Using Chatbot Technologies to help Individuals make Sound Personalized Financial Decisions

Reshawn Ramjattan
University of the West Indies
St. Augustine, Trinidad
reshawn.ramjattan@gmail.com

Patrick Hosein
University of the West Indies
St. Augustine, Trinidad
patrick.hosein@sta.uwi.edu

Nigel Henry
Arthur Lok Jack Graduate School of Business
Mount Hope, Trinidad
nigel.henry@fac.gsb.tt

Abstract—**Those that struggle with debt and poor financial management can find many sources of online content to increase their financial literacy. However, consumption of educational content often does not translate to behavioural change. Software-based on just-in-time education can make use of nudge theory and gamification to help increase financial literacy while also influencing positive financial behaviour. Using chatbot technology as a conversational interface to this educational software increases convenience and usability, especially among those that struggle with learning to use technology. We present the design for a financial education chatbot that defines core situations for providing suggestions and information to users. We also used a survey to evaluate its usefulness and found that 82 per cent of 68 participants consider the chatbot strongly beneficial to their financial education and behaviour.**

Index Terms—**Chatbots, Personal Finance, Education**

I. Introduction

Financial literacy and impulsivity have often been tied to poor debt management and over-indebtedness [1], [2], [3]. Financial literacy can be defined as the ability to use knowledge and skills to manage financial resources effectively and for a lifetime of financial well-being [4]. Gaining this literacy through education can be a seemingly daunting exercise, especially to those that are not tech-savvy, since online education or assisted financial management through apps are often the most convenient and cost-effective means.

Chatbot technology has seen success in increasing the ease of use of educational software in healthcare [5]. Work in [6] also demonstrates the impact of nudges and gamification towards encouraging beneficial change. We, therefore, believe chatbots are a promising way forward for inclusive and effective financial education. This is because, through conversation-driven functionality, users can take advantage of the software by focusing on what they want to accomplish rather than knowing specifically how. Thus, in this paper, we propose the design and implementation of a chatbot focused on financial education and assistance.

The objective of this chatbot is to first provide basic financial assistance by supporting budget management tasks, and then use that awareness of the users' goals and actions to provide analytical advice and suggestions in order to increase their financial literacy over time. Understanding where such

literacy can benefit one's debt management and financial decisions can be woven into this chatbot through its situational advice. These high impact situations are defined as use cases in the chatbot's design.

The ability of chatbots to be integrated into popular social media platforms significantly increases its convenience as educational software. This is because users of those platforms are likely already devoting their attention to those apps. Moreover, the convenience allows the chatbot to be accessible for in the moment decisions, where users are more likely to make impulsive financial mistakes and therefore benefit from well-timed education.

Convenient frequent use and in the moment access also presents an opportunity for applying nudge theory [7]. Cognitive biases, such as impulsivity and a lack of self-control, are often present in poor financial decisions [8]. Nudges are well-timed optional suggestions that aim to resist those negative cognitive biases and encourage actions that progress the user towards their set goals. Nudges based on sound mathematics can urge them in the direction better suited to their long term goals like saving or addressing debt. For example, consider a user that is thinking about risking credit card debt for a luxury purchase like a smartphone. The short term benefit of having the device sooner could be blinding them from the additional cost of the debt and its interest. Calculating and presenting to them how much they can save over time by waiting to use savings to purchase the device instead can deter that short-term focused behaviour.

Lastly, gamification can also be used to reinforce positive behaviour and support user education [9]. This can be done through encouraging streaks of staying within budget, gameful tokens as a reward mechanism, completing short quizzes that highlight important concepts and introducing friendly competition. Chatbots encapsulate these benefits in a simple to use interface that can make financial education for our target groups accessible, convenient and immediately impactful. Our solution defines the core use cases for providing in the moment advice. We exemplify its use through a prototype and evaluate its usefulness through a survey that displays its functionality.

II. Related Works

A study by Fox et al. reviews the content and impact of 90 financial education programmes [10], where one of the

three major programme categories was directed at personal finance topics including budgeting, saving and credit management. The size and scope of these programmes demonstrate recognition of financial education's value and importance. While these broad scope educational programmes are rich in content, work by Fernandes et al. shows that the effect of such educational interventions has little correlation with changes in financial behaviour [11]. They instead recommend a "just-in-time" approach to financial education. With this approach, information is blended with incentives, thus making it easier to consider choices and act towards desirable outcomes.

