



Framework for A Foreign Language Teaching Software for Children Utilizing AR, Voicebots and ChatGPT (Large Language Models)

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ABSTRACT

The cognitive capabilities of children develop during the early years of their life. Preschool years are considered the best time for children to learn a second language. An increasing number of parents would like their children to start learning a foreign language at an early age. However, engaging little children with learning activities is challenging. In this study, we propose a framework for developing a foreign language learning software tool utilizing Augmented Reality (AR), Voicebots, and ChatGPT (an AI tool utilizing the Large Language Models) technologies to provide a unique product for young children to teach a foreign language. With AR and Voicebots, the product can grab attention, motivate, and provide an entertaining learning environment. The capabilities of ChatGPT can be utilized to efficiently prepare the content for the software tool. We show how to utilize the capabilities of ChatGPT to generate interactive dialogs that can be hosted at Google DialogFlow. We also present important design principles for the software, such as gamification, social interaction, and surprise rewards. We believe the framework and the design principles we propose in this study can be a blueprint for developing highly effective foreign language teaching software.

1. INTRODUCTION

THE cognitive capabilities of children develop during the early years of their life. Research shows that learning a foreign language helps develop cognitive skills. Preschool years are considered the best time for children to learn a second language or to acquire a second language which is defined as learning a second language after a first language is already established [1, 2, 3, 4, 5]. Moreover, learning a foreign language has become essential, and many parents would demand their children start learning a foreign language at an early age. However, engaging young children with learning activities or tasks are challenging due to their short attention span compared to older children. Parents who want their children to learn another language might hire a tutor. However, hiring a teacher would not be affordable for most families, and a teacher will not be available anytime needed. Children become technology savvy and start enjoying apps on mobile devices even during toddler ages. Augmented Reality apps especially grab the attention of young children with their 'magical' features as they pop up a 3D virtual model of a

child's actual surroundings. Besides, the curious minds of young children like to engage in conversations with voice assistants like Apple Siri, Google Assistant, Microsoft Cortana, or Amazon Alexa. Once Augmented Reality technology is combined with Voice Assistant technologies, a software tool can be realized for young children to play and learn a foreign language. A 3D avatar can pop up in a child's surroundings to teach him/her a foreign language while having conversations or playing games. This 3D Avatar will essentially be a voicebot to provide children with a fun and engaging learning experience. Moreover, the voicebot will be much more cost-effective for the parents and will be available anytime to teach the child a foreign language.

Voicebots (sometimes called conversational bots) are the product of recent technological advancements in AI, Machine Learning, Natural Language Processing, Voice Recognition, and Speech to Text technologies [6]. Voicebots are currently used mainly as a customer-facing application to answer product-related questions, order a product, or schedule an event. We believe voicebots can be utilized for education and have considerable potential for supporting education in many

fields, including foreign language teaching. When designed and implemented carefully, voicebots can be a game changer for learning a foreign language, not only for children but for adults as well.

One of the challenges of such software is content creation. The software needs to have dialogs ready for interactions with the user. The interactions could be not only in the foreign language but both in the native and the foreign language. The interactions could aim to teach a specific subject, for example, to teach animals, numbers, shapes, colors, body parts, jobs, etc. All these variations increase the cost and time needed to develop such software.

Recently, ChatGPT became available for public use, and was surprised its users with its capabilities. It can generate content such as short stories and dialogs based on the brief instructions given by the user [7]. It can even generate code when the problem is defined. ChatGPT made content and code creation amazingly easy. While ChatGPT might be available for public use for a limited time, we believe that similar capable large language AI models will be available soon for content creation.

In this study, we propose a framework for developing a language learning software tool utilizing Augmented Reality (AR), Voicebots, and ChatGPT (an AI utilizing the Large Language Model) technologies to provide a unique product for young children to teach a foreign language. With AR and Voicebots, the product will grab attention, motivate, and provide an entertaining learning environment. The capabilities of ChatGPT (or a similar large language model) will be utilized to prepare the content for the software tool efficiently.

