APPLICATION OF ARTIFICIAL INTELLIGENCE FOR VIRTUAL TEACHING ASSISTANCE (Case study: Introduction to Information Technology)

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Abstract -*Technology has advanced and diversified throughout Zimbabwe's institutions of higher learning and has led to drastic and inevitable improvements in the higher and tertiary education sector of the country. These improvements are the genesis of enhanced students' learning environments: as we now have e-resources, online learning and video-conferencing, to mention a few. This paper aims at exploring how to leverage Zimbabwean higher and tertiary education with Artificial Intelligence (AI) based Virtual Assistants (VAs) among learners from various faculties at Midlands State University (MSU). Due to the increase of lecturer to student ratio per module as the economic crisis tightens and lecturers are being drained out to seek for better life, students are enduring a real and untamed challenge in their learning environments. It has become difficult for students to consult the lecturer one-on-one in case they want more information about the module due to their hefty figures and limited time. Therefore, the researchers intend to research, design and develop an Artificial Intelligence grounded VA that would respond to the students' requests and act as an introduction to Information Technology study pack.*

Key words: Virtual Assistant(VA); Artificial Intelligence(AI); machine learning(ML); Chatbots in higher education; ChatGPT; conversational agents; generative pre-trained transformers (GPT); learning & teaching.

1. INTRODUCTION

According to [28] and [39], Information Technology (IT) is playing a substantial role in facilitating people to connect, survive, and overcome constraints. They also claimed that Artificial Intelligence (AI) and machine learning (ML) carry on to revolutionize with technology advancements and supported by [43], [12] and [30]. [14] , [25] and [1] also pointed out that ample and prominent AI- driven Virtual Assistants (VAs) have been developed by numerous corporations and recognized globally for their significant role for example Chat GPT by OpenAI, Siri by iOS, Cortana by Microsoft, Alexa by Amazon, and G-Assistant by Google. [9] indicated that some AI based VAs run-through voice recognition technology and try to imitate human conversation. VAs are an amazing element in the development of Robotic Automation (RA) this is because they are capable of work out multiple and intricate user requests as well as evaluating tricky alternative resolutions in order to yield a more significant response. In addition, [23] and [36] specified that VAs have also been developed as assistances to persons with disabilities in accessing technology whose aim is to create a hassle-free user's experience. AI and ML, as sound as other developments in AI technology, have given escalation to the spread of Vas [33].

AI and ML will comprehensively influence higher and tertiary learning systems in the future as more scientists explore various developments with research efforts although there is an argument on whether or not AI will entirely replace educators in the future. The researchers in [13] predicted the genesis of a dramatic change in institutions of higher learning with learners and lecturers resorting to use these Chatbots as part of their environment. Therefore, advancement in the field of AI and ML-based VAs proves to be worthy in making unlimited learning environments for the learners. This is because, the Virtual Assistant (VA) can be used to identify students with learning disabilities in the initial phases and generate general guideline reports for the lecturers. Lecturers will be able to improve their teaching with that report and use educational software, customize modules, and simplify grading. Nowadays, technology is evolving every day. With such evolving technology, lecturers are also using AI-based smart learning tools, like PrepAI, to generate question banks and class test papers. This way, AI enhances the higher and tertiary education area in terms of content delivery, and assessment.

1.1 Problem Statement

Introduction to Information Technology is a module that is designed to familiarize elementary computer skills and applications software that are relevant for beginners to appreciate the world of technology and being capacitated in it to make their life at university and beyond better. It is definitely a complicated module especially here in Zimbabwe where some students have never come across a computer prior to pursuing higher and tertiary education. This module carries a huge volume of students, which becomes a burden to lecturers who might be few to teach the students clustered in different campuses. Teaching hundreds of students in a single class is also cumbersome and difficult and may lead to lecturers snubbing classes. Henceforth with the help of the VA, students will be greatly assisted around the clock and when need arises. A VA is the best option for these learners because apart from responding to student requests, it can assist lecturers on tasks such as grading of assignments and tests papers autonomously; teaching management for support on matters such as course

scheduling; and assistance for self-study and adaptive learning.

