

## **AI-Powered University Student Support Chatbot using AWS Serverless Technologies and Claude AI**

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### **Abstract**

Artificial Intelligence has boosted the adoption of chatbot systems across higher education, yet many chatbots face limitations. Systems provide shallow or generic responses, struggle with informal or vague student languages, fail to maintain context across multi-turn conversations, and function only as FAQ tools without integration into real university services. To address these challenges, this research aims to design, develop, and evaluate a cloud-native conversational chatbot built on an architecture intended for real-time intelligence. Testing results showed strong intent recognition, accurate data retrieval, effective handling of informal inputs, and reliable multi-turn conversation performance, reducing administrative strain and supporting diverse, complex student inquiries.

**Keywords:** Chatbot; Amazon Lex V2; Artificial Intelligence; Higher Education.

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### **1.0 Introduction**

Universities today operate in a fast-moving digital environment where students expect information the moment they need, not hours or days later. Whether they are worrying about tuition deadlines at midnight, seeking clarification on a visa before class, or trying to book an advising appointment during peak periods, students increasingly rely on technology for instant answers. In response to these expectations, higher education institutions are increasingly implementing AI-powered chat systems to enhance student support. These systems enhance accessibility, deliver continuous assistance, and reduce administrative staff workload, particularly during peak periods such as enrollment and examinations. Studies indicate that adopting chatbots in educational settings has substantially increased response efficiency and student satisfaction, particularly for routine inquiries and support services. Prior research highlights that chatbot technologies are widely adopted across multiple domains, including education, to simulate human conversation and provide automated assistance (Adamopoulou & Moussiades, 2020).

#### **1.1 Background and Problem Statement**

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Conversational Artificial Intelligence has emerged as a scalable method for enhancing access to information and support in higher education. Early chatbot systems were primarily rule-based, relying on keyword matching and predefined responses, which limited their ability to handle informal or ambiguous user input (Adamopoulou & Moussiades, 2020). While recent advancements in Natural Language Processing and Large Language Models have enhanced the ability of these systems to interpret user intent and generate more natural responses, many existing educational chatbots still face significant limitations.

Research indicates that while chatbots can support administrative tasks and improve accessibility, many systems struggle with complex, real-life student input and often provide shallow or generic responses (Okonkwo & Ade-Ibijola, 2022). Furthermore, most existing solutions cannot maintain context across multi-turn conversations, fail to integrate seamlessly with institutional data (Pereira et al., 2023), and rarely support multiple service domains on a unified platform. These limitations reduce their effectiveness in real-world university environments, where student inquiries are diverse, time-sensitive, and often interconnected.

### 1.2 Research Question and Objectives

What if student support were as accessible and immediate as digital messaging, with no delays or confusion, and with instant responses tailored to students' needs? The purpose of this study is to design, develop, and evaluate a cloud-native conversational chatbot for real-time, context-aware student support. By integrating Amazon Lex V2, AWS Lambda, DynamoDB, and Claude Sonnet 4.5, the system delivers intelligent, responsive interactions while handling informal input and maintaining multi-turn conversational context.

## 2.0 Literature Review

The emergence of generative AI and Large Language Models has accelerated this transformation by enabling chatbots to interpret natural language more effectively and respond in a more human-like and context-aware manner. Research highlights that modern chatbot systems are increasingly capable of handling complex interactions, supporting real-time feedback, and enhancing student engagement in digital learning environments (Pereira et al., 2023).

At the same time, the adoption of chatbot technologies continues to grow globally, with studies showing increasing acceptance and use among university students, driven by demand for instant, accessible, and personalized support (Ilieva et al., 2023). In addition to their academic applications, these systems are expanding into administrative and advisory roles, positioning chatbots as central components of digital campus ecosystems [4].

However, despite these advancements and expanding roles, current chatbot implementations still face critical challenges. Research indicates that many systems struggle to maintain conversational coherence, ensure response accuracy, and adapt to diverse user inputs in real-world environments (Lambebo & Chen, 2024). In addition, concerns remain about reliability, trust, and the limitations of AI-generated responses, particularly in high-stakes or complex student scenarios (Labadze et al., 2023).

Therefore, these persistent limitations reveal a significant gap between the potential of conversational AI and its actual effectiveness in supporting higher education environments. Addressing this gap requires systems that combine structured intent recognition with advanced language reasoning, enabling more reliable, context-aware, and integrated student support solutions.

