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iNOUN: Architecture and Usability of a Chatbot for Academic Enquiries

iNOUN: L'architecture Et Le Fonctionnement Du Chatbot Pour Les Enquêtes Universitaires

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Abstract

The use of artificial intelligence (AI)-based applications are increasingly influencing the daily lives of people in the modern world. In recent years, intelligent web user interfaces, virtual assistants, robotics, the internet of things, and automation have gained widespread popularity. In AI, the goal is to achieve and improve the machine's ability to emulate as many human abilities as possible. Human-Computer Interaction (HCI) interfaces supported by artificial intelligence are used in many innovations intended to improve service delivery. As part of this study, a web-based virtual assistant chat robot (chatbot) named iNOUN was developed to provide human-like responses to academic and general questions about the National Open University of Nigeria for text and voice input. The conversational chatbot was designed using a content management system and Google's Natural Language Processing (NLP) framework (Dialog Flow) to understand and respond to end users' queries. The iNOUN chatbot prototype was successfully implemented on a web interface and could serve as a virtual assistant responding interactively to frequently asked questions from students. In order to evaluate the chatbot's usability, a user-experience survey was administered using Think Aloud Usability Testing. Survey responses and feedback by the participants on the chatbot based on the standard of the System Usability Scale were evaluated at the 77% percentile, which is a level above the average 67% percentile, indicating that users were relatively comfortable working with the Bot. Chat Bots are a giant step in transforming web interfaces to the next generation of digital experiences and engagement. Research and focus on developing AI tools aimed at delivering effective

learner support and academic services are likely to hasten the realization of AI's full potential for expanding and enhancing educational practices.

Keywords: *Artificial Intelligence (AI), Chatbots, Human-Computer Interaction (HCI), Usability, User Experience (UX), Dialog flow, Dialog Flow, Think Aloud Usability Evaluation Protocol, conversational UI*

Resume

L'utilisation de logiciels à base d'intelligence artificielle (IA) influence, de plus en plus, la vie quotidienne des gens dans le monde moderne. Dans les années présentes, les interfaces utilisateur web intelligentes, les assistants virtuels, la robotique, l'internet of things et l'automatisme sont largement popularisés. En matière d'IA, l'objectif est de réaliser et de perfectionner la capacilité de la machine à émuler autant que possible les capabilités humaines. Les interfaces d'interaction homme-machine (IHM) assistées par l'intelligence artificielle sont utilisées dans de nombreuses innovations destinées à améliorer fourniture de services. Dans cette étude, un robot assistant virtuel (chatbot) à base de web, nommé iNOUN, a été développé pour fournir des réponses à caractère humain aux questions académiques et générales sur la National Open University of Nigeria, par le biais de la transmission de texte et de la voix. Le chatbot de conversation a été conçu en utilisant un système de gestion de contenu et le cadre de traitement du langage naturel (NLP) de Google (DialogFlow) pour comprendre et répondre aux questions des utilisateurs ultimes. Le prototype de chatbot iNOUN a été implanté avec succès sur une interface web et pourrait servir d'assistant virtuel répondant de manière interactive aux questions fréquemment posées par les étudiants. Afin d'évaluer la convivialité du chatbot, une enquête sur l'expérience des utilisateurs a été réalisée à l'aide du test de convivialité de Think Aloud. Les réponses à l'enquête et les commentaires des participants sur le chatbot basés sur la norme de l'échelle convivialité du système ont été évalués au percentile 77%, soit un niveau supérieur au percentile moyen de 67%, ce qui indique que les utilisateurs étaient relativement à l'aise pour travailler avec le Bot. Les chatbots constituent un grand pas vers la transformation des interfaces web à la prochaine dimension des expériences numériques et de la vie quotidienne. La recherche et la focalisation sur le développement d'outils d'IA visant à fournir un support efficace aux apprenants et des services académiques sont susceptibles d'accélérer la réalisation du plein potentiel de l'IA pour un élargissement et une amélioration des activités éducatives.