1.2 Research objectives

1. To design and implement an intelligent Virtual Teaching Assistant System for Introduction to Information Technology.
2. To assess the validity and intelligibility of the Chatbot application in handling user requests.
3. To assess the accuracy and effectiveness of the system

2   RELATED WORK

For the past few years, the Covid-19 pandemic became a real obstruction to students' learning experiences in all institutions of higher learning in Zimbabwe and it had forced the adoption of new learning models to mitigate the impact of the pandemic in the educational institutions. The students in institutions of higher learning in Zimbabwe were the most affected by such a dramatic change in their daily rhythms and ways of learning. Some of their peers recommended specific technology for those who had not discovered the AI VA [10]. They have learned to overcome their struggles by correctly utilizing their ability to cope with the situation with the help of someone more capable or with a self-learning technique [40]. Given the unique circumstances, suitable modifications to learning and assessment activities should be provided. The preceding account necessitates the urgent attention of policymakers, representatives from various rehabilitation services, stakeholders, and government agencies to examine and implement these ideas to achieve the precious goal of providing access to education to visually impaired individuals and forestall the digital divide [27].

2.1 Chatbots in the industry

According to [14] and [25], ChatGPT is a conversational AI Chatbot by Open AI that has gained considerable ground globally and has prompted a significant number of researchers to dig deeper into opportunities and applications of conversational Chatbots. ChatGPT can produce text for you based on any prompt you input, generating emails, essays, poems, raps, grocery lists, letters, and much more. ChatGPT has become the blueprint for many Chatbots to enter the scene, including Bing Chat, Bard, Ernie to mention a few [25]; [13].

The researchers in [25] did a systematic comparison on selected Chatbots (ChatGPT, Bing Chat, Bard, Ernie and others for a large variety of purposes) for their relevance to higher education. Their results indicated that there were no A-students, no B-students in this bot cohort, despite all published, sensationalist claims to the contrary, and the AI is not yet that intelligent, it would appear. They concluded that GPT-4 and its predecessor did best, whilst Bing Chat and Bard were akin to at-risk students with F-grade averages.

[6] did a comparative study of the accuracy and quality of the responses produced by ChatGPT, YouChat, and Chatsonic, based on the prompts (use cases) related to selected areas of applied English language studies. The researcher claimed that YouChat was technically unstable and unreliable, and had some inconsistency in generating responses while the other two, ChatGPT and Chatsonic, consistently exhibited a tendency to plagiarise responses from internet information without acknowledging the sources.

Like ChatGPT, most Chatbots uses Natural Language Processing (NLP) to generate human-like responses. YouChat also uses OpenAI's GPT-3. With YouChat, you can input a prompt for what you want to be written and it will write it for you, just as ChatGPT would for free. The Chatbot outputs an answer to anything you input including math, coding, translating, and writing prompts. A huge pro for this Chatbot is that, because it lacks popularity, you can hop on at any time and ask away. Another major pro is that this Chatbot cites sources from Google, which ChatGPT does not because it does not have internet access. For example, if you ask YouChat "What is Coffee?" it will produce a conversational text response and cite sources from Google specifying where it obtained its information. The Chatbot is just as functional, without annoying capacity blocks, and has no cost

Chatsonic is a dependable AI Chatbot, especially if you need an AI Chatbot that is up-to-date on current events. Because Google supports Chatsonic, it is aware of current news and can provide you answers and stories that relate to it, which ChatGPT cannot do since its database does not go past 2021. Chatsonic also includes footnotes with links to the sources so you can verify the information it is feeding out to you, another vast contrast from ChatGPT. Another major benefit is that Chatsonic is based on GPT-4, OpenAI's latest and most advanced model [6]; [15]; [21]

2.2 Chatbots in teaching and learning

[37] stated that Chatbots can be built with AI and NLP to interact with a user in a conversation using text or voice. [11] also described Chatbots as VAs capable of answering questions and providing appropriate responses. Chatbots can also be Rule Based (RB); that is, can responds to questions by following a built-in set rules, allowing them to respond to their users requests [5]; [41]; [45]. [2] claimed that Chatbots can also be viewed as instances of software applications that understand questions faster and provide efficient answer. These various kinds of Chatbots have gained significant recognition in the educational industry and other learning contexts. [34] also reiterated that most Chatbots employed in higher education are teacher-oriented. [31] highlighted positive impressions from a sample of students when they were engaged with a Chatbot. Various scientific articles also point out that students employ Chatbots to ask questions, receive responses, and receive individualized support as mentioned by [32] and [38]. The

research conducted by [50], indicated that there was no significant difference in the learning achievements of undergraduate students randomized into experimental and control groups (with or without the support of a Chatbot), and also discovered that there was higher levels of motivation in learners interacting with the Chatbot.

