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A Human-Centered, Theory-Based Approach to Designing Conversational AI for Food Insecurity at HBCUs

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ABSTRACT

Students at Historically Black Colleges and Universities (HBCUs) experience disproportionately high rates of food insecurity, yet despite available resources, persistent barriers prevent help-seeking. Conversational AI offers potential to address these barriers and shape help-seeking behaviors. This work examines the current landscape of food insecurity support to inform the design of a conversational AI intervention. To inform intervention design, a needs assessment is conducted through semi-structured interviews with four campus administrators and nonprofit leaders involved in food insecurity programming, representing six private HBCUs in the Southeast, examining resources, communication strategies, and access barriers. Analysis revealed that underutilization stems from psychological barriers: stigma prevents help-seeking even when students know resources exist; traditional communication channels fail to reach students; and fear of being seen deters usage regardless of need. Stakeholders identified technology as uniquely positioned to address barriers, offering discreet access that bypasses stigmatizing face-to-face interactions while providing 24/7 information through channels students use. Recognizing the barriers as constructs of the Theory of Planned Behavior (TPB), attitudes, social norms, and perceived control, findings informed a conversational AI prototype grounded in the TPB to shape help-seeking behaviors. The system addresses TPB constructs by normalizing language and social-proof messaging to improve attitudes and social norms, providing step-by-step guidance to enhance perceived control, and integrating diverse resources that reflect interconnected needs. This work demonstrates a stakeholder-informed approach to designing AI for sensitive contexts where psychological barriers are as significant as practical ones. Future work will evaluate system usability and its impact on help-seeking behavior.

Keywords: Conversational AI, Human-centered design, Human-centered AI, Theory-based design

INTRODUCTION

Food insecurity is a widespread issue that affects individuals' ability to meet basic nutritional needs and navigate daily life. College students face unique challenges in accessing adequate food while managing academic, financial, and personal demands, with food insecurity affecting academic performance, quality of life, and overall well-being (U.S. Government Accountability

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Office, 2024). The issue is particularly pronounced at Historically Black Colleges and Universities (HBCUs), where reported rates of food insecurity are substantially higher (Batchelder et al., 2025). National estimates show a disproportionate burden, with approximately 38% of students at HBCUs experiencing food insecurity compared with 20% of students at institutions that were not classified as minority-serving institutions (U.S. Government Accountability Office, 2024). Despite its prevalence, food insecurity often remains hidden, as students may struggle silently without seeking available support.

Technology-based approaches offer an opportunity to address some of these barriers by providing accessible, private, and responsive support. Conversational AI can provide on-demand interaction and personalized resource navigation without requiring students to engage in immediate, visible, face-to-face interactions. However, effective systems must be responsive to the barriers students experience and the behavioral and social factors that influence help-seeking.

This study examines how stakeholder perspectives can inform the design of a theory-based conversational AI intervention to support food insecurity at HBCUs. Through a qualitative needs assessment with campus and nonprofit stakeholders, the study identifies barriers to resource awareness, access, and use; examines communication and support practices; and identifies opportunities for technology-based intervention. Findings are interpreted through the Theory of Planned Behavior (TPB) and translated into conversational design requirements addressing attitudes, subjective norms, and perceived behavioral control. These requirements informed the development of a conversational AI prototype for discreet, accessible, and personalized resource navigation. This work demonstrates a stakeholder- and theory-informed approach for translating HBCU-specific food insecurity barriers into conversational AI design requirements.

BACKGROUND

Food Insecurity Among College Students and HBCUs

Food insecurity (FI), as defined by the United States Department of Agriculture (USDA), refers to limited or uncertain access to adequate and safe food or the inability to acquire food through socially acceptable means (USDA ERS, n.d.). College students are particularly vulnerable to FI, which has been associated with academic difficulties, health challenges, and persistence, with disproportionate effects among students from marginalized and low-income backgrounds (Thompson et al., 2019). These concerns are particularly relevant at Historically Black Colleges and Universities (HBCUs), where research suggests FI is more prevalent than at other institutions, with reported rates of up to 77% among HBCU students (Thompson et al., 2019; Duke et al., 2021; Hagedorn-Hatfield et al., 2023).