By also incorporating nudge theory, where optional suggestions toward good behaviour are made, a solution can not only provide education but also positively influence financial behaviour. A review by Damgaard et al. examines the different applications of nudge theory to education [12]. These include reminders that seek to address attention limitations or short-term temptations, as well as informational nudges that increase the accessibility of important information. Evidence of nudge theory's impact on behaviour can be seen in its application to adult dietary behaviour where it resulted in a 15.3% increase in healthier choices [13].

There is a growing number of educational chatbots in different disciplines [14]. This can be attributed to the benefits of usability and convenience chatbots bring. Past evaluations of certain chatbots have shown users were able to reach optimum proficiency in language-driven tasks after just one repetition of use [5]. The ability to integrate these chatbots with social media applications like Facebook, Twitter and Instagram, increases their accessibility and convenience, which are desirable attributes for just-in-time education and nudging.

Another technique that can take advantage of digital interfaces in learning is gamification. Gamification has been shown to bring motivation and social engagement benefits to education [15], [16]. It includes features such as reward badges, good behaviour streaks and competition among chosen friends [17]. These features can further increase the likelihood of users consistently learning and improving their financial behaviour.

III. Objectives

This intervention was required in order to assist in stemming increasing debt levels. The target beneficiaries of the proposed design are young and low-income adults, regardless of their computer literacy levels. The objective of this work is to use advances in chatbot technology to facilitate and apply a combination of just-in-time education, nudge theory and gamification to financial literacy and behaviour. We expect that the proposed design and implementation will make it easier and more convenient for the target groups to attain the financial education and behavioural change needed to address their debt and debt-inducing habits without requiring a large upfront dedication of their time.
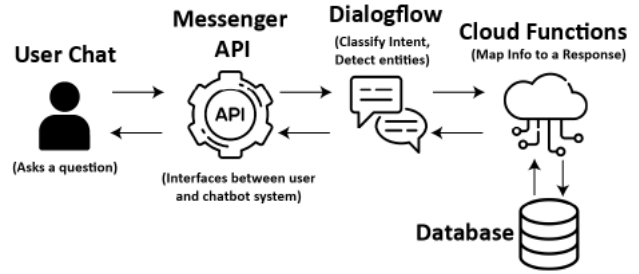

Fig. 1. System Architecture

IV. Methodology

Figure 1 show the architectural flow of the proposed system. Google's Dialog Flow service was used as the natural language understanding platform. This cloud service was responsible for classifying the intent of a user's message and recognizing any terms or entities that we deemed important. Our custom serverless cloud functions are accessed via API calls and run in response to appropriate user intents. These functions are responsible for sending and retrieving the needed data from the database and returning the text responses to be sent to the user. Relevant APIs were also used to integrate the chatbot with the Twitter and Facebook social media platforms.

Messages sent by the user will, through the API of the platform used (for example, Messenger), go to the Dialogflow API for classification. Dialogflow then triggers relevant cloud functions for processing responses, which are sent back to the user. A more detailed explanation is included in the illustrative example below.

We made foundational functions for creating and querying a budget, adding transaction history items and setting or updating budget items via natural language. Building on top of those, we also defined several key use cases or scenarios for providing in the moment information and possibly a nudge or suggestion.

The user goals we aim to support are understanding budget management and bridging the gap between long term stability and short term decisions. We build on top of the foundational functions to provide use cases towards these goals and consider this basic financial assistance that can act as the starting point for more advanced and nuanced means of education and aid. These use cases were defined by consulting relevant industry experts in finance, with a priority on debt-inducing behaviour scenarios contrary to our user goals. The application of gamification is involved in the way the cases are to be maintained. For instance, a point-based quantification of good behaviour based on the follow-up actions of users. These points can be presented along with a periodic summary of user performance and can include an opt-in social competition element. The following describes some of the key use cases.

A. Use Cases

- **Luxury Affordability** - Estimates how much a luxury purchase might exceed the budgeted allowance, as well

Budget Category	Allocation
Food	15%
Rent	30%
Insurance	8%
Entertainment & Luxury	10%
Transportation / Vehicle Services	12%
Health & Personal Expenses	10%
Savings	15%

Fig. 2. User Perspective of Use Case Example

Rating / Use Case	1	2	3	4	5
Luxury Affordability	7%	6%	12%	32%	43%
Budget Tracking	0%	3%	7%	25%	65%
Transaction Affordability	2%	3%	7%	28%	60%
Loan Affordability	1%	2%	6%	22%	69%
Savings Estimate	0%	1%	6%	21%	72%

as the potential credit card debt interest. Responds with whether or not the budget is sufficient and if not, includes estimated interest on the purchase.

