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Research Article

PhonoBot: A Chatbot for Sound Changes

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ABSTRACT

The use of artificial intelligence is gradually expanding in various fields today. Its applicability to many areas and its ability to make people's lives easier can be considered as the strongest points of AI. Artificial intelligence systems enable people to access information faster and can also provide an interactive and individualised education environment. Chatbots, one of the most common examples of artificial intelligence, can chat with people using natural languages such as Turkish and English. It can be said that the communication environment offered by chatbots has enabled them to become widespread in the field of education. People go through social, cultural and economic changes over time. These changes shaped according to people's needs can lead to various changes in language as in the education environment. As one of the most important elements of language and communication, sound can be affected by this situation and cause various sound changes to occur in words over time. This study focuses on the PhonoBot developed to facilitate students and instructors in accessing information and examples related to sound changes more guickly. The purpose, design, user interaction, and potential benefits that PhonoBot can provide to users are the main subjects of this study.

Keywords: Chatbot, Linguistics, Phonology, Artificial Intelligence, Sound Changes

Introduction

The developments in artificial intelligence that started with Alan Turing's question have led to innovations in education as well.Artificial intelligence, especially in recent years, is widely used in various fields such as health, finance, defence, and education.It would be appropriate to say that the main reason for the widespread use of AI is its ability to make human life easier. Various AI applications are being used in today's world, and chatbot is one of them.

Chatbots can simply be defined as the systems that enable human-machine interaction and have a wide range of applications. As the chatbots can provide personalised and interactive learning environment, they hold a significant position in education. Chatbots can be used in education for various purposes such as machine translation, text analysis, educational support systems, and language teaching/learning.



Language ensures the continuation of human life as a fundamental tool used to convey thoughts, cultures, and knowledge. Language, as a dynamic and intricate system, plays a vital role in human communication, evolving through the interplay of cultural, social, political, and technological factors. The continuous evolution of language is a reflection of societal changes propelled by factors such as migration, trade, and technological advancements. At its core, language thrives on sound, with sound changes serving as vital components. This linguistic evolution, examined through both diachronic and synchronic lenses, unravels the tapestry of human communication. Understanding these linguistic nuances called sound change is crucial as theyshed light on the ever-changing speech patterns of societies and reveal both similarities and differences among them.

A chatbot called "*PhonoBot*" is designed for students and instructors to learn and teach the sound changes. This study focuses on its purpose, design, user interaction and the potential benefits for users. PhonoBot is designed to enable users to interactively access information about sound changes, reducing the time it takes for them to reach relevant information.

1. Artificial Intelligence

The Turkish Language Association defines *Intelligence* as "the ability to think, reason, learn, visualise concepts and objects, perceive objective facts, judge, draw conclusions, control the body, perceive emotions correctly, evaluate, invent, etc. the full range of talents and skills of human beings" (TDK, n.d.). The American Heritage Dictionary (n.d.) defines it as; "the ability to acquire, understand and use knowledge". It is also defined as "the ability to learn, understand, and make judgments or have opinions that are based on reason" in the Cambridge Dictionary (Cambridge, n.d.). McCarthy (2007) defines intelligence as "the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines."People are born with a certain level of intelligence, and various factors such as social environment, education level and learning ability affect their intelligence throughout their lives. The intelligence that human beings born with has enabled them to create and invent new ways to make their life easier from the early ages to today's modern world. *Artificial Intelligence (AI)* is a creation of human intelligence and is used in many areas today.

The developments in the field of artificial intelligence started with Alan Turing's question "*Can machines think?*" (Turing, 1950). The idea of making machines that can think and act like humans become popular since then. In 1956, John McCarthy used the term artificial intelligence for the first time at the Dartmouth Conference and became the person who gave name to the field (Copeland, 1993, p. 8). "What is supposed to be 'artificial' about artificial intelligence, no doubt, has to do with its origins and mode of creation in arising as a product of human contrivance and ingenuity rather than as a result of natural (especially biological or evolutionary) influence." (Fetzer, 1990, p. 3). Minsky (1968) definesAI as "the science of making machines dothings that would require intelligence if done by men".