HBCUs have implemented campus-based resources, including food pantries, meal vouchers, meal swipe programs, mobile pantries, and farmers' markets, to address FI (Antwi et al., 2024). However, resource availability does not necessarily translate into student utilization. Students may have limited

awareness of available resources, encounter unclear access procedures or logistical barriers, or avoid assistance because of stigma and concerns about judgment (Antwi et al., 2024; Thompson et al., 2019; Hagedorn-Hatfield et al., 2023; Kornbluh et al., 2021). Institutional challenges, including limited staffing and funding, can further affect access to and sustainability of resources (Antwi et al., 2024; Hagedorn-Hatfield et al., 2023). Together, these findings suggest that addressing FI at HBCUs requires attention not only to resource availability but also to the social, psychological, and practical factors that influence students' decisions and ability to seek support.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) provides a framework for understanding the behavioral and social factors that may influence whether students seek food assistance. Regarding food insecurity, students' decisions may be shaped not only by resource availability but also by their beliefs about seeking help, their perceptions of how others may respond, and their confidence in their ability to access available resources. TPB has been applied across health and social contexts, including help-seeking and service utilization (Adams et al., 2022).

TPB proposes that behavioral intention is the most immediate predictor of behavior and is influenced by three primary constructs: attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). Attitudes reflect evaluations of a behavior and its expected outcomes, subjective norms reflect perceived social expectations, and perceived behavioral control reflects an individual's perceived ability to perform a behavior given available resources and barriers (Ajzen, 1991). Applied to food assistance, these constructs provide a framework for understanding negative perceptions of receiving assistance, concerns about judgment, and uncertainty about how or whether available resources can be accessed. TPB can also inform intervention messaging by addressing these underlying beliefs, such as emphasizing positive outcomes, addressing perceived social expectations, and providing information that reduces barriers to action (Casper, 2007).

Although TPB has frequently been used to explain or predict behavior, it can also provide a foundation for designing interactive interventions. Conversational systems offer an opportunity to deliver TPB-informed information and guidance in response to users' expressed concerns and barriers. In this study, TPB serves as the theoretical foundation for interpreting stakeholder-identified barriers and translating them into conversational design requirements targeting attitudes, subjective norms, and perceived behavioral control.

Conversational AI for Health and Resource Support

Digital health technologies provide scalable approaches for distributing information and supporting health behaviors, but static tools may offer limited opportunities for individualized interaction. Conversational agents provide an alternative by allowing users to communicate through natural

language and receive responsive, context-sensitive guidance (Pereira and Diaz, 2019; Aggarwal et al., 2023; Silva and Canedo, 2024).

Prior research has demonstrated chatbot applications across mental health, behavior change, nutrition, and social needs navigation. Sun et al. (2023) demonstrated how theory-grounded chatbot interventions can target behavioral barriers, while Sezgin et al. (2024) demonstrated the use of conversational systems to identify social needs and connect users with resources. A systematic review by Aggarwal et al. (2023) identified personalization, nonjudgmental interaction, engagement, integration, and scalability as important characteristics of chatbot interventions.

These capabilities are particularly relevant to food insecurity help-seeking, where students may experience stigma, concerns about judgment, uncertainty about eligibility, and difficulty navigating available resources. Conversational systems can provide private, on-demand interactions while adapting information to users' questions and concerns (Pereira and Diaz, 2019; Aggarwal et al., 2023). However, information provision alone may not address the behavioral and social factors that influence whether students seek assistance. Integrating TPB into conversational design provides an opportunity to address these factors by intentionally targeting attitudes, subjective norms, and perceived behavioral control.

