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CHATBOT-SUPPORTED SMART LEARNING: ALGORITHMS AND IMPLEMENTATION

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ABSTRACT

Recently, increasing numbers of chatbots have been used in diverse fields, using various languages and technologies. Designing an interactive smart chatbot based on query-response systems in education has emerged as an important challenge in managing online discussion with natural language. This paper presents the SCBHE, which can receive queries from students and deliver responses about educational and administrative support to improve communication and services while decreasing the huge workload in universities. The SCBHE depends on identifying students' intents and extracting contextual information to deliver appropriate responses to students' queries, the framework will assist with decreasing the work burden, as educators will no longer need to repeatedly answer the same questions and explain the same points to various students. The SCBHE was built based on Dialogflow, an artificial intelligence tool introduced by Google. The chatbot was developed using an algorithm with the eight following phases: GUI development, acquisition, preprocessing, extraction, response induction, updating, awareness , and authentication. In this study, handling the SCBHE context information is limited to implementing the first five phases of the proposed algorithm.

Keywords: *Educational Robotics, Artificial Intelligence, Context-aware Technology, E-learning.*

Abbreviations

SCBHE: Smart Chatbot for Higher Education

GUI: Graphical User Interface

1. INTRODUCTION

A good higher education establishment is not only one with profoundly qualified educators, up-to-date and prepared labs, or advanced courses; it is one that offers excellent help to its students. Most students who exit college before completing their studies do so because of poor support (Okonkwo & Ade-Ibijola, 2021). Therefore, it is important for each institution to continuously direct their students by giving them accurate information that they can access conveniently as a form of support. Yet, it is difficult to ensure that every undergraduate is being appropriately supported in a practical sense (Mutovkina, 2020). In contrast, we observe every day that many students either search online for help with their tasks or search for fast responses regarding the courses they are taking, campus updates, admissions, faculty, and so on. Similarly, educators require some efficient options because approaches they currently use to support students are time-consuming (Venusamy & Basha, 2021).

A chatbot can make the difference for productively searching for information. There is no need to manually search for simple answers that the institution can set up for their chatbot once, and which will then be accessible for as long as necessary. A chatbot can help students find information on topics from class updates to task accommodation cutoff times. What is more, educators can profit from a chatbot in numerous ways to work in order to save time and effort during sending responses for their students; in addition,

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the framework will assist with decreasing the work burden, as educators will no longer need to repeatedly answer the same questions and explain the same points to various students. (Ryoo & Winkelmann, 2021).

Using chatbots, students can access up-to-date information on nearly everything to do with their studies. Whether they need data about the upcoming events, grants, library participations, or course modules, a chatbot will generally be accessible to answer their questions; as a result, the number of students who drop out because they cannot find adequate information will decrease.

Specifically, the utilization of Chatbots to improve understudy connection is turning out to be more well known in this present reality where educated understudies depend vigorously social media and instant messaging platforms. Chatbots can possibly give normalized data to understudies promptly, including evaluation standards, due dates and location of recommended resources.. Not exclusively can such Chatbots increment understudy backing and commitment, however they can likewise altogether diminish the regulatory responsibility of speakers, freeing them up for course development and research . Right now, techniques for cooperation exist, for example, correspondence through email, and collaboration face to face, but these don't work with moment and customized correspondence on occasion that are more advantageous to understudies.

This paper focuses on the development of a chatbot named SCBHEBOT that will provide learning support and regulatory support to students. The remainder of the paper is structured as follows: Section 2 reviews related works, whereas section 3 presents the algorithm for building the chatbot. Section 4 discusses the inspiration for the project, and section 5 presents the implementation of the chatbot. Finally, sections 6 presents conclusion and future work.

2. RELATED WORK

The concept of chatbot technology was first introduced in the 1960s by Joseph Weizenbaum with his "ELIZA" program; it was designed to trick clients into believing that they were speaking with a real human (Hussain & Athula, 2018). When a catchphrase was found, the program would change the sentence. A reaction was produced using reassembly controls related to chosen disintegration rules. Watch words and their related change rules establish the script (representing information, not a piece of the actual program) for a specific class of discussion (Hussain & Athula, 2018). Another chatbot called ALICE, the ALICE open-source chatbot beginning around 2002. ALICE 11, 31 is the Artificial Linguistic Internet Computer Entity, began by Wallace in 1995 (AbuShawar& Atwell, 2015). In the ALICE design, the "chatbot motor" and the "language information model" are obviously isolated, with the goal that elective language information models can be stopped and played. used heuristic example matching to meet the guidelines from the information (Wallace, 2005).

