Enhancing Education with AI: A Comparative Study of Traditional and Generative AI Chatbots

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Abstract

Chatbot technologies are transforming education through the integration of artificial intelligence (AI). The present study compares the educational applications of traditional rule-based chatbots (ELIZA, ALICE, Mitsuku) and modern generative AI-powered chatbots (Chat GPT, Google Bard, Jira, Hugging face and Jasper AI). Natural Language Processing (NLP) is the common ground for both types of chatbots, while the traditional chatbots employ the rule-based NLP techniques – pattern matching and scripted response, and generative AI chatbots rely on deep learning and dynamic interactions.

The core objective of the present study is to assess and contrast the concept, functionality, adaptability and integration capabilities of both chatbot types within educational contexts.

The evaluation methodology involves secondary data analysis drawn from academic sources, using criteria such as background, setup, cost, knowledge, personalization, privacy, security, ethics, accessibility, teaching impact, privacy & security providing a qualitative basis for comparison. This approach helped uncover their strengths and weaknesses, offering insights for schools, teachers, and educational technologists.

The primary purpose of this study is to compare the roles and effectiveness of both types of AI chatbots in education. Ultimately, it helps educators and stakeholders choose the right chatbot for their specific learning environment.

Findings show that while both types of chatbots aim to streamline communication and support students with routine tasks, their core mechanisms differ. Traditional chatbots rely on static, rule-based logic, whereas generative AI chatbots adapt dynamically and generate human-like responses. Privacy concerns are also key differentiators—generative bots need strict data regulation compliance compared to the more controlled data usage in traditional bots.

This study concludes by emphasizing AI chatbots can shape the future of learning through enhanced personalization and support, while acknowledging technological, ethical, and implementation challenges that need addressing in future research.

Keywords: Artificial Intelligence (AI), Chatbots, Education, Generative Chatbots, Traditional Chatbots.

Introduction

Artificial Intelligence (AI) is a leading factor for change, particularly in such sectors as healthcare, business, and most importantly,education. Digital systems are now acutely integrated with AI technologies such as natural language processing (NLP) and machine learning (ML). Such systems are built to perform complex reasoning and learn to identify patterns of user engagement, providing a tailored learning experience. One of the major applications of Artificial Intelligence (AI) in the education industry is chatbots – conversational agents that mimic human conversations (Maher, 2020).

The term chatbot comes from a combination of "chat" and "robot" and was initially used to describe text-based dialogue systems that simulated human

conversation. (Gupta) The early versions of chatbots, primarily computer programs, used input and output masks to imitate an interactive, real-time conversation with the users. Chatbots have been continuously growing well beyond just having fixed scripts for their answers. The emergence of advancements in artificial intelligence (AI), natural language processing (NLP), and machine learning (ML) has contributed to the ability of chatbots to understand context, provide relevant responses, and improve based on conversations with users. Initially, chatbots were simple, text-based computer programs built to replicate a human conversation. Original chatbots were response and template-driven, which meant wider acceptance across domains, even those like education, now facilitating the role of virtual tutors, advisors, and learning assistants.(Kooli)

Two major groups of chatbots that have played a huge role in modern education are: traditional and generative artificial intelligence (AI) chatbots. Using rule-based or retrieval-based systems, traditional chatbots provide standardised answers to predefined questions. They can perform brilliantly on simple questions, but fail to do well in more subtle or vague questions. On the contrary, generative AI chatbots leverage advanced deep learning algorithms to facilitate realistic conversation patterns, address varied student needs, and deliver dynamic and customised educational experiences. The research will look at the benefits and drawbacks of the two types of chatbots in enhancing educational engagement, support, and outcomes for students and educators.

Purpose of the Study

The primary purpose of this study is to compare traditional AI chatbots and generative AI chatbots usage in education. This study aims to guide that decision-making process by identifying key differences between the two chatbots types. It looks at how each chatbot supports learning, answers questions, and interacts with students. It also checks how much each cost and how safe they are for student data. This study helps them choose the right type.

Ultimately, the present study serves as an informative resource for educational stakeholders—teachers, curriculum designers, technologists, and policymakers to understand the good and bad sides of each. This understanding can guide their decisions when planning to use chatbots in their institutions.

