Systems Engineering and Embodied AI for Financial Literacy Social Robots
(Technical project)

Financial Literacy Courses in K-12 Education
(STS project)

A Thesis Prospectus
In STS 4500
Presented to
The Faculty of the
School of Engineering and Applied Science
University of Virginia
In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Systems Engineering

By
Qinyuan Jiang

November 1, 2022

Technical Team Members:
Shirley Leshem
Pulkit Rampa
Sophie Howle
Lucas Zak

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.

ADVISORS

MC Forelle, Department of Engineering and Society

Tariq Iqbal, Department of Engineering Systems and Environment

Introduction:

As students graduate from their K-12 education, they will be faced with many challenges as a young adult. A big factor when considering the challenges that they will face is their financial well-being and the decisions they make. Some of the common financial problems that young adults face after high school includes paying back student loans, increasing levels of debt, and learning to invest (Fontinelle, 2022). One way for students to prepare for these obstacles is to gain a better understanding of financial literacy and make more informed decisions.

According to the Congressional Research Service (2021), financial literacy is the knowledge that is used to make well-informed financial decisions to support personal goals. With the changes that are happening, including "retirement of the baby boomers; the emergence of new financial products; and increasing costs for health care, higher education, and retirement", it is even more important to have an understanding in financial literacy (Government Accountability Office, Washington, DC., 2012). When considering Americans specifically, only 64.3% are financially literate, with those who have a college degree being significantly more financially literate than those without one (Newall & Diamond, 2022). It is even more important for financial literacy to be taught starting at a young age so that the knowledge in financial literacy can develop into responsible decisions in adulthood (Jayaraman, Jambunathan, & Adesanya, 2021). Courses in school can be one of the ways that students can learn these skills.

As a student in K-12 education, parts of their knowledge are obtained from the various fields of education that they receive from school. Despite having access to many fields of education, including mathematics and history, only 22.7% of high school students have guaranteed access to personal finance courses and only 8 out of the 50 states have fully implemented the guaranteed access to personal finance courses ("State of Financial Education

Report 2021-2022," 2022). According to the U.S. Chamber of Commerce (2020), many students graduating from high school don't have the skills necessary to manage their personal finances. Financial literacy will not only teach students to be more financially successful in the future, it will teach them to accomplish more goals related to aspect of finance, whether that is paying for lunch or paying off debt (Rose, 2021). With the lack of courses available in school for students to obtain proficiency in financial literacy, it is difficult for students to have the time outside of school to become financial literate on top of extracurricular activities.

To gain a better understanding of the lack of financial literacy courses across the United States, my STS project focuses on why students lack the exposure to financial literacy courses in their K-12 education. On the more technical side, my technical project addresses the issue of financial illiteracy by programming a Nao robot to interactively teach elementary school students about certain topics within financial literacy. My STS project and my technical project are closely related in that one attempts to understand the reasons for the limited financial literacy courses while the latter attempts to address it. These perspectives will provide a new insight into why financial literacy courses are not offered and discover new ways to allow students to gain the necessary finance knowledge.

Technical Topic:

With the advancement of technology, it is becoming more and more common to see robots working alongside humans to help accomplish a task, whether that is seeing a robot vacuum or helping out in a science lab. However, it has not come to the point where we see robots at K-12 schools often. When it comes to education, there are ways that robots can help.

For example, they can help by "promoting active learning, motivating young students to learn, improving learning effectiveness, and providing a counterpoint to teacher-led classroom lessons" (Wu, Wang, & Chen, 2013).

The technical project my team is completing will continue the work that another team did last year with MITRE. Last year, two lesson plans were created: spending and savings for kindergarteners and credit and debit for fourth graders. These lesson plans were developed based on the benchmarks provided in the National Standards in K-12 Personal Finance Education (Miu et al., 2022). Then, the team re-created these lesson plans on Google Dialogflow. Dialogflow is a "platform that makes it easy to design and integrate a conversational user interface" ("Dialogflow," n.d.). After that, the lesson plans were connected to a phone number so that anyone could call the number to learn and answer questions about spending and savings or credit and debit from a kindergarten or fourth graders' perspective.

