

WIP: Finances, Financial Literacy and Social Well-being: Addressing the Problem Through Gamification, Game-Based Learning, and Artificial Intelligence (AI)

Trina Fletcher
School of Universal Computing
Construction and Engineering
Education (SUCCEED)
Florida International University
Miami, FL
trfletcher@fiu.edu

Joaquin Molto
Knight Foundation School of
Computing and Information
Sciences (KFSCIS)
Florida International University
Miami, FL
jmolt001@fiu.edu

Isabel Guitton
Department of Marketing and
Logistics
Florida International University
Miami, FL
iguit005@fiu.edu

Destiny Washington
The Gold Horizon
dwashington@thegoldhorizon.com

Abstract— This work in progress (WIP) focuses on the role of finances and financial literacy in whether students enroll in college and their persistence toward degree completion has been well-documented. Additionally, increased attention has been placed on the role of finances in students' decision-making around higher education during and immediately following the COVID-19 global pandemic. Higher education institutions have also seen historic declines in enrollment and higher attrition rates around the pandemic. Increasing tuition rates, students' hesitation in pursuing or taking on additional student loan debt, and associated costs such as transportation, necessary technical equipment, and textbooks are other factors linked to college students' finances, and everything shared above has been found to have negatively impacted students' well-being.

When connecting this knowledge to the national demand for engineering graduates within the U.S. workforce (particularly high-impact areas such as cybersecurity, Artificial Intelligence and climate change roles), it is essential to understand how finances and a lack of financial literacy impact this population more thoroughly. Additionally, engineering majors, on average, take longer than the traditional 4-year timeframe to complete their degrees, and this average is higher for students who work while pursuing their degrees or have family obligations, among other scenarios.

Based on this information, the focus of this paper was to answer the following research question: *How can current technology be used to help address the financial literacy gap for engineering students?* Our team utilized the information in the literature related to engineering students, finances, financial literacy, students' social well-being and advancements in student learning to develop and introduce a practical solution – a game-based course. This course was developed as a part of a start-up company, *m3i journey*, designed and driven by the gaps and findings. An overview of the company's core product/service, a financial literacy gaming-based course, is shared, including details on how Artificial Intelligence (AI) and Machine Learning (ML) tools are incorporated into the course. The results and discussion section highlights the significance of finances within students' ability to persist to degree completion.

Keywords—Finances, Financial Literacy, Gamification, Game-based Learning, Artificial Intelligence, Machine Learning

I. INTRODUCTION

College student attrition has consistently been connected to academic performance (i.e. graduates during high school and college and standardized tests), degree requirements of colleges and universities institutional and degree commitments, the intersectionality of social and academic engagement, access to

institutional support services, finances, peer and/or family support, and student's individual needs/requirements being met (i.e. sense of belonging) and physical/emotional adjustments to new environments [1][2]. Additionally, we know that finances can impact students' ability to finish college, especially within the average expected time to completion (four to six years), in various ways. First, the overall cost of college continues to increase and has risen consistently for decades. This has caused many students hardships during their efforts to afford tuition, fees, and other expenses, even if they qualified for financial aid. For many students, taking on debt via student loans increases the chances of attrition to begin working and paying off their loans rather than continue collecting more debt. Second, the time commitment is often juggled between academics and working part-time or even full-time to support the financial cost of pursuing an education. This leads to less time being spent focusing on academics and is correlated with receiving lower grades, missed classes, and challenges with completing assignments and missed opportunities to receive academic assistance such as tutoring or peer studying sessions [3]. Third, financial stress has increasingly become a key distraction contributor for students navigating toward degree completion. When students are worried about paying for bills associated with school or resources, they need to support their academic goals (i.e., rent, food, transportation, books, supplies, technology), it can be challenging to focus on areas such as class attendance and completing homework [3][4]. Given these findings, our goal for this study was to review the literature to understand how finances have impacted engineering students' ability to complete their academic degrees.

II. LITERATURE REVIEW

While previous studies have emphasized the expectation/qualifications of higher educated individuals to lead the population in increasing financial literacy, research has mainly focused on comparing business students and students of all other majors [5]. Therefore, it is imperative to understand the unique challenges that impact these students' academic persistence through degree completion, specifically concerning finances.