Mots clés: *Intelligence artificielle (IA), Chatbots, interaction homme-machine (IHM), convivialité, expérience utilisateur (UX), Dialogflow, DialogFlow, protocole d'évaluation de la convivialité Think Aloud, interface utilisateur conversationnelle.*

Introduction

Increasingly advanced computing and information processing techniques have accelerated the development and applications of artificial intelligence (AI). This technology aims to simulate intelligent human behaviour in order to enable computers to perform tasks. A significant amount of progress has been reported by researchers who have studied artificial intelligence in the past decades (Hwang et al., 2020). With the aid of machine learning techniques such as conventional machine learning algorithms, neural networks and modern deep learning, more and more products can perform "intelligent services" by combining inferences and behaviours (Okonkwo & Ade-Ibijola, 2021). The application of artificial intelligence in various domains has reached unprecedented levels today, including visual and voice recognition, decision-making, natural language processing, translation between languages, embedded control systems in equipment, and robotics. An important objective of AI in education is to provide personalized learning guidance or support according to each student's learning status, preferences, or characteristics (Hwang & Chang, 2021)).

A chatbot is a conversational or interactive agent that provides instant responses to users. In today's technology-fueled world, where communication and many other activities rely heavily on online platforms, chatbots are increasingly being used to improve student interaction. Students in higher education often use internet applications on their smartphones. A chatbot system can be deployed as a mobile web application to assist in learning. Chatbots can provide students with information, such as the course content, instantly. Study materials, practice questions and answers, evaluation criteria, assignment due dates, advice (Ismail & Ade-Ibijola, 2019), and learning pathways (Mabunda & Ade-Ibijola, 2019). In addition to improving student

engagement, these systems can also significantly reduce lecturers' administrative workload, allowing them to focus on curriculum development and research.

Advancements in digital technology are increasing with time and pace, with applications and devices being produced and improved regularly. Today's businesses and organizations are subject to waves of innovations with a magnitude not seen in earlier industrial revolutions (Westerman, Spence, & Van Der Heide, 2014) Artificial Intelligence is rapidly driving activities in society and opening up new opportunities for growth and development. Artificial Intelligence (AI) describes the concept where computer systems can perform tasks typically requiring human intelligence, such as visual perception, speech recognition, decision-making, learning, problem-solving, pattern recognition and translation between language recognition (Nilsson, 2014; Russell & Norvig, 2016). Technologies like Intelligent Tutoring Systems (ITS), Data analytics, the Internet of Things (IoT), autonomous vehicles, robotics and virtual assistants are gradually being mainstreamed and ingrained into our daily lives. The transformative power of AI cuts across all economic and social sectors, including education. In the education space, new teaching tools, ways of learning, access to knowledge and teacher training are being revolutionized. AI is perceived as having the potential to accelerate the process of achieving global education goals by reducing barriers to access learning, automating management processes, and optimizing methods to improve learning outcomes.

Open and Distance Learning (ODL) techniques are being applied globally to widen access and provide quality education at a large scale in many countries (COL, 2000; Jegede & Okebukola, 1992). It is not surprising that ODL will leverage the affordances of AI and emerging technologies to facilitate its processes since ODL relies heavily on human-machine interactions (Fadzil & Munira, 2008). A critical component of an effective ODL or online programme is the learner support services (Ludwig-hardman & Dunlap, 2003). A learner or prospective student needs to interact with learner support services on a one-to-one basis. Ludwig (2003) argues that the interaction that the

learner has with learner support services personnel should be individualized based on the specific needs and goals of the learner.

The National Open University of Nigeria is the largest ODL institution in sub-Saharan Africa, with a student population of about 500 000. It has over 103 Study Centers across Nigeria, with a minimum of two centres per state. One-to-one dissemination of accurate and verifiable information makes the amount of Centre sufficiently inadequate in comparison to the large population the university has current enrollee as well as even large audience, which each see the university as a viable option for studying and working. Indeed, the study centres can be easily overwhelmed by the number of people seeking similar information about activities, programmes and processes. Although, the University through the study centres has human agent, personnel, receptionists and counsellor who help in giving firsthand information regarding the institution, albeit, the human resource can eely get bored and get a feel of drudgery having to repetitively answer the same or similar question to an average of 20-50 times daily. This process has largely been considered not optimal and inefficient, because significant time, effort and human energy are usually expended. The queries can be handled with the use of an intelligent system to reduce stress and also minimize oversight and human error.

AI-driven tools such as automated chatbots and digital assistants are increasingly being used in businesses and large organizations to complement human agents to ensure quality service delivery. These techniques can serve ODL by providing students with quick information about admission and course requirements, news update, available course resources, registration procedures, Study Centres, e-Examination centres, and study tips. This study describes the implementation of a web-based intelligent agent called iNOUN that can hold a conversation with prospective students responding to frequently asked questions (FAQs) and general academic queries about the National Open University of Nigeria. The study also evaluates the User Experience (UX) by modelling the Think Aloud Usability Evaluation Protocol to obtain feedback on the usability of the chatbot for information sharing. Specifically, in the study, the interactive

conversational chatbot was designed to respond to academic enquiries from students or prospective candidates.