Table 1. Summary of Related Works and Identified Gaps

Authors & Year	Focus Area	Key Contribution	Limitations
Adamopoulou & Moussiades (2020)	Chatbot Technology Overview	presents a comprehensive overview of chatbot architectures and applications across various domains	Lacks focus on real-world educational deployment and modern LLM capabilities
Winkler & Söllner (2023)	Chatbots in Education	explores the role of chatbots in supporting educational processes and student services	Limited discussion on context awareness and system integration
Pereira et al. (2023)	Conversational Agents in Higher Education	reviews applications of chatbots in academic environments and their growing adoption	Highlights gaps in scalability and real-time interaction capabilities
Labadze et al. (2023)	AI Chatbots in Education	systematic review of chatbot use in learning and administrative support	Identifies lack of personalization and limited adaptability

Ilieva et al. (2023)	Generative AI in Education	examines the impact of generative chatbots on learning and engagement	Notes challenges in accuracy and reliability of AI-generated responses
Tian et al. (2024)	Chatbot Adoption	studies user acceptance and adoption trends of AI chatbots in universities	Focuses more on perception than technical implementation
Ramandanis & Xinogalos (2023)	Educational Chatbot Systems	discusses chatbot integration in educational systems	Limited multi-domain support and scalability discussion
Lambebo & Chen (2024)	Chatbot Performance	reviews effectiveness and challenges of chatbot systems	Highlights issues with handling complex queries and maintaining context

### 3.0 Methodology

Designing an effective AI-powered student support system requires an architecture that is flexible, intelligent, and capable of handling real student conversations. The system developed in this research brings together natural language understanding, scalable cloud-native components, and external APIs into a unified and responsive platform for efficient user interaction and service delivery. Each part of architecture plays a specific role, and together they deliver a smooth, context-aware experience for students seeking academic, financial, administrative, or general information.

This section explains the system’s structure, describes how the components interact, and outlines how the chatbot developers implemented its features. It also outlines the methodology used to build and refine the system through iterative testing and improvement.

#### 3.1 System Architecture

The architecture follows a structured workflow that begins with the student’s initial message and concludes with a personalized chatbot response. The user sends a message through the web interface. The system forwards this message to the API Gateway, which serves as its secure entry point. The request then goes to Amazon Lex V2, which interprets the text, identifies intent, and determines the required action.

After Amazon Lex identifies the student’s intent, it invokes AWS Lambda, which serves as the system’s central processing engine.. Lambda functions handle the execution of all necessary logic and facilitate coordination with external services. For tasks such as retrieving or updating student information, Lambda interacts with DynamoDB. This database stores essential records, including tuition balances, appointments, and knowledge-base content. DynamoDB was chosen specifically for its proven scalability, high availability, and ability to manage variable workloads without reducing performance, making it particularly appropriate for scenarios where query patterns shift throughout academic cycles (Amazon Web Services, n.d.).

When a message requires deeper interpretation, particularly when students use informal or ambiguous language, AWS Lambda forwards the input to Claude Sonnet for advanced language analysis. This language model was selected for its advanced natural language reasoning capabilities, which enable it to provide nuanced understanding and contextual analysis of complex queries that may not be resolved by rule-based intent detection alone.

Lambda is also responsible for triggering additional services when needed. For instance, Amazon SES is used to send appointment confirmation emails, and the integrated Weather API provides real-time weather updates when requested. CloudWatch monitors the entire system, ensuring logs, diagnostics, and visibility across all components. Through this layered design, the system remains flexible, scalable, and capable of delivering smooth interactions without service interruptions.