To continue this project with MITRE this year, my team is aiming to improve the engagement of the users. While a phone call may be engaging for some, Jensen (2001) stated that younger students are able to make informed decisions while learning in an effective and interactive environment. To incorporate this aspect into the previous work that has been done, we will be coding a Nao robot to execute and verbalize the developed lesson plans on Dialogflow. A Nao robot is a programming tool commonly used in education and research because of its ability to move and adapt to the environment ("NAO," n.d.). It was created by Aldebaran, a part of a United Robotics Group. The Nao robot has microphones and can pick up sounds when someone is speaking to it to interact with the speaker. On top of this, it has a camera to recognize people and shapes. In the spring semester, our goal is to bring the programmed Nao robot to local elementary schools around Charlottesville, Virginia to gain feedback from actual users. With the

feedback that we receive from the students, we will improve the lesson plans on Dialogflow and the robustness of the robot. Developing the experiment will be challenging because we do not have prior experience developing social experiments and interacting with local elementary school students. It is also difficult coming up with experiments aimed at the younger population. The results of our project will confirm our hypothesis that a robot will be a beneficial first step when it comes to teaching financial literacy to the younger population. In the end, we hope to deliver an interactive Nao robot that can engage the young students and teach them about spending and savings or credit and debit. This will be the first step of action to creating technology that can be used to teach more students about financial literacy in an engaging way.

STS Topic:

While the technical topic of this prospectus focuses on creating a solution to the existing problem, the STS topic focuses on why there is a lack of financial literacy courses in K-12 education in the U.S. Despite there being plenty of other courses offered in a wide range of fields, many teachers do not have experience in teaching personal finance or are not qualified to teach the subject based on the standards (Henning & Lucey, 2017). Although there is a rise in the number of states mandating finance courses to be required in K-12 education, as of June 2005, only 8 states require financial literacy education in high school (Anders & Crawford, 2005). This does not get better in 2022. Only 8 states have state-wide requirements for finance courses and outside of these states, only 9.3% of the students are required to take finance courses (Ross, 2022). While it may not be significant, it is alarming that only about one third of Americans have a working understanding of some of the important terms and concepts in finance, including interest rates and financial risk (McMillon & Bryant, 2022). My research will focus on why there

is only a small number of states that require finance courses despite past studies showing that financial literacy is acknowledged as important for students to learn about (Tschache, 2009). This lack of improvement in the finance education makes me wonder what the interaction between social groups is like and how these social groups might see financial literacy differently.

For the discussion of the connections between human, social, and technical elements in regards to financial literacy, the Social Construction of Technology (SCOT) framework will be used. This framework argues that the relevant social groups involved can drive the development of the technology (Pinch & Bijker, 1984). Due to the fact that a lot of education is organized by different levels of the government, SCOT can be used to see how the relevant social groups, including the policy makers in different levels of government, the teachers, the parents, and the students within the education system, interact with financial literacy courses. This framework is appropriate for this analysis because the policy makers have a say in what courses should be taught each year and how much money goes into each field while the students and parents are the ones who experiences the effect of the decisions made (American University, 2019). In addition, the teachers are the ones who use the resources designated by the policy makers to teach students. Now, applying interpretative flexibility, the policy makers see financial literacy courses as not important so they often do not decide to spend as much resources in this field. The elementary and preservice teachers think that financial literacy is too complicated to be taught in early education and does not see it as a priority (Henning & Lucey, 2017). On the other hand, parents can be divided into two groups. Some parents see financial literacy as important and necessary for their children's education while others do not mind as much. The students may see financial literacy as indifferent or important based on their grade levels.

Some of the challenges that I will face when completing this portion of the prospectus include not being able to find the most recent or any information for me to determine an accurate interaction between two connections. I anticipate that in my deliverable, I will be able to determine which social groups have the strongest influence in financial literacy courses and how this social group may have a negative influence on the students.

Research question and methods:

The research question is why aren't more financial literacy courses offered in K-12 educations in the U.S.? It is important to ask this question because the number of high school graduates who are not financially literate is alarming and financial literacy can help in many different situations in one's life for them to achieve other goals and reach their financial success. To answer the research question, most of the analysis will be done through literature reviews and close readings. One of the primary sources for this research is looking at what the board of education and policy makers for the education system have done. By analyzing the plans formulated by these government officials, I will be able to understand what parts of the education system has been emphasized the most. With the majority of financial literacy courses being offered in high school, another area that should be analyzed is the curriculum for high schools across the country and what factors determine what courses are being taught each year. This will help me understand what courses are chosen over financial literacy courses. Besides analyzing what the government's decisions have been, another area of the research is looking at past studies that have been done on topics related to financial literacy education and see what the results from those studies are. This analysis will provide insight from someone else's perspective and analyze the issue from different people's views. Through the examination of multiple

sources, I hope to gain a multivariate perspective on the issue in order to create a multifaceted solution.

Conclusion:

The value of financial understanding is immense as it has the potential to impact an individual's career trajectory and prospective on financial decisions. Limited knowledge of finances also contributes to widening the socioeconomic gap and propagates differences in income levels to future generations. In my research, I will be addressing this issue from a technical perspective and an STS perspective.

