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Development and evaluation of virtual assistant to assist elderly caregivers

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ABSTRACT
The increase in longevity in Brazil brings new challenges to the care of the elderly, with the caregiver of the elderly assuming, often without support or training, the responsibility of providing care to these demands. Technology supported by artificial intelligence can be used to guide and assist caregivers. In this field, virtual assistants are software with the ability to converse with human beings and have features and functionalities that can be used for this purpose. The article deals with the development and evaluation of a virtual assistant to assist caregivers of the elderly. This usage proves to be reliable, easy to use, and has a consistent knowledge base.

Keywords: Virtual assistant, Caregivers of the elderly.

1 INTRODUCTION

Brazil has been facing changes in the demographic, economic, social and political spheres. About demography, the sharp drop in fertility and the increase in longevity imply changes in the age structure of the population, which is now characterized by population aging1. The elderly population grew from 2.1 million in 1960 to 14.6 million in 2000. It is estimated that there will be 32 million elderly people in 2025, making Brazil the sixth country with the largest elderly population in the world [2].

This increase in longevity brings new challenges to the health care of the elderly, given the helplessness and fragility that we may present at this stage of life. Older adults often have chronic health problems, which may require costly interventions. Therefore, families and the community assume more responsibilities in the care of the elderly, especially when there is a limitation of autonomy and independence [3].

In this process, the caregiver of the elderly emerges as one of the main agents in the support to satisfy the needs of those who require differentiated care, aiming to improve the quality of life of the

individual being cared for3-5. However, it is not enough for the caregiver to just monitor the daily activities of the elderly, they need to be adequately trained and qualified to offer help in what the other can no longer do on their own3,6.

In this context, technology supported by artificial intelligence, related to the functionality and availability of *software* known as virtual assistants, *can be used to develop a* chatbot to *assist caregivers of the elderly, in order to provide greater guidance for carrying out their tasks in caring for the elderly.*

These virtual assistants or *chatbots* are *software with the* ability to converse, through text or voice, with other similar systems or with human beings. An attempt is made to simulate in them a behavior similar to that of a human being, in order to facilitate interaction with other people. The *chatbot*'s operation starts when it receives the user's request through an application that uses text or voice input, such as *Facebook,* WhatsApp, and *Skype* [7].

The use of this category of systems is comprehensive in the areas of customer service and customer relations of companies, educational institutions and government agencies, since the *chatbot* can inform users about products, services and processes, fill out registrations, schedule appointments, among other operational tasks, highlighting its high availability, working 24 hours a day, every day of the week8-10.

The *chatbot* created in this study seeks to provide support to the caregiver, especially the informal category, i.e., the unpaid caregiver, who provides care to the elderly person at home, with or without family ties6, because, in this way, even the individual who is not professionally trained can learn to perform the tasks properly and more effectively in day-to-day situations in the care of the elderly.

The possibility of using these systems is mainly due to the improvement of natural language processing (NLP) technologies. A new generation of virtual assistants has been developed with characteristics that point to a transition to a proactive performance model, which adapts to the characteristics and reactions of customers8-10. However, this does not mean that traditional solutions for the application of *chatbots*, based on lists of frequently asked questions (FAQ) and content libraries, are no longer efficient. They bring advantages due to their simplicity, speed of development and low cost of implementation [11-13].

In this scenario, an evolution of this category *of more traditional chatbots* appears represented by specialized conversational systems, which exploit the capacity of artificial intelligence algorithms. These *software programs* learn and adapt sentences and responses by interacting with users [11-13].

It is worth mentioning that the increasingly rich and complex information infrastructure represents a virtual risk to the adoption of *chatbots*. Without a good source of knowledge, structured and clearly organized, the efficiency of these systems can be severely compromised2. This

phenomenon of knowledge scarcity can lead the *chatbot* to enter a state of infinite *loop*, whose recurrence in giving evasive, incomplete, or, in the worst cases, non-existent answers can irritate users and compromise the reliability of the system8,11.

In view of the above, the present work records the development and evaluation of a virtual assistant to the *chatbot* user to answer questions and provide guidance to caregivers of the elderly, especially those in the unpaid category.

2 METHODOLOGY

Because it involved human participants, the present study was submitted to the appreciation and authorization of a Human Research Ethics Committee (REC), and was approved under CAAE number 49981221.1.0000.5415.

A theoretical study was carried out regarding the reality of the caregiver of the elderly in the context of Brazil, mainly through the "Practical Guide for the Caregiver" of the Ministry of Health4 and the book "Caregiver of the Elderly" by Eliana Elvira5. It is noteworthy that the materials used as a theoretical basis for the *chatbot's commands* are intended to guide, not train, the caregiver6.