A. Financial Literacy and Engineering Students

Two overarching needs for including financial literacy-based courses in engineering curriculums in her 2016 published thesis, *Engineering Financial Literacy: Modules to*

Teach Engineers Core Business Topics. First, for universities to satisfy all student outcomes of ABET accreditation, the programs must find a connection between engineering and economics [6][19]. ABET is an internationally recognized accrediting body that ensures institutions prepare students to achieve a quality educational standard and become professional engineers equipped for the global workforce. Secondly, as engineers enter the industry, business aspects such as product commercialization terminology and the company's profit margins are necessary for career success. By developing course objectives to outline a course module, Bartlett offered students material to help them learn core business concepts within an hour. While covering topics like interest, present value, and depreciation, Bartlett's course builds on the foundations of a course commonly taken by engineering students: Engineering Economy. The three objectives required students to demonstrate understanding, perform knowledge in an applicable sense, and identify common terminology. Lastly, Bartlett's module ends with a four-question quiz upon completion of the module to allow participants to review their understanding of the concepts covered [6]. This approach considers students' availability (or lack thereof) to take on additional courses that will lend space for in-depth instruction on core financial concepts, with an immediate opportunity to identify knowledge gaps. To collect immediate feedback, Bartlett hosted a lecture with 24 students in attendance, using her developed module as the lesson. The verbal feedback received afterward insisted that the course was "helpful for completing their senior design project [6]. Despite engineering career pathways providing an "abundant" amount of specialty tracks and career stability opportunities, these programs' enrollment is still substantially low for STEM students in general [7]. While low enrollment rates may be seen as a phenomenon, the attrition factors certainly are not. Dr. Silthe's report found that more than 50 percent of students who pursue a STEM degree either drop out or transition into a non-science or non-technical degree.

B. Finances and Financial Stress for Engineering Students

Financial stress occurs amongst most students from the start of securing a four-year postsecondary degree, whilst STEM students are measured at a six-year completion rate. With less than 40% of STEM students persisting within the six-year completion rate, they are likely to drop out or transfer to a non-technical or non-science field [7][8]. As costs of college attendance have risen steadily over the last decade in the United States, the elongated academic timeline leaves these students vulnerable to additional challenges with social well-being as it relates to the impact of financial stress and hardship [9]. To investigate prior scholarship on opportunities to remedy such stress and hardship, we examined a 2006 literature review on financial literacy [5]. Marcolin and Abraham's examination reports that financial hardships (in general) are sources of increased "isolation, emotional stress, depression, and lower esteem." The authors encourage young people to understand the basis of planning and investing for the future, given that these skills are essential for both avoiding and solving financial challenges.

With further analysis within this study, a survey on America's higher educated population (924 college students) exposed an overall failed understanding (52.87 percent correct scores) of financial literacy. This finding has no contingency on any specific academic discipline, somewhat only congruent to the "non-business majors, and [those] who were female, in a lower-class rank, under the age of 30 and with little work experience" that were in the lower levels of financial knowledge. The survey scores of only 52.87 percent raise serious concerns about "the economic well-being of nations and the personal well-being of such individuals [5].

Financial stress can also lead to mental and physical health problems, which can further impact academic performance. In addition to these direct impacts, financial constraints can also indirectly impact students' ability to finish college. For example, students who cannot afford to participate in extracurricular activities or social events may feel isolated and disconnected from their peers. This can make adjusting to college life and succeeding academically more challenging. Research has shown that students from low-income families are likelier to drop out of college than those from high-income families. One study found that only 20% of students from the lowest income quartile complete a four-year college degree within six years, compared to 60% of students from the highest income quartile [10][12].

C. Finances and Social Well-Being for Engineering Students

In our review, student social well-being is recognized as one of multiple dimensions within the broader term student wellness or well-being, along with emotional, mental, financial, physical, and spiritual health. With little prior research focusing exclusively on social well-being, we relied on different universities' definitions of social well-being for our base understanding. Boston University defines social well-being as "building and maintaining healthy relationships and having meaningful interactions with those around you [11]. Similarly, other universities also use the status of interpersonal relationships to measure and define students' social well-being [11]. However, when we mention social well-being, our team reference the impact of stress from finances conjoined with interpersonal experiences that affect their ability to focus on academics. Previous literature examining how financial stress impacts college students underscores our definition of student social well-being. In Dr. Moore et al.'s 2019 study [12], 115 students who self-reported a degree of, then present, financial stress were invited to participate in a focus group held at a large, private, urban university in the United States. Amongst the 30 participants, over four focus groups, the analysis revealed two key themes. First, students noticed the effects of financial stress on their academic lives, significantly; secondly, such effects and overall economic status hinder their ability to succeed academically [13][14]. The details of the focus group responses uncovered connections between students perceived financial hardship and academic challenges experienced like securing course materials, prioritizing jobs to earn money over studies- in terms of stunting their career goals, social division from classmates based on socio-economic status, stress as a distraction from focusing on

academics, and feelings of isolation [13][15]. Based on the literature findings related to finances, financial literacy, and the impact of these areas on engineering students' social well-being, this study will answer the following research question: *How can current technology be used to help address the financial literacy gap for engineering students?*

III. ADDRESSING THE PROBLEM

Given the impact financial stress and the lack of financial literacy has had on college students, the goal of this study was to answer the following research question [18]: *How can current technology be used to help address the financial literacy gap for engineering students?* To answer this question, our team decided to explore avenues that have been found to assist significantly in motivating and encouraging students to learn in an engaging way that can keep their attention [16][17].

