Multimedia Enriched Practices

# Using Chatbot Technology in Education: Example of Newton Model

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**Abstract:** *It is not possible to achieve modern learning goals with traditional methods. For this reason, it is important to produce educational technologies that enable students to continue their learning and can help teachers. In recent years, Artificial intelligence and Chatbot technologies have been among the most effective methods that have begun to exist at many points in the learning process. Being interested in the lives and work of scientists will increase students' interest in science and the communication of science with society. In this study, firstly, a literature review was done on the use of chatbots in the field of education, and then it was aimed to develop a three-dimensional audible model that would enable students to chat about the life and works of Isaac Newton. This study is a design and development research. Newton recognition test, which was prepared by the researchers during the preliminary information gathering, was applied to a group of 65 middle school 8th-grade students. The obtained data were analyzed by content analysis and turned into a question-and-answer list that the model would use during the conversation. Then, using the MIT App Inventor application, a chatbot application was developed with the blog coding method and loaded into the prepared questions and answers. Later, the mobile application interface was designed. The prepared application was combined with a realistic Newton model, which was loaded on a tablet and printed with a 3D printer.*

**Keywords:** *Newton, chatbots, science teaching, scientists*

## Introduction

Science education has an important role in the development of countries. All countries give special importance to science education and try to increase the quality of science education in order to be at the forefront of the science and technology race and to equip individuals with the desired qualifications (Balbağ et al., 2016). Reaching today's goals is impossible by using only

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traditional learning resources and methods in learning processes. Therefore, in addition to listening to the teacher in the classroom, different media platforms and educational technologies have been developed for students to use.

Duman (2013) stated that the course material should stimulate more than one sensory organ in order for the learning to be permanent, increasing motivation and attention. He stated that stimulating more than one sense organ and using materials with audio-visual aspects in the lesson will save the teaching process from monotony. In addition, one of the reasons why teachers prefer the use of technology in education is that technology enables individualized education (Nagao, 2019). It is considered as the superiority of technological materials over traditional materials that each student has the opportunity to complete the learning process at his own pace and repeat it as much as he wants (Akdeniz, 2019). In support of this, Gao (2014) argues that the developed technologies offer students an individualized education opportunity to develop their different abilities and potentials, and that modern societies should pay attention to this. Modern artificial intelligence technology is one of the most effective methods to help teachers and students in the learning process. Len Cairns and Margaret Malloch (2017) state that artificial intelligence can bring many changes in the teaching process. The main function of artificial intelligence technology in education is to provide a personalized teaching environment on the computer and in this environment; It is the development of a system that will provide information and support to students with different needs and different characteristics (Joshi et al., 2021; Li et al., 2020). The application of artificial intelligence in the field of education changes the shape and effect of modern education and accelerates the modernization process of education (Han, 2018).

**What is Artificial Intelligence?**

> *''The term Artificial Intelligence or AI was coined by John McCarthy in 1956, two years after the death of Alan Turing, known as the initiator of AI. But before that, in 1950, when the first general-purpose computers were being produced, Turing had already asked, "Can machines think?" grappling with the question. He developed a hypothetical machine, called the Turing machine, to encrypt generated codes to test and describe Machine Intelligence, and launched computer programs that exhibit human-like intelligence, such as logical reasoning, problem solving, and learning" (Chatterjee & Raunak, 2018).*