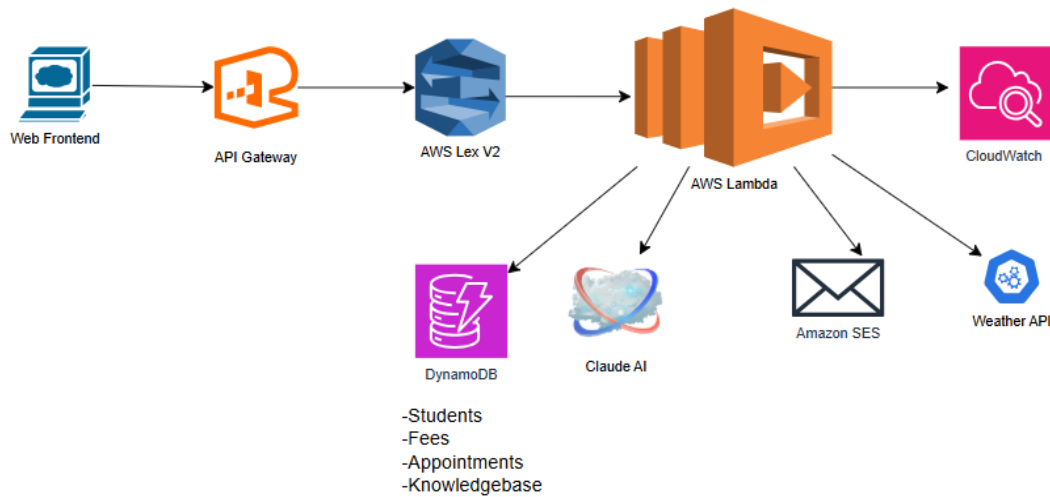


Figure 1. System Architecture

### 3.2 System Design and Implementation

The implementation phase focused on transforming the system design into a fully functional chatbot capable of handling real student tasks. Each service domain was modelled as an individual intent within Amazon Lex V2. These intents were trained using natural, informal, and varied examples of student messages, allowing the chatbot to understand real-world communication patterns. Every intent is connected to a dedicated AWS Lambda function responsible for executing logic, retrieving student information, and generating accurate responses.

Table 2. Supported Student Services and Their Functions

Service Domain	Description / Functionality
Tuition & Fees	retrieves the student's fee balance, payment status, and financial reminders from Amazon DynamoDB.
Academic Advising	provides advising information and supports appointment scheduling workflows.
GPA Calculation	computes GPA based on grades provided by the student.
Visa & Immigration Information	offers document requirements, visa rules, and compliance instructions for international students.
Dormitory Rules & Housing Info	provides dormitory regulations, living guidelines, curfew rules.
Health Insurance Guidance	explains insurance coverage, required documents, and renewal steps.
Mental-Health Support	provides safe, basic emotional support and directs students to official resources.
Weather Information	retrieves live weather updates using the integrated Weather API.
Cancel Appointment	allows students to cancel previously scheduled advising appointments.
View Appointment	retrieves and displays the student's upcoming advising appointments from amazon DynamoDB.
Part-Time Job Policies	provides rules, eligibility, and employment restrictions for international student part-time work.

The backend processing flow focuses on how the system dynamically handles different types of user input rather than simply routing requests between components. When a query is received, the system first determines whether it can be resolved through predefined intents or requires deeper semantic understanding. For straightforward requests, structured intent recognition ensures fast and accurate responses. However, for vague, incomplete, or complex queries, additional processing is triggered to enhance interpretation and response quality.

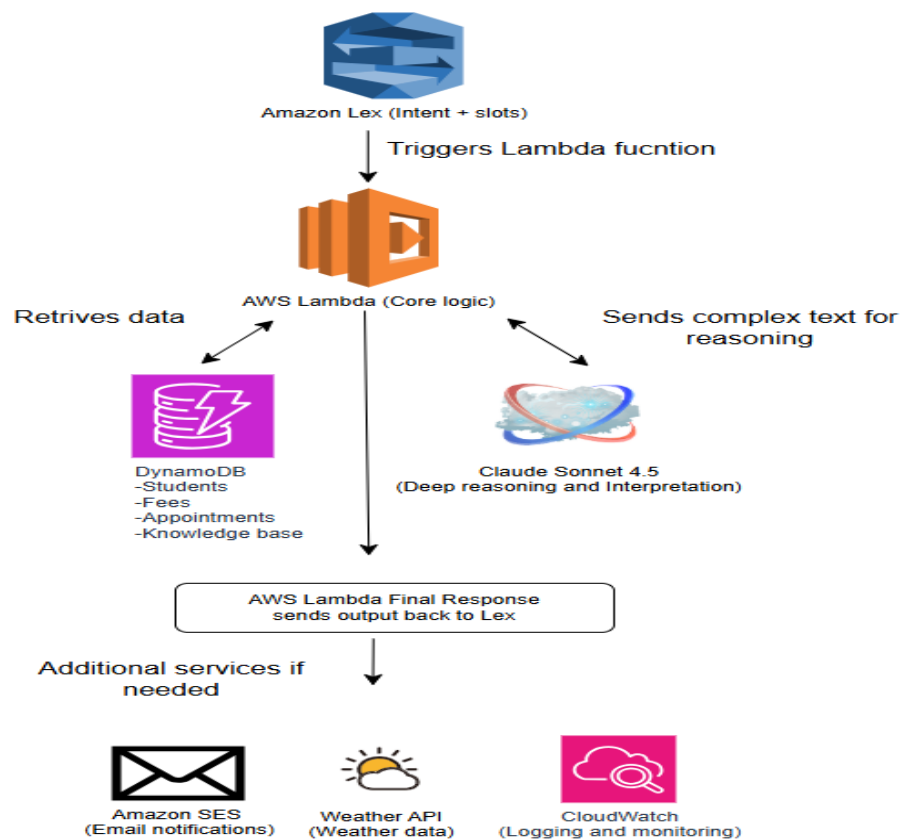


Figure 2. Backend Processing Workflow

This guarantees consistent, reliable processing of every student request. By centralizing logic within Lambda, the system maintains a clear separation between natural language understanding, reasoning, and database operations. The modular design also allows new services to be added or existing ones to be refined without impacting the overall architecture.