Methodology

This comparison was made using clear and practical criteria. The main criteria were: background, meaning, definition, function, knowledge, setup, cost, conversation, teaching uses, error handling, assessment, ethics, accessibility, teacher impact,future, personalisation, privacy and security. These factors were chosen because they reflect the most critical elements influencing chatbot performance, scalability, user experience, and data safety in an educational context. By focusing on these criteria, the methodology shows the strengths and weaknesses of each chatbot type.

The analysis involved secondary data collection from academic research articles, research papers, reports, case studies and conference papers on chatbots were searched across major databases like Scopus, Digital Library, SpringerLink and google scholar. Each criterion was analysed for how it is handled by both traditional rule-based chatbots and generative AI-based-chatbots.

The aim was to explore the use of chatbots in education. The method helped find what is good or not good. This gives useful insights for teachers, schools, and educational technologists.

Traditional AI Chatbots

Traditional chatbots are rule-based virtual helpers that provide already set answers within a particular framework. Their operation involves the use of decision trees and keyword recognition, which allow them to answer in script-like responses to user questions. Traditional chatbots in education are broadly applied for automating administrative procedures, providing academic help, and fulfilling general requests from students. Traditionally, robots changed digital engagement by offering instant support when chatbot development first started. These chatbots are virtual FAQs, automatically pulling and providing answers that are already maintained. Their use of fixed scripts, on the other hand, limits them in terms of what they can do to have real, interactive dialogues. When students

raise questions outside what has been scripted, the chatbot may fail to address the questions adequately. Despite their limitations, the traditional chatbots have significantly simplified the procedure of providing answers to routine queries, thus relieving the administrative organs of teachers and support staff. Chatbots, by providing answers consistently, get rid of personal biases and mistakes, allowing students to receive standardised information. Due to its affordability, traditional chatbots are sought after by educational institutions that require a basic level of automation without the finances for high-level AI platforms.

Conventional chatbots have been instrumental in the automation of student support, though they are lacking in contextual awareness, emotional response, or customising learning. Their rigid design makes them incapable of adapting, which makes them inappropriate for dealing with more complex educational problems. In the course of artificial intelligence development, there has been a precedent for various institutions to switch to employing generative chatbots, which generate flexible and prompt answers. However, conventional chatbots are still helpful for educational institutions with their structured, rule-based automation of administration and instructional work. (Jeong)

Application of AI Traditional Chatbots

Automated FAQs Responses

Traditional AI chatbots have been trained to respond to frequently asked questions one is likely to make of them like those regarding timelines for admission, due dates, prerequisites, exam dates like: A university chatbot receives queries such as, "When will the semester start?" and answers automatically preventing staff members from addressing each request.

Course Enrolment Support

Students are walked through their registration with the use of chatbots that are used to help the students enrol in the courses and abide by the credit limits to fill in the forms according to their needs. Example: Through using an interface resembling a menu, the chatbot assists students who cannot understand elective registration to complete the enrolment used.

Basic Learning Support

In this regard, the conventional chatbots use a defined knowledge base to provide quick answers to the students about the academic topics, such as definitions and explanations of the key terms. For example, when a student asks, "What is photosynthesis?", the chatbot brings up a saved answer and gives a short explanation.

Administrative Task Assistance

Chatbots make administrative processes easy because students can get details for timetable access, directions to the exam hall, as well as alerts for fee payment without any stress. Example: Because of the chatbot, students are informed of approaching deadlines for fees.

Student Support Services 24/7

They offer non-academic support such as mental health hotline information, library timings and contact for IT help, especially during off-peak hours. Example: A chatbot provides evening students in need of IT with resources to self-resolve. (Laviola)

Benefits of TraditionalAI Chatbots

Chatbots are a valuable tool in education, automating administrative duties, increasing access to services to students, and providing a smoother communication process. Chatbots serve as elaborate virtual assistants to make the learning process easier for educators and administration staff. The following main benefits are discussed with supporting examples:

Instant Response and Availability

Providing round-the-clock support, chatbots allow students to receive ano-delay response to their concerns at any time. A chatbot in a university can solve repeated questions as to course registration, the deadline dates, and the payment process without any help from staff. This attribute is particularly useful to international students in case they need assistance at a non-business time.