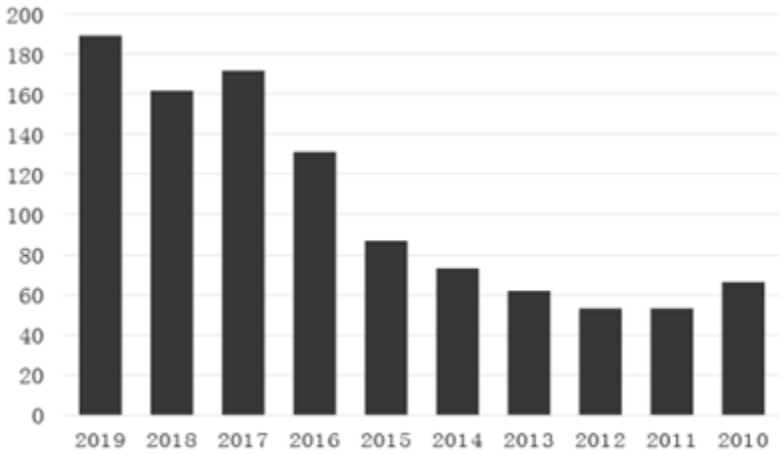
If we examine the leap of artificial intelligence in education, we see that intelligent computer-assisted teaching studies were from the 1970s to the 1980s (Nagao, 2019). In the 1970s, Artificial Intelligence Education (AIED) emerged as a field covering teaching and learning new technology, particularly higher education (Joshi et al., 2021).

**How Can Artificial Intelligence Be Used in Education?**

If we look at the situation of artificial intelligence in education in recent years, we see that it has an increasing momentum every year. As can be seen in Figure 1 from 2010 to 2019, there was a steady increase in the articles published on "AI" and "Education" on the Web of Science and Google

**Figure 1**

*Papers made with the keywords "AI" and "Education" in Web of Science and Google Scholar between 2010-2019(Chen et al., 2020.)*




As one of the countries that attaches most importance to artificial intelligence in education, the USA, in the report on the artificial intelligence market in the education sector, determined that the use of artificial intelligence in the education system will increase by 47% from the current level between 2017 and 2021. With the "Next Generation Artificial Intelligence Development Plan" published by the Council of State in 2017, the introduction of talent training models that propose smart education methods and target the use of artificial intelligence technology, and the change in education by explaining teaching methods (Panigrahi & Joshi 2020). Likewise, Ohio State University and some other institutions in the USA are currently using artificial intelligence as a pilot application (Chassignol, 2018). In Asia, in 2018, the Ministry of National Education of China published the "Innovative Action Plan for Artificial Intelligence in Higher Education" and stated: "Facing the next generation AI development opportunities, universities should continue to integrate AI as it provides new avenues for education reform." (Li & Wang, 2020, p.589).

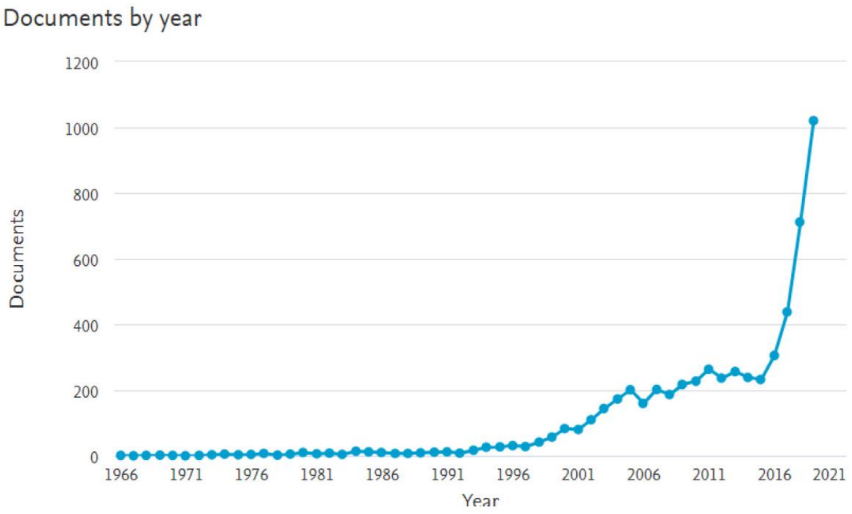
By looking at the literature, it can be predicted that the application of artificial intelligence technology in the field of education will continue to deepen in the future. Both domestic and foreign artificial intelligence experts and education experts attach more and more importance to the application and promotion of artificial intelligence technology in the field of education.