Artificial Intelligence products are classified depending on how close their capabilities are to human behaviour. John R. Searle coined the terms "*Strong AI*" and "*Weak AI*" and introduced them in his article "*Minds, Brains and Programs*" published in 1980. Searle (1980, p. 417) states that for the weak AI, the principal value of the computer in the study of the mind is that it gives us a very powerful tool and enables us to formulate and test hypotheses in a more rigorous and precise fashion. On the other hand, according to strong AI, the computer is not merely a tool in the study of the mind; rather, the appropriately programmed computer really is a mind.

Advancements in AI, the technology that tries to realise the equivalents of human behaviour with artificial neural networks (Coskun and Kuşçu, 2021 p. 117), have enabled machines to evolve beyond simple calculations, allowing them to become intelligent entities capable of speaking, interpreting, listening, and making inferences like humans. Machine learning, deep learning, robotics, computer vision, speech technology, and natural language processing are the methods widely used in the creation of AI systems. These methods enable people to create machines or computer programs that act like humans. Naqa and Murphy (2015, p. 3) defined machine learning as "the branch of computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment". Yılmaz and Kaya (2021, p. 1) state that deep learning is an artificial intelligence method that uses multi-layered artificial neural networks in areas such as object recognition, speech recognition, and natural language processing, and is one of the types of machine learning. According to Aydın (2021, p. 107), computer vision is an important AI application and can use computers and cameras to replace the human eye for object recognition, tracking, measurement, and other problems. Yu and Deng (2015, p. 2) state that speech technology can be used in human-human interaction by removing the barriers between individuals speaking different languages through speechto-speech translation, and in human-machine interaction thanks to applications such as voice search and personal assistant. As Hirschberg and Manning (2015, p. 261) explain, natural language processing can aid human-human communication, such as in machine translation; aid human-machine communication, such as with conversational agents; or benefit both humans and machines by analysing and learning from the enormous quantity of human language content.

Applications created using artificial intelligence and imitating many human-specific behaviours are widely used in various fields today. Artificial intelligence products such as smart homes and cars, as well as object, face, or voice recognition systems and chatbots are encountered in many aspects of our daily lives. There is no doubt that chatbotsare of great significance among these innovations as they are able to make human- machine communication possible with the help of natural language processing and speech technology.

2. Chatbots

People constantly create products that facilitate their lives with their abilities such as thinking and interpreting (Yavuz, 2023, p. 9). One of the most important of these products,

especially encountered in many aspects of our lives in recent times, is the chatbot. The term *"chatbot"* was coined by Michael Mauldin (Mauldin, 1994, p. 16-21). They are known by a variety of different names such as Conversational AI, AI Assistant, Intelligent Virtual Assistant, Virtual Customer Assistant, Digital Assistant, Conversational Agent, Virtual Agent, and Conversational Interface (Surendran, Murali, and Babu, 2020, p. 1).

Chatbots are computer programs that interact with users using natural languages (Maher, Kayte and Nimbhore, 2020, p. 503). A chatbot is an artificially intelligent creature that can converse with humans. This could be text-based or a spoken conversation (in case of voice-based queries) (Lalwani et al., 2018, p. 26). In text-based chatbots, users can interact with the machine through written communication, while in voice-based chatbots, users can engage in verbal dialog with the machine. They can be created in various natural languages, such as Turkish and English, using different artificial intelligence methods like natural language processing, machine learning, and deep learning to enable human-machine interaction.

Each chatbot has different features depending on how it is programmed. There are two main types of chatbots available, one whose functions are based on a set of rules and the other is the more advanced version that uses artificial intelligence (Sharma, Goyal and Malik, 2017, p. 52). The first one of these approaches is called*Rule-Based* and the other one is *AI-Powered*. In the Rule-Based approach, there is a database containing prepared questions and answers within a set of predefined rules (Maher et al., 2020, p. 507). The system checks if the input provided by the user matches anything in the database and responds accordingly. In AI-Powered chatbots, even if the user's input does not match the data in the database, the machine, using machine learning and deep learning techniques, selects a probable response and submits it to the user. These approaches are used today depending on the intended use of a chatbot.