Reducing Educator Workload

Chatbots handle routine questions, and hence, educators and administrators concern themselves with critical tasks. By assuming attendance-related

questions, a school chatbot gives teachers extra time to focus on lesson planning and students' interaction.

Streamlined Enrolment Process

There is a tendency for many institutions of higher learning to include chatbots so as to ease the admissions process. One example is how Georgia State University's chatbot was used to answer more than 200,000 questions by new students, which helped reduce dropout rates, as a result of timely support.

Enhancing Student Engagement

Conventional chatbots facilitate dynamic and interactive learning experiences. For example, language learning chatbots can provide the grammar support, quiz the students on their vocabulary, conduct quizzes, all of which supplement in-class teaching. At the beginning, the Duolingo app, which makes use of AI technology, used rule-based chatbots to organize the users into lessons.

Cost-Effective Solution

Instead of employing additional staff with the use of funds, the implementation of a chatbot requires a single initial expenditure, making it a budget-friendly measure for learning establishments. Education institutions, especially those faced with budgetary constraints can use chatbots relying on them to take care of responsibilities that are non-teaching without having to hire more support.

Challenges of Traditional AI Chatbots

Even though the traditional chatbots are helpful in many ways, the significant limitations prevent the role that the chatbots play in educational apps. Some major challenges are depicted with practical examples as follows:

Limited Understanding of Complex Queries

The limitation of relying on static scripts is that traditional chatbots find it hard to adjust to questions falling out of their prescribed program. It would sometimes disappoint the student if he or she asks about some uncommon scholarship criterion, and his or her query cannot be addressed by a chatbot.

Lack of Personalisation

Traditional chatbots are not capable of adapting the kind of responses to accommodate various learning preferences. If a student with math difficulties appeals for help, rule-based chatbots are likely to provide vague guidance instead of paying heed to the student educational background. Khan Academy and other such services have therefore integrated AI-driven technologies to provide them with more adaptive and personalised systems of education. (Lee)

Difficulties in Managing Various Languages

Chatbots that use hard-coded rules generally do poorly when it comes to dealing with non-native speakers. If a student asks a broken English question as a non-native speaker, a standard chatbot may interpret it improperly or give an inappropriate answer. Chatbots may also not be available to users of different language backgrounds, hence reducing inclusivity.

Dependency on Maintenance and Updates

The fact that traditional Chatbots rely on unchangeable databases requires constant updates to retain their usefulness. If a university revises its course catalogue but fails to change the chatbot's responses, students may receive incorrect information and therefore become confused.

Poor Context Recognition

On the contrary, traditional chatbots do not deal with contextual understanding as well as AI alternatives. If a student does not know if they could drop a course and then inquiries about its consequences, if a conventional chatbot fails to realise the connection, it may answer both queries independently, inducing confusion or low-quality advice. (Lin)

Generative AI Chatbots

Generative chatbots are advanced AI systems that employ natural language processing to generate answers as human-like as possible. In order to list some, these chatbots use large language models such as GPT from OpenAI and LLaMA by Meta, which digest the users' inputs and generate relevant context

regarding answers. Dynamically, with AI and deep learning moving forward, the generative chatbots have also moved away from static rules, and are capable of offering personal, creative and adjustable interactions. Generative AI chatbots augment customer support, content creation, educational platforms, and increase productivity. (Yu)

Generative AI chatbots are different from traditional bots that rely on set responses. Rather, new answers are constructed through a process of analysing user prompts and mindlessly recording what the chatbot has learned about language. They can, therefore, be easily deployed in various applications and domains. The appearance of the AI progress, with platforms such as ChatGPT, Bard (Gemini), and Claude, demonstrates how important their role has become for consumer and organisational contexts (Goodfellow). To understand the effectiveness of these chatbots, it is always good to examine the relevance, coherence, sentiment, and readability of the evaluation. With increased dependency on such tools in both personal and professional tasks, knowledge of their advantages and disadvantages is important to enhance the overall utility of these tools. (Yazdani)

Application of Generative AI Chatbots

The integration of generative chatbots has transformed education with the provision of dynamic learning opportunities, instant response, and personalized learning. Their utility is far beyond answering questions marking them as essential pieces of equipment in the classrooms today.