This study introduces a chatbot with foster learning networks developed at a London university that essentially has a global learner base. The chatbot was developed with the two following aims: to facilitate students' transition into their most memorable year of college study and to increase concentrate on commitment. Four learning networks were created utilizing the chatbot as follows: level 3, establishment; level 4, undergraduate; level 6, undergraduate; and level 7, postgraduate. Students and program pioneers were furnished with admittance to the bot by means of a portable application before their review acceptance and all through the autumn term of 2019. Toward the end of the term, information was gathered through polls and center gatherings with students and support staff to identify advantages and difficulties of the chatbot. The results demonstrated a positive connection between study commitment and commitment to peers (Studente et al., 2020).

Cordero et al. (2018) showed the need for new instruments or correspondence channels that would permit students to address various forms of feedback Such as registration steps, excuses, how to cancel, and others about various fields at the college level. Specifically, they introduced findings on the utilization of three chatbots in an advanced education institution. The outcomes obtained from the reviews, which considered the ease of use of the chatbot and the precision of the reactions, showed that student satisfaction with chatbots was high; hence, the authors recommended using chatbots in this setting (Cordero et al., 2018).

Augello et al. (2016) suggested using a social chatbot sample for an open ability-mastering game, considering social practice that can pick the most proper discourse. Slope et al. showed an alternate chatbot; for example, human–chatbot discussions need scope, rate, and jargon, and human–human discussions over IM (instant messaging). Hill et al.

(2015) discussed a virtual specialist chatbot. In addition, Shrestha and McKeown (2004) offered a way to distinguish sets in an email discussion crafted by email synopsis. Finally, Zhou and Hovy (2005) created a summarization method for technological chats and emails about the Linux kernel. In contrast to these works, we created a search-based chatbot for the Arabic language using Dialog flow.

The following table (Table 1) compares some common frameworks based on some broad criteria. These are a few examples of existing frameworks at the moment:

Table 1 – Comparison of Common Chatbot Frameworks

	Company	Paid/ Free	Ease of Use	OTB Integration	Open Source	Popularity	Web based	Language
QnA Maker	Microsoft	Free	High	Yes	No	Med	Yes	C#
Dialogflow	Google	Free	High	Yes	No	High	Yes	JavaScript
RASA	RASA	Free	Low	No	Yes	High	No	Python
Wit.ai	Facebook	Free	High	Yes (Facebook)	No	High	Yes	JavaScript
Luis.ai	Microsoft	Free	High	Yes	No	Med	Yes	JavaScript
Botkit.ai	Botkit	Free	Low	Yes	No	Med	No	JavaScript

*OTB = Out of the Box

3. CHATBOTS IN HIGHER EDUCATION (MOTIVATION)

The chatbots a truly elegant methodology of correspondence between the user and the system text interface. We want to utilize this framework on college sites to expedite communication between the student and administration. Students can utilize an educational institution website's chatbot for queries instead of going having to go to school or contact people directly for information. Usually, college site based bots square measure foster communication between various branches and work with the board to deliver innovative arrangements. Our project to make a college site chatbot could enhance the relationship between educational institutions and students (Haller & Rebedea, 2013).
In the customary framework for students to find solutions to their requests, students physically visit the school to ask questions, which are answered by an administrator. This technique is time-consuming and incurs monetary costs because the student is expected to travel to the school. In addition, this/ approach could cause a correspondence hole among understudy and school (Yang & Evans, 2019).
Custom information chatbots are needed to help students and support their relationship with the higher education institutions they attend. Using chatbots helps save a lot of time for students because they not need to visit the educational institution for information. Rather, they can raise queries to the chatbots on the institutional website and gain the information they need effortlessly (Cordero et al., 2020; Neumann et al., 2021).

4. Algorithm of the proposed chatbot SCBHE

Chatbots support smart learning in higher education. They automatically provide responses on behalf of academic staff and several services related to the higher education system. Moreover, the chatbot can be a smart assistant. This section presents the eight main phases of developing SCBHE, as depicted in Fig. 1. It shows the main phases and its sub-processes of SCBHE. The eight phases of SCBHE are as follows: GUI development, acquisition, preprocessing, extraction, response induction, updating, awareness, and authentication. These are described in turn below.

4.1 GUI development

The initial phase aims to choose a GUI that represents the SCBHE interface. A simple interface should be presented to receive the students' queries and deliver the suitable responses.