METHODOLOGY

This study used a qualitative research design using semi-structured interviews with campus stakeholders at Historically Black Colleges and Universities (HBCUs) in the Southeast. Interviews explored existing food insecurity resources, barriers to student awareness and access, communication strategies, and stakeholder perspectives on student needs. Findings were used to identify stakeholder-informed requirements for a digital intervention to address food insecurity and resource navigation. Three research questions guided the study:

(i) RQ1. What resources are currently available at HBCUs to support students experiencing food insecurity, and what barriers do stakeholders perceive as limiting student awareness and access to these resources?
(ii) RQ2. How do campus stakeholders communicate information about food insecurity resources, and how effective are these strategies in addressing student needs?
(iii) RQ3. What improvements or strategies do stakeholders recommend to strengthen student awareness, access, and utilization of campus food insecurity resources?

Participants were recruited through purposive sampling to capture the perspectives of individuals directly involved in student well-being, basic-needs support, or food-insecurity initiatives. Recruitment was conducted through email and telephone outreach. Four stakeholders participated, representing six private HBCU institutions in the Southeast. Participants were campus administrators and representatives of non-profit organizations

with direct experience supporting students and developing or coordinating food insecurity and basic-needs resources.

Data were collected through semi-structured interviews using an interview protocol aligned with the three research questions. Questions were open-ended with optional probes to support consistency while allowing participants to elaborate on their experiences. The protocol was pilot tested to assess question clarity and alignment with the research questions, and feedback was used to refine the interview flow. Participants provided informed consent prior to the interviews. Interviews were conducted and recorded through Zoom using institution-approved encrypted recording procedures. Transcripts were generated using MAXQDA's secure transcription tools, manually reviewed for accuracy, and de-identified using pseudonyms. Research data were stored in secure, access-controlled university storage.

Interview data were analyzed using thematic analysis following Braun and Clarke's six-phase approach (Braun and Clarke, 2006). MAXQDA was used to organize transcripts, apply codes, retrieve coded segments, and compare patterns across participants. Analysis began with repeated transcript review, followed by inductive coding of segments related to resources, barriers, communication practices, and recommendations. Related codes were grouped into broader categories, and candidate themes were iteratively reviewed and refined against coded excerpts and the full transcripts.

The analysis was primarily inductive, allowing themes to emerge from stakeholder accounts rather than imposing TPB constructs during initial coding. Following thematic analysis, the resulting themes were mapped to TPB to identify behavioral, normative, and control-related barriers relevant to food insecurity help-seeking. These findings were then translated into design requirements addressing attitudes, subjective norms, and perceived behavioral control, which informed the conversational strategies, content, and system features implemented in the chatbot prototype.

The study followed institutional requirements for human subjects research, and all research data were stored in secure, access-controlled university systems.

RESULTS

Thematic analysis identified six interconnected themes describing how HBCU stakeholders understand food insecurity, resource access, and communication. Across interviews, participants described food insecurity as a broader basic-needs issue shaped by financial constraints, stigma, communication gaps, and practical barriers to accessing support. They also identified opportunities for more student-centered and technology-enabled approaches to resource navigation.

Theme 1: The Multifaceted Nature of Food Insecurity and Resource Provision

Participants described food insecurity as part of broader financial and basic-needs challenges rather than an isolated lack of food. Participant D characterized it as a "complex problem" and described a pantry providing food alongside toiletries, hair products, and clothing. Participants also

connected food insecurity to housing costs, financial aid, transportation, and difficulties qualifying for SNAP, noting that basic needs "link to each other." HBCUs therefore provide resources beyond traditional food pantries, including farmers markets, transportation, meal credits, take-home meals, and emergency assistance. However, staffing and operating hours remained challenges; Participant A highlighted the need for additional "staffing to keep the pantry open long," demonstrating how institutional capacity can affect accessibility.