2. DESIGN PRINCIPLES of a FOREIGN LANGUAGE TEACHING SOFTWARE SYSTEM

Developing software for teaching a foreign language to children can be most effectively achieved if we can decide on the design principles correctly. Based on the research on similar language learning tools, we propose that the software should have the following components and properties [8]:

- Gamification
- Social Interaction
- Surprise Rewarding
- Application of Cognitive, Communicative, and Audio-Lingual Methodologies

2.1. Gamification

Due to the positive effect of the game on learning, digital games, which were previously for entertainment purposes, have also started to be used in education. Recent studies have focused on how games can be used effectively as teaching materials and how they will affect learning. As a result, numerous applications were developed that support learning with gamification design in many areas of education. One of these areas is foreign language education.

Today, gamification has become an area that is constantly developing and gaining popularity. One of the approaches to gamification design was proposed by Werbach and Hunter [9]. Their gamification design model includes 1) Determining the objectives, 2) Determining the target behaviors and how to measure them, 3) Identifying the players (grouped according to their abilities, fears, future plans, and game type), 4) Preparing the activity cycles (user should be able to progress within the system and the difficulty level of the game should be increased with each step taken) 5) Incorporating the

entertainment element for all types of users. 6) Using appropriate tools to progress according to the purpose, cycle, and user characteristics [10].

In many studies on gamification, it is underlined that gamification makes learning more interesting and therefore creates an effective and qualified learning process. At the same time, it is emphasized that it supports cognitive, emotional, and social development by increasing motivation as it provides an active participation environment for individuals [4]. By adopting gamification in the design principles of the software, we aim to increase the interest and curiosity of preschool and elementary school children in language learning.

Andrew Stott and Carman Neustaedter have included some dynamics and concepts that are applied in the learning environment and emphasized that they make success permanent by taking part in game design in their literature review called "Analysis of Gamification in Education" [7]. These concepts include freedom to fail, rapid feedback, progression, and storytelling [10]. Gamification techniques are used to bring game players into a competitive environment that has feedback, score collection, badges, leaderboards, winning prizes, etc. items were found [4, 11, 12, 13].

2.2. Social Interaction

Interaction is the event that occurs mutually between people. Social interaction, on the other hand, leads to dialogue and communication. Playing a game with more than one person rather than a single person will have a more successful learning process if played interactively in a social environment [14, 15, 16].

2.3. Surprise Rewarding

Surprise rewards need to be added to games in order to increase the time children spend in the application and to spend more learning time. Many products apply the technique of surprise rewards to make their user excited about the product. Nir Eyal mentioned in his book 'Hooked: How to Build Habit-Forming Products', a product should include a Surprise/Variable Reward System as one of the techniques used to create a desire to use it over and over again. [17]

2.4. Application of Cognitive, Communicative, and Audio-Lingual Methodologies

The software should build new knowledge on previous learning by following a hierarchical order in teaching foreign words and sentences. It should also provide a learner-centered approach and enable children to control their own learning and move them to the next stages in line with their own learning pace. The voicebot will help users focus on first listening and speaking skills. These can be achieved by applying the cognitive method, the communicative method, and the audio-lingual methods.

In the cognitive method, old learning is associated with new learning to achieve a meaningful learning experience. Instead of memorization and mechanical learning, teaching is carried out with participatory learning and methods that support learning that can create active memory.

In the communicative method, teaching is student-centered and teaching materials, environment, and activities are produced specifically for students. Care is taken to produce these materials in a way that reflects the culture of the target language and is functional in daily life.

According to the audio-linguistic method, the natural learning of the language begins with acquiring first listening and then speaking, reading, and writing skills. For this reason, the method gives more importance to listening, understanding and speaking than other skills. Structures and new words in the target language are taught through dialogues [8].

3. COMPONENTS of the FOREIGN LANGUAGE TEACHING SOFTWARE SYSTEM

We propose that an engaging foreign language learning software for young children needs to incorporate three main components:

- Augmented Reality (AR.)
- Voicebots (Chatbots supported by speech-to-text and text-to-speech)
- Content creation utilizing AI tools such as ChatGPT

3.1. Augmented Reality (AR.)

Augmented reality (AR) is a technology that overlaps computer-generated data (images, sounds, etc.) onto the user's view. It enhances the user's perception of the real world by adding layers of digital information to it [18].