4.2 Acquisition phase

The acquisition phase consists of three sub-processes. First, there is how the chatbot receives the student query; in this case, the student types a query in the SCBHE, then clicks the ENTER button on the screen. Second, there is the process of raw data clean from noise or unnecessary words; this starts with clearing all the other non-textual data, such as markup and metadata, and transforming the text to the needed encoding form.

4.3 Preprocessing phase

The next phase aims to preprocess students' queries by dividing a text into words and sentences. That is done to clear special characters and digits and convert all words to lowercase letters. Preprocessing includes preliminaries, meaning sentence segmentation and word tokenization. Frequent steps are stop word removal, stemming, lemmatization, removing digits/punctuation,

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lowercasing, and so on. Other steps include normalization, language detection, code mixing, and transliteration.

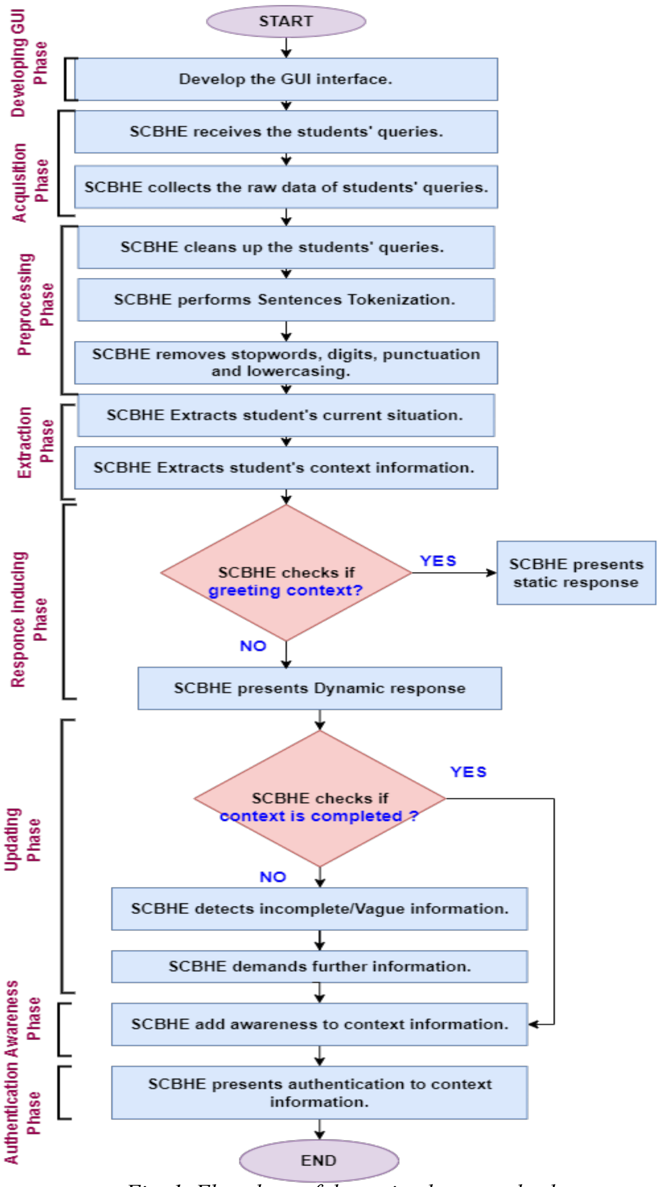

Fig. 1. Flowchart of the main phases and sub-processes of SCBHE.

4.4 Extraction phase

The extraction phase consists of two sub-processes, as depicted in Fig. 2. First, the student's intention/purpose is extracted. We classify the student's query to clarify his goal and identify his intention. Second, the main context information is extracted. The context information can be any relevant information regarding the higher education system and its students, staff, and services to deliver personalized services to students' intentions according to their queries. In this way, the chatbot can identify the current situation and generate a suitable reply

Algorithm1: Student's query analysis in SCBHE.

Step1: Start.
Step2: Student inputs his/her query in SCBHE.
Step3: SCBHE cleans up the student's query.
Step4: SCBHE segments the queries into sentences and words.
Step5: SCBHE applies words tokenization.
Step6: SCBHE removes stopwords, digits, punctuation and lowercasing.
Step7: SCBHE applies stemming words.
Step8: SCBHE extracts the student's intention.
Step9: SCBHE extracts the relevant information related to the current query.
Step10: SCBHE identifies the entities.
Step11: SCBHE builds relations among entities.
Step12: SCBHE captures the whole situation.
Step13: END

Fig. 2. Algorithm 1: student's query analysis in the SCBHE.