A. Gamification

The application of typical elements of game playing, such as users being able to score points, play in a competitive format against one or more opponents, receive some form of award when passing a level, and being able to track their progress, all falls within the defining realm of gamification [20][21]. The use of gamification has been found across various industries, including health and wellness (i.e., FitBit), within places of work, everyday food-related apps (i.e., Chick-fil-A, Smoothie King, Starbucks), and education, the focus of this study. The rising use of gamification within organizations is heavily built on the various benefits found, including positive behavior changes (most notably within the health and wellness space), increased learning and skill development, increased engagement individually and within or across groups, and increased motivation by those who use them [21]. From an education standpoint, gamification is a type of social engagement and teamwork like those who participate in video games, a field that is one of the fastest growing as it relates to every human interest and engagement area [21][22][23].

B. Game-Based Learning in Education

While gamification centers around applying game-design components and foundational information within non-gaming contexts to increase participants' motivation and engagement, game-based learning refers to using actual gaming platforms within an educational context [24]. This can include applying gaming principles as the avenue for learning within a curriculum that is already established. Instead of using traditional read, review, and assess processes, real-life gaming applications can be utilized [25]. Increasing the utilization of technology has had its benefits and also negative impacts. Students are more distracted and have shorter attention spans; therefore, motivating students to focus on gaining a conceptual understanding of information is essential [24]. Motivational techniques are a unique component within game-based learning, allowing users to work on their educational goals (i.e., educational material) in a unique, creative way that can keep their attention. This is done by taking the fundamental aspects of gaming and adding concepts and

educational content that provides guidance to the participants as they work to achieve their overarching goals [22].

C. AI and Machine Learning within Game-Based Education

Artificial Intelligence (AI) and Machine Learning (ML) are closely related but are different when it comes to design, purpose and implementation [27][28]. AI is the overarching field that is concerned with creating intelligent machines. At the same time, ML is a subset of AI that deals explicitly with developing algorithms that enable machines to learn from data. Both areas have significantly impacted and advanced learning at all levels of education and continue to advance our abilities to gain knowledge and learn as human beings [28]. AI use within game-based learning is well documented. One of the most notable projects, initially funded by the National Science Foundation (NSF), is ALEKS - Assessment and Learning in Knowledge Spaces. ALEKS is a widely used, web-based educational system that allows users to learn subjects such as math and science through an adaptive learning AI algorithm [29][30]. Another example of an AI-driven game-based learning tool is ASSISTments. This tool provides real-time insight and feedback to users who are learning math [31][32].

IV. METHODOLOGY

Taking into consideration the findings from the literature and research around advancing technology around gamification, game-based learning, AI and machine learning in education, we incorporated this information into the design and development of *m3i journey*.

A. *m3i-Journey: Overview*

While there is an overarching acceptance that financial literacy exposure should be accessible to more high school and college students, the details of how this unique and diverse population (i.e., socioeconomic status, regional location, gender, etc.) are impacted by finances and decisions linked to finances are not as clear. This is especially true when considering five key areas: (1) advancement in how people learn about finances (i.e., social media), (2) COVID-19's impact on learning, (3) COVID-19's impact on what people prioritize financially, (4) increasing inflation rates, cost of living and college of higher education and (5) evolution and increasing use of Artificial Intelligence (AI). The *m3i journey* (mindset, minimalism, money management, and investing) was developed with this information in mind.

The start-up company consists of a research-driven financial literacy focus that aims to provide access to high-quality, holistic, and culturally relevant financial literacy knowledge to students and young adults, especially those from historically marginalized communities within the United States. *M3i journey* serves as a foundational avenue towards access to financial literacy within formal and informal education systems to normalize those individuals' & families' discussions of finances. The mission of *m3i journey* is to "provide personalized, holistic, innovative, relevant and engaging financial literacy education as a pathway to long-term economic well-being and success". The core components

of the start-up consist of (1) research, (2) design and (3) practice with the voice of the customer (VOC) being emphasized through the three processes. This includes discovering that insight across different populations (i.e. gender, race/ethnicity, regional location, socio-economic status). Figure 1 below provides a high-level overview of the core components of *m3i journey*.