Related Works

A chatbot is a program that is used to participate in conversations with humans. It uses an appropriate interface for input and output, and with the use of AI techniques, it can provide real answers to the user, who will think that the communication taking place is with another human. The history of the conversational interface can be traced to the first Telegraph, which was built in the 1830s and was used to send long-distance messages. 1939 saw the first device to output continuous human speech (Adamopoulou & Moussiades, 2020). While IBM Shoebox was invented in 1962, which was a voice recognition software, ELIZA was created to interact with humans through text in 1966 (Weizenbaum, 1966). Subsequently, the first ever text adventure game called Colossal Cave came into the picture in 1976.

A chatbot named ALICE was created in 1995 and was influenced by ELIZA (Shawar & Atwell, 2007). ALICE was designed to be a conversationalist, and many people believed they were talking to a real person when they interacted with it (Raj, 2019). It is now common for people to use chatbots daily. As virtual assistants, Apple's Siri, Amazon's Alexa, Microsoft's Cortana, and Samsung's Bixby are all capable of opening apps, playing music, setting calendar events, and setting reminders (Dale, 2016). Facebook messenger alone had over 30,000 text-based chatterbots in 2017 (Brandtzaeg & Følstad, 2017). According to Global Market Insights (2018), the chatbot market size will exceed USD 1.34 billion by 2024. In light of these statistics, it is clear that chatbots are growing in popularity and that they can be used for a variety of purposes.

For educational purposes, experimental chatbots have been deployed for online open courses by Ser Ling and Ong Sing (2016). The MOOC-bot was able to provide correct answers during a quiz competition, demonstrating its capability for interesting conversations. Nikolaos Platidis (2014) studied chatbots using an algorithmic approach for locating, extracting, and retrieving "potential" responses in response to users' admissions questions. If a valid answer is not available, the

chatbot simply re-directs the user to web links containing the answer. Despite the success of the project, limitations, such as the usability of the system, were not considered, nor was the overall user experience considered (Pollard, 2018).

Chatbot Frameworks

Chatbot frameworks, such as NLP engines, abstract away the complexities of creating a chatbot through the use of predefined functions(Techlabs, 2020). The following chatbot frameworks are discussed by Raj (2019):

1. Microsoft QnA Maker - a cloud-based framework that develops a simple Q&A chatbot from FAQs, URLs, and structured documents.
2. The Dialog flow cloud-based framework from Google is flexible and easy to use and allows integration with many platforms
3. Rasa NLU & Core - an open-source framework for Python developers. A steep learning curve is associated with this powerful toolkit.
4. Wit.ai - a cloud-based AI framework provided by Facebook that is similar to Dialog flow but not as robust. The best results are obtained when it is integrated with Facebook Messenger.
5. Microsoft's Luis.ai is a cloud-based framework with similar capability to Dialog flow and Wit.ai.
6. The Botkit.ai library is similar to Rasa, it uses JavaScript as its programming language, but it also offers a GUI.

These frameworks enable fast-paced development and implementation of chatbots

Potential Benefits

One of the advantages of a chatbot is its ability to provide 24-hour service that can serve different time zones and locations (Shawar & Atwell, 2007). Additionally, it allows for more personalized responses to a large number of students (Brandtzaeg & Følstad, 2017). Chatbots can be extended with additional functionality to encourage more dialogue and discussion between students (Georgescu & others, 2018).

Another useful feature of chatbots is the ability to store a knowledge base of stored questions that can be used over an extended period. Furthermore, it may be possible to identify communication issues between educators and students. Teachers may need to consider how they currently communicate with students if students are always asking the same questions.

Potential Drawbacks

There are several potential limitations to integrating chatbots into regular university operations. First and foremost, accurate information provided by university staff is crucial for populating the chatbot's database (Georgescu & others, 2018). Incomplete forms or inaccurate data render the chatbot useless for those subjects. Secondly, students must use the product to save time for themselves and the staff (Shawar & Atwell, 2007). To accomplish this, lecturers and tutors need to inform students about the chatbot, its capabilities, and its purpose. Thirdly, Chatbots have technical limitations when it comes to understanding questions, so some level of human interpretation may be necessary to refine and train the bot accordingly (Hwang & Chang, 2021).