**What are Chatbots?**

Chatbot systems are one of the most popular technologies used to support the teaching and learning activities of Artificial Intelligence, which is increasingly used in education. (Okonkwo & Ade-Ibijola, 2020). From 1966 to 2019, we can see the continuous increase in the studies on chatbot technology in Figure 2. "Chatbot" is a combination of the words Chat and Bot (short for "robot") and they are programs that talk to the user over the internet (Clarizia, 2018). Chatbots are a virtual assistant that mimics human speech via text chats and voice commands and can answer a series of user questions with correct answers (Clarizia, 2018; Sreelakshmi, 2019). Since the creation of the first chatbot, Eliza, whose purpose was to study natural language and human-machine communication, in 1966, the use of chatbots has experienced significant growth, and there are estimates indicating that it is increasing (Perez, 2020). Chatbots, which became popular in online chat rooms especially in the 90s, were one of the first examples of automatic program types called "bots". These bots looked for specific patterns of text sent by chat room participants and were tasked with responding with automated actions (Clarizia, 2018). Today, in many platforms that still have the opportunity to chat online, it can be used to follow the words and discourses used by the chatters to warn them and if necessary to remove users from the chat who make inappropriate statements and share content or add fun to the chat by offering various games and entertainment tools in the chat environment. If we look at the most well-known chatbots developed by large companies in the world, used for both industrial solutions and research: Apple Siri, Microsoft Cortana, Facebook M, IBM Watson (Clarizia, 2018), and ChatGPT examples appear.

**Figure 2**

*Search Results for the keywords "chatbot" or "speech agent" or "speech agent" on Scopus (Scopus preview—Scopus—Welcome to Scopus, 2020) from 1966 to 2019* (*Adamopoulou & Moussiades, 2020)*



**How Can Chatbots Be Used in Education?**

Recently, while online learning platforms have been create to support students' learning, there has been an increase in Chatbots used for educational purposes. Chatbot technology can be an effective teaching tool to bridge the gap between technology and education, as it offers students an interactive learning experience, such as one-on-one interaction with the teacher. Benefits of chatbots in education:

- From testing students behavior and monitoring their progress and even checking their homework,
- Developing self-learning skills
- Motivating the student to study by sending notifications and encouraging messages,
- Organizing instruction according to their own learning speed,
- Chatbot also as a social learning resource,
- Dealing with and working with more than one student and group at the same time in multi-student classes (Clarizia, 2018; Sreelakshmi, 2019).

**The Importance of Knowing Scientists in Education**

When a literature review is done about the ideas and thoughts of secondary school students towards scientists, it is seen that the studies have obtained similar results. In a study conducted by Song and Kim (1999) when the scientists measured how many witnesses of Korean students, they found that their knowledge of scientists' work was limited they thought there were no scientists around and they did not feel close to scientists. In the study conducted by Güler and Akman (2006) to determine the opinions of preschool students about scientists it was seen that 32.2% of the students gave the answer "I don't know" to the question "What does a scientist do?" (Özdeş, 2014). Metraux (1957) conducted a study to determine students' perceptions of scientists, and it was determined that they saw scientists as asocial people, far from their families. In the research Balkı (2003) conducted, after asking students the question "What would you do if you were a scientist", it was seen that 49.6% of them answered as "I would explore, invent and invent", and very few (3.9%) answered that they would gather information.

**Research Purpose and Problem**

In this study, it was aimed to develop a three-dimensional audio model that will allow middle school students to chat with Isaac Newton about his life and work. The problem statement of this study was expressed as follows: Is it possible to develop a 3-dimensional, audio Isaac Newton's model to chat with middle school students?

## Method

This study was a Design and Development Research (DDR). DDR is research on the development of products and tools, and studies such as the development, implementation and evaluation of teaching materials, educational software and learning systems to be used in learning and teaching processes can be given as examples of such research. DDR can be used in social sciences research for product (tool, material, etc.) model or process development. However, this method is especially recommended for research in the field of instructional design and technology (Büyüköztürk et al., 2020). The reason why DDR was chosen in this research is that an educational software will be developed, teaching material will be created and then implemented and evaluated.