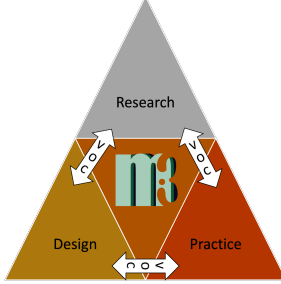


Fig. 1 *m3i journey* Core Components

Additionally, at the heart of our products and services are the core concepts known as PHIRE (1) personalized, (2) holistic, (3) innovative, (4) relevant and (5) engaging. The core concepts are directly in line with the organization's mission, and by incorporating these concepts, the organization's vision - to provide a pathway toward clarity, purpose, and peace - will be made possible. Figure 2 below provides a high-level overview of the core concepts of *m3i journey*.

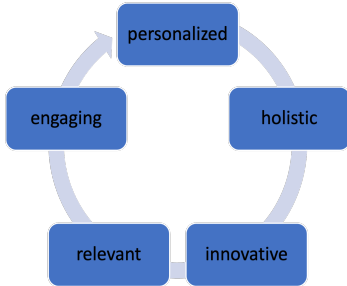


Fig. 2 *m3i journey* Core Concepts

B. *m3i-Journey: Technical Details*

m3i-Journey is a web application whose functionality is similar to an LMS (Learning Management System) such as Blackboard and Canvas—two of the most common current proprietary solutions. It stands out from similar web applications by incorporating state-of-the art, nascent technologies, including: LLM (Large Language Models) with RAG (Retrieval Augmented Generation), classical ML algorithms like Decision Trees and Artificial Neural Networks (ANN), and GMOC (Gamification Massive Online Course) elements. The technology stack for *m3i Journey* follows a standard MERN architecture, with MongoDB as our NoSQL database solution, Express.js as the Node.js backend framework to write server-side logic using the JavaScript programming language, and React (with Next.js) as the frontend framework with Tailwind CSS for styling.

Upon creating a new account, the user will be prompted to fill out a self-identification questionnaire/survey with standard demographic information in addition to a quick assessment of the user's degree of comfort with important financial topics that will constitute the knowledgebase of the application. Based on the results, a simple custom-made Multilayer Perceptron (MLP) or Decision Tree (DT) model will drive the order of the modules presented to the user to more accurately tailor their learning needs. Careful consideration is also being given to the idea of dynamically rearranging module content delivered to the student based on their real-time performance after 't' time intervals, which can be leveraged through Time-Series (TS) models like ARIMA or training a custom LSTM (Long Short-Term Memory) network on relevant user performance metric features for a given t-horizon (1-week, 2-weeks, 1-month progress, etc.). While navigating *m3i-Journey*, users will have access to a rich Graphical User Interface (GUI) containing several tools to enhance their learning, such as a fine-tuned LLM assistant extended with a RAG framework to help the user navigate the User Interface (UI); enhancing interactivity with the course content while being grounded on the content itself and select sources of information deemed reputable by subject matter experts.

V. DATA COLLECTION AND MEASUREMENT

To validate the effectiveness of *m3i-Journey* as a modern, state-of-the-art digital Financial Literacy Education (FLE) platform, we will primarily rely on built-in user engagement analytics programmed into the application itself. That is, the application will—upon receiving clear consent from the user—gather engagement metrics such as overall time spent on the platform, modules completed, scores obtained in quizzes and assessments, user tendency to use different tools like the aforementioned 'SmartNotes' feature or the fine-tuned LLM assistant, and even implement an optional pop-up message within the app to allow users to express their satisfaction level with the app verbally. The data will be aggregated in a data warehouse, using ETL (Extract, Transform, Load) process to ensure consistency and displayed through an interactive dashboard for real-time monitoring of KPI (Key Performance Indicators) using real-time application traffic. The data will be validated by using a paired samples t-test with null hypothesis 'there is no significant difference between the means. This will allow us to understand whether there is a correlation between pre- and post-course scores in relation to the material presented to the students with an acceptable degree of statistical significance. We are also considering developing predictive ML models to identify at-risk users who are not engaging with the platform as intended, who could skew the correlation results as outliers.

VI. CONCLUSION

When considering the importance of higher education institutions producing engineering graduates to meet workforce demands, the role of finances is an important area of impact on students' ability to persist academically and should be heightened in both research and practice. Additionally, the gap

in financial literacy education for all students continues to be a problem. The two combined are contributing towards negative implications for students' social well-being and their journey towards degree completion. Policymakers and decision-makers within higher education can assist in addressing these issues by finding ways to make pursuing degrees more affordable. This can be done through the support and increased conversations on the topic across local, state, and federal governments and through process improvement efforts at the institutional level. Collectively, these efforts can create and increase the level of need-based financial aid that is distributed, increase the amount of grant funding going directly to students, such as food and housing stipends, and new and innovative forms of scholarships along with academic and other performance-based scholarships.

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