The present study was inspired by these and other works to develop a chatbot model that can seamlessly respond to FAQs related to admissions, study tips, available course resources, and other related matters to enquiries about National Open University's procedures and processes.

Methodology

The goals of the iNOUN chatbot are to provide human-like responses to academic and general enquiries to text input queries about the National Open University of Nigeria, provide powerful and personalized conversational experiences to students and to offer required information to enquirers 24/7 in a cost-effective and time-efficient manner. The digital assistant uses Google's Dialog Flow AI engine to respond to a wide range of student inquiries about NOUN such that students can get information and insights that can support their studies or get directions to resources available on the website

without the need to search through tons of web pages or immediately asking for human assistance. The Bot can respond to student questions, including inquiries from students about the university (for example, how to go about registration, semester dates, NYSC issues, study centre locations, the application processes, and more).

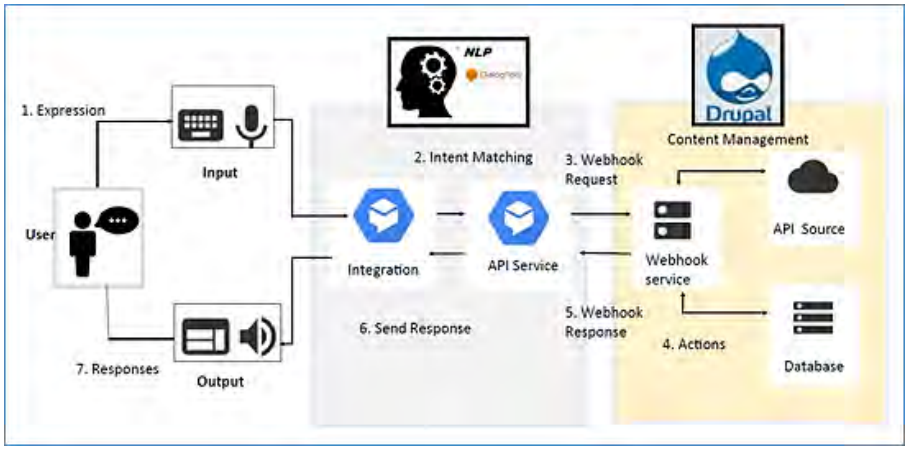

Figure 1: Chatbot System Architecture

A stepwise description of the system is as follows:

1. The user inputs data into the application by using a device. It is possible to enter text or voice messages as input. The message is passed on to the Dialog flow NLP engine.
2. Dialogue flow categorizes the incoming message and matches it with the defined intents. During the process of developing the intents, training phrases are used to help train the system in intent identification.
3. A request is sent to the web hook service on the Drupal content management system to determine what action needs to be taken for the entry.
4. After using the external API and scanning the database, Dialog flow is again informed of the action to take.
5. Next, the Dialog flow answer will be arranged so that the appropriate answer can be transmitted into the integrated platform.

6. To perform the right action in the application or device, formatting is done.
7. The message is then delivered to the end user.

Key components of the conversational chatbot

The essential elements of iNOUN are Natural Language Processing (NLP) engine, intent, entities, dialogue and context

1. Natural Language Processing (NLP) Engine

Designing and building computers to interpret, understand and generate natural languages is a branch of Artificial Intelligence called Natural Language Processing. Language Processing is the computational technique in which the process is written, text and spoken human languages as language by a computer system (J, H Martin & Jurafskey, 2009; Nilsson, 2014). Natural Language Processing allows chatbots to understand a query or message and respond appropriately. When a "Hello" message is sent, it is the NLP that lets the chatbot know that a standard greeting has been posted, which in turn allows the chatbot to leverage its AI capabilities to come up with a fitting response. In this case, the chatbot will likely respond with a return greeting (Pokatilo, 2016). The iNOUN Chatbot system was trained with the knowledge base based on the FAQ on relevant academic and general information of the University. Having won popularity in the Artificial Industry, the Google Dialog Flow Framework was carefully reviewed and chosen to be used to develop the conversation bot.