Based on this study, the most relevant topics for the *chatbot* commands were defined, namely: personal hygiene of the elderly (oral and body), mobility, food care, medication administration and home emergency.

The content of the *chatbot* was elaborated prior to its creation, through the formulation of "FAQs" (*Frequently asked* questions) regarding the categories mentioned, that is, through questions were elaborated possible doubts of an informal caregiver of the elderly regarding the care of an elderly person. The FAQs were answered and added to the *chatbot*'s database, thus, from the 34 types of general questions created, the most appropriate answers for guidance and instruction were elaborated according to the support of the bibliographic material studied.

The virtual assistant was programmed in the *Google Dialogflow Essentials system* [14,15,] and the textual interface of the *WhatsApp Business application 16* was chosen for interaction with users. In this study, the use of voice conversation interfaces was discarded10,11. To integrate *Dialogflow* with *Whatsapp Business, the* AutoResponder WA *application was used* in version 2.5.317. A .json file was generated in the *Dialogflow* admin and imported into the *AutoResponder WA* application as an access key.

In addition to the general sentences of orientation and instruction, sentences of shallow social behavior of interaction with the user were added. Greeting greetings, such as "Hi," "Hello," "Good morning," and "What's up" are answered by the *chatbot*'s standardized introduction message on how it can help the user, while farewell greetings, such as "Bye," "See you later," and "Thank you," are answered by a standardized thank you and farewell message.

For the feasibility of the project, it was necessary to acquire a cell phone and a prepaid SIM card. The WhatsApp Business and *AutoResponder WA* applications need to be installed on the device and the proper settings on Google and *WhatsApp Business* accounts must be made for the proper functioning of the system.

In order to evaluate the chatbot, health professionals with training in gerontology (n=6) were selected for convenience through the application of an adapted version of the experience assessment questionnaire (SUPR-Qm)[18] and an open-ended question with free response: "What suggestion would you give to improve the *chatbot*?".

As an inclusion criterion, participants should have experience in the areas of geriatrics or gerontology, among other correlated areas, being able to deal with issues of aging and old age. Participants who did not agree with the terms of the Free and Informed Consent Form (ICF) were excluded.

The collected data, initially registered in *Excel*, were imported into the IBM-SPSS *Statistics* software version 28 (IBM *Corporation*, NY, USA) for exploratory analysis. Exploratory data analysis included descriptive statistics, mean, median, standard deviation, minimum and maximum values for numerical variables, and number and proportion for categorical variables.

To analyze the behavior of continuous variables, descriptive statistics, histogram and *boxplot graphs,* and the specific test for the theoretical assumption of normality Shapiro Wilk (CONOVER, 1999) were considered. Statistical analysis was performed using IBM-SPSS *Statistics* version 28 (IBM *Corporation*, NY, USA)[19].

3 RESULTS

Once the programming and feeding of the *software were completed, the* chatbot *was* tested by the developers and was able to carry out more tests in order to answer possible doubts of an informal caregiver of the elderly, providing guidance and instruction for the execution of tasks. The database was filled with information contained in the Ministry of Health's "Practical Guide for Caregivers"4 and in the book "Caregiver of the Elderly" by Eliana Elvira5, materials with essential content for those who are concerned about offering personalized treatment, but do not always know what to do or how to act in the face of day-to-day situations in the care of the elderly.

The chatbot-user interaction begins when the user, when accessing the *chatbot* through the *WhatsApp* platform, sends a text message. The program receives the message and starts processing it, analyzing, among the entries stored in its database, which one most resembles the user's request.

In this *chatbot*, the question templates are directed by menus, which initially present through enumeration the general themes: 1. Food, 2. Oral Hygiene, 3. Body Hygiene, 4. Mobility, 5. Medications and 6. Emergency at home (Figure 1). After the user chooses the topic of interest by

sending the selected number, the *chatbot* again presents questions related to the topic by enumeration. The user again chooses the question of interest by sending the selected number. Then, the *chatbot* sends the response with guidance and instruction according to the theoretical contribution mentioned (Figure 2).