[3] designed a Chatbot for computer science students, employed for goal-oriented requirements modelling; the students found the Chatbot functional and desired to use it in the future. A study performed by [26] using Chatbots and web modules to improve students' mental health reported a higher probability of efficacy as Chatbots guided self-learning, enhanced motivation, and lessened stress. [29] pointed out that the University of Georgia also did designed a Chatbot named 'Jill Watson' which was adopted in a computer science course. The students who used the Chatbot were more responsive and interested in expended use of such Chatbot in different lessons.

From the research work by [47]; [42]; [19], we can learn that it is very important for students to be ability to interact with their instructors through asking questions and receiving respective answers and it is an essential process of learning that can contribute to enhanced academic performance. [15] realized a similar scenario in their research carried out in Ghana where they discovered that university students in Ghana have inadequate interaction with their course instructors during class sessions hence the need for a Chatbot to help then answering their questions. They claimed that the sole reason was the increase in the student–instructor ratio that proportionally reduced the time instructors spend with their students. In addition, other researchers indicated that some students are afraid to ask questions because they are always scared of the negative feedback form their teachers as indicated by [46] and [35]. A Chatbot becomes the answer to provide personalized assistance to the students with such case because it have enough time to respond to questions and provide timely and individualized response. A Chatbots is relevant in situations where course instructors cannot provide timeous responses for students' learning at any time of the day [50]. A Chatbot can simulate human-like dialogue-based interactive communications to assist students in revisiting learning resources [18]; [24]; [44], promoting learning achievement and self-efficacy [7] and enhancing adaptive learning [16].

This study, is however aimed at exploring an in-depth analysis of leveraging education through AI VAs among visually impaired learners. The investigation centers on describing the challenges and struggles encountered by a group of learners from various faculties, highlighting the usage of AI virtual assistants, the adaptability of the learners, and the enhancement of the curriculum. This study will utilize a qualitative case study research design using [4] data analysis method to describe an in-depth dissection of the research. The proposed system is required to be designed and developed using Artificial Intelligence for Introduction to Information Technology Virtual Teaching Assistant System for MSU and assess its accuracy and effectiveness.

3 MATERIALS AND METHODS

The virtual AI Teaching Assistant was developed using the following:

- Windows 10 Operating system

- Visual Studio Code

- Flask

- Dataset (Created from Introduction to Information Technology lecture notes)

- Python 3.9

3.1 How the Virtual AI Teaching Assistant System Works

The Virtual AI Teaching Assistant Chatbot for Introduction to Information Technology responds to questions posed to it in natural language as if it were a real person. It responds using a combination of pre-programmed scripts and machine learning algorithms. The Chatbot will answer using the knowledge base that is currently available to it. Thus, the dataset used by the authors comprised of Introduction to Information Technology Questions and Answers. It enables the communication between a human and a machine, which can take the form of message commands. The VA Chatbot is designed to work without the assistance of a human operator.

If the conversation introduces a concept it is not programmed to understand, it will pass it to a human operator ("I do not understand"). It will learn from that interaction as well as future interactions in either case. As a result, the scope and importance of the Chatbot will gradually expand.

3.2 Data collection methods

Observations were used as a data collection tool. Multiple cycles were run and the system was exposed to different scenarios and observations on how it responded were made. The observations gave the researchers room to analyze the accuracy of the system and the response time of the solution.

Preparation of Data Set and Implementation: The dataset was prepared as Questions and Answers that people usually ask under the Introduction to Information Technology module. Data was acquired from various lecturers and the Library was consulted for more data about Introduction to Information Technology.

Pre-processing: The Natural Language Tool Kit (NLTK) library for NLP was used. As user input would be in English statements, to let the machine understand this language NLP

was used. To decrease further processing and removing ambiguity caused due to use of the same word in different forms a pre-processing was conducted. Steps included in this task are: Removing punctuation marks and extra spaces. To generate sequence of words from user's input query tokenization was used. Most of the common words like 'want', 'are', 'can', which do not need to be considered while processing were removed for improving the performance of the system. WordNet Lemmatizer was used for getting lemma (root form of the word) of each token e.g., 'processing' and 'process' should be considered equal while processing. So, for getting 'process' from 'processing', lemmatization is used.

Text data was converted to vectorized format using Bag of Words (BOG) concept. BOG is a method for preparing text for input to our machine learning algorithm. BOG model develops a vocabulary from all of the documents and then model each document by counting the number of times each word is appearing in the respective document.

Classification: As the data set increases in size, it takes more time to find similarity between user's query and the questions from the large data set and return the answer

4 RESULTS

The authors managed to implement the system using the prototype software development model. The authors trained the system with a set of numeric data from Introduction to Information Technology Questions and Answers. The data was trained to develop a .pkl model which was used to communicate with the user.