Figure 2 The iNOUN Chatbot User Interface

2. Intents

An Intent represents the intention of the user, or the users, interacting with the chatbot. The intent is defined for each type of request the application supports. For each type of user request, you want your application to support (Pollard, 2018). For instance, consider a student's request for registration: How can I go about my semester registration? The intent is a request for guidance on registration. But this could be expressed in many different ways. NLP engines, like those that power Alexa, Dialog flow, Watson, Conversable etc., rely

on being fed many examples of ways in which intent can be phrased to accurately work out what the user is trying to accomplish

3. Entities

The Entities enable the NLP engine to identify details in the user's input which can then be used to provide different responses to the user (Gliozzo et al., 2017; Marietto et al., 2013). Extracting both intent and entity from the user's question enables the provision of very specific and precise responses to the user. Regarding the registration query, the NLP engine knows that the **intent** is a **registration support request**. It will work out what entities the request concerns, so it can point the user in the right direction.

4. Dialogue

A dialogue is a branching conversation flow that defines how the application responds when it recognizes the defined intents and entities. It is composed of many branching dialogue nodes. A dialogue branch is created for each intent to gather required information and make a helpful response. It matches intents (what users say) to responses (what the Bot says back). Each node of the tree has a condition that triggers it based on user input.

5. Context

The dialogue context is the mechanism for passing collected information between the dialogue and the application code. Context stores information and also continue to pass it back and forth across different dialogue nodes. For instance, if the chatbot identifies the name of a user in the Conversation flow, it could store the information in the context and retrieve it at any time within the conversation when it wants to refer to the user by name. Context is described as a JSON entry within the node. Each conversation will have its context, which evolves as the conversation progresses and is cleared when the conversation ends.

Design of the conversational experience

The NLP engine is the brain behind the conversation experience, while the chatbot is the face which interacts with the user. This is a bot in a messaging app (either embedded in the website of the Content

Management System (CMS) or an external app like Facebook Messenger. From behind the scenes, the conversation is three-way: the user asking the question; the NLP, which understands the query and translates it into machine-friendly language and the chatbot. Assistant, which performs the required logic (sending an email, providing a link or booking an appointment).

Evaluation

It is vital in a software system that it behaves as expected therefore, usability tests need to be carried out (Brooke, 2013). The following presents the evaluation of the first version of the iNOUN Chatbot conducted to determine the usability of the chatbot. *Usability testing focuses on measuring a human-made product's capacity to meet its intended purpose.* (Gould & Lewis, 1985; Lewis, 2006) The System Usability Scale (SUS) is a simple scale based on ten-item relying on the Likert scale grading to give a global view of subjective assessments of usability. The "SUS" is one of the best-known standardized usability rating scales for usability evaluation. It focuses on providing lightweight (10 questions) subjective feedback from users testing the system(Salvendy, 2012; Sauro & Kindlund, 2005).

The SUS is a 10-item questionnaire with five response options is:

i. I think that I would like to use this system frequently.
ii. I found the system unnecessarily complex.
iii. I thought the system was easy to use.
iv. I think that I would need the support of a technical person to be able to use this system.
v. I found the various functions in this system were well integrated.
vi. I thought there was too much inconsistency in this system.
vii. I would imagine that most people would learn to use this system very quickly.
viii. I found the system very cumbersome to use.
ix. I felt very confident using the system.
x. I needed to learn a lot of things before I could get going with this system.

These Questions are graded from Strongly Disagree (1) to Strongly Agree (5).

Based on the System Usability Scale (Saura, 2011), the evaluation procedure is as follows;

- **For odd items:** *one is subtracted from the user response.*
- **For even-numbered items:** *five is subtracted from the user response*

This scales all values from 0 to 4 (with four being the most positive response). The values are added up for the converted responses for each user and then multiplied by 2.5 to give 100. This conversion results in a range of possible values from 0 to 100 instead of from 0 to 40. The average score regarding how usable the system can be is regarded as the 67 percentile (Bangor et al., 2009)

Usability Factor

In System Usability Scale (Brooke, 2013; Jordan et al., 1996), the first Eight Questions of the questionnaire are based on the Usability Factor of the designed system, which is used to independently determine the usability of the test model with regard to survey response and grading system.

Learnability Factor

The learnability factor determines how easy it is to learn the new system and indicates where improvement needs to be made to make it more usable and how easy it is for first-time users to adapt and understand its capabilities (Travis & Hodgson, 2019). The last two questions are based on the learnability of the model and graded in combination with the usability factor to arrive at the system usability scale value as a percentile.

Result

The study designed and implemented a chatbot for handling simple educational enquiries. The usability study evaluated the extended system with users. The system was used by active students of the university.

Thirty-eight users tried the system and answered the questionnaire; the analysis was based on the Standard SUS grading for all users' responses. Accordingly, the 67 Percentile of the System Usability Scale, is considered the cut-off mark as average rather than 50%. Thus, the responses are collated in percentage, and an average is taken to get the statistical mean of the survey and then evaluated in Percentile.