Moreover, chatbots can have an open or closed knowledge domain depending on their intended use. Chatbots with an open knowledge domain, like *ChatGPT*, can provide responses on any topic within the limits permitted by their databases. Conversely, chatbots with a closed knowledge domain are designed to interact only on specific subjects, such as chatbots designed for teaching a particular subject or for taking orders.

Eliza, developed by Weizenbaum in 1966, is considered the first chatbot for its ability to engage in dialog with humans using natural language. Eliza can chat with individuals like a psychologist (Weizenbaum, 1966). Since then, chatbots have been more widely used with various approaches in many fields. Chatbots are successfully used in various industries such as healthcare, finance, travel, education, and many others. Chatbots providing financial advice, answering different types of queries of the clients such as Maxi (Türkiye İş Bankası) and Erica (Bank of America), giving travel advice, making reservations like Expedia's Virtual Agent, making phone calls, texting, checking weather forecast etc. such as Siri (Apple) and Google Assistant (Google Inc.) can be regarded as the main examples of the use of chatbots in different fields. The diversity in the use of chatbots and changes in human life have also affected the education process.

3. Chatbots in Education

Rapid advances in technology have changed our lifestyles in many ways. With only one click, we can access a compilation of data (Srivani & Manhar, 2020, p. 232). Nowadays, students learn through online platforms. They would rather use their smartphones to browse and read information online than to read textbooks or subject materials (Okonkwo & Ade-Ibijola, 2021, p. 6). Thus, as Mercan et al. (2009, p.369) state, theories and methods developed over centuries in the fields of producing, transferring, providing, and using information are undergoing radical changes. For this reason, changes in education have become inevitable. AI use in education has become widespread around the world, as computers offer the possibility of truly individualised instruction (Bitzer, 1973, p. 173). This capability allows educators to create more adaptive, flexible learning environments where teaching can be tailored to meet the needs of each student.

Language, as a dynamic and intricate system, plays a crucial role in human communication and in education as well, as it serves as the primary medium through which knowledge is conveyed, ideas are exchanged, and understanding is fostered among students and educators. In this context, the integration of chatbots into education leverages the fundamental role of language, using it as a tool to facilitate continuous, personalised, and interactive communication between students and computers. Students appreciate that the chatbot is always available, unlike a teacher or study buddy (Bjelland et al., 2024, p. 1461). Since their inception, these chatbots have been used for various applications, including answering questions, generating explanations and summaries, translating between languages, and performing other natural language tasks (Dastani & Mohseni, 2024, p. 710). They can be implemented in many parts of the educational process, including content development, teaching methods, student assessment, and communication between teachers and students (Khandakar, 2024, p. 3810)

Chatbots, due to their versatility and accessibility through smartphones, computers, and tablets, as well as their ability to provide an interactive learning environment without time and space limitations, are becoming increasingly widespread in education (Hwang and Chang, 2021). SCHOLAR, developed by Carbonell in 1970 to teach the geography of South America, stands as the first example of the use of intelligent machines in education (Carbonell, 1970). The Tactical Language and Culture Training System developed by Johnson and Valente to teach French focuses on the language and cultural skills needed to accomplish particulartypes of tasks and gives learners rich, realistic opportunities to practice achieving those tasks (Johnson & Valente, 2009). Dibitonto et al. (2018) designed a chatbot named LISA intended to help students in their campus life, through information and services. Chatbots use natural language processing (NLP) to communicate with humans; thus, theyare of great importance in linguistics, mainly in Computational Linguistics. The transformative role of artificial intelligence (AI) in language teaching, particularly in second language (L2) acquisition, is a burgeoning field in applied linguistics (Kartal and Yeşilyurt, 2024, p. 359). Yavuz (2023) designed a chatbot named

GABBY to enable students who learn English as a foreign language to find an interactive learning experience by simulating real-life language interactions. Ogunlade et al. (2023) developed an AI chatbot focused on improving the linguistic skills in spelling, reading and comprehension of dyslexic learners.

