students are graduating from college already at a disadvantage. Then once students become adults it has been found that 32% could not cover a

$400 emergency expense and that 22% were having an okay or difficult time getting by financially (Board of Governors of the Federal Reserve System, 2022). Young adults are not being prepared well for the struggles of supporting themselves. Due to the increased concern for financial illiteracy and struggles of adults, efforts are being put into financial education at the primary and secondary levels. The idea is that if students become financially literate at a younger age, then they will be better prepared to manage college loans and real-life financial planning. Thus, financial education standards in public schools are becoming popular with twenty-eight states mandating the implementation of these standards (Sherraden, 2011). The national standards for financial literacy provide a guideline for teaching personal finance for K-12 grades, these standards include six primary areas (earning income, saving, using credit, etc.) with benchmarks for each grade level (Council for Economic Education, 2021). Although change is occurring with this growing curriculum, there is still room for improvement in how and what is being taught. Thus, the objective of my capstone team advised by Tariq Iqbal, from the Department of Engineering Systems and Environment, is to create an interactive learning tool for students to use to learn about finances. The capstone team from the previous semester began by utilizing Dialogflow to create a phone number that you could call to run through lesson plans with. They worked on building out the first standard for two lesson plan options for the kindergarten and fourth-grade levels: credit and debit or saving and spending. These lesson plans were based on national standards. This semester my team will continue this capstone project by transferring this learning experience from a phone call to a physical robot which students can interact with. This transition will be done through Dialogflow, Choregraphe, and NAO robots. Robots are the center of this capstone due to the increasing promise and ability of educational robots as well as the technological advances that continue to occur in this field. The NAO robots

being utilized can blink, have voice sensors that allow them to look toward the person speaking, give verbal and nonverbal cues, etc. According to a review of the applicability of robots in education, it has been proven that young children perform better on post-learning examinations and indicated more interest when learning took place through a robot instead of audiotapes and books (Mubin, 2013). As a main concern with robotics in education is the lack of human experience or robustness, my capstone group plans to continue to make the robot interactions more personalized to the user. For instance, the goal is to make the NAO robots understand a wider range of cues and responses and be able to correspondingly reply with a smooth transition. Our hope is that, by utilizing the robot instead of a virtual phone call and offering non-verbal and personalized cues, the students' focus, willingness to learn, and enjoyment will increase. We are planning an experiment to compare the robot to other forms of learning such as paper, virtual, and in-person methods to the robot. This experiment will be conducted with the help of local Elementary School students from the Charlottesville and Albemarle County districts. The results should prove which form of learning is more enjoyable, engaging, and results in higher retention. Currently, our timeline for the capstone project is to finish programming the robots by the end of the semester and then to evaluate the robots with students starting next semester. The final deliverable will include flexible Choregraphe lesson plans that have been evaluated with implemented feedback from students.

STS Discussion

As the need for financial education continues to become more essential it is important to consider how we can ensure that all students receive an equitable, reliable, and quality financial education. According to the Program for International Student Assessment (PISA), the financial

literacy gap between socioeconomically advantaged and disadvantaged students is about 26%
wider in the US than the average across OECD countries (Contreras, 2021). This wide gap is
because, in the US, financial literacy depends on a student's demographic and socioeconomic
status. For instance, a student's financial knowledge is often correlated to their gender, race,
parent education level, household income, etc. According to the National Financial Capability
Study (FNCS), the demographic groups with the lowest financial literacy levels are women,
Hispanic and African Americans, young adults, lower social class, and from families with lower
levels of formal education (Bradley, 2021). It is crucial that as the financial education system
continues to form, educators and policymakers are aware of the disadvantages many individuals
are being put at and how to best mitigate them. These disadvantages may include lack of access
to a computer or the internet, lack of a foundation because of being raised in a low-income home,
lack of knowledge due to never being trusted with or having money as a young child, etc. These
preventative measures could include starting financial education at a younger age since the
financial literacy gap based on socioeconomic status can be seen by age 15 (Banh, 2019),
utilizing low-cost materials to teach, and providing ways for all students to have the opportunity
to handle money starting at a young age even if the money is fake. For instance, one researched
method to increase access to low-income students specifically is Individual Development
Accounts (IDAs) which is a financial tool that encourages low-income students to save up
toward acquiring an appreciating asset. This asset could be a home, college, a small business, etc.
These IDAs are known to come with a matched savings account, financial literacy education,
training, etc. (Kezar, 2008). Evidently, IDAs are one of many solid options to help disadvantaged
students learn how to financially care for themselves. The topic of equitable access to financial
education is loosely coupled with my capstone project as my capstone explores a robot's role and

capability within financial education. My STS research will focus more on the student's personal lives and the social factors related to financial literacy while the capstone focuses on building out the teaching tool and artificial intelligence. In the future, the STS and technical portions of my report could be integrated as robots could be utilized to bridge inequality gaps in financial education at primary and secondary schools.

Research Question and Methods

I aim to answer the question "How are students' socioeconomic and demographic factors affecting their financial literacy? And how can we best combat this?" The anticipated scope of my topic is a deep dive into how personal and household characteristics can affect students' financial literacy. Further, my scope will include ways to limit these inequalities both in the general financial education system and within my capstone project. To research this topic, I plan to do a comprehensive literature review of previous studies and research on this topic. As my capstone deals with testing AI financial education robots in local elementary schools, other research methods that I will utilize are interviewing and observing. As I attend the schools, I will observe to see if there are any substantial differences in children's ability to interact with robots and technology. I will also have the opportunity to speak with teachers and principals and can ask them questions about if they see any disadvantages between students when it comes to their financial education.

Conclusion

Furthermore, financial education is on the rise and the curricula and methods of teaching are constantly being formed. In order to ensure equitable access to financial education and opportunities, awareness and planning need to come now. The goal of my capstone is to form a

robust artificial intelligence robot to help teach young students about finance based on national standards. This project will include an experiment to hopefully support the fact that robots are a viable and effective way to teach financial literacy. Tangentially, my STS portion focuses on shedding light on which socioeconomic characteristics place young students at a disadvantage when it comes to financial literacy. After identifying the demographics of this group, the STS portion will go into a review of recommendations on how to prevent inequalities between groups. Optimistically, with continued research into financial literacy and the deep-rooted inequalities that could affect it, the curricula can be formulated with groundbreaking technology that surpasses inequalities and changes families' lives.

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