89.4% of the respondents rated beyond average and considered the system Usability index high enough to represent a Human responder. The iNOUN Chatbot learnable factor is regarded as high as fewer respondents required additional learning to be able to interact and respond to the iNOUN.

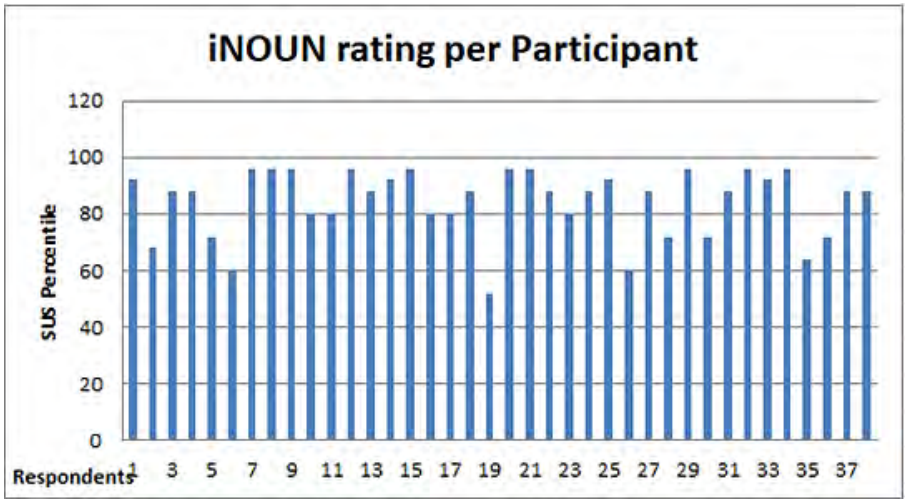

Figure 3. Ratings by participants

Only a marginal 4 respondents overall had an index below the average with a total rating of 52, 64, 60 and 60 percentiles that is the 1st, 3rd, 6th, 8th and 9th respondents. On collation of the entire survey response and feedback, the iNOUN Chatbot rates based on the standard of System Usability Scale was evaluated as 77%, This percentile is a level high above the average 67% which is considered acceptable. Based on the survey, 69% of the respondents reviewed the system to be beyond average rating and consider the system usability index high enough to be similar to a Human responder. The iNOUN chatbot is regarded as

usable, and the learnability factor is seen high as fewer respondents require additional learning to be able to interact and respond to the bot.

The survey allowed the respondent to state questions asked during the interaction with the chatbot where the chatbot was unable to provide concise or suitable answers adequately. These responses were collected following the adoption of the incremental developmental approach in the design phase, which involves a continual increment of the knowledge base to support newer knowledge to be able to provide better answers.

The iNOUN chatbot received a high level of usability and perception among users based on testing and experience with using it. Therefore, it is considered satisfactory for use as a representative of a human agent when responding to general or straightforward inquiries about the National Open University of Nigeria.

Conclusion

The main objective of this study is to design, implement and evaluate a chatbot to provide answers to frequently asked academic questions at the university. FAQs from the National Open University of Nigeria were used in the study. A usable system was successfully designed, implemented and deployed to the web environment of the Drupal content management system. An evaluation of the resulting product was carried out among students at the university to assess its usability in responding to basic questions. The students found the prototype tool to be useful in providing text and voice conversations regarding quick academic queries about NOUN.

Live Assistants or Chat Bots are proving to be the next technological advancement in providing a better and unprecedented digital experience and strong customer relations. This paper briefly reviewed past literature and present work that is related to the usage of Artificial Intelligence conversation chatbots expected to complement a human support officer. The system was not envisioned as a replacement for human effort nor the relegation of the human agent. Rather the system is to provide first-level support before escalation to a human agent where necessary.

Limitations

While the current study provided useful insights into the possibilities of academic support using chatbots, there are a few drawbacks. The scope and depth of conversations implemented on the prototype bot are limited. The Bot was only able to respond to simple FAQ questions without holding deep prolonged conversations. There were also a limited number of participants in the usability study.

Future works

In this study, chatbots in education were found to offer both benefits and challenges. The potential of the iNOUN chatbot was examined. A full-scale deployment of the chatbots for holding deep conversations will be examined in future works. Furthermore, the deployment of bots for micro-teaching and learning will be given full attention.

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