4.5 Response inducing phase

The next phase generates responses based on the analysis phase. In other words, the responses are induced regarding the student intention and the context information; there is more than one model to determine the response generation, as depicted in Fig. 3. First, there is the pattern-based model, in which SCBHE separately matches students' queries with implicit question-answer practice to develop a reply. Second, the retrieval-based model is more satisfactory for students. It displays model questions/answers through available application programming interface (API) resources. Third, the generative model provides more intelligence by producing questions/answers based on existing student queries and earlier queries. The appropriate responses are divided into static and dynamic responses. Static responses refer to greetings, wherein the SCBHE automatically generates answers. For example, when the SCBHE receives a message intended to say hello, the SCBHE always says "hello" in combination with the student's name. In contrast, dynamic responses depend on the academic database system and allow the chatbot to generate a reply relevant to the query received from the student.

Algorithm2: SCBHE generates the responses.

Step 1: Start.
Step 2: SCBHE detects the student's intention according to the current query.
Step 3: SCBHE determines the context information.
Step 4: Choose the appropriate model of SCBHE.
Step 5: SCBHE checks the query.
Step 6: **If** the query includes greeting **Then**
SCBHE generates a static response.
Step 7: **Else** tell the academic database to match the query words with the database.
Step 8: SCBHE sends a dynamic response.
Step 9: End.

Fig. 3. Algorithm 2: SCBHE generates responses.

4.6 Updating phase

The updating phase concerns upgrading context information based on students' queries after predetermined intervals, as depicted in Fig. 4. In essence, this includes identifying queries that are vague from the perspective of the SCBHE. Vague queries are those that contain unknown keywords and do not match the database. Moreover, the SCBHE detects incomplete information. Consequently, the chatbot requests further context information. This can in turn improve the SCBHE's performance and add more intelligence and understanding to the conversation between the SCBHE and students.

Algorithm3: SCBHE updates the context information.

Step 1: Start.
Step 2: SCBHE checks the student's queries.
Step 3: SCBHE extracts the keywords from queries.
Step 4: **If** keywords in queries match database **Then**
SCBHE gives the appropriate response.
Step 5: **If** keywords are vague or incomplete **Then**
SCBHE collects them in a file.
Step 6: SCBHE requests further context information.
Step 7: SCBHE can be updated.
Step 8: End.

Fig. 4. Algorithm 3: SCBHE updates the context information.

4.7 Awareness phase

The next phase aims to create awareness and reasoning in the design and performance of the SCBHE to provide social interaction and more flexibility for discussions between the SCBHE and students, as depicted in Fig. 5(a) and Fig.5(b). This involves enhancing the current educational services, reducing work charges, and creating new creative services. The SCBHE contacts students by mail to guide them in their courses. In addition, the SCBHE can focus students' attention on their roadmap over the semesters by reminding them of midterm quizzes, appointments to receive tasks, and other educational services. Furthermore, SCBHE supports awareness by presenting a tip or hint when students do not choose the suitable keywords in their queries.

Algorithm 4: Additional awareness has been created for SCBHE

Step 1: Start.
Step 2: SCBHE asks the student about his/her name.
Step 3: SCBHE greets the student "Hello + name".
Step 4: SCBHE asks the student about his/ her e-mail.
Step 5: SCBHE asks the student about his/her academic profile.
Step 6: SCBHE suggests recommendation about the student's roadmap, midterms, quizzes and etc.
Step 7: End.

Fig. 5(a) Algorithm 4: Example of the SCBHE promoting additional awareness.

Algorithm 5: Another Example for additional awareness of SCBHE.

Step1: Start.
Step 2: Student inputs his/her query in SCBHE.
Step 3: **If** SCBHE realized the student's query **Then**
SCBHE generates the response.
Step 4: **Else** SCBHE requests student to use other keywords to clarify his/her query.
Step 5: **If** the query still not clear **Then**
SCBHE presents a tip to the student for enhancing his/her query.
Step 6: Else if the query still not clear
SCBHE asks student more questions to clarify the query.
Step 7: SCBHE provides more tips according to the answers of the student.
Step 8: SCBHE receives the student's intention.
Step9: SCBHE generates the appropriate responses.
Step 10: End.

Fig. 5(b) Algorithm 5: Another example of the SCBHE promoting additional awareness.

4.8 Authentication phase

The authentication phase aims to create a personalized service for the student with relevant context information. Consequently, it adds further intelligence and adaptive behavior to response generation for students' queries. For example, if the SCBHE connects with the academic profiles of students, it can access the academic progress of each student and the assessment degrees. This supports authentication of the student and the performance of the SCBHE by enhancing the

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generation of the appropriate response for students' queries.