Beyond structural efficiency, the system is designed to support meaningful user interaction through context-aware communication. Unlike Single-turn systems, the chatbot maintains relevant information across multiple exchanges, enabling it to interpret follow-up queries accurately without requiring the user to restate previous inputs. This enables more natural and efficient communication, particularly in scenarios where user requests evolve or depend on prior context.

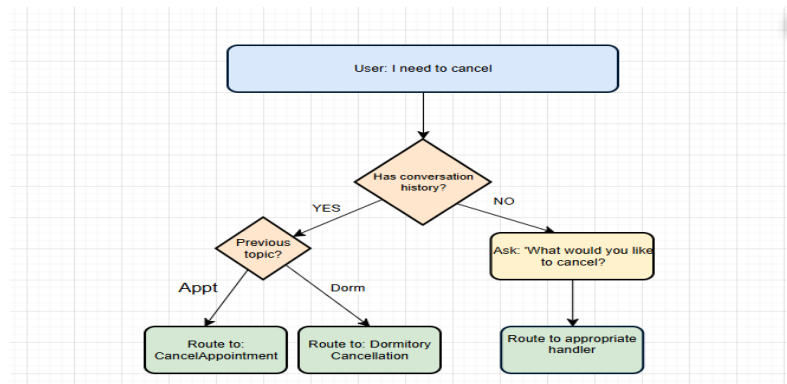


Figure 3. Multi-turn Conversation Flow

## 4.0 Findings

This sector presents the results of the functional evaluation of the AI-powered student support chatbot. The evaluation focuses on how effectively the system interacts with realistic student queries, emphasizing functional correctness, conversational flow, and response accuracy rather than performance metrics such as latency. Overall, the findings demonstrate that the chatbot can deliver reliable, context-aware, and meaningful responses across multiple service areas.

### 4.1 Functional Performance of the Chatbot

The chatbot was tested using real and informal student-style messages covering all supported services, including tuition inquiries, advising appointments, GPA calculation, visa information, dormitory rules, and part-time job policies.

System validation employed 63 test cases across 6 query categories:

- 1) Simple Queries (12 cases): e.g., "Check my tuition balance"
- 2) Casual Language (15 cases): e.g., "yo what do i owe?"
- 3) Typographical Errors (10 cases): e.g., "tution balancce"
- 4) Complex Sentences (12 cases): e.g., "I was wondering if it might be possible..."
- 5) Ambiguous Queries (14 cases): e.g., "I need to cancel" (what?)
- 6) Multi-turn Conversations (10 cases): e.g., GPA calculation dialogues

The system demonstrated strong intent recognition across different input styles, including simple requests, informal expressions, typographical errors, and more complex sentence structures. It consistently retrieved accurate information from the database and generated appropriate responses. In cases of unclear or incomplete input, the chatbot effectively prompted users for clarification rather than producing incorrect outputs.

A notable strength of the system was its ability to handle multi-turn conversations. The chatbot maintained context across interactions, allowing users to complete tasks such as reviewing or canceling appointments without repeating information. This contributed to a more natural and efficient conversational experience.

### 4.2 Summary of Findings and Limitations

*The overall evaluation confirms that the chatbot performs reliably across its primary functions. It effectively interprets natural language input, adapts to varied user expressions, and maintains conversational continuity during multi-step interactions. These capabilities highlight the system's suitability for real-world student support scenarios.*

Test Focus	Observation
Intent Recognition	correctly identified user queries across varied phrasing styles
Data Accuracy	returned accurate information from DynamoDB
Multi-Turn Conversations	maintained context during multi-step interactions
Error Handling	requested clarification for unclear inputs
Natural Language Input	handled informal language, typos, and short expressions effectively

However, the evaluation revealed some limitations. The system's performance decreases when handling highly ambiguous or overly complex queries that lack sufficient context. Additionally, its functionality is currently limited by the scope of integrated data and services, indicating the need for further expansion.