Chatbots like those and many others are widely used in education as they have lots of benefits for both students and instructors. Roos (2018, p. 17) demonstrates the features and benefits of chatbots: (Table 1)

Table 1. Chatbot Features (Roos, 2018, p. 17)				
Bot Features What can the hot do?				
Sub-Theme	Description (The chatbot can)			
Demonstrate the learning task	demonstrate a task			
Animated gestures supporting the knowledge base	use animated gestures			
Allow input as speech	accept input in speech format			
Control the e-learning platform's activity	monitor activity on the platform			
Provide means of contact with the teacher	contact teacher for learner			
Point of interaction for the learner	act as a point of interaction			
Provide output as speech	provide the spoken output			
Help students 24/7	provide its services at any time of day and year			
Provide content from other knowledge sources	use other knowledge sources for its answers			
Support feedback to students	provide feedback to students or teachers			
Give recommendations about the learning material	give recommendations about the learning material			
Hold topic-specific conversation	conduct a topic-specific conversation			
Hold a general conversation	conduct a general conversation			
Teacher can edit bot content	be edited by the teacher			
Ask the student questions	ask the student questions			
Conversational strategies	use conversational strategies			
Answer student questions	answer the student' questions			

The features listed in Table 1 show what chatbots can do and actually explain the reason why chatbots are widely used in education.

4. Language and Sound Change

Language is a complex symbolic system that facilitates communication among people and is in a continuous process of evolution through the interaction of cultural, social, political, and technological factors. Ergin (1985, p. 3) defines language as a natural means of communication among humans, a living entity with its own laws that develops within the framework of these laws, a system of hidden agreements laid down in unknown times, and a social institution woven from sounds. Language is considered more than just a communication tool; it becomes a means to convey ideologies, reinforce power structures, and shape shared worldviews (Syam et al., 2023, p. 578).

Language can undergo changes as long as there is a need for it (Akay, 2007, p. 4). Factors such as migration, trade, and technological advancement strigger changes in language. For

instance, since the emergence of computers, AI and social media languages have acquired many new words through various means. Therefore, language adapts to the needs of societies and changing conditions, shaping through processes such as the creation or introduction of new words, the obsolescence of old words, and the evolution of grammatical structures. Language change is taking place slowly and subtly, unpredictable in its outcome, and recognised only after some time has passed (Crystal, 2018, p. 1).

Meillet (1921, p. 230) describes language as an indispensable tool of human societies and a social phenomenon, emphasising the interdependence of language and society.Since each society has a different history, culture, perspective of the world and social experiences, the elements contained within languages also differ. Every language forms a whole by encompassing many complex structures that carry the traces of the society in which it is used.

"Even if we have no knowledge of a nation's way of life, beliefs, traditions, worldview, various qualities, and the historical events that have occurred within that society, we can still obtain valuable information and reliable clues on all these matters solely through linguistic studies, by delving into the vocabulary and depth of the language's lexicon." (Aksan, 2015, p. 65).

Apart from linguistic differences between different societies, even within the same society, factors such as age, gender, and social status can lead to various distinctions in the language of individuals. Macaulay (2005) observed that *aye* (the Scottish equivalent of *yes*) is more likely to be used by working-class adults, while *yes* is more frequently used by middle-class adults. Therefore, as Eker (2007, p. 127) points out, language is not homogeneous. When a language that reflects the characteristics of the time in which it is used undergoes an evolutionary analysis, both diachronic and synchronic approaches can be pursued. This evolutionary process adapts to the changing needs of societies and facilitates communication among language users. Diachronic variation falls within the scope of historical linguistics; spatial variation is the domain of linguistic geography; and social variation is examined by sociolinguistics (Kıran & Kıran, 2018, p. 372). Aksan (2015, p. 65) demonstrates that by examining a text of a particular language from a specific period solely in terms of foreign elements and influences, we can determine which cultural movements that society witnessed during that time and what external influences it was subject to.

The language that facilitates communication among people is composed of various complex structures. The most fundamental element enabling this communication is the word. In other words, understanding a language is possible primarily by understanding the vocabulary and relationships between words in that language. Therefore, the vocabulary of a language holds importance. On the other hand, due to the continuous evolution and change in language, various factors such as cultural, social, political, and technological influences can lead to changes in words. "Language undergoes transformation over time and due to various factors, altering in terms of sound, form, and syntax, and each stage of the language takes on different appearances. The most affected aspect is the language's vocabulary." (Aksan, 2015, p. 53).