5. Implementation

The SCBHE was created based on Dialog flow, a Google platform for artificial intelligence. The original purpose of creating this system was to generate a chatbot to provide educational and administrative support for students' queries. Consequently, the SCBHE provides timely responses to common questions that relate to professors' contact information, credit hours programs, regulations, discussion forums participation, scholarships, submission procedures, courses, grading policies, accessibility services, projects, assignments, and so on. It can help save time and effort consumed in manually replying to students, which represent a huge workload for administrative staff in higher education. This section presents the execution of the proposed SCBHE.

5.1 GUI interface

SCBHE depends on the Telegram platform as an interface as depicted in Fig.6 to receive queries from students. This platform is seamless, simple, freely accessible, and easy to use.

Fig. 6 SCBHEBOT interface.

5.2 Collecting common queries

The possible queries as seen in Fig. 7were collected from students, and responses were developed and stored in Dialog flow.

Fig. 7 Examples of queries.

5.3 SCBHE analyzing students' queries

The SCBHE analyzes the student's query by identifying the student's intent and extracting the context information. By determining the student's intent, it discovers the aim of each query and then generates a prepared response. Correspondingly, student text queries are classified into 10 topics in which each topic corresponds to a student intent, as depicted in Table 1.

Table 2. *Main user intents in the SCBHE*

User Intent	Example
Course registration	What number of courses can be enrolled in this semester?
Exercise	What happens if you miss the exam?
Course score	How are semester grades calculated?
Prerequisite courses	What is the prerequisites?
Expenses	What is the deadline for paying tuition fees?
Excuses	What are the acceptable excuses for failing the exam?
Pulling out	Can a student be pulling out from registered courses?
Attendance	How many hours of attendance are needed to enter the exam
Cancellation	Can a student delete courses after registration?
General Inquiries	What is meant by a study plan?

These intents are course registration, exercise, course score, prerequisite course, expenses, excuses, pulling out, attendance and cancellation.

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Once the student's intent is determined, the SCBHE begins to extract the context information on the query. Table 2 describes the main context information.

***Table 3** Main context information in the SCBHE*

Context information	Description
@ Course	The course information the user wants to ask chatbot.
@ Exams	The exams information the user wants to ask chatbot.
@ Registration	The registration information the user wants to ask chatbot.

5.4 *SCBHE interaction for communication*

The possible queries were collected from students, and responses were generated and stored in Dialog flow. Moreover, the responses per probable query were incorporated as interactions for communication. Each interaction had adequate information and help for the student to reach the query response. The SCBHE determined keywords from the student's query to investigate the created interactions and giving the corresponding responses. It then delivers the response to the student as text, asks if additional queries are required, and waits for the student's further query. This is how the ongoing interactive conversation is created: The student asks for information; the SCBHE then responds using familiar language and then for another query from the student, whether about the same matter or a different one.

Fig. 8 Screenshot of simple query chat.

For each student's intent, corresponding responses are terminated and created to develop the proper responses. Particularly, for greetings, the SCBHE generates static and unchanging responses. For example, when a student sends a query that is defined to be a greeting, the SCBHE automatically develops the answer, "Hello." When the SCBHE obtains a query planned to say

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goodbye, the SCBHE always says, "Bye bye" to the student.

6. Conclusion and future work

The chatbot is a promising technology in various fields, especially education, when it comes to fielding users' queries. This paper developed a chatbot in higher education called the SCBHE to engage in educational and administrative support for students. The SCBHE was built based on Dialog flow as an artificial intelligence tool introduced by Google. In addition, an algorithm was built to generate responses to common queries of students, save time and effort, and reduce the huge workload of professors' staff. This algorithm includes the eight following phases to develop SCBHE: GUI development, acquisition, preprocessing, extraction, response induction, updating, awareness, and authentication. To handle the SCBHE context information, the current paper was limited to implementing the first five phases of the proposed algorithm.

In future work, we intent to implement the three remaining phases of the proposed algorithm on SCBHE to improve the intelligence, personalization, and awareness of SCBHE. Moreover, we intend to extend the context information in SCBHE to provide more flexibility for further contextual requirements in the future. Finally, we hope to use the text mining domain in the information context in SCBHE, such as text classification and named entity recognition.

7. CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

8. DATA AVAILABILITY STATEMENT

The data described in this article are openly available in the open science framework at **http://t.me/SCBHEBot**

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