Figure 1. Initial interaction with virtual assistant presentation

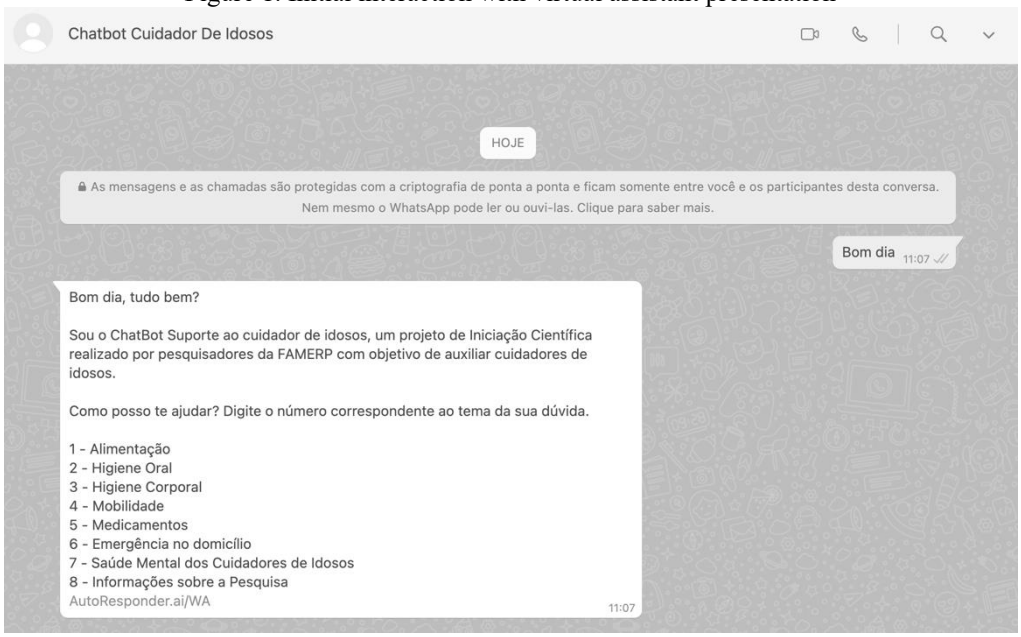
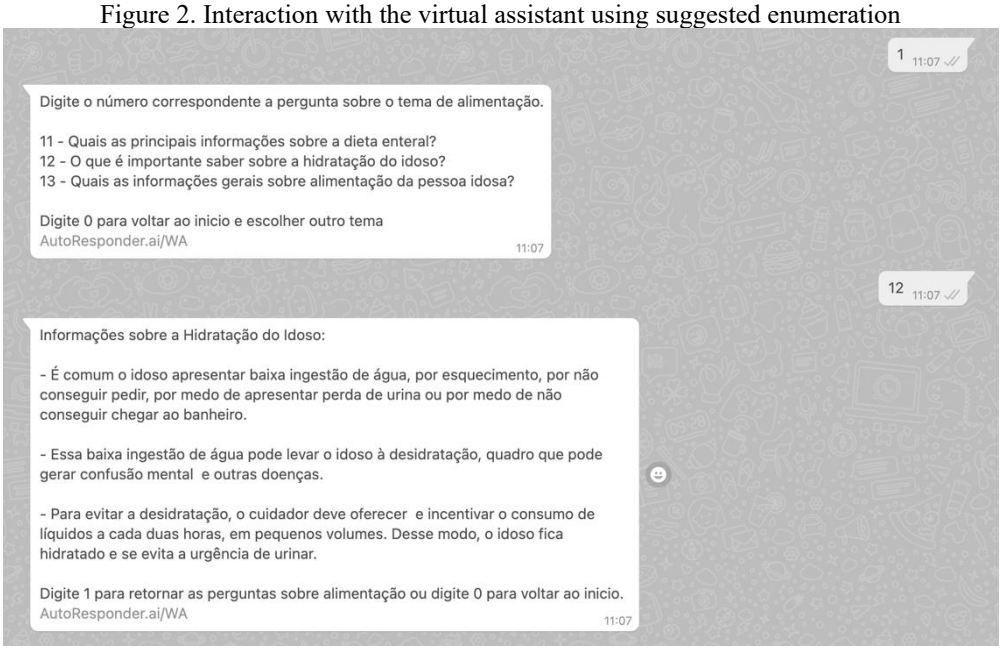


Figure 2. Interaction with the virtual assistant using suggested enumeration



The *chatbot* is also able to directly answer questions asked by the user, even when the recommended enumeration is not used (Figure 3). However, this feature has some limitations: if the request is not recognized or the chatbot is *not able to answer it, an automatic message is sent through the chatbot's own mechanism*, *called* fallback, which analyzes the keywords contained in the question

or the statement made by the user20. This message is patterned and presents the initial menu for interacting with the wizard (Figure 4). However, the system may confuse some words and misinterpret the user's request, offering an answer to another question (Figure 5).