Language is based on sound; the raw material of language is sound (Karaağaç, 2013, p. 17). In other words, the fundamental elements used in constructing a word are its sounds. Therefore, changes in language are primarily seen in sound. Languages vary, languages change; sound change is assumed to occur when there has been a change in the system in which that sound exists (Smith, 2007, p. 5-7). The same sound is measurably different not only when spoken by the different speakers but also when spoken by the same speaker in different phonetic environments or at different rate or level of loudness (Jones, 2014). Changes in words can occur through the addition or removal of a sound, sound change, changes in emphasis, and tonal shifts. While some of these sound changes occur diachronically during the development of languages, others occur synchronously at the time of language use (Efendioğlu and İşcan, 2010, p. 128). Sound changes hold a significant place in studying language because the analysis of these changes can reveal how the speech patterns of societies have changed over time and can highlight language similarities and/or differences among different societies.

Considering the advances in artificial intelligence and benefits of using chatbots in education as well as the importance of learning and teaching sound changes; a chatbot named *Phonobot* is designed to help students and instructors in learning/ teaching sound changes. The design, user interface, user interaction and the potential benefits for users are discussed in the following sections.

5. PhonoBot

Today, advancing technologies have impacted the field of education, just as they have affected almost every other area. Technological improvements in education have made life easier for students, instead of using pen and paper; students nowadays use various software and tools (Haleem et al., 2022). Consequently, students' expectations and needs are also changing rapidly. Technology is the means and atmospheres that engage students (Sabzian et al., 2013). The use of technology at various stages of education can increase students' interest in lessons. Therefore, a chatbot named PhonoBot was designed to provide students with an interactive learning environment, support instructors, and offer quick and easy access to information on sound changes.

5.1. PhonoBot's Design and User Interface

PhonoBot is a text-based chatbot with closed knowledge domain. It was developed to introduce and analyse sound changes, helping users understand phonological processes in Turkish and other languages. It provides information on sound changes, including examples, definitions, and English equivalents. Users can also add new sound changes or update existing information, making it a flexible tool for learning about phonetics.

Voice-based systems can be influenced by ambient noise and are highly sensitive to variations in accent, tone, and pronunciation. On the other hand, a text-based chatbot like PhonoBot can

be easily used in any environment. This approach ensures consistent and reliable performance, especially when users introduce examples of sound changes from diverse languages that might be challenging to pronounce. By avoiding the risks associated with pronunciation errors, PhonoBot maintains its effectiveness, enabling users to freely explore sound changes and linguistic phenomena without compromising comprehension.

PhonoBot, built with Python, uses Natural Language Processing (NLP) techniques to analyse and interpret user queries. It employs similarity matching to determine the closest known sound change or identify the user's intent, ensuring that the information provided is relevant and precise.



Figure 1. Architecture of PhonoBot

The system architecture is optimised to handle text-based interactions, making it both lightweight and fast. Users are able to type in their request information on a specific sound change. After the user's query, PhonoBot determines the request and then matches it to the most relevant sound change. Based on the detected intent and matched sound change, PhonoBot generates a detailed response and displays it (See Figure 1).

PhonoBot: A Chatbot for Sound Changes



Figure 2. PhonoBot Part 1: Chat

PhonoBot's user-friendly design emphasises simplicity and clarity, making it easy for users to navigate and interact with. The interface is streamlined, with minimal distractions, allowing users to focus solely on learning about sound changes.PhonoBot is structured into two main sections to optimise user interaction and learning: the first part is the chat section, which is the primary interactive area, in which the users ask about sound changes and PhonoBot responds with a detailed explanation (See Figure 2).

The second part allows users to manage the sound change database. Here, users can add new sound changes or update existing ones, including definitions, examples, and translations. This feature enhances PhonoBot's adaptability, ensuring that it remains a comprehensive and up-to-date resource for phonetic studies. To update the database, users must fill the textboxes; "Ses Olayı" ("Sound Change"), "İngilizce" ("English"), "Açıklama" ("Definition") and "Örnek" ("Example") and then click the "Ses Olayını Ekle" ("Add Sound Change") button (See Figure 3).