VA in training mode

Fig. -1: The VA in training mode

4.1 AI Virtual Chatbot

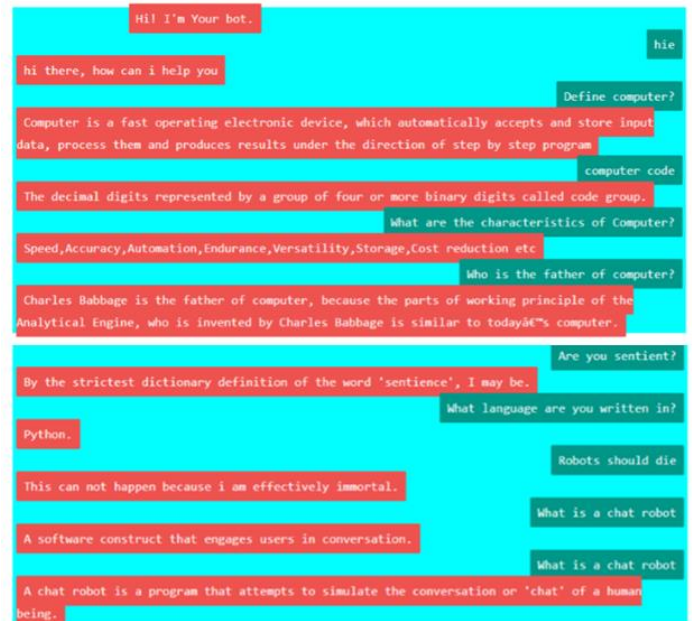The following screenshot illustrates the Chatbot while in use.

Fig. -2: AI Virtual Chatbot

4.1 Measuring System Performance

The researchers used Net Promoter Score (NPS) as an excellent instrument for testing the Chabot's strategy. To track the metric, the follow-up questions were asked at the end of a session (using a 0-10 rating system):

The users were divided into three groups (Promoters, Neutrals and Detractors):

Promoters: those who would use the bot again and recommend its services to other people: score between 7 or 10;

Neutrals: as the name suggests, they had a neutral experience towards the Chatbot: Grading it between 4 and 6;

Detractors: Those who did not like the experience and would probably not recommend the Chatbot: score of between 0 and 3.

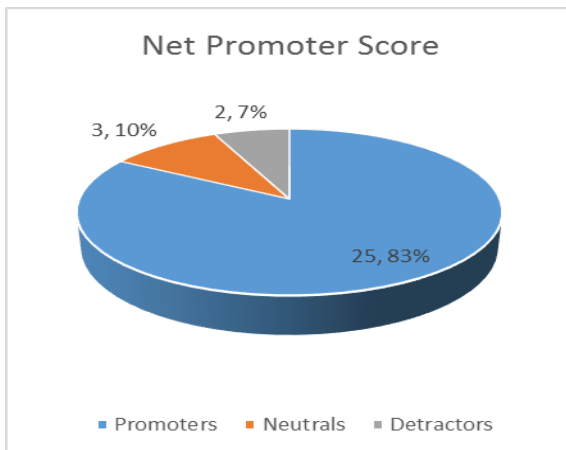Therefore, the researchers took a group of 30 students on campus to perform the NPS.

Chart -1: The NPS

From the 30 participants, 25 participants indicated that they were promoters and comprised 83% of the total, 3 were neutrals and constituted 10%. Then 2 were detractors and constituted 7%.

4.2 Chatbot Rates (CR)

CR is another interesting metric. Basically, at the end of service or each response, you can request the user to provide a positive or negative evaluation of the experience. A good opportunity for MSU to use the emoji: one could, for example, create "thumbs up" and "thumbs down" buttons.

Example:
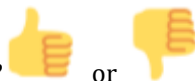
Was this answer helpful? 👍 or 👎

With the results, it is possible to rethink the training of the bot or if necessary, revise the AI entities and intentions that have been used to train the model (if any need arises).

It is important not to forget to consider the users who did not respond to the questionnaire – the same is true for NPS. Understanding why they have not interacted with the evaluation system can also bring interesting insights and help develop improvements.

The researchers requested students on the campus to do the Chatbot Rates (CR) who ever wishes to do. From unknown number of participants, here are the results captured from students rating.

Table 1: Chatbot Rates (CR)

Was this helpful	USERS
👍	173
👎	17

Table 1 illustrates the CR rating by the users, it indicates that 173 (91%) users liked the assistant and 17(9%) did not like the assistant. The 9% indicates that some users did not consider such an application as a rational tool for the intended task or maybe preferring the usual human assistant.