### Data Collection Instruments

In this study, the model used in a public school with a student group of 65 students. The students who use the model we created didn't have any experience with artificial intelligence education tools. The data obtained by the Newton recognition test was used in the development of the model.

### Newton Recognition Test

Before the use of the model a Newton recognition test before the model being constructed. Before starting the construction of the model, a "Newton Recognition Test" was prepared to determine the students' prior knowledge about Newton. In the Newton recognition test, questions about Newton's biographical information, academic life, theory and laws were asked. While preparing these questions, attention was paid to the age levels of the students and not to stray from the science curriculum. The data from this test were evaluated by content analysis. Content analysis is a method that allows to reach conceptual conclusions by classifying the data (Demirel & Aydın, 2017). As a result of the data received from the students, a "Questions and Answers" pool was created. This pool is loaded into the application after the algorithm is written.

The findings of the Newton Recognition test is given in Table 1 below.

**Table 1.**

*Data from Newton recognition test*

| CATEGORIES | CODES | f | % |
|---|---|---|---|
| Views on who Newton is | He is the one who discovered/proved gravity | 38 | 58.46 |

| | | | |
|---|---|---|---|
| | He is a scientist | 8 | 12.31 |
| | He is a physicist. | 7 | 10.77 |
| | The scientist who discovered the color wheel | 2 | 3.08 |
| | He is the inventor of "Newton" unit of weight/force. | 2 | 3,08 |
| | He's an Astronomer | 1 | 1.54 |
| | He is an inventor | 1 | 1.54 |
| Opinions about the university he studied and worked at | He studied and worked at Oxford University. | 4 | 6.15 |
| | He also studied and worked at Cambridge University. | 1 | 1.54 |
| | He studied and worked at the royal academy. | 6 | 9.23 |
| | I don't know which university he studied and worked at. | 2 | 3.08 |
| | He also studied and worked at the University of Space Sciences. | 1 | 1.54 |
| Views on Newton's scientific theory and laws | He discovered the law of gravity. | 43 | 66.15 |
| Opinions on the scientific fields he works in | He worked in the field of physics. | 43 | 66.15 |
| | He worked in the field of science. | 6 | 9.23 |
| | He worked in the field of chemistry. | 5 | 7.69 |
| | He worked in the field of mathematics. | 4 | 6.15 |

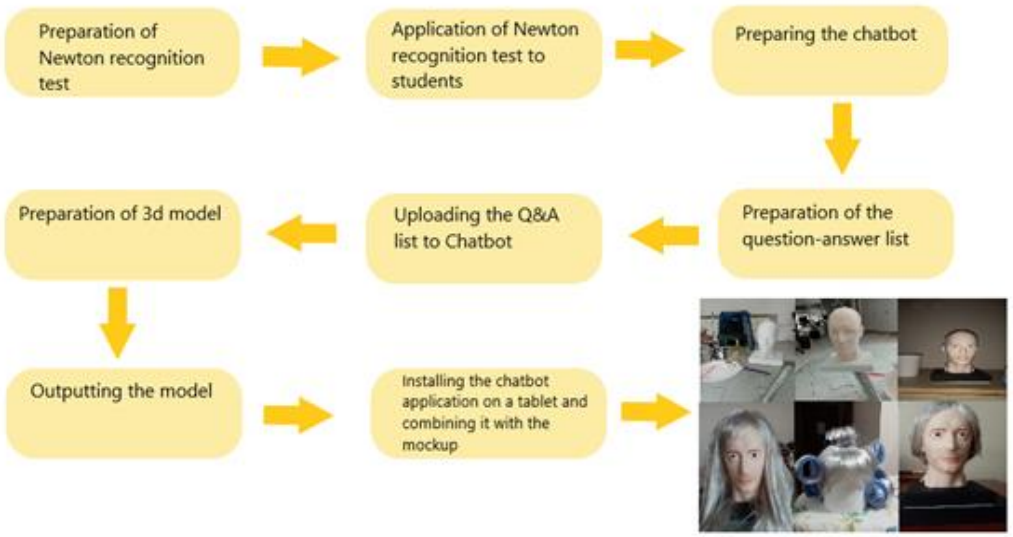
In the table above, the categories and codes, frequency and % values obtained as a result of the analysis of the data obtained by applying the Newton recognition test to the students are presented. According to this, 58% is the person who finds/proves gravity, 12% is a scientist, 10% is a physicist, 3% is a scientist who finds the color wheel, 2% is the inventor of Newton unit, 1% is an astronomer, inventor. 6% of them stated that he worked at Oxford University, 1% at Cambridge University, 9% at the Royal Academy, and 1% at the University of Space Sciences. 3% stated that they did not know which university he studied or worked at. 66% of the students stated that he found the law of gravity. They stated that he worked in physics (66%), science (9%), chemistry (7%), and mathematics (6%).