Figure 3. Interaction with the virtual assistant using direct questions

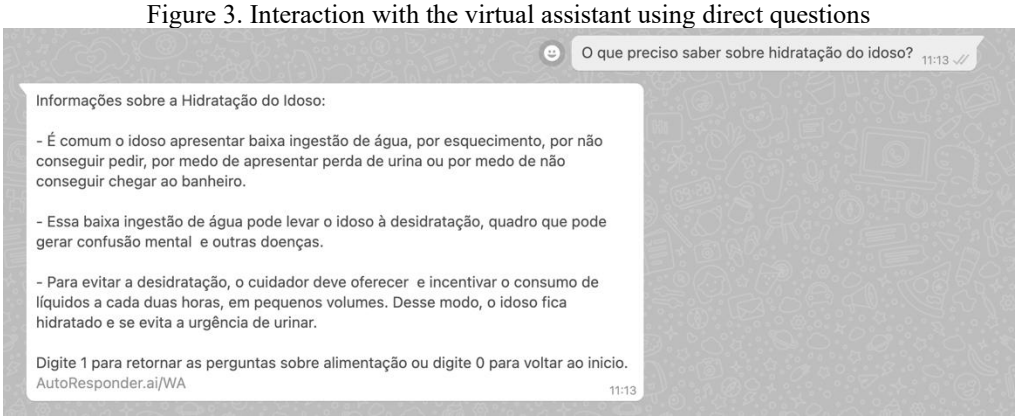


Figure 4. Fallback Example with Virtual Assistant Standardized Response

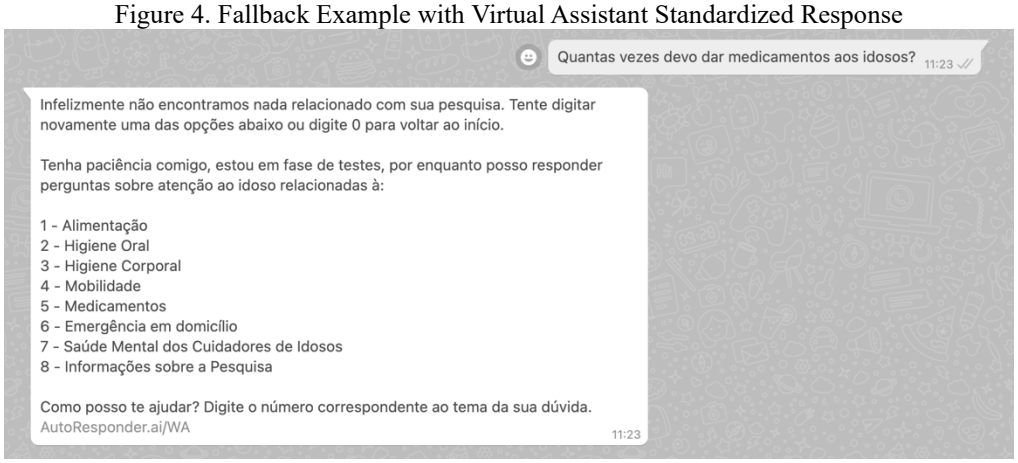
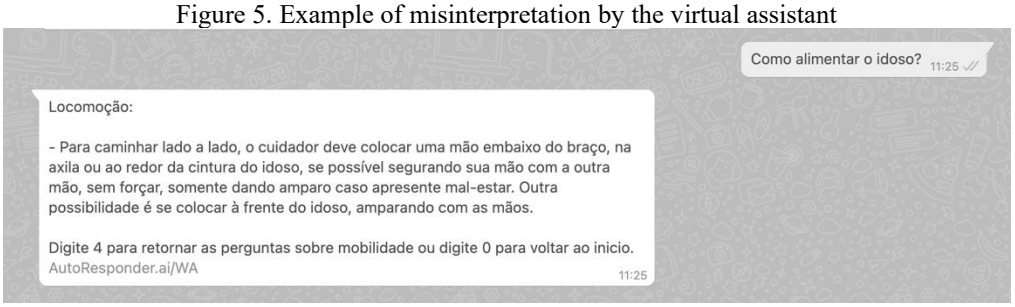


Figure 5. Example of misinterpretation by the virtual assistant



The study participants evaluated the *chatbot* after reading and signing an Informed Consent Form. The system was used by them over a period of 60 days. The collection of participants' impressions about various aspects of the *software* was carried out through an adapted version of the questionnaire consisting of 10 (ten) questions, which address topics related to ease, preference, attraction, intention to use and user expectations18.

Participants were 6 (n=6) health professionals from various areas, with a mean age of 41.3 years, with the youngest participant being 27 years old and the oldest being 61 years old. There was a greater number of women (83.3%), including a social worker, a teaching nurse, a speech therapist, a psychologist and an occupational therapist, while the only man (16.7%) is a physical therapist.