AR can be experienced through a smartphone or tablet with a camera and a specialized app or through AR headsets or glasses. When the app is open, and the camera is pointed at a specific image or object, the app recognizes it and displays additional information or digital content on top of the user's view.

AR has many potential applications in many areas, including education, entertainment, and industry. For example, AR can be used to visualize complex concepts, create immersive gaming experiences, or provide real-time instructions and assistance in manufacturing or repair processes. Augmented Reality apps especially grab the attention of young children with their 'magical' features as they pop up a 3D virtual model of a child's real surroundings. AR can be an engaging and interactive way for children to learn a foreign language. It allows children to actively participate in the learning process and makes it feel more like a game than a traditional lesson. AR can provide children with a context for learning new words and phrases. For example, children can learn about the objects in their surroundings and can remember the words better as they are associated with real-world objects and concepts. AR can engage multiple senses, such as sight, and sound which can make the learning experience more immersive and memorable.

AR technology can be embedded into mobile apps utilizing one of the several AR frameworks such as ARCore, ARKit, or Vuforia. ARCore is a part of the Android development software development kit (SDK) developed by Google. ARKit is a part of the software development kit (SDK) developed by Apple for iOS devices. On the other hand, Vuforia is a cross-platform AR development framework that allows developers to create AR experiences for a wide range of devices, including smartphones, tablets, and AR glasses. Vuforia can be utilized for developing AR applications for both Android and iOS platforms. For our prototype, we wanted to cover both iOS and Android devices, however did not want to develop two separate mobile apps via two separate code bases. Therefore, we decided to utilize Unity3D to develop a mobile app for AR using a single code base and then export it for iOS and Android. Unity is a cross-platform game development platform that allows developers to create 2D,

3D, AR, and VR games and experiences for a variety of platforms, including iOS, Android, Windows, and console platforms. Inside the Unity development environment, we utilized Vuforia software libraries for AR development and were able to export the Unity project as iOS and Android projects.

Several AR products have been introduced to teach children language concepts. These products include:

- Magical Animals [1],
- Neobear Popup Zoo (www.neobear.com),
- ZooKazam (www.zookazam.com),
- Shifu Safari
- (www.playshifu.com),
- Animal 4D+ (www.octagonstudio.com)

Only two of these focused on foreign language teaching and only one incorporated voice, text, and voice recognition in their product.

3.2. Voicebots

The developments in machine learning, speech recognition, and text-to-speech technologies in recent years have made possible the developments in virtual personal assistants. For example, virtual personal assistants such as Apple Siri, Microsoft Cortana, Google Assistant, and Amazon Alexa, which have become widespread in use, provide many conveniences to people in their daily lives and have become routine helpers for operations such as sending e-mails, making phone calls, changing music, and sending messages. Conversational robots (chatbots) developed with similar technologies can answer the phone and perform special tasks such as taking orders and giving directions. Many commercial products with varying capabilities that help the development of chatbots emerged. Some of them are listed here:

- Dialogflow (<https://dialogflow.com>)
- IBM Watson Assistant (<https://www.ibm.com/cloud/watson-assistant/>)
- Amazon Lex (<https://aws.amazon.com/lex/>)
- ManyChat (<https://manychat.com/>)
- Chatfuel (<https://chatfuel.com/>)
- Wit.ai (<https://wit.ai/>)
- MindMeld (<https://www.mindmeld.com/>)
- Chatbot (<https://www.chatbot.com>)
- Azure Bot Service (<https://azure.microsoft.com/en-us/services/bot-service/>)

The listed products are not for foreign language learning but for producing chatbot applications. They take a text as input and output a text. Most of them lack voice-to-text or text-to-speech capabilities. Our goal is to develop voicebots. The only product on the market that utilizes voicebots to teach a foreign language is Mondly's Conversational Chatbot. However, Mondly's product is developed for adults and does not include any gamification features. It is more like a regular chatbot with speech recognition capabilities.