Personalized Tutoring

Generative chatbots provide immediate clarification and paths tailored to their learners behaviours. Unlike standard chatbots, these systems analyse student interaction to individualise and transform responses. ChatGPT by OpenAI is one way of how chatbots can disassemble math problems into actionable steps and adjust guidance according to the needs of each student.

Interactive Learning Assistance

These chatbots stimulate students to discuss ideas, thus as they speak, they strengthen their comprehension. By assuming the collars of historical figures, such as “Albert Einstein” or “Cleopatra”, a history chatbot provides students with immersive interaction that will facilitate the understanding of historical events.

Research and Writing Assistance

Students use generative chatbots to come up with ideas, condense articles, and enhance their essays. They advise on the organisation, clarity and language parallelism of written work. Generative AI tools such as Grammarly and ChatGPT assist students in academic writing by persuading them on how to form sentences and use logic. (Al-Hasan)

Language Learning Support

Chatbots based on artificial intelligence enable students to practice language with simulated day-to-day situations for enhanced skills in real-world communication. Duolingo Max is fueled by generative AI and allows students to practice their skills and pronunciation in many situations and become proficient in language simulations.

Instant Student Support

Universities are adding generative chatbots in their system to simplify admissions procedures, advice on courses, and help students prepare for exams. For example, Arizona State University employs an AI-powered chatbot to assist students with problems concerning enrollment, financial aid, and academic advising.

Generative chatbots bring flexibility and intrigue when it comes to learning. Their ability to adjust, interpret, and direct students increases their worth as a powerful asset in digital classrooms, making access and long-term student participation possible. (Al-Hasan) Benefits of Generative AI Chatbots

The integration of generative chatbots allows educators to engage their students in tailored, engaging, and efficient learning environments. Some of the key benefits explained through a practical example are:

Personalised Learning Paths

Generative models expand from rule-based chatbots as they use student data to personalise

responses. Khan Academy's AI tutor is one such example, as it uses GPT-4 to provide custom responses that cater to individual strengths of each learner and areas of improvement, to design learner-specific study plans.

Improved Student Engagement

AI chatbots add an entertaining flavour to education and increase the attractiveness of the learning process. In the world of science education, chatbots could mimic lab exercises in a fun way, allowing learners to grasp chemical processes through interactive breakdowns. Quiz Bot uses artificial intelligence to generate personal quizzes based on learning modules, which will help boost revision processes. (Kasneci)

Academic Support 24/7

Using AI chatbots, students easily get information about complex topics within a short period, thereby reducing their reliance on educators. A student can approach a chatbot when faced with hands-on problems in a subject like calculus that provides in-depth solutions and takes the learner step by step. IBM Watson's AI tutor provides instant real-time feedback to learners who will then make better sense of their uncertainties and act accordingly within no time. (Kasneci)

Language Translation and Accessibility

Generative chatbots remove language barriers by offering support in various languages. To cite a specific example, consider Google's Bard, which helps students to understand academic resources in multiple languages, making it easier for non-native speakers to learn.

Efficient Research Assistance

Chatbot technology helps students to gather information on articles, organise citations and understand complex topics in a more relaxed way. Such research assistants as Elicit help students skim academic papers and offer straightforward overviews, meaning the students can do deeper research faster without oversimplifying the tasks.

With their dynamic intelligence and instant provision of help, generative chatbots are able to increase inclusivity, customisation, and impact of learning.

Challenges of Generative AI Chatbots

Educational adoption of Generative AI chatbots has significant advantages, but several hindrances must be overcome for the best results from their utilisation. Five major challenges are displayed below with examples to support them, which include:

Accuracy of Information

Chatbots fueled by a generative AI can disseminate misleading or inaccurate data, particularly in response to specialised or complex subjects. As an example, ChatGPT and similar bots could provide a convincing review on quantum physics, but the subtlety nits in its explanation could be misleading for students. For learning, the dependence on correct data is essential; therefore, the possible misinformation is particularly worrying. (Fostikov).