All participants believe that the assistant is not complex and they do not need to learn new skills before they can use it. Despite not having received previous training, 83.3% of the participants strongly disagree that the system is difficult to use, 83.3% strongly disagree that they need the help of a person with technical knowledge to use it, 66.7% strongly agree that it is easy to use, and 66.7% strongly agree that they feel confident when using the system. Only one participant (16.7%) was neutral about the judgment of ease of use.

In addition, all participants share an interest in using the *chatbot* frequently, with 50% of them strongly agreeing and 50% partially agreeing with this statement. Finally, half of the participants strongly agree that the functions are well integrated and 66.7% strongly agree with the statement that they imagine that people will learn how to use the system.

To the open-ended question of suggestion to improve the system, only 4 of the participants answered (66.7%). Their suggestions are transcribed in full: "Enhance the features with photos and videos if possible!"; "put pictures of the orientations"; "I hope it will be put into practice as soon as possible"; "My suggestion is to reduce the texts a little and add illustrative figures, that is, to improve visual communication to facilitate understanding. I think it is possible in the items that talk about falls, medications, bathing, eating, in short, I believe in all 6 items. Also, in the item mobility, question 42 (report on medications used, suggestion to use only medications prescribed by the physician)."

4 DISCUSSION

At first, *chatbots* had numerous limitations. The first *chatbot,* called Eliza, was unveiled in 1966 and had a script so that it would be able to hold a conversation with a human being. However, over the decades, several limitations have been overcome and chatbots have become able to perform previously unimaginable tasks21.

Technological advancements have revolutionized the way of interpersonal communication, and new conversational tools have been created. These new systems are characterized by the multiplicity of conversations, ubiquity and simplicity. This environment was favorable to the return and popularization of *chatbots23*.

Currently, the use of *chatbots* is focused on the provision of information and the tasks performed by these virtual assistants range from simple work, such as solving common questions on websites, to complex activities, such as automating commerce systems and providing services to large companies.

A great gain acquired with the use of *chatbots* is the increase in productivity, both due to the tool's ability to handle a large volume of data and users, and the lower expense with employees. In addition, they are able to personalize the user experience, welcoming customers and making it easier for them to navigate the service in question.

In order to answer the possible doubts of caregivers of the elderly, the *chatbot* of this study was developed with a simple, direct and accessible language, in order to promote a greater approximation between the user and the suggested instructions according to the theoretical basis already mentioned. The use of simple and direct language was also sought to make the relationship more realistic, but not to the point that the user confuses the *chatbot* with a person.

The results of the evaluation of the virtual assistant were generally positive: more than half of the participants consider it easy to learn to use, with well-integrated functions and a consistent knowledge base, in addition to sharing the feeling of confidence in the system. Although they had not received previous training, there was no report of any difficulty or complexity in the process of textual communication with the system.

However, the *chatbot* still has important limitations. As for the *chatbot database,* even though the system has been tested by health professionals and has obtained a good response, it is necessary to apply it in the daily life of the caregiver of the elderly to confirm if the questions really simulate the possible doubts of the caregiver and if the guidelines provided are in fact relevant to the execution of their tasks.

Regarding the correspondence between the various formulations of questions in an attempt to reduce *fallbacks*, the numerical menu system acts in this sense, however, it is noted that the questions need to be even more standardized, so that the use by the caregiver of the elderly is simple, fast and efficient, so that he does not get annoyed or waste time receiving automatic messages of non-recognition of the command. which could also compromise reliability in the system.

In addition, the insertion of images for a better visualization of maneuvers and positions by the caregiver can facilitate the execution of tasks. This fact was evident in 3 of the 4 (75%) suggestions provided by the professionals participating in the evaluation.

5 CONCLUSION

The *chatbot* was developed according to possible doubts of caregivers of the elderly, especially those in the informal category, in order to provide support to them in the daily care of the elderly. The materials used as a theoretical basis for the *chatbot commands* are intended to guide the caregiver in order to facilitate the execution of their tasks and improve the quality of life of the individual being cared for.

The results of the virtual assistant's evaluation were generally positive. The evaluators did not receive previous training and even so, there was no report of any difficulty or complexity in the process of textual communication with the system. However, there are still important limitations regarding the database, the matching of questions and answers, and the lack of images to illustrate the guidelines.

In general, despite the limitations pointed out, it can be said that the use of the virtual assistant to assist the caregiver of the elderly in their work is reliable and easy to use, and its knowledge base is consistent.

The project is still under development, caregivers of the elderly were included as participants in the research and *the chatbot* is receiving improvements with the insertion of new intents.

RECOGNITION

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