The chatbot development products listed above can be utilized to create voicebots once voice-to-text or text-to-speech functionality is integrated. In our prototype, we utilized DialogFlow (a product offered by Google) due to its ease of integration with the voice-to-text or text-to-speech functionality. Google's DialogFlow is also built on top of the

Google Cloud Platform, so it will be easy to scale when the number of users increases. It also supports many languages. There are four important concepts when developing a chatbot with Dialogflow:

- **Agent:** A Dialogflow agent is similar to a human call center agent. You train both to handle expected speaking scenarios, and your training doesn't have to be overly explicit. Agents also act as a high-level container for settings and data
- **Intents:** Links between what the user says and how you want the system to respond
- **Entities:** These are the subject categories your bot understands. For example, if your chatbot is for a clothing store, an entity category might be a product type: shoes, dresses, pants, hats, and another entity might be size: large, xl, small, medium, and another color.
- **Context:** Information obtained by the bot during the conversation. For example, the user's name or the users' favorite shoe color.

The interaction from the user is met by the agent and answered by the most appropriate intent (intent matching) defined for the agent. In the selection of intent, the interacting words and the previous words spoken during the conversation play an important role. With training phrases and parameters defined for 'Intent', it prepares the response (response) and delivers it to the user.

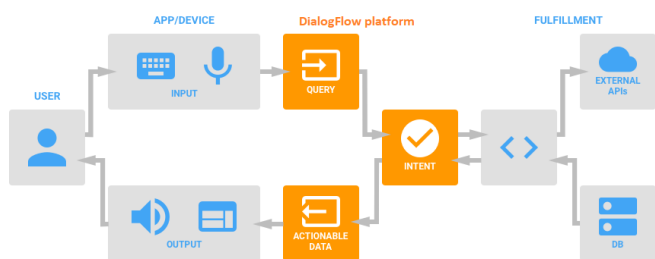


Fig.1. DialogFlow Interactions (Image Credit Google DialogFlow Documentation)

Figure 1 shows the flow of interactions between a user and a chatbot implemented using DialogFlow. Voice inputs from the user are translated into text and transmitted to the Dialogflow agent as input. The 'intent' corresponding to the text transmitted to the Dialogflow agent is selected based on the training phrases entered for intents. After the intent that will respond to the interaction from the user is determined (intent matching), the 'fulfillment' code, whose answer is determined for the intent, is prepared. This fulfillment code can be an external API and prepare the response after interacting with an external database.

Figure 2 shows the Interactions between the components of a voicebot. In response to the child's interactions (via speaking), the voice recognition software, embedded or called from within the software that is developed using the Unity development environment, translates the voice into text and transmits it to an agent in the Dialogflow. One of the many intents defined in this agent is selected via intent-matching algorithms to answer the incoming text. If a dynamic response is not required, the response is prepared by the intent and returned to the software without going to external APIs. If a dynamic response from the external environment is required, these external services are accessed via web interfaces and the prepared response is returned to the intent and then forwarded to the software.

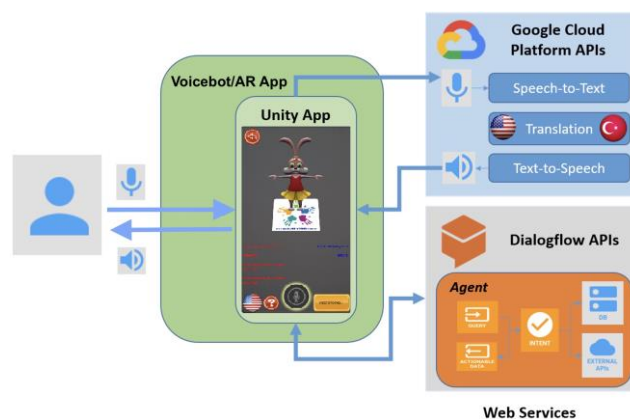


Fig.2. Interactions between the components of a voicebot

During the development process of Voicebot, Google Dialogflow product and Google Cloud Platform's speech-to-text, translation, and text-to-speech products were used. As seen in Figure 2, the user interacts with the mobile application developed in the Unity3D environment. After the user's voice is translated into text with 'Speech-to-Text', it is sent to DialogFlow. The answer text prepared in Dialogflow is converted into sound with 'Text-to-Speech' and transmitted to the user. In this interaction, the APIs of the Google Translation library are used when text is needed to be translated between languages.