Theme 2: The Pervasive Influence of Stigma and Disclosure Barriers

Stigma emerged as a significant barrier to help-seeking. Participants described concerns about being perceived as impoverished or being seen using food assistance. Participant A explained that some students "do not want to be seen as that," and that some visit the pantry outside regular hours to avoid being observed. Participant C similarly identified embarrassment as a barrier to disclosing need. Participants described confidentiality, discreet communication, and less stigmatizing resource environments as strategies for addressing these concerns. Participant D cited a "strict confidentiality policy," while Participant C described a pantry designed to allow students to access services without being visibly identified. These findings suggest that resource availability alone does not ensure utilization.

Theme 3: The Evolving Landscape of Communication Channels

Participants described a shift from traditional institutional communication toward digital and peer-based channels. Although email and flyers remain common, Participant C reported that "most students do not check their email." In contrast, social media, student organizations, ambassadors, and word of mouth were viewed as more effective at reaching students. Participant D described word-of-mouth as "always the biggest" source of information. At the same time, Participant C identified student organizations and groups such as SGAs, fraternities, and sororities as important communication channels. Thus, resource awareness depends not only on information availability but also on whether information is communicated through channels students regularly use and trust.

Theme 4: Balancing Outreach With Confidentiality

Participants identified a tension between increasing resource awareness and protecting student privacy. Some organizations intentionally limit direct outreach or avoid identifying students who may need assistance. Participant D explained that the organization does not attempt to identify students experiencing need because "it is not our business," reflecting a deliberate prioritization of confidentiality. However, highly discreet outreach may also limit visibility for students outside existing peer networks. Participants therefore emphasized the need for approaches that reach students broadly without publicly identifying those seeking assistance.

Theme 5: Fostering a Student-Centered and Holistic Support Ecosystem

Participants emphasized that support should reflect students' lived experiences and involve students in service delivery. Participant D described having students staff the pantry and develop marketing materials because "it helps us keep it student-centered." Participant A similarly described a student-run pantry that allows students to "see themselves" in the service. Participants also emphasized connections among food insecurity, housing, transportation, finances, and other basic needs. Some institutions complemented food resources with cooking and nutrition education, suggesting that effective support extends beyond food provision to a broader, student-centered support ecosystem.

Theme 6: Leveraging Technology for Enhanced Accessibility and Discretion

Participants identified technology as an opportunity to improve communication and access. Participant C described text-based communication as useful because students are more likely to read texts than institutional emails. At the same time, Participant D expressed interest in a mobile application that could centralize pantry information. Technology was also valued for reducing face-to-face interactions that may trigger embarrassment or stigma. Participant C proposed allowing students to request assistance from "the comfort of their own dorm." At the same time, Participant D emphasized making access easier so students do not have to "struggle" to obtain information. Suggested technologies included mobile applications, text-based systems, and web-based forms.

Synthesis of Findings

Across the six themes, participants described a gap between the availability of food insecurity resources and students' ability or willingness to access them. Stigma, disclosure concerns, limited awareness, communication preferences, logistical barriers, and institutional capacity can constrain resource utilization. These barriers were interconnected: communication must increase awareness without compromising privacy, while resource access must account for students' broader financial and basic-needs circumstances.

These findings informed the design of the conversational AI intervention. Stakeholder-identified barriers were subsequently interpreted through the TPB to identify implications for behavioral beliefs, perceived social expectations, and perceived control over seeking assistance.

TRANSLATING FINDINGS INTO CONVERSATIONAL AI DESIGN

Findings informed the design of a conversational AI intervention implemented as a chatbot by connecting stakeholder-identified barriers with the TPB. Rather than relying on generic assumptions about student needs, the chatbot is designed around the barriers, communication preferences, and resource-access

challenges identified by HBCU stakeholders. The design process followed a three-step approach: (1) identifying barriers from the thematic findings, (2) interpreting those barriers through TPB constructs, and (3) translating them into conversational and system-level design requirements. Table 1 summarizes how the stakeholder-identified themes and TPB constructs were translated into the chatbot's four-stage conversational flow.