Lack of Personalisation

AI chatbots can be customised to suit individual requirements, but their capacity for personalisation is always short of what teachers offer. For instance, YouChat could play upon the relevant study sources from a student's research, but it generally does not factor in the unique studying style, speed, or understanding of the relevant student. This could disservice to students who need personal guidance and full feedback to maximise their studies.

Emotional Understanding and Empathy

AI chatbots sometimes struggle to understand emotional cues and provide compassionate responses. Students who are frustrated or anxious might be missed by chatbots more readily than by a sympathetic teacher. For example, if a student contacts someone because they are disappointed by poor test results, that person may receive reassurance, but a chatbot like Hugging Face provides an emotionally insensitive and non-motivating response. (Rane)

Dependence on Technology

`Excessive reliance on AI chatbots can lead students to lose their problem-solving and analytical skills. A learner who uses CopyAI to write essays or summaries may lose the opportunity to improve their writing and analytical skills. There may be

restrictions in the intellectual development and imaginative growth among students because of excessive dependence on these technologies. (Kasneci)

Data Privacy and Security

The incorporation of AI chatbots in educational platforms calls for sensitive student data, which is sensitive, raising privacy and security concerns. As an example, notifiers like those in Notion or Jira collect data on students' enquiries, decisions, and growth. Without proper security, this data can be exposed to breaches,jeopardising students' privacy and potentially violating measures like the General Data Protection Regulation (GDPR).(Eke)

Comparison Between TAIC & GAIC

Basis	Traditional AI Chatbots (TAIC)	Generative AI Chatbots (GAIC)
Background	TAIC was introduced in the 1960s and became common with ELIZA & gained popularity in educational institutions during the 2000-2010s.	GAIC emerged after 2017 with advanced AI technology and became widely used after 2020.
Meaning	TAICare simple, rule-based system. Computer programs that use pre-programmed rules to pick responses from a fixed set of possibilities.	In GAIC, an AI system creates brand new responses based on patterns learned from data, producing unique answers for each situation.
Definition	According to Adamopoulou & Moussiades (2020), "Computer programs that simulate conversation through pre-programmed rules and pattern matching techniques to retrieve or construct responses from a fixed set of possibilities".	According to Kasneci et.al (2023), "AI system generates novel responses by predicting sequential language patterns based on learned representations from large datasets, capable of producing relevant outputs".
Function	TAIC follows scripted flows and gives fixed rule-based responses. For example, when asked "What is the course fee?", it replies "The fee is Rs. 10,000."	GAIC understand the user intent and generates human-like responses. For example, when asked "Can you explain the cost?", it may outline the fee structure, payment options, and compare other similar programs.
Knowledge	TAIC is limited to the pre-programmed database. It can't answer new, unanticipated questions or provide updated information. For example,generate the same response to all users.	GAIC is trained on big datasets and can generate responses for a wide range of topics. For example,Can tailor the replies based on user profile, previous questions or learning behaviour.
Conversation	TAIC cannot hold a natural conversation and handle it intelligently.	GAIC can handle context-aware conversation with memory of past interactions within a session.
Cost	Lower startup cost, but expensive to update	Higher initial cost, but adapts to new topics more easily.
Teaching Uses	Literature quiz bot that only accepts exact character names and dates from "Romeo and Juliet" as correct answers.	Literature discussion bot that can talk about themes in "Romeo and Juliet" and connect them to your ideas about the play.
Error Handling	It has difficulty managing unclear, misspelled, or unexpected inputs. Often responds with "I don't understand" or similar errors. For example: if a student types "wht is regstration", it may fail to answer	GAIC is capable of handling errors, rephrasing questions, and seeking clarification. For example: replies to "wht is regstration" with "Do you mean registration process? Here's how it works…"
Assessment	TAIC gives fixed quizzes and checks for exact answers. For example: A Geography test bot that marks "USA" wrong if the answer key says "United States of America."	GAIC evaluates written answers and gives detailed feedback with cross cross-check from multiple sources. For example: A Geography test bot that recognises "USA" and "United States of America" as equivalent.