Some of the results I expect to see in my research paper include different social groups having an effect on financial literacy and government officials designating more resources on courses outside of finance. These results will be delivered in the form of an interactive Nao robot for the technical work and an improved understanding of why there is a limited number of financial literacy courses for the STS work. Through this work, I hope that more policyholders will understand the importance of financial literacy in early education so that more teachers can be qualified and trained to teach students across the U.S.

References:

American University. (2019, April 7). 5 Ways Policy Makers Can Improve the Quality of Education. Retrieved November 29, 2022, from https://soeonline.american.edu/blog/5-ways-policy-makers-can-improve-the-quality-of-education/

Anders, S. B., & Crawford, T. M. (2005). Financial Literacy: CPAs Can Make a Difference. *CPA Journal*, *75*(9), 6–9.

Congressional Research Service. (2021). *Financial Literacy and Financial Education Policy Issues*. Retrieved from https://crsreports.congress.gov/product/pdf/R/R46941

Dialogflow. (n.d.). Retrieved October 24, 2022, from https://cloud.google.com/dialogflow/docs

Fontinelle, A. (2022, April 24). The Biggest Financial Hurdles Young People Face. Retrieved October 23, 2022, from Investopedia website: https://www.investopedia.com/financial-edge/0712/the-biggest-financial-hurdles-young-people-face.aspx

Government Accountability Office, Washington, DC. (2012). *Financial Literacy: Strengthening Partnerships in Challenge Times* (No. PB2012105048; p. 25). Retrieved from https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB2012105048.xhtml

Henning, M. B., & Lucey, T. A. (2017). Elementary Preservice Teachers' and Teacher Educators' Perceptions of Financial Literacy Education. *The Social Studies*, *108*(4), 163–173. https://doi.org/10.1080/00377996.2017.1343792

Jayaraman, J. D., Jambunathan, S., & Adesanya, R. (2021). Preparedness of early childhood teachers to teach financial literacy: Evidence from the US. *Education 3-13*, *50*(8), 1121–1136. https://doi.org/10.1080/03004279.2021.1939399

Jensen, K. (2001). *Interactive Robot for Educating College-Bound Students About Engineering Disciplines* (No. ADA402995). Utah Univ., Salt Lake City. Dept. of Mechanical Engineering. Retrieved from Utah Univ., Salt Lake City. Dept. of Mechanical Engineering. website: https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/ADA402995.xhtml

McMillon, D., & Bryant, J. (2022, June 10). Financial Literacy Education Could Help Many Americans. *TIME*. Retrieved from https://time.com/6186290/americans-financial-literacy/

Miu, C., Gopurathingal, J., Thota, V., Thompson, M., van Beek, N., Kuczynski, J., … Iqbal, T. (2022, April). *A Financial Literacy AI-Enabled Voice Assistant System for Educational Use*. IEEE. https://doi.org/10.1109/SIEDS55548.2022.9799370

NAO. (n.d.). Retrieved October 25, 2022, from https://www.aldebaran.com/en/nao

Newall, M., & Diamond, J. (2022, April 27). Over one in three Americans are not considered financially literate. Retrieved October 25, 2022, from Ipsos website: https://www.ipsos.com/en-us/news-polls/money-masters-financial-literacy

Pinch, T. J., & Bijker, W. E. (1984). The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other. *Social Studies of Science*, *14*(3), 399–441.

Rose, S. (2021). 7 Expert Perspectives on Why Financial Literacy Is Important. *OppLoans*. Retrieved from https://www.opploans.com/oppu/articles/why-is-financial-literacy-important/

Ross, J. (2022, May 17). Mapped: Personal Finance Education Requirements, by State. Retrieved October 25, 2022, from Visual Capitalist website: https://www.visualcapitalist.com/students-receiving-personal-finance-education-by-state/

State of Financial Education Report 2021-2022. (2022, April). Retrieved October 22, 2022, from https://www.ngpf.org/state-of-fin-ed-report-2021-2022/

Tschache, C. A. (2009). Importance of Financial Literacy and Financial Literacy Content in Curriculum. *Montana State University*.

U.S. Chamber of Commerce. (2020, September 3). Financial Literacy: K-12. Retrieved October 24, 2022, from https://www.uschamber.com/workforce/education/financial-literacy-k-12

Wu, W.-C. V., Wang, R.-J., & Chen, N.-S. (2013). Instructional Design Using an In-House Built Teaching Assistant Robot to Enhance Elementary School English-as-a-Foreign-Language Learning. *Interactive Learning Environments*, *23*(6), 696–714. https://doi.org/10.1080/10494820.2013.792844