3.3. Content Creation Utilizing AI tools (ChatGPT)

Designing conversations is a very important, challenging, and time-consuming task. The success of a voicebot heavily depends on how the interactions take place. To overcome the task of content generation, we propose to utilize an artificial intelligence (AI) tool, specifically, a large language model ChatGPT [19].

Large language models are trained to generate human-like text. They are called "large" because they are typically trained on very large datasets of text, often consisting of billions of words or more. The size of the data used to train a large language model can vary widely, but it is typically measured in billions of words. For example, the GPT-3 language model developed by OpenAI was trained on a dataset of over 8 billion words [20, 21], while the BERT language model [22], developed by Google was trained on a dataset of over 3 billion words.

Large language models have many potential applications, including natural language processing tasks such as translation, summarization, and question answering, as well as generating original content for a variety of purposes. They have been used to generate news articles, stories, and even poetry, and have the potential to revolutionize many fields that rely on text generation and understanding.

GPT and BERT are two of the well-known large language models. GPT (Generative Pre-training Transformer) is a transformer-based language model developed by OpenAI in 2018 that has been trained on a large dataset of web pages and books. BERT (Bidirectional Encoder Representations from Transformers) is another transformer-based language model developed by Google that has been trained on a large dataset of books and articles. New versions and variations of GPT and BERT have been introduced such as GPT-2, GPT-3, RoBERTa (Robustly Optimized BERT), and ALBERT (A Lite BERT) [21, 22, 23, 24].

Large language models have the potential to revolutionize the way that languages are taught and learned, by providing access to high-quality, customized, and personalized language learning materials.

We have tested ChatGPT to generate dialogues that would help in learning a foreign language. Some of the initial dialogues and subjects that are covered while teaching a foreign language, especially with young children, are introducing oneself, and conversations about animals, foods, vehicles, family members, body parts, vehicles, occupations, etc. We have asked the following prompts to ChatGPT, a large language AI model.

TABLE I^[1]
UTILIZING CHATGPT TO GENERATE DIALOGUES TO TEACH FOREIGN LANGUAGE

ChatGPT Prompt: <i>Generate a dialogue to teach English to young children whose native language is Turkish. Write Turkish meanings next to English sentences</i>
ChatGPT Output: <i>Teacher:</i> Hello, how are you? (Merhaba, nasılsın?) <i>Student:</i> I'm good, thank you. How are you? (İyiyim, teşekkür ederim. Sen nasılsın?) <i>Teacher:</i> I'm good too. What's your name? (Ben de iyiyim. Adın ne?) <i>Student:</i> My name is Selin. What's your name? (Adım Selin. Senin adın ne?) <i>Teacher:</i> My name is Mrs. Smith. Where are you from? (Benim adım Bayan Smith. Nereden geliyorsun?) <i>Student:</i> I'm from Turkey. And you? (Türkiye'den geliyorum. Sen nereden?) <i>Teacher:</i> I'm from the United States. Do you like learning English? (Amerika Birleşik Devletleri'nden geliyorum. İngilizce öğrenmeyi seviyor musun?) <i>Student:</i> Yes, I really like it. What do you want us to do today? (Evet, gerçekten seviyorum. Bugün ne yapmak istersin?) <i>Teacher:</i> Today we are going to learn some new words and phrases in English. Are you ready? (Bugün İngilizce'de yeni kelime ve cümleler öğreneceğiz. Hazır mısın?)