Table 1: Stakeholder findings and TPB-informed chatbot design.

Chatbot Stage	Theme(s)	TPB Construct(s)	Design Purpose
Greeting & Introduction	Stigma and Disclosure; Balancing Outreach with Confidentiality	Attitudes; Subjective Norms	Establish supportive, private, nonjudgmental interaction
Food Insecurity Screening	Multifaceted Nature of FI; Stigma and Disclosure	Attitudes; Perceived Behavioral Control	Provide a structured and discreet way to identify need
Resource Matching	Multifaceted Nature; Student-Centered Support; Technology	Perceived Behavioral Control; Attitudes	Provide relevant resources and actionable access information
FAQ(s)	Multifaceted Nature; Stigma and Disclosure; Communication	Perceived Behavioral Control	Address eligibility, privacy, logistics, and access concerns

Mapping Findings to TPB-Informed Design Requirements

Three TPB constructs guided the design of the chatbot: attitudes, subjective norms, and perceived behavioral control.

Attitudes. Stigma-related findings informed the use of supportive, normalizing, and nonjudgmental language. Help-seeking is framed as a practical strategy for meeting basic needs rather than as a reflection of personal failure.

Subjective Norms. Concerns about peer judgment informed messages emphasizing social acceptance and institutional support. The chatbot communicates that food assistance is available to students and that seeking support is an acceptable part of maintaining student well-being.

Perceived Behavioral Control. Practical barriers such as limited awareness, uncertainty about eligibility, transportation, pantry hours, and difficulty navigating services informed the use of step-by-step guidance, eligibility information, locations, operating hours, and alternative resources.

Conversational Flow

The chatbot is organized into four stages: (1) greeting and introduction, (2) food insecurity screening, (3) resource matching, and (4) frequently asked questions. Each stage incorporates stakeholder findings and TPB-informed design requirements.

Stage 1: Greeting and Introduction. The interaction begins with a supportive and discreet introduction that establishes the chatbot as a nonjudgmental source of assistance and allows students to explore resources privately.

Stage 2: Food Insecurity Screening. The chatbot uses the USDA six-item short form to identify food-related needs through a structured and private interaction. Screening language is simple and nonjudgmental to reduce the burden of disclosing need.

Stage 3: Resource Matching. Screening responses and student questions are used to provide tailored recommendations. Consistent with the holistic nature of food insecurity identified in this study, recommendations extend beyond food pantries to resources such as SNAP assistance, transportation, toiletries, emergency support, and educational programs. Recommendations include actionable information such as eligibility requirements, locations, operating hours, and next steps.

Stage 4: Frequently Asked Questions. The FAQ component addresses common concerns about eligibility, privacy, pantry access, and operating hours while providing immediate answers to logistical questions.

Design Synthesis

Together, the findings and TPB provide a direct link between stakeholder needs and chatbot functionality. Stigma and concerns about judgment informed nonjudgmental, discreet interactions; communication gaps informed accessible information; logistical barriers informed step-by-step navigation; and the interconnected nature of food insecurity informed broader resource matching.

The resulting prototype represents a stakeholder- and theory-informed translation of qualitative findings into conversational AI chatbot design requirements.

CONCLUSION

This study demonstrates a stakeholder- and theory-informed approach to designing a conversational AI chatbot for food insecurity resource navigation at HBCUs. Stakeholder interviews identified barriers related to stigma, confidentiality, communication, resource awareness, and access, which were interpreted through the Theory of Planned Behavior and translated into chatbot design requirements. A key limitation is the small stakeholder sample and the lack of direct student evaluation at this stage. Future work will evaluate the chatbot to examine response quality and its effects on TPB constructs and help-seeking intentions.

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