*Model development stages*

It is divided into 3 parts as algorithm, interface-components and 3D output:

**Figure 3**

*Development of the model*




**Algorithm**

Block coding was prepared using the open source "Mit App Inventor", the algorithm and interface of the chatbot application. The algorithm was developed in a way that analyzes the words of the question asked aloud, as an example in Table 3 and Figure 4, understands what the question is asking from word combinations, chooses the answer from the answer pool and answers it aloud from Newton's model. Although it is possible to understand what the user is typing and what his wishes are, thanks to the use of Natural Language Analysis (NLA) algorithms and techniques. However, there are some issues: it is not possible to match all user requests, and existing Chatbots do not perform remarkably due to the unpredictability of user thinking during a conversation. The correct design of the chat flow plays an important role in the development of the Chatbot. In fact, it is important to deal with all user requests and give correct answers for a successful conversation (Clarizia, 2018). For this reason, a code has been added in the Chatbot, which was developed to prevent students from being unanswered by asking a question that is not attached in the application, which directs the user to google and directs the user to the coding page after the answer to the question is learned, allowing new questions and

answers to be added. Thus, an application that is constantly expanding and renewed is developed.

**Figure 4**

*Example of algorithm created in the model*

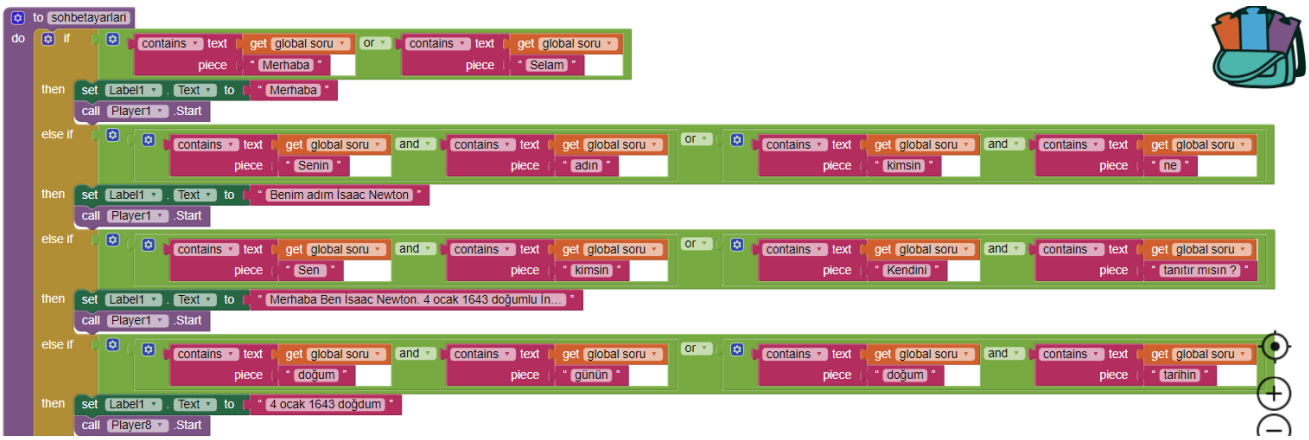



**Table 2.**

*Example of Q&A algorithm*

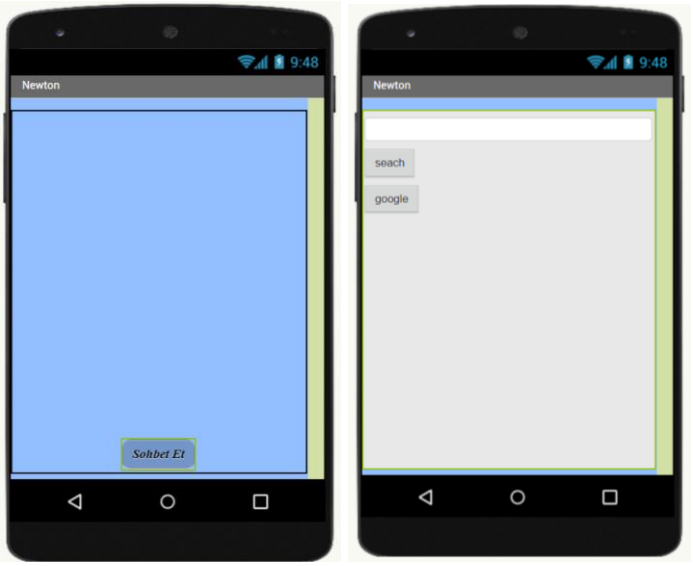
| **Question Example** | **Answer Example** |
|---|---|
| "Your" and "your name" or "Who are you" | My name is Isaac Newton |
| 'where' and 'you were born' or 'hometown' and 'where' or 'where are you from' | I was born in England. |
| "your family" and "your relationship" and "how was" or "family" and "your life" and "how was" or "home" and "your life and" how was it" | My father died while my mother was pregnant with me. I lived with my grandparents because my mom married someone else when I was little. As a child who lost his father before he was born, I could never fully forgive him when my mother left me. In general, my relationships with family and friends have not been very successful throughout my life. |
| "In which" and "areas" and "worked" or "subjects" and "interested" | You know I work on Physics, Mathematics, Astronomy. I was also interested in philosophy and theology. |