- **Budget Tracking** - Estimates an "on track" limit at a given day in the month for a budget category. Responds with whether or not the user is within that limit at the given time of the month.
- **Small Transaction Affordability** - Calculates a category based allowance for the day using the aforementioned "on track" limit for that day. Responds with that category limit for the day.
- **Loan Affordability** - Estimates the duration for someone to pay off a loan. Responds with the period as well as an estimate on how much the user would spend extra in interest versus saving for that duration of time.
- **Savings Estimate** - Uses average savings and budget allotted savings to estimate how much one can save in a specified time period. Responds with an estimated amount.

B. Illustrative Example

To exemplify the process of triggering and interacting with a use case, consider the following customer profile and example that steps through a use case flow. The customer account for the example is that of a middle-aged adult with the budget allocations described in Table I and a monthly income of $2,300.00 USD.

Savings Estimate: In a situation where a user is deliberating or preparing for a large upcoming expense, they may find it useful to estimate the amount they can save in some amount of time. This estimate is an important part of planning ahead and understanding one's financial position in order to avoid spontaneous decisions or debt-inducing behaviour.

Should the user ask the chatbot, "How much can I save in 2 months?" via Messenger, that message is channelled through Facebook's API and goes to the Dialogflow API for intent classification. Our "savings estimate" intent classifier was trained using manually-written variations of that phrase. The savings duration is also detected, in this case, as "2 months".

Dialogflow sends the identifier of the classified intent and the duration, along with user ID and any other needed parameters, to our custom cloud webhook function.

Using the intent given, the appropriate sub-function is called with the user's Facebook ID and the time period passed as variables. The user ID is used to retrieve budget records, budget allocations and recorded transactions. With transaction history available, the estimate would be calculated as an average of savings from the last 3 months, else it would be their income multiplied by their percentage allocated to savings. Once calculated, the estimate is returned to Dialogflow and then the user through Facebook's API. The user's perspective is shown in Fig. 2. This can also serve as an opportunity to recommend areas to increase savings. For example, pointing out to a user that they frequently exceed their luxury budget.

C. Evaluating User Interest & Potential Impact

In order to gauge the usefulness of these cases as well as to collect new suggested cases, we designed a survey. For each use case, users were given a description and scenario exemplifying its use and were then asked to rate its usefulness. We then asked two questions to gauge their interest in using such a chatbot and whether or not they think it would be beneficial to their financial education and decisions. Lastly, we included two open-ended questions on which financial decisions participants deemed as most troublesome and which they would most like the support of sound mathematics for. The sample size was 68 participants. We used convenience sampling and the sample largely matched the demographics of the intended target audience, consisting of young and low-income adults.

V. RESULTS AND DISCUSSION

Table II shows the results of the questions gauging interest in the use case example scenarios, where a rating of one means

not useful and five means very useful. While most questions had a positive response, those that were focused more on immediate or regular decisions had a noticeably more positive result. We believe these results show that the sample of our target groups has a strong inclination towards this type of approach to improving their financial education and behaviour. Moreover, the response indicates not only the existence of a need but also the belief that the example use cases can be a step towards satisfying that need. This notion is supported by the positive results to the two questions gauging interest and belief in using such a chatbot. When asked if they would use such a chatbot, 75% said yes, 21% maybe and 6% no. When asked if they think such a chatbot would improve their financial education and habits, 83% said yes, 13% maybe and 4% no.

The survey also included open-ended questions regarding specific financial decisions participants want the support of sound mathematics for or that they specifically want automated help with. Upon analyzing the results of the responses we found that the most frequent topics mentioned were budget allotment recommendations, investment education, savings opportunity recommendations and assistance with spending decisions. The specific requests within open-ended responses align with our goal and support the idea that those struggling with their financial literacy and decisions want convenient and impactful help.

One of the major flaws with our methodology is the attachment of social platforms like Facebook Messenger which may bring concerns around data privacy for personal financial information. This was kept in mind during the design of the system, the social platform and its API intermediates messages between the user and the rest of the system in a loosely coupled fashion. So, it can be replaced by any other messaging service or custom trusted solution.

As the use cases and supported functionality of the system grows, suitable work must be done in tandem to ensure the usability and quality of user onboarding for the service is maintained over time. This can be done through an accessible catalogue of supported features while highly prioritizing the most effective and important features to new users.