4.3 Fall Back Rates (FBR)

Most Chatbots have fallback answers, programmed to suit the user if he "explores" areas that are still unknown to your robot. Usually, the VA says: "Not sure of what you mean, Please Try ChatGPT for further assistance!"

Monitoring incidents of this type of response was crucial, as this may mean the need for dataset update and re-training or simply the identification of new intentions and entities not currently covered in the bot design.

If we divide the number of times the Chatbot has had to use a fallback response by the total number of messages, we will have the rate of confusion.

Confusion rate = number of fallback answers / total answers offered

The Confusion metric was developed where a total of 60 questions on the Chatbot from the 30 participants, with two questions from each participant were crafted. From the 60 questions the number of fallback answers was 4.

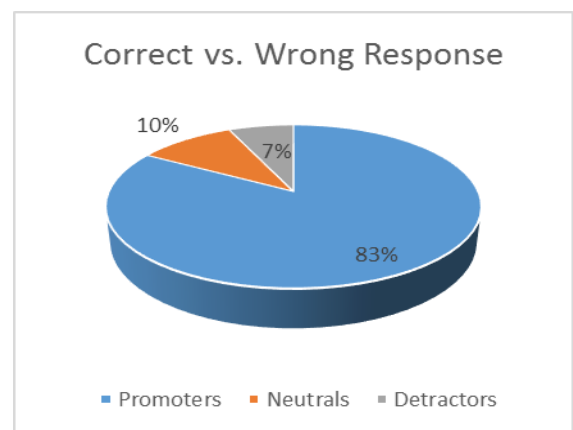**Chart -2:** Confusion Metric

Therefore, the confusion rate =4/60

=0.0667

=6.67% fallback rate

4.4 Goal Completion

The VA, did not respond well to 4 questions from the 60 questions given which gives the success rate of 93.3%. The 6.67% fallbacks mean that the questions missed where outside the scope of the VA. This means that the VA requires

an update on dataset and re-training since technology changes. There is usually new knowledge generated every day, hence the need for re-training to update the system knowledge base.

5 DISCUSSIONS

In summary the objective of the research was the design and develop an Artificial Intelligence grounded VA that would respond to the students' requests and act as an introduction to Information Technology study pack. The application was developed using machine learning, and natural language processing used of sentiment analysis in machine learning to be able to reply accurately to learner's requests. The library NLTK in python was used to develop the system. The system was able to train and answer request appropriately. Therefore, the application became capable of solving user requests. The system Goal Completion Rate (GCR) has become 93.3% which was of great importance.

The researchers used a sample of 30 students on campus to perform the Net Promoter Score (NPS) on measuring Chabot's performance. From the 30 participants, 25 participants indicated that they were promoters and comprised 83.33% of the total, 3 were neutrals and constituted 10%. Then 2 were detractors and constituted 6.67%. The 83.33% indicates the majority of the Chatbot system users, who would use the bot again and recommend its services to other students and other modules. According to Table 1 that illustrates the CR rating by the users, it indicates that 173 (91%) users liked the assistant and 17(9%) did not like the assistant. The 9% indicates that some users did not consider such an application as a rational tool for the intended task or maybe preferring the usual human assistant.

Figure 4 indicates that the VA, did not respond well to 4 questions from the 60 questions given which gives the success rate of 93.3%. The 6.67% fallbacks mean that the questions missed where outside the scope of the VA. Most Chatbots have fallback answers, programmed to suit the user if he "explores" areas that are still unknown to your robot. In our case, the VA says: "Not sure of what you mean, Please Try ChatGPT for further assistance!" The 93.3% indicates that majority of the responses from the Chatbot where relevant, while the 6.67% indicates that some responses from the Chatbot where either wrong or correct but not the users really wanted as the correct response.

3. CONCLUSIONS

This paper have explored how to leverage Zimbabwean higher and tertiary education with Artificial Intelligence (AI) based Virtual Assistants (VAs) among learners from various faculties at Midlands State University (MSU). The existence of VAs was greatly appreciated as it was able to respond to the students' requests in real-time and was available around the clock. They did recommended that the VSs can be considered to act as part of an introduction to Information Technology study pack. Due to the increase of lecturer to student ratio per module as the economic crisis tightens and lecturers are being drained out to seek for better life, students were enduring a real and untamed challenge in their learning environments. It was difficult for students to consult the lecturer one-on-one in case they want more information about the module due to their hefty figures and limited time. Therefore, the researchers' intension to research, design and develop an Artificial Intelligence grounded VA that would respond to the students' requests and act as an introduction to Information Technology study pack was a success.

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