**Interface and Components**

When the application is opened, the first thing to do is to enter a blank page with a "Chat" button. When the button is pressed, "Speech Recognizer" starts to work and receives the question asked. Afterwards, if the answer to the question is known, the answer is written on the screen and "Text To Speech" works, the answer is read and the next question is awaited. If the answer to the question is unknown, the "Research" notification appears on the screen and the sound "I couldn't remember the -question-answer, shall we learn the answer together?" You can go to google with the search bot under the notification. Afterwards, when the search is pressed, questions and answers can be added to the coding page that opens on the side tab.

**Figure 5**

*Interface of the model*




**3D model**

First, a suitable unlicensed 3D model was found for 3D model development. Afterwards, by making changes on the 3D model through the "Blender" application (https://www.blender.org/), it was likened to Isaac Newton and made ready for output. The model was printed out by paying a payment to a company. The model was painted with acrylic paint and combined with the application loaded on the tablet. Video of the application in action can be accessed from the link (https://youtu.be/M363EsRgwq0)

**Figure 6**

*Development of the 3D model*

## Results

In the Newton recognition test conducted before the model was developed, it was observed that the students did not know Isaac Newton himself and his works even though they were in the content of the textbooks. During the construction phase of the model, the application was developed as desired. Afterwards, keywords are determined by the algorithm created with block codes, and the answer to the question is written on the screen and read out loud from a middle-aged man's voice. Although we wanted to use the "Text to Speech" plug-in in the MIT app invantor, such as the speech recognizer, which we use for voice reception, the fact that the Turkish language support in the MIT app invantor is a female voice disrupted the conversation with Newton, who was trying to be provided in the application. For this reason, Turkish text to speech was searched for the male voice to be used in the project suitable for the purpose, but could not be found. As a solution, it has been decided that the answers will be voiced by Ahmet Aykul as a volunteer and then uploaded to the answers section. As planned, the application answered questions for which the answer was in the database. If the answer to the question asked is not found in the application, first of all, "Sorry - I could not remember the answer to the question

asked. Shall we learn together?" After the announcement is made audibly, the search button in the form of a notification appears on the screen. The search button directs students to Google. After the research, the application coding page can be opened from the computer or tablet, added and loaded back onto the tablet. Thus, students were provided to enter new information by coding them into the database.