Ethics	Research helper bot that only provides information from a set of approved sources, missing many relevant perspectives.	Research helper bot that can find information from many sources, but might occasionally present incorrect information as factual.
Accessibility	It has the same standards to help all learners. For example: A Statistics tutorial bot that explains concepts in one way only, regardless of students learning preferences.	It adjusts style to meet different and individual learning needs. For example: Statistics tutorial bot that explains the same concept visually, mathematically or through real-world examples based on the learners needs.
Teacher Impact	TAIC handles simple admin tasks.	GAIC transformed teaching by providing personalised support.
Future	TAIC is being replaced by advanced systems.	GAIC is rapidly developing new capabilities.
Privacy & Security	TAIC are safer and more controllable since it does not process or store large volumes of personaldata. For example,it can answer basic queries without logging any user information.	GAIC involve more complex data handling, including storing or analysing user inputs. For example,when integrated with learning systems, it may track student performance to give personalised help, which requires strong data protection.

Key Findings

The comparison reveals both overlapping functionalities and significant differences between traditional and generative AI chatbots in education. A key similarity is that both aim to enhance communication and automate routine tasks such as answering frequently asked questions or assisting with course navigation. They are also increasingly used to improve student support services, regardless of their underlying architecture.

However, the differences are more significant-

Traditional chatbots operate using rule-based systems and are limited to pre-programmed responses. In contrast, generative AI chatbots generate human-like responses, and adapt to new queries dynamically. Another difference lies in cost and setup complexity.

Traditional chatbots are more affordable and easier to implement but offer limited scalability but Generative AI chatbots are expensive,intelligent support and broader language capabilities.

In terms of privacy, traditional bots offer more control due to limited data processing. Generative bots, though powerful, require careful compliance with data regulations like GDPR. Overall, the findings highlight that the choice between chatbot types should be guided by institutional goals, technical capacity, and the desired level of interaction.

Recommendations and Future Directions

Based on the findings, it is recommended that educational institutions adopt generative AI chatbots when detailed and individualized assistance is needed, while keeping traditional chatbots for simple, set-in-stone tasks. The use of chatbots in education needs reliable data, privacy processes and proper training for teachers. It is important for future research to look at how learners perform in the long run, how chatbots may be adapted for various cultures, key ethical matters connected to AI in education and approaches to limit excessive reliance on such tools. Additionally, longitudinal studies are needed to assess the evolving role of AI chatbots in shaping pedagogical practices and student engagement across diverse academic contexts.

Conclusion

The introduction of AI chatbots is completely transforming education by increasing accessibility and promoting interaction as well as individual personalisation. Traditional chatbots provide predictable, rule-based help,which makes them effective at performing basic administrative tasks and providing support to students. However, those chatbots tend to struggle with flexible responses and the inability to cater to individual learning styles, thus reducing the depth of education engagement.

Generative chatbots with back-end AI and the use of natural language processing alleviate these concerns as they provide appropriate and engaging responses that can be applied in a given situation. They can adapt to individual student needs, making learning enclaves more attractive to all learners.

Starting from virtual tutoring and research help, to overall academic support without pauses, the generative AI completely transforms the approach to education.

However, issues such as misinformation, ethics, overreliance on chatbots and expensive systems need to be addressed. Educational institutions must come up with rules regarding AI usage to ensure chatbots supplement human interaction and critical thinking rather than overshadow them.

The future of education blends AI capabilities with the distinctly human aspects that not only ensure the technology serves learning but also does not overshadow personal engagement. Educational institutions using the traditional and generative chatbots have the chance to develop a smarter, more efficient, and student-centred educational process.

The development of AI is ongoing, and there should always be continued efforts made to encourage responsible innovation so that chatbots can support students learning journey while adhering to accuracy, ethical guidelines, and personalised educational goals.

Moreover, future investigations could reveal more valuable information by assessing the lasting effects on student education, examining differences in implementation based on cultures and identifying potential biases within chatbot responses. Studies should also explore ethical issues, strategies to limit student reliance on chatbots and how to encourage a collaborative relationship between educators and AI.

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