## 5.0 Discussion

The results of this study indicate the practical implications of deploying an AI-powered chatbot within a real university support environment. Rather than emphasizing solely on technical performance, the findings demonstrate how chatbot platforms can reshape student interaction by reducing dependence on traditional, time-bound support channels. The ability to respond instantly and handle evolving queries denotes a shift toward more accessible and continuous student services (Pereira et al., 2023).

Building on this, a key insight from the evaluation is the significance of context awareness in conversational systems. The chatbot's ability to sustain multi-turn interactions indicates that effective student support depends not only on answering isolated questions but also on maintaining continuity throughout the interaction. This reflects a broader transition in chatbot design from simple query-response systems toward more dynamic, conversation-driven support tools (Labadze et al., 2023).

Furthermore, integrating multiple service domains into a single platform underscores the value of a unified system design. Instead of requiring students to navigate separate services, the chatbot consolidates access into one interface, improving usability and reducing interaction complexity. This aligns with recent studies emphasizing system integration as a critical factor for real-world chatbot deployment in education (Labadze et al., 2023).

However, the findings also suggest that achieving fully reliable conversational intelligence remains a challenge. Situations involving unclear or highly ambiguous input expose the limitations of current approaches, particularly in understanding user intent without sufficient context. This is consistent with existing research highlighting difficulties in handling ambiguous queries in conversational AI systems (Lambebo & Chen, 2024).

In addition, the limited language support underscores a broader issue in conversational AI systems: accessibility across diverse user groups is often constrained. Expanding multilingual capabilities and improving adaptability to different communication styles are widely recognized as essential for broader adoption in global educational environments (Ilieva et al., 2023).

Overall, this study underscores that current chatbot technologies represent a transformative advancement in student support services. Their continued success depends on deliberately balancing structured processing with adaptive language understanding. The analysis makes it clear that future progress must prioritize not only technical accuracy but also champion adaptability, inclusivity, and real-world usability to fully realize the potential of conversational AI in education.

## 6.0 Conclusion & Recommendations

Student support no longer needs to be fragmented, slow, or restricted by time. The system developed here shows how intelligent conversational technology can deliver instant, reliable, and context-aware assistance across diverse university services, enabling meaningful, real-time engagement for both simple and complex interactions.

A major advantage of the system lies in its ability to understand authentic student communication, by handling informal, unstructured, and evolving interactions naturally. By preserving conversation context and blending structured intent detection with advanced understanding, the system delivers continuous, natural support beyond standard Q&A.

Crucially, the architecture integrates scalability and intelligence. Its cloud-native, serverless design ensures efficient adaptation to changing university demands, supporting agile, consistent student experiences.

Overall, this work demonstrates a transformation in student services from reactive, delayed responses to proactive, accessible, and always-on support that empowers students.

### 6.1 Recommendation

*While the current system performs strongly, several opportunities can further push its capabilities:*

- **Expand multilingual support** to include other commonly used languages, improving accessibility for a more diverse student population.
- **Integrate actual university databases** to enable more personalized, real-time responses based on student-specific information.
- **Enhance the mental health module** by incorporating safer escalation pathways and connections to professional support services.
- **Improve the dormitory, visa, and part-time job modules** through richer and more frequently updated data sources.
- **Introduce analytics capabilities** to track common user queries and continuously improve system training and response quality.
- **Develop a mobile version** of the system to increase accessibility and provide more convenient, on-the-go student support.

### Acknowledgement

The guidance, support, insights, feedback, and continuous encouragement from the supervisors and faculty members of the Smart Computing Department at Kyungdong University Global were essential to this research and directly shaped its direction and quality.

I extend my appreciation to everyone who contributed, whether directly or indirectly, to the development and completion of this project.

### Paper Contribution to Related Field of Study

This paper contributes to the field of artificial intelligence in education by presenting a practical, scalable approach to student support systems. Unlike chatbot solutions limited to single-domain or FAQ interactions, it introduces a unified platform that addresses diverse student needs via a single conversational interface.

A primary contribution is the integration of structured intent recognition with advanced language understanding, which robustly supports both precise and flexible user interactions. This hybrid approach empowers the system to effectively handle informal, incomplete, and multi-turn queries, decisively addressing a common limitation in traditional chatbot implementations.

In addition, a cloud-native, serverless architecture delivers a deployable, cost-efficient model that positions higher education institutions to achieve scalable digital solutions. The study provides practical insights into chatbot performance through rigorous functional evaluation and realistic student interactions.

Overall, this work decisively advances the development of context-aware, integrated, and adaptable conversational systems, leading to the evolution of intelligent digital support services in higher education.

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