When it comes to the form in which the application answers can be added, work has begun on the three-dimensional model of the model. Although the researcher initially aimed to make the model using the Blender application, organic models-models in which the model was shaped from a virtual clay from the very beginning- were abandoned because they require high dexterity, experience and different design equipment such as drawing tablets and pens. A suitable model was found and taken from the site called "Cgtrader", where there are ready 3d models for people who need 3d design in their projects to use in their projects as "Royalty Free". Minor detail adjustments were made by the researcher through the Blender application so that the image of the 3d model approaches Newton. The model, which is ready for printing, was printed in a company called "3D Printing Workshop" for a fee. Later, the white model was painted by the researcher with the help of the visual arts teaching department in order to make it look realistic. As for the adequacy of the model, inferences were obtained in order to increase the amount of information in it, to develop the sound detection system and to make the model's movement unified.

## Discussion

After the literature review, it was seen that artificial intelligence and chatbots participated in education with a rising momentum and many countries fell on the need to individualize education, carry it to digital life and train students to be both users and producers. Again, when the literature is examined, it is seen that the history of science and scientists are not included in the science curriculum much (Laçin-Şimşek, 2009, 2011; Sarıtaş, 2020) and the emphasis on the history of science and scientists in science programs is very low. (İdin & Yalaki, 2016; Sarıtaş, 2020). It was seen that students have reached the conclusion that over time, they will gain knowledge about scientists, their experiments and which concepts and scientific knowledge they are related to. It has been seen in different studies that not knowing what scientists basically discovered, in which field they work or what their contribution to the formation of scientific knowledge can lead to the fact that the society is far from being scientific in the long term, people are not interested in science and that science is only the work of scientists. (Güven et al., 2022). At the same time, with the historical information presented to them, students were able to recognize the similarity between their own pure ideas and those of scientists (Roach & Wandersee 1995; Stinner & Williams 1993).

As a result of the study, a 3D, audio Isaac Newton model was developed that could chat with the students as it was aimed in the study, and then suggestions for the next studies were presented. In the age we live in, students lead a life intertwined with technology in every aspect of life. It is not possible to exclude education from this technological transformation because technological transformation takes place in every part of the world in educational life. The study resulted in the development of a model that supports this.

**Limitation and Implications**

This model was limited to the pool of questions and answers included in the application. It can turn it into a system where answers are pulled from the internet. It cannot work without internet. Offline use feature can be brought. The application was sometimes not able to perceive the questions asked aloud. In order to eliminate both the sound coming out of the model and this problem, a microphone, headset and speaker can be added to the model. The model can make the face move. It can be arranged to include different scientists.

**Declaration of Interest Statement**

All authors state that there is no conflict of interest in this study.

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**Appendix 1: Questions that can be used for measurement and evaluation activities**

1. Does talking to the model contribute to Newton's teaching of life?
2. Do you become more interested in Newton's life and work after using the model?
3. How to fix problems encountered with a problem while using the application?
4. How can the model be made more interesting?
5. What are the features that should be added or removed from the model?
6. Do you think the model can be used in your lessons?

**Appendix 2: People From The History Of Science And Engineering**

| | |
|---|---|
| Alan Turner (1912-1954) | In 1950 he developed a hypothetical machine called the Turing machine to test and explain machine Intelligence, and launched computer programs that displayed human-like intelligence abilities (Chatterjee & Raunak, 2018). |
| John McCarthy (1927-2011) | The term Artificial Intelligence was coined by John McCarthy in 1956 (Chatterjee & Raunak, 2018). |
| Richard Wallece (1960-) | In 2001 ALICE" artificial intelligence chatbot written by Dr. Richard Wallace from Carnegie University is one of the most famous examples of artificial intelligence (Wallace, 2009). |