TABLE II^[2]
UTILIZING CHATGPT TO GENERATE DIALOGUES TO TEACH ANIMAL NAMES TO YOUNG CHILDREN

ChatGPT Prompt: <i>Using a similar style, generate a dialogue to teach English animal names to a Turkish young child.</i>
ChatGPT Response: <i>Teacher:</i> Look at this picture. Can you see the cat? (Bu resme bak. Kediyi görüyor musun?) <i>Student:</i> Yes, I see the cat. (Evet, kediyi görüyorum.) <i>Teacher:</i> Can you say "cat" in English? (İngilizce'de "kedi" diyebiliyor musun?) <i>Student:</i> Cat. (Kedi.) <i>Teacher:</i> Very good! Now, can you see the dog? (Çok iyi! Şimdi, köpeği görüyor musun?) <i>Student:</i> Yes, I see the dog. (Evet, köpeği görüyorum.) <i>Teacher:</i> Can you say "dog" in English? (İngilizce'de "köpek" diyebiliyor musun?) <i>Student:</i> Dog. (Köpek.) <i>Teacher:</i> Excellent! Let's learn some more animal names. Can you see the elephant? (Harika! Daha fazla hayvan ismini öğrenelim. Fil görüyor musun?) <i>Student:</i> Yes, I see the elephant. (Evet, fili görüyorum.) <i>Teacher:</i> Can you say "elephant" in English? (İngilizce'de "fil" diyebiliyor musun?) <i>Student:</i> Elephant. (Fil.) <i>Teacher:</i> Great job!

ChatGPT can also be used for generating code. In the framework, we proposed to utilize Chatbot creation products such as DialogFlow. We wanted to see if ChatGPT can put these dialogs into a format that can be easily imported to DialogFlow for usage. Therefore, we asked ChatGPT to create the one of the dialogues above in a format that can be imported into DialogFlow. ChatGPT was able to generate it

successfully. We present an excerpt of the response in Table 2 and 3.

TABLE III^[3]
AN EXCERPT OF THE INTERACTION WITH CHATGPT TO PREPARE THE CONVERSATION ABOUT FOREIGN LANGUAGE TEACHING IN A FORMAT THAT CAN READILY BE IMPORTED INTO DIALOGFLOW

ChatGPT Prompt: Can you generate the json file to import this dialog to Google DialogFlow?
ChatGPT Response: <pre>{ "id": "9c80f039-1b3d-46d3-b7f2-a3b3c3b75d71", "name": "Animal Names", "contexts": [], "responses": [{ "resetContexts": false, "parameters": [], "messages": [{ "type": 0, "lang": "en", "speech": ["Look at this picture. Can you see the cat?"] }, { "type": 0, "lang": "tr", "speech": ["Bu resme bak. Kediyi görüyor musun?"] }] }, { "resetContexts": false, "parameters": [], "messages": [{ "type": 0, "lang": "en", "speech": ["Yes, I see the cat."] }, ...] }] }</pre>

4. DISCUSSION

In recent years, studies have been carried out on teaching foreign languages with social robots. The 3D Avatars that will be utilized in the software along with augmented reality are similar to a robot. These studies revealed that the utilization of social robots improved the outcomes of foreign language learning tasks. It has been observed that learning achievements increase after spending more time with the robot [24]. According to these studies, the interactions with social robots (virtual 3D avatars) must be designed in a way that is pleasing, pedagogically sound, and challenging the limits of the learner [25, 26, 27, 28]. According to the studies, it would be meaningful to choose well-known word groups learned in the mother tongue in the selection of foreign language words that are aimed to be taught. The meaningful and interesting content of the teaching will also increase learning. In addition, it was recommended that the learning period be 10-15 weeks in 15-20 minutes doses every day and that a maximum of 6 words should be taught each time and each word should be repeated at least 10 times [28].

Software developed using the framework can scale in several dimensions including offering products in new countries with new native language options, offering products to teach new foreign languages, and offering new products to teach more content and concepts to cover more of the preschool curriculum for foreign language. Such a foreign language software will serve millions of families since there are approximately 26 million children between the ages of 4 and 8 in the Europe Union and there are about 17 million children between the ages of 4 and 8 in the USA. In

developing countries, learning a foreign language is considered even more essential.

5. CONCLUSION

We hope the framework we present here for developing foreign language teaching software will help bring innovative products to the market and will have a positive social impact. When children excel in a foreign language at an early age that means they communicate and understand each other better and possibly embrace the similarities and differences. Recent advancements in technology enable developers, researchers, and entrepreneurs to realize the components of the proposed framework more rapidly than ever. The cognitive development of young children can be increased by introducing them to foreign languages in a way that will grab their attention and engage them by utilizing Augmented Reality and Voicebots. The content for the foreign language teaching software can be conveniently produced using large language models such as ChatGPT.

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