PhonoBot Set Olavi Fkle		-	×
JOINDER OUP ONLY TIME			
	Ses Olay1:		
	İngilizce:		
	Açıklama:		
	Örnek:		
	Ses Olayını Ekle		

Figure 3. PhonoBot Part 2: Add Sound Change

5.2. PhonoBot and User Interaction

PhonoBot uses Natural Language Processing (NLP) techniques to analyse and interpret user queries, allowing it to respond effectively to questions about phonological events. It accesses a database containing information on various sound changes and retrieves relevant data, such as definitions, examples, and English equivalents, in response to user inquiries. PhonoBot's NLP architecture is designed to handle minor spelling errors, ensuring it understands the intended question even if the user makes a typo. For example, if a user types "göüşme" instead of "göçüşme," PhonoBot can still retrieve and provide information about the intended sound change, "göçüşme" (metathesis).

PhonoBot maintains context by remembering the last sound change discussed. This feature allows users to continue asking related questions(such as examples or English equivalents) without needing to re-specify the topic until a new sound change is inquired about. For instance, if a user initially asks about "göçüşme" (metathesis), they receive pertinent information. Subsequent inquiries about related terms such as "uzak göçüşme" (incontiguous metathesis) are also correctly matched and responded to based on NLP-driven word matching, providing a seamless, intuitive interaction experience (See Figure 4).



Figure 4. User Inquiries

PhonoBot can successfully retrieve and provide responses related to sound changes as stored in its database. When a user requests additional examples, PhonoBot can show these until it reaches the limit of available examples in the database, at which point it informs the user that no more examples are available (See Figure 5). To extend PhonoBot's ability to provide more answers, users need to add more examples for each sound change in the database.



Figure 5. Providing Examples

PhonoBot can provide instant responses for sound changes presented in the database. When PhonoBot encounters a query or expressionthat is not found in its database, it responds to the user with "Üzgünüm, ne dediğini anlamadım. Eğer sorduğun bir ses değişimi ise bunu bilmiyor olabilirim. Bana öğretmek için 'Ses olayı Ekle' butonunu kullan" ("Sorry, I didn't understand what you said. If you are asking about a sound change, I may not know it. Use the 'Add Sound Change' button to teach me")

PhonoBot can also detect the sound change applied to a word. By analysing the transformation of the word, PhonoBot identifies the relevant sound change, provided it exists within its database. This feature allows users to quickly understand the phonological process affecting a word without needing extensive background knowledge. PhonoBot's ability to pinpoint specific sound changes makes it an efficient and user-friendly tool for learning about complex phonological concepts straightforwardly (See Figure 6).



Figure 6. Detecting Sound Change

Conclusion and Suggestions

AI is widely used in many fields in today's world. The integration of Artificial Intelligence (AI) in education has ushered in a transformative era, redefining traditional teaching and learning methods (Ayeni, et al., 2024). One of the greatest assets of the computer is its boundless potential to store information, and in addition, to create more (Andriessen & Sandberg, 1999, p. 134). Chatbots can interact with humans via natural languages with the help of their algorithms, the information in their database and their ability to learn like humans by using NLP or machine and deep learning techniques. As chatbots have various features and benefits, they are used in different fields. Chatbots can provide personalised and interactive learning environment; therefore, they hold a significant position in education as well.

PhonoBot can play a crucial role in creating an interactive learning environment for students and instructors. Traditional methods of learning sound changes can be time-consuming and less engaging. PhonoBot's text-based chat interface allows users to ask questions and receive instant responses, enhancing the learning experience. By allowing users to update the database with new sound changes, PhonoBot encourages users to become active participants in the process of documenting and studying sound changes. Instructors can benefit from PhonoBot as a supplementary tool for teaching sound changes.

As technology continues to play a pivotal role in education, innovative solutions like PhonoBot exemplify the potential for AI to enhance the learning experience across diverse academic disciplines. Chatbots and other AI products should be used more widely in education. Considering the results, the following suggestions can be made for further studies:

- Chatbots like PhonoBot can be used in teaching other linguistics fields.
- Chatbots in Sound changes can be designed as voice-based.
- Chatbots like PhonoBot can be designed to use in other languages.
- The pronunciation of the word can be added to the chatbot.
- Games can be integrated into the chatbot.

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