A key aspect of the chatbot's evaluation missing from the survey is a review of hands-on use. Considering the importance of user-friendliness to the adoption of such a tool, a critical component of future work revolves around the thorough testing of a distributable prototype.

This tool has the potential to greatly contribute to inclusive and equal access to quality education. Therefore, another important route for future work includes the gathering of suggestions from more educators and professionals in finance.

VI. Conclusion and Recommendations

The importance of financial literacy is well understood. For that education to be effective there must be immediate incentives and ties to the daily lives of those that struggle with debt and poor financial decisions. This must be done through a means that is also convenient and accessible. Our objective was to design and implement an effective solution that can aid young, low-income and non-tech savvy adults with financial literacy. We've presented the use of chatbot technology to encapsulate the concepts of just-in-time education, nudge theory and gamification to provide impactful in the moment financial education. Integrating such a chatbot with social media platforms also increases its convenience as the targeted users are likely already using them often. The results of our survey gauging interest show promising signs of the chatbot being able to help meet our objectives.

This work can be improved upon by the design of budget and savings opportunity recommender systems. Furthermore, additional cases that cover wider scenarios in areas of financial literacy like loans and investments can be designed. Data from the deployment of the chatbot can also be used to model the spending behaviour of users which can be used to simulate the effect of future educational techniques and nudges.

References

[1] J. Gathergood, "Self-control, financial literacy and consumer over-indebtedness," *Journal of economic psychology*, vol. 33, no. 3, pp. 590–602, 2012.

[2] V. Bahovec, D. Barbić, and I. Palić, "Testing the effects of financial literacy on debt behavior of financial consumers using multivariate analysis methods," *Croatian Operational Research Review*, pp. 361–371, 2015.

[3] C. Ottaviani and D. Vandone, "Financial literacy, debt burden and impulsivity: A mediation analysis," *Economic Notes: Review of Banking, Finance and Monetary Economics*, vol. 47, no. 2-3, pp. 439–454, 2018.

[4] A. Hung, A. M. Parker, and J. Yoong, "Defining and measuring financial literacy," *RAND*, 2009.

[5] S. Holmes, A. Moorhead, R. Bond, H. Zheng, V. Coates, and M. McTear, "Usability testing of a healthcare chatbot: Can we use conventional methods to assess conversational user interfaces?" in *Proceedings of the 31st European Conference on Cognitive Ergonomics*, 2019, pp. 207–214.

[6] T. Pospelova *et al.*, "Uncovering nudges in gamification and their application in organizational change," 2020.

[7] C. R. Sunstein and L. A. Reisch, *The economics of nudge*. Routledge, 2017.

[8] C. Frydman and C. F. Camerer, "The psychology and neuroscience of financial decision making," *Trends in cognitive sciences*, vol. 20, no. 9, pp. 661–675, 2016.

[9] K. Seaborn and D. I. Fels, "Gamification in theory and action: A survey," *International Journal of human-computer studies*, vol. 74, pp. 14–31, 2015.

[10] J. Fox, S. Bartholomae, and J. Lee, "Building the case for financial education," *Journal of consumer affairs*, vol. 39, no. 1, pp. 195–214, 2005.

[11] D. Fernandes, J. G. Lynch Jr, and R. G. Netemeyer, "Financial literacy, financial education, and downstream financial behaviors," *Management Science*, vol. 60, no. 8, pp. 1861–1883, 2014.

[12] M. T. Damgaard and H. S. Nielsen, "Nudging in education," *Economics of Education Review*, vol. 64, pp. 313–342, 2018.

[13] A. Arno and S. Thomas, "The efficacy of nudge theory strategies in influencing adult dietary behaviour: a systematic review and meta-analysis," *BMC public health*, vol. 16, no. 1, pp. 1–11, 2016.

[14] P. Smutny and P. Schreiberova, "Chatbots for learning: A review of educational chatbots for the facebook messenger," *Computers & Education*, vol. 151, p. 103862, 2020.

[15] D. Dicheva, C. Dichev, G. Agre, and G. Angelova, "Gamification in education: A systematic mapping study," *Journal of Educational Technology & Society*, vol. 18, no. 3, pp. 75–88, 2015.

[16] D. Huynh, L. Zuo, and H. Iida, "Analyzing gamification of "duolingo" with focus on its course structure," in *International Conference on Games and Learning Alliance*. Springer, 2016, pp. 268–277.

[17] J. Pereira and Ó. Díaz, "Using health chatbots for behavior change: A mapping study," *Journal of medical systems*, vol. 43, no